STARK COUNTY, OHIO

TECHNICAL SUPPORT DATA NOTEBOOK

U.S. Route 30 and Interstate 77 interchange over West Branch Nimishillen Creek in Canton, Ohio.

SUBMITTED BY: U.S. Geological Survey
Ohio-Kentucky-Indiana Water Science Center

GENERAL DOCUMENTATION

BACKGROUND

Nimishillen Creek and its tributaries have a history of flooding areas of Stark County, Ohio[1]. Discussions between the U.S. Geological Survey (USGS), the Muskingum Watershed Conservancy District (MWCD), and officials from Stark County resulted in the prioritization of tasks and the scope of work for inclusion in this study. A total of 14 stream reaches were identified for this study within Stark County. The stream reaches and existing Flood Insurance Study (FIS) (Federal Emergency Management Agency [FEMA], 2012) information is shown in table 1 below.

Table 1. Study reaches and existing level of study.

Stream Name	Level of Study
Broad-Monter Creek	Detailed and Approximate
Chatham Ditch	Detailed
East Branch Nimishillen Creek	Detailed
Fairhope Ditch	Detailed
Firestone Ditch	Detailed
Hayden Ditch	Detailed and Approximate
Middle Branch Nimishillen Creek	Detailed
Middle Branch Nimishillen Creek Tributary Number 1	Detailed
Nimishillen Creek	Detailed
Reemsnyder Ditch	Detailed
Sherrick Run	Detailed and Approximate
Unnamed Stream	Approximate
West Branch Nimishillen Creek	Detailed and Approximate
Zimber Ditch	Detailed

Scope of Work

A FEMA FIS was recently completed for Stark County (FEMA, 2012). Much of the hydrology for the 14 studied streams was based on Bulletin 45 (Bartlett and Webber, 1976) and was completed several decades ago. This study includes updated hydrology and steady-state hydraulic modeling for the 14 selected reaches using the Hydraulic Engineering Center – River Analysis System (HEC-RAS) (U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2010a-c). The scope of work of each stream can be found below (table 2) and a map of the stream locations is provided in figure 1.

Table 2. Limits of selected reaches for hydraulic models in this study.

[1] Major flooding has occurred in 1913, 1935, 1959, 1969, and 1979 in Stark County.

Stream Name	Downstream Limit	Upstream Limit	Reach Length (miles)
Broad-Monter Creek	Mouth (confluence with East Branch Nimishillen Creek)	Meese Road Northeast	2.1
Chatham Ditch	Mouth (confluence with West Branch Nimishillen Creek)	Laurel Green Drive Northeast	1.0
East Branch Nimishillen Creek	Mouth (confluence with Nimishillen Creek)	50 feet upstream from Meese Road NE	9.0
Fairhope Ditch	Mouth (confluence with East Branch Nimishillen Creek)	Just west of Noel Street	2.9
Firestone Ditch	Mouth (confluence with Middle Branch Nimishillen Creek)	Applegrove Street Northeast	1.3
Hayden Ditch	Mouth (confluence with Sherrick Run)	2,700 feet upstream from State Route 43 (Waynesburg Drive SE)	0.6
Middle Branch Nimishillen Creek	Mouth (confluence with Nimishillen Creek)	Diamond Street Northeast	9.5
Middle Branch Nimishillen Creek Tributary No. 1	Mouth (confluence with Middle Branch Nimishillen Creek)	2,000 feet upstream from South Point Circle	0.7
Nimishillen Creek	CSX Railroad	Confluence of Middle Branch and East Branch Nimishillen Creek	6.9
Reemsnyder Ditch	Mouth (confluence with McDowell Ditch)	Whipple Avenue Northwest	0.9
Sherrick Run	Mouth (confluence with Nimishillen Creek)	0.8 mile upstream from Hayden Ditch	3.9
Unnamed Stream	Mouth (confluence with East Branch Nimishillen Creek)	0.75 mile upstream from farm road	2.2
West Branch Nimishillen Creek	Mouth (confluence with Nimishillen Creek)	Confluence with McDowell Ditch	4.5
Zimber Ditch	Mouth (confluence with McDowell Ditch)	275 feet upstream from Mayfair Road (confluence with Zimber Ditch Tributary 1)	4.2

Note: The stream reach studied has been assigned an alphabetical designation (A – Broad-Monter Creek, B – Chatham Ditch, etc.) that will be reflected throughout the organization of this Technical Support Data Notebook (TSDN). All exhibits pertaining to a particular stream will be labeled using an alphanumeric scheme (for example A-1, A-2; B-1, B-2)

A. Broad-Monter Creek

Broad-Monter Creek flows generally southwest through east central Stark County in the southern half of Louisville, Ohio. The downstream limit of this study is the confluence with East Branch Nimishillen Creek and the upstream limit is Meese Road Northeast. The stream reach is approximately 2.1 miles in length.

B. Chatham Ditch

Chatham Ditch flows generally southeast through north central Stark County in North Canton, Ohio. The downstream limit of this study is the confluence with West Branch Nimishillen Creek and the upstream limit is Laurel Green Drive Northeast. The stream reach is approximately 1.0 mile in length.

C. East Branch Nimishillen Creek

East Branch Nimishillen Creek flows generally southwest through east central Stark County within Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is approximately 50 feet upstream from Meese Road NE. The stream reach is approximately 9.0 miles in length.

D. Fairhope Ditch

Fairhope Ditch flows generally south through central Stark County just west of Fairhope, Ohio. The downstream limit of this study is the confluence with East Branch Nimishillen Creek and the upstream limit is just west of Noel Street. The stream reach is approximately 2.9 miles in length.

E. Firestone Ditch

Firestone Ditch flows generally southeast through north central Stark County just west of Fairhope, Ohio. The downstream limit of this study is the confluence with Middle Branch Nimishillen Creek and the upstream limit is Applegrove Street Northeast. The stream reach is approximately 1.3 miles in length.

F. Hayden Ditch

Hayden Ditch flows generally north through south central Stark County just south of Waco, Ohio. The downstream limit of this study is the confluence with Sherrick Run and the upstream limit is 2,700 feet upstream from State Route 43. The stream reach is approximately 0.6 mile in length.

G. Middle Branch Nimishillen Creek

Middle Branch Nimishillen Creek flows generally south through central Stark County through Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is Diamond Street Northeast. The stream reach is approximately 9.5 miles in length.

H. Middle Branch Nimishillen Creek Tributary Number 1

Middle Branch Nimishillen Creek Tributary 1 flows generally south through central Stark County through Canton, Ohio. The downstream limit of this study is the confluence with Middle Branch Nimishillen Creek and the upstream limit is approximately 2,000 feet upstream from South Point Circle. The stream reach is approximately 0.7 mile in length.

I. Nimishillen Creek

Nimishillen Creek flows generally south through central Stark County through Canton, Ohio. The downstream limit of this study is the CSX Railroad and the upstream limit is the confluence of Middle Branch and East Branch Nimishillen Creek. The stream reach is approximately 6.9 miles in length.

J. Reemsnyder Ditch

Reemsnyder Ditch flows generally southeast through west central Stark County within Canton, Ohio. The downstream limit of this study is the confluence with McDowell Ditch and the upstream limit is Whipple Avenue Northwest. The stream reach is approximately 0.9 mile in length.

K. Sherrick Run

Sherrick Run flows generally west through central Stark County in and near Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is approximately 0.8 mile upstream from the confluence of Hayden Ditch. The stream reach is approximately 3.9 miles in length.

L. Unnamed Stream

Unnamed Stream flows generally south through east central Stark County in and near Louisville, Ohio. The downstream limit of this study is the confluence with East Branch Nimishillen Creek and the upstream limit is approximately 0.2 mile downstream from U.S Route 62. The stream reach is approximately 2.2 miles in length.

M. West Branch Nimishillen Creek

West Branch Nimishillen Creek flows generally south through central Stark County in Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is the confluence of McDowell Ditch. The stream reach is approximately 4.5 miles in length.

N. Zimber Ditch

Zimber Ditch flows generally south through north central Stark County in and near North Canton, Ohio. The downstream limit of this study is the confluence with McDowell Ditch and the upstream limit is approximately 275 feet upstream from Mayfair Road. The stream reach is approximately 4.2 miles in length.

Special Problem Report

Not applicable.

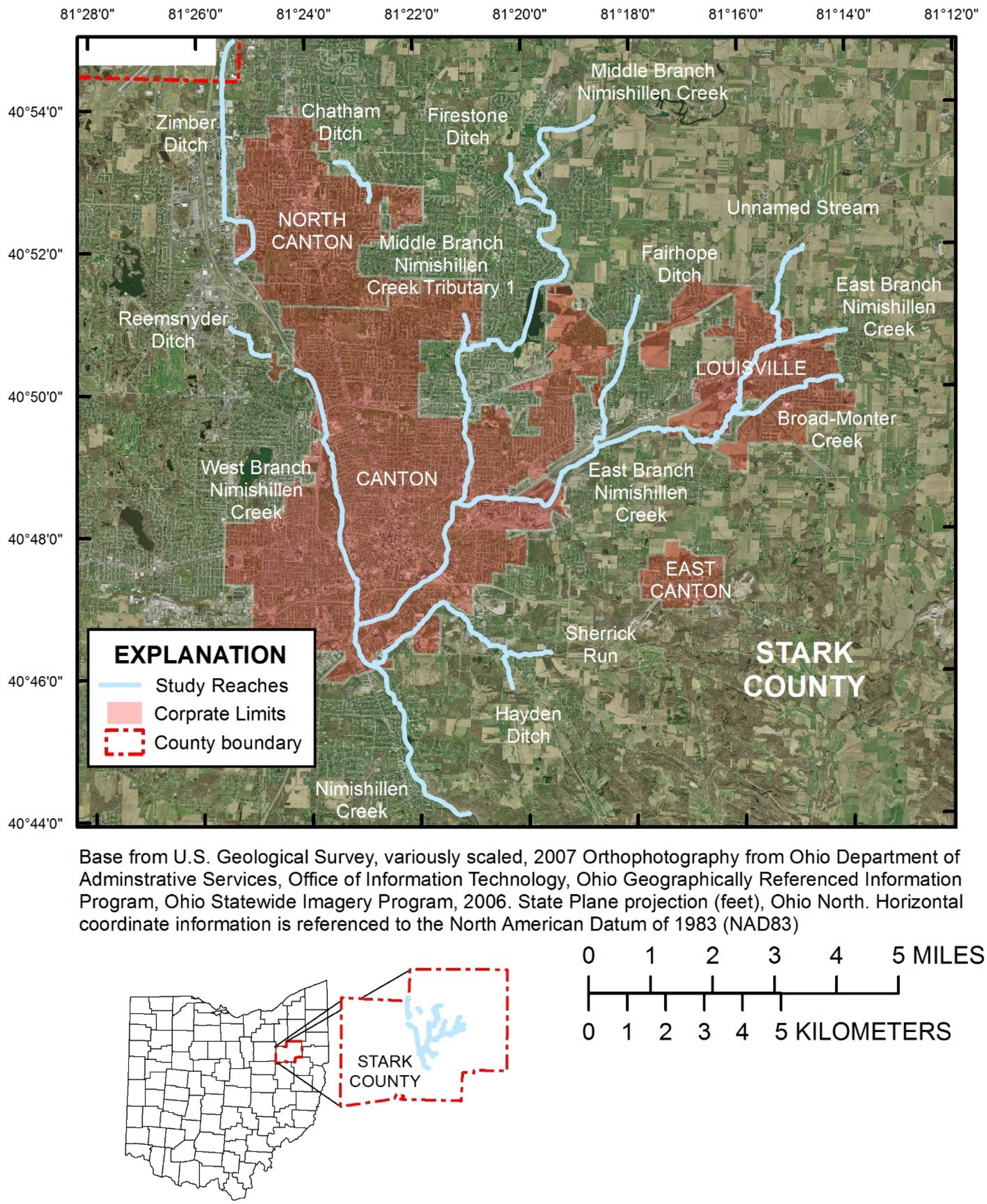

Figure 1. Map depicting the locations of the 14 study reaches in Stark County, Ohio.

ENGINEERING ANALYSES

HYDROLOGIC ANALYSES

This FIS was conducted by the USGS in cooperation with the Muskingum Watershed Conservancy District (MWCD) and Stark County, Ohio officials. Flood profiles were estimated for the 14 study reaches in table 1. Estimates for the 10-, 4-, 2-, 1-, "1+"[2], and 0.2-percent annual exceedance probability flood-peak streamflows, reported in cubic feet per second (ft^3/s), were determined at various locations along the streams for this study. The paragraphs following describe the hydrologic analyses used in estimating these peak streamflows.

Regression Estimates

Initial estimates of the 10-, 4-, 2-, 1-, "1+"-, and 0.2-percent annual-exceedance probability flood-peak streamflows for all streams were estimated with regression equations using StreamStats (Koltun and others, 2006). The StreamStats application uses: (1) drainage area in square miles, (2) main channel slope characteristic in feet per mile, and (3) storage area in percent of drainage area. StreamStats determines drainage-basin boundaries by use of digital elevation data. The equations used to estimate streamflow statistics for ungaged sites were developed through a process known as regionalization. This process involves use of regression analysis to relate streamflow statistics computed for a group of selected streamgaging stations (usually within a state) to basin characteristics measured for the stations (Koltun and others, 2006).

The StreamStats prediction error for the 1-percent annual-exceedance probability flood-peak streamflows for these streams is 38%. Therefore, the "1+"-percent annual-exceedance probability flood-peak streamflows were computed by multiplying the 1-percent annual-exceedance probability flood-peak streamflows by 1.38. A summary of variables used in the regression equations, as well as the initial estimates of flood-peak streamflows are given in table 3.

[2] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

Table 3. Summary of basin characteristics and the initial estimates of flood-peak streamflow for the 10-, 4-, 2-, 1-, “1+”-, and 0.2-percent annual exceedance probability floods for the studied stream reaches. Dark gray shaded values indicate data from the 2012 effective Flood Insurance Study. Light gray values indicate data calculated for this study not included in the 2012 effective FIS. Bold values indicate the locations of U.S. Geological Survey streamgages.
[US, upstream; DS, downstream; SW, southwest]

Location	Drainage area, square miles	Channel slope, feet per mile	% of Basin classified as water or wetlands	Flood-peak streamflow estimate (cubic feet per second) for indicated annual-exceedance probability, in percent					
				10	4	2	1	“1+”	0.2
Broad-Monter Creek									
At Broad Street	1.09	47.1	1.69	158	200	230	259	357	324
At abandoned railroad	1.65	45.4	1.16	227	289	332	375	518	471
At mouth	2.20	43.5	0.96	288	365	420	475	656	597
Chatham Ditch									
At mouth	1.15	19.6	1.69	139	173	197	220	304	271
East Branch Nimishillen Creek									
At Nickel Plate Street	9.29	20.4	0.57	788	985	1,130	1,270	1,750	1,570
US from Tributary 2	9.40	26.5	0.55	838	1,050	1,200	1,350	1,850	1,680
US from North Chapel Creek	15.0	24.9	0.65	1,160	1,450	1,650	1,850	2,540	2,300
US from Broad-Monter Creek	19.3	23.4	0.66	1,380	1,720	1,960	2,200	3,020	2,720
US from Unnamed Tributary	21.9	21.2	0.73	1,480	1,830	2,080	2,340	3,200	2,880
At SW Louisville corporate limit	32.6	18.7	0.87	1,900	2,350	2,660	2,980	4,090	3,660
At Trump Avenue	42.7	12.5	0.96	2,170	2,660	3,010	3,360	4,640	4,110
US from Middle Branch Nimishillen Creek	46.5	12.4	1.09	2,270	2,780	3,140	3,510	4,840	4,280
Fairhope Ditch									
At State Route 62	1.99	56.0	0.30	310	399	463	527	727	670
At mouth	3.90	28.9	0.97	411	516	591	665	918	829
Firestone Ditch									
At mouth	2.58	25.6	2.54	253	314	356	398	549	489
Hayden Ditch									
At mouth	2.42	24.8	1.56	260	324	370	414	571	512
Middle Branch Nimishillen Creek									
US from Firestone Ditch	28.5	3.75	4.54	973	1,140	1,260	1,380	1,900	1,610
At 55th street	37.1	4.45	3.98	1,260	1,490	1,650	1,800	2,480	2,130

At USGS streamgage (03118000)	**43.3**	**4.79**	**4.17**	**1,430**	**1,680**	**1,860**	**2,040**	**2,820**	**2,410**
US from East Branch Nimishillen Creek	46.6	5.76	3.97	1,580	1,870	2,080	2,280	3,150	2,700
Middle Branch Nimishillen Creek Tributary Number 1									
At mouth	3.25	28.9	1.87	325	406	463	519	716	641
Nimishillen Creek									
US from West Branch Nimishillen Creek	97.9	5.57	2.46	3,020	3,600	4,010	4,410	6,090	5,250
US from Hurford Run	145	5.50	2.64	4,020	4,770	5,300	5,830	8,050	6,930
US from Sherrick Run	157	5.53	2.57	4,290	5,100	5,670	6,240	8,610	7,420
At USGS streamgage (03118500)	**172**	**6.16**	**2.56**	**4,700**	**5,590**	**6,230**	**6,860**	**9,470**	**8,170**
350 feet DS from CSX railroad	175	6.71	2.56	4,840	5,770	6,430	7,090	9,780	8,460
Reemsnyder Ditch									
DS from Whipple Ave NW	3.34	10.6	4.15	237	286	320	353	487	424
At mouth	3.69	9.62	4.41	247	298	333	367	506	439
Sherrick Run									
US from Hayden Run	4.61	42.7	2.51	435	544	621	697	962	865
US from east tributary (DS from State Route 43)	7.21	32.2	2.23	591	735	837	939	1,300	1,160
US from north tributary (US from Warner Road)	8.66	23.9	2.46	631	779	883	986	1,360	1,210
At mouth	10.4	16.8	2.44	679	832	939	1,050	1,450	1,270
Unnamed Stream									
At mouth	5.29	31.6	0.82	538	677	777	876	1,210	1,090
West Branch Nimishillen Creek									
US from State Route 62	38.6	12.2	2.65	1,710	2,070	2,320	2,570	3,550	3,110
At mouth	46.6	10.9	2.99	1,880	2,270	2,550	2,820	3,890	3,390
Zimber Ditch									
At Mount Pleasant Street	5.46	36.0	3.51	449	557	632	707	976	871
At Portage Street	7.63	23.9	2.76	561	692	783	874	1,210	1,070
At Whipple Avenue	10.3	21.8	3.03	680	835	945	1,050	1,450	1,280
At Mouth	12.3	18.3	2.60	775	950	1,070	1,190	1,640	1,460

For Nimishillen Creek and Middle Branch Nimishillen Creek, the initial regression estimates were adjusted to consider data from the streamgages Nimishillen Creek at North Industry, Ohio (03118500) and Middle Branch Nimishillen Creek at Canton, Ohio (03118000), respectively. The Nimishillen Creek gage has been in operation since 1921, while the Middle Branch Nimishillen Creek gage has operated since 1941. The initial regression estimates for these streams were adjusted using a gage weighting ratio technique provided in Koltun and others (2006). For the “1-percent plus” flood, the ratio was assumed to be the same as the 1- percent annual exceedance probability flood.

The 2012 effective FIS reported urbanized estimates of flood-peak streamflow for Broad-Monter Creek. This restudy also employed the use of the same urbanization techniques. The regression estimates for Broad-Monter Creek were urbanized using techniques outlined in Sauer and others (1983). The gage weighting data and the urbanization data used to adjust the initial regression estimates are given in tables 4 and 5, respectively. Final estimates of flood-peak streamflow for all streams are given in table 6.

Table 4. Peak-flood streamflow estimates for the 10-, 2-, 1-, and 0.2-percent annual exceedance probability floods for selected locations as reported in Koltun and others (2006). The weighting ratio is equal to the weighted regression estimate divided by the regression estimate.

Location	Drainage area, square miles	Peak discharge estimate (cubic feet per second) for indicated annual-exceedance probability, in percent					Estimate type
		10	4	2	1	0.2	
Nimishillen Creek at North Industry, Ohio (03118500)	175	5,260	6,330	7,130	7,930	9,820	Log Pearson Type III
		4,830	5,770	6,430	7,070	8,470	Regression
		5,240	6,300	7,080	7,870	9,720	Weighted Regression
		1.085	1.085	1.092	1.113	1.148	Ratio
Middle Branch Nimishillen Creek at Canton, Ohio (03118000)	43.1	1,170	1,500	1,780	2,080	2,890	Log Pearson Type III
		1,420	1,670	1,850	2,020	2,390	Regression
		1,180	1,510	1,780	2,070	2,840	Weighted Regression
		0.831	0.904	0.962	1.025	1.188	Ratio

Table 5. Basin development factor estimates (as described in Sauer and others, 1983) used to urbanize the initial estimates of flood-peak streamflow for Broad-Monter Creek.

Location along Broad-Monter Creek	Basin Development Factor
At Broad Street	6
At abandoned railroad	6
At mouth	3

Table 6. Summary of the final estimates of flood-peak streamflow for the 10-, 4-, 2-, 1-, "1+"-, and 0.2-percent annual exceedance probability floods for the studied stream reaches. Light gray shaded values indicate data from the 2012 effective Flood Insurance Study. Dark gray values indicate data calculated for this study not included in the 2012 effective FIS. Bold values indicate the locations of U.S. Geological Survey streamgages.
[US, upstream; DS, downstream]

Location	Flood-peak streamflow estimate (cubic feet per second) for indicated annual-exceedance probability, in percent					
	10	4	2	1	"1+"	0.2
Broad-Monter Creek						
At Broad Street	230	279	319	356	463	434
At abandoned railroad	372	449	512	575	749	702
At mouth	470	565	647	728	949	893
Chatham Ditch						
At mouth	139	173	197	220	304	271
East Branch Nimishillen Creek						
Nickel Plate Street	788	985	1,130	1,270	1,750	1,570
US from Tributary 2	838	1,050	1,200	1,350	1,850	1,680
US from North Chapel Creek	1,160	1,450	1,650	1,850	2,540	2,300
US from Broad-Monter Creek	1,380	1,720	1,960	2,200	3,020	2,720
US from Unnamed Tributary	1,480	1,830	2,080	2,340	3,200	2,880
At SW Louisville corporate limit	1,900	2,350	2,660	2,980	4,090	3,660
At Trump Avenue	2,170	2,660	3,010	3,360	4,640	4,110
US from Middle Branch Nimishillen Creek	2,270	2,780	3,140	3,510	4,840	4,280
Fairhope Ditch						
At State Route 62	310	399	463	527	727	670
At mouth	411	516	591	665	918	829
Firestone Ditch						
At mouth	253	314	356	398	549	489
Hayden Ditch						
At mouth	260	324	370	414	571	512
Middle Branch Nimishillen Creek						
US from Firestone Ditch	921	1,110	1,240	1,390	1,920	1,710
At 55th street	1,110	1,390	1,610	1,830	2,530	2,420
At USGS streamgage station (03118000)	**1,190**	**1,520**	**1,790**	**2,090**	**2,880**	**2,860**
US from East Branch Nimishillen Creek	1,350	1,720	2,010	2,330	3,210	3,130
Middle Branch Nimishillen Creek Tributary Number 1						

At mouth	325	406	463	519	716	641
Nimishillen Creek						
US from West Branch Nimishillen Creek	3,060	3,640	4,060	4,480	6,180	5,360
US from Hurford Run	4,250	5,050	5,630	6,280	8,670	7,630
US from Sherrick Run	4,590	5,460	6,100	6,820	9,420	8,320
At USGS gaging station (03118500)	**5,100**	**6,060**	**6,800**	**7,640**	**10,500**	**9,380**
350 feet DS from CSX railroad	5,250	6,260	7,020	7,890	10,900	9,710
Reemsnyder Ditch						
DS from Whipple Ave NW	237	286	320	353	487	424
Mouth	247	298	333	367	506	439
Sherrick Run						
US from Hayden Run	435	544	621	697	962	865
US from east tributary (DS from SR43)	591	735	837	939	1,300	1,160
US from north tributary (US from Warner Road)	631	779	883	986	1,360	1,210
At mouth	679	832	939	1,050	1,450	1,270
Unnamed Stream						
At mouth	538	677	777	876	1,210	1,090
West Branch Nimishillen Creek						
US from State Route 62	1,710	2,070	2,320	2,570	3,550	3,110
At mouth	1,880	2,270	2,550	2,820	3,890	3,390
Zimber Ditch						
At Mount Pleasant Street	449	557	632	707	976	871
At Portage Street	561	692	783	874	1,210	1,070
At Whipple Avenue	680	835	945	1,050	1,450	1,280
At Mouth	775	950	1,070	1,190	1,640	1,460

HYDRAULIC ANALYSES

HEC-RAS (version 4.1.0; U.S. Army Corps of Engineers, 2010a, 2010b, 2010c), using the conveyance computations option set to breaks in *n* values (Manning's roughness coefficient) only, was used to model flood profiles for all streams analyzed in this study. 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 (using techniques such as adding cross sections and adjusting ineffective flow areas), 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 7 shows the models used and the model analysis date for each stream submitted in this study.

Table 7. Hydraulic model used for each stream and model analysis date.

Flooding Source	Hydraulic Model Used	Model Analysis Date
Broad-Monter Creek	HEC-RAS 4.1.0	13 Feb 2019
Chatham Ditch	HEC-RAS 4.1.0	11 Feb 2019
East Branch Nimishillen Creek	HEC-RAS 4.1.0	29 Jul 2019
Fairhope Ditch	HEC-RAS 4.1.0	13 Feb 2019
Firestone Ditch	HEC-RAS 4.1.0	29 Jul 2019
Hayden Ditch	HEC-RAS 4.1.0	11 Feb 2019
Middle Branch Nimishillen Creek	HEC-RAS 4.1.0	12 Feb 2019
Middle Branch Nimishillen Creek Tributary Number 1	HEC-RAS 4.1.0	11 Feb 2019
Nimishillen Creek	HEC-RAS 4.1.0	30 Jul 2019
Reemsnyder Ditch	HEC-RAS 4.1.0	11 Feb 2019
Sherrick Run	HEC-RAS 4.1.0	11 Feb 2019
Unnamed Stream	HEC-RAS 4.1.0	10 Jul 2019
West Branch Nimishillen Creek	HEC-RAS 4.1.0	30 Jul 2019
Zimber Ditch	HEC-RAS 4.1.0	29 Jul 2019

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 foot of the low chord elevation of a bridge.

The standard-step method (energy equation) is applicable to a wide range of hydraulic problems (U.S. Army Corps of Engineers, 2010c). 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, 2010a). The HEC-RAS model uses a default maximum submergence ratio of 0.95 for weir flow calculations. The HEC-RAS Applications Guide (U.S. Army Corps of Engineers, 2010a, p. 3-10) 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.

A. Broad-Monter Creek

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[3], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Broad-Monter Creek flows generally southwest through east central Stark County in the southern half of Louisville, Ohio. The downstream limit of this study is the confluence with East Branch Nimishillen Creek and the upstream limit is Meese Road Northeast. The stream reach is approximately 2.1 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with East Branch Nimishillen Creek).

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

The USGS surveyed 50 cross sections at 12 hydraulic structures and 2 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 99 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.00435 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 392 and 1,609. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,091.53 feet was

[3] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 392) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.030 to 0.050 for the main channel, and from 0.044 to 0.056 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 107 feet.

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 (energy equation based or based 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 A1 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 1-percent annual exceedance probability flood profile.

Table A1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
1,723	State Route 44 (Ravenna Road)	Bridge	No	Energy
2,885	South Chapel Street	Bridge	No	Energy
3,032	High school driveway	Culvert	No	Energy
3,387	Nickel Plate Trail (old railroad)	Culvert	No	Energy
4,033	Private driveway	Bridge	Yes	Pressure/Weir
4,138	5th Street	Bridge	Yes	Pressure/Weir
5,459	South Street	Culvert	Yes	Energy
5,718	Private driveway	Bridge	Yes	Energy
6,166	Nickel Plate Road	Culvert	No	Energy
7,784	East Broad Street	Culvert	Yes	Energy
9,787	Private driveway	Culvert	No	Energy
10,363	Brookfield Street	Culvert	No	Pressure/Weir

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Broad-Monter Creek is subject to backwater from East Branch Nimishillen Creek. A backwater elevation of 1,092.86 feet was taken from cross section 32,701 of the 100-year flood-profile model of East Branch Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 718 (water-surface elevation equal to 1,092.82 feet) of Broad-Monter Creek. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Broad-Monter Creek.

B. Chatham Ditch

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[4], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Chatham Ditch flows generally southeast through north central Stark County in North Canton, Ohio. The downstream limit of this study is the confluence with West Branch Nimishillen Creek and the upstream limit is Laurel Green Drive Northeast. The stream reach is approximately 1.0 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with West Branch Nimishillen Creek).

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

The USGS surveyed 10 cross sections at 2 hydraulic structures and 2 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 35 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all 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 was obtained by means of a slope-conveyance calculation. A slope of 0.005 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 2,139 and 3,633. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1088.89 feet was

[4] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 1,017) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.040 to 0.042 for the main channel and were set to 0.05 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in the GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are, on average 128 feet.

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 (energy equation based or based 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 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 1-percent annual exceedance probability flood profile.

Table B1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
2,315	Marquardt Avenue	Culvert	No	Energy
3,812	Laurel Green Drive NE	Culvert	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Chatham Ditch is subject to backwater from West Branch Nimishillen Creek. A backwater elevation of 1,087.92 feet was obtained from cross section 21,865.48 of the 100-year flood-profile model of West Branch Nimishillen Creek from the 2012 FIS (Federal Emergency Management Agency, 2012). This backwater elevation will end before the first modeled cross section for Chatham Ditch (cross section 1,017 (water-surface elevation equal to 1,088.89 feet). As a result, the backwater elevation will not be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Chatham Ditch.

C. East Branch Nimishillen Creek

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[5], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

East Branch Nimishillen Creek flows generally southwest through east central Stark County within Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is approximately 50 feet upstream from Meese Road NE. This study incorporates an approximately 4.0-mile reach of East Branch Nimishillen Creek that was included in the 2012 FIS. The stream reach is approximately 9.0 miles in length.

Hydraulic Baseline

The 2012 FIS study reach of East Branch Nimishillen Creek followed previous work and was referenced to feet above the mouth of Nimishillen Creek - a point over 19 miles downstream on a different stream. Referencing a tributary's stationing to the mouth of its receiving stream does not make logical sense. Therefore, the stationing used for the hydraulic baseline for this study reach is referenced to feet upstream from the mouth (confluence of East Branch Nimishillen Creek with Middle Branch Nimishillen Creek – which combine to form Nimishillen Creek).

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

The USGS surveyed 89 cross sections at 23 hydraulic structures and 6 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 214 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

---

[5] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0021 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 195 and 811. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,037.66 feet was determined at the initial section (river station 195) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.038 to 0.050 for the main channel, and from 0.040 to 0.150 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 225 feet.

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 (energy equation based or based 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 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 1-percent annual exceedance probability flood profile.

Table C1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.
[N/A, not applicable]

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
721	Walkway bridge	Bridge	No	Energy
1,748	Beldon Road	Bridge	No	Energy
2,287	Low head dam	Dam	N/A	Energy
4,519	Norfolk and Southern Railroad	Bridge	No	Energy
5,251	Republic Steel railroad	Bridge	No	Energy
5,306	Republic Steel railroad	Bridge	No	Energy

5,740	Republic Steel railroad / driveway	Bridge	No	Energy
5,767	Low Head Dam	Dam	N/A	Energy
10,402	Private road	Bridge	No	Energy
10,511	Trump Avenue NE	Bridge	No	Energy
11,539	Norfolk and Southern Railroad	Bridge	No	Energy
14,644	Norfolk and Southern Railroad	Bridge	No	Energy
17,600	Low head dam	Dam	N/A	Energy
19,025	Broadway Avenue NE	Bridge	No	Energy
23,198	Beck Avenue	Bridge	Yes	Energy
27,296	Energy Drive	Bridge	No	Energy
34,804	Access road	Bridge	No	Energy
35,059	Norfolk and Southern Railroad	Bridge	No	Energy
36,201	State Route 153 (West Main Street)	Bridge	No	Energy
36,274	Norfolk and Southern Railroad	Bridge	Yes	Energy
38,799	SR 44 (North Chapel Street)	Bridge	No	Energy
42,681	North Nickel Plate Street	Bridge	No	Energy
47,436	Meese Road NE	Culvert	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

East Branch Nimishillen Creek is subject to backwater from Nimishillen Creek. A backwater elevation of 1,038.25 feet was obtained from cross section 79,589 of the 100-year flood-profile model of Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 195 (water-surface elevation equal to 1,038.16 feet) of East Branch Nimishillen Creek. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for East Branch Nimishillen Creek.

D. Fairhope Ditch

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[6], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Fairhope Ditch flows generally south through central Stark County just west of Fairhope, Ohio. The downstream limit of this study is the confluence with East Branch Nimishillen Creek and the upstream limit is just west of Noel Street. The stream reach is approximately 2.9 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with East Branch Nimishillen Creek).

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

The USGS surveyed 47 cross sections at 11 hydraulic structures and 3 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 86 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0026 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 24 and 408. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,067.98 feet was determined at the initial section (river station 24) for the 1-percent annual exceedance probability flood profile.

---

[6] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

Manning's Roughness Coefficients

Manning's roughness coefficients (n) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.040 to 0.042 for the main channel, and from 0.050 to 0.054 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 180 feet.

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 (energy equation based or based 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 D1 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 1-percent annual exceedance probability flood profile.

Table D1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
382	Norfolk and Southern Railroad	Culvert	No	Energy
813	Norfolk and Southern Railroad	Culvert	No	Energy
3,922	State Route 153 (Louisville St NE)	Culvert	No	Energy
7,427	Private driveway	Culvert	Yes	Energy
8,182	Lesh Street NE	Culvert	No	Energy
8,874	Willis Street NE	Culvert	No	Energy
9,570	Peach Street NE	Culvert	No	Energy
10,948	Francesca Street NE	Culvert	Yes	Energy
10,967	US Route 62 (Atlantic Blvd NE)	Culvert	No	Energy
11,658	Private driveway	Bridge	Yes	Energy
12,897	Broadview Street NE	Culvert	Yes	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Fairhope Ditch is subject to backwater from East Branch Nimishillen Creek. A backwater elevation of 1,069.00 feet was interpolated between cross sections 15,107 and 15,300 of the 100-year flood-profile model of East Branch Nimishillen Creek included in this study. This backwater elevation will be in effect up through cross section 24 (water-surface elevation equal to 1,068.08 feet) of Fairhope Ditch. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Fairhope Ditch.

E. Firestone Ditch

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, “1+”-[7], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Firestone Ditch flows generally southeast through north central Stark County just west of Fairhope, Ohio. The downstream limit of this study is the confluence with Middle Branch Nimishillen Creek and the upstream limit is Applegrove Street Northeast. The stream reach is approximately 1.3 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with Middle Branch Nimishillen Creek).

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

The USGS surveyed 35 cross sections at 7 hydraulic structures and 4 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 52 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0024 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 23 and 434. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,073.83 feet was

[7] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 23) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Manning's roughness coefficients were set to 0.042 for the main channel and 0.050 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 134 feet.

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 (energy equation based or based 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 E1 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 1-percent annual exceedance probability flood profile.

Table E1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.
[N/A, not applicable]

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
542	Weir	Dam	N/A	Energy
1,786	Amsel Avenue NE	Culvert	No	Energy
2,050	Private walkway	Bridge	No	Energy
2,355	Middlebranch Avenue NE	Culvert	No	Energy
2,517	Private walkway	Bridge	No	Energy
2,803	Aspen Street NE	Culvert	No	Energy
3,841	Wheeling and Lake Erie Railroad	Culvert	No	Energy
4,377	Firestone Avenue NE	Culvert	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Firestone Ditch is subject to backwater from Middle Branch Nimishillen Creek. A backwater elevation of 1,077.50 feet was interpolated between cross sections 36,578 and 36,851 of the 100-year flood-profile model of Middle Branch Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 538 (water-surface elevation equal to 1,075.14) of Firestone Ditch. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Firestone Ditch.

F. Hayden Ditch

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[8], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Hayden Ditch flows generally north through south central Stark County just south of Waco, Ohio. The downstream limit of this study is the confluence with Sherrick Run and the upstream limit is 2,700 feet upstream from State Route 43. The stream reach is approximately 0.6 mile in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with Sherrick Run).

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

The USGS surveyed 10 cross sections at 2 hydraulic structures and 3 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 21 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0014 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 223 and 2,618. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,051.54 feet was

---

[8] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 223) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Manning's roughness coefficients were set to 0.040 for the main channel and 0.050 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 142 feet.

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 (energy equation based or based 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 F1 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 1-percent annual exceedance probability flood profile.

Table F1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
584	State Route 43 (Waynesburg Drive SE)	Culvert	No	Energy
2,666	Farm road	Culvert	Yes	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Hayden Ditch is subject to backwater from Sherrick Run. A backwater elevation of 1,049.92 feet was taken from cross section 16,450 of the 100-year flood-profile model of Sherrick Run included as part of this study. This backwater elevation will end before the first modeled cross section for Hayden Ditch (cross section 223 (water-surface elevation equal to 1,051.54 feet). As a result, the backwater elevation will not be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Hayden Ditch.

G. Middle Branch Nimishillen Creek

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[9], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Middle Branch Nimishillen Creek flows generally south through central Stark County through Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is Diamond Street Northeast. The stream reach is approximately 9.5 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence of East Branch Nimishillen Creek with Middle Branch Nimishillen Creek – which combine to form Nimishillen Creek).

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

The USGS surveyed 81 cross sections at 20 hydraulic structures and 7 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 211 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0016 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 260 and 1,240. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,036.21 feet was

[9] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 120) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.038 to 0.044 for the main channel, and from 0.046 to 0.056 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 238 feet.

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 (energy equation based or based 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 G1 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 1-percent annual exceedance probability flood profile.

Table G1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.
[N/A, not applicable]

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
192	Walkway bridge	Bridge	No	Energy
237	Low head dam	Dam	N/A	Energy
709	State Route 153 (Mahoning Road NE)	Bridge	No	Energy
1,347	Low head dam	Dam	N/A	Energy
1,607	Private driveway	Bridge	No	Energy
2,478	Union Metal Corporation building	Bridge	No	Energy
2,819	Private driveway	Bridge	No	Energy
4,410	19^{th} Street NE	Bridge	No	Energy
5,830	Wheeling and Lake Erie Railroad	Bridge	No	Energy
8,340	Spangler Street NE	Bridge	No	Energy
9,183	U.S. Route 62	Bridge	No	Energy
13,606	Martindale Road NE	Bridge	No	Energy
14,576	Middle Branch Trail walkway	Bridge	Yes	Energy
14,980	Wheeling and Lake Erie Railroad	Bridge	No	Energy

17,645	Private driveway	Multiple Opening	Yes	Energy
17,691	Private dam	Dam	N/A	Energy
18,076	Middle Branch Avenue NE	Bridge	No	Energy
26,286	55th Street NE	Bridge	No	Energy
35,208	Easton Street NE	Bridge	No	Energy
42,600	Applegrove Street	Bridge	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Middle Branch Nimishillen Creek is subject to backwater from Nimishillen Creek. A backwater elevation of 1,038.25 feet was obtained from cross section 79,589 of the 100-year flood-profile model of Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 714 (water-surface elevation equal to 1,038.22 feet) of Middle Branch Nimishillen Creek. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Middle Branch Nimishillen Creek.

H. Middle Branch Nimishillen Creek Tributary Number 1

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[10], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Middle Branch Nimishillen Creek Tributary 1 flows generally south through central Stark County through Canton, Ohio. The downstream limit of this study is the confluence with Middle Branch Nimishillen Creek and the upstream limit is approximately 2,000 feet upstream from South Point Circle. The stream reach is approximately 0.7 mile in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with Middle Branch Nimishillen Creek).

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

The USGS surveyed 6 cross sections at 1 hydraulic structure and 2 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 21 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0034 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 38 and 1,487. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,050.99 feet was

[10] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 38) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.042 to 0.048 for the main channel, and from 0.052 to 0.068 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 187 feet.

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 (energy equation based or based 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 H1 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 1-percent annual exceedance probability flood profile.

Table H1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
1,584	South Pointe Circle	Bridge	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Middle Branch Nimishillen Creek Tributary Number 1 is subject to backwater from Middle Branch Nimishillen Creek. A backwater elevation of 1,055.62 feet was obtained from cross sections 14,288 and 14,495 of the 100-year flood-profile model of Middle Branch Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 1,147 (water-surface elevation equal to 1,055.06 feet) of Middle Branch Nimishillen Creek Tributary Number 1. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Middle Branch Nimishillen Creek Tributary Number 1.

I. Nimishillen Creek

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, “1+”-[11], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Nimishillen Creek flows generally south through central Stark County through Canton, Ohio. The downstream limit of this study is the CSX Railroad and the upstream limit is the confluence of Middle Branch and East Branch Nimishillen Creek. The stream reach is approximately 6.9 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with Sandy Creek).

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

The USGS surveyed 93 cross sections at 23 hydraulics structures and 5 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 172 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0015 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 43,048 and 43,323. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 980.87 feet was

[11] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 43,048) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.034 to 0.040 for the main channel, and from 0.046 to 0.050 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 214 feet.

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 (energy equation based or based 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 I1 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 1-percent annual exceedance probability flood profile.

Table I1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
43,382	CSX Railroad	Bridge	No	Energy
44,240	Cheyenne Street SE	Bridge	No	Energy
47,819	Baum Street SE	Bridge	No	Energy
51,855	Faircrest Street SE	Bridge	No	Energy
60,064	Mill Street SE	Bridge	No	Energy
62,781	Interstate 77	Bridge	No	Energy
65,049	Kimball Road SE	Bridge	No	Energy
65,910	Interstate 77	Bridge	No	Energy
66,196	CSX Railroad	Bridge	No	Energy
66,390	Allen Avenue SE	Bridge	No	Energy
69,039	Cherry Avenue SE	Bridge	No	Energy
71,247	11th Street SE	Bridge	No	Energy
72,759	Abandoned railroad	Bridge	No	Energy
73,045	Wheeling and Lake Erie Railroad	Bridge	No	Energy
73,881	4th Street SE	Bridge	No	Energy

74,265	3rd Street SE	Bridge	No	Energy
74,829	State Route 172 (Tuscarawas Street E)	Bridge	No	Energy
75,345	3rd Street NE	Bridge	No	Energy
75,962	5th Street NE	Bridge	No	Energy
76,253	6th Street NE	Bridge	No	Energy
76,558	Norfolk and Southern Railroad	Bridge	No	Energy
77,098	8th Street NE (abandoned)	Bridge	No	Energy
79,497	Ira Turpin Way NE	Bridge	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Nimishillen Creek Tributary is not subject to backwater.

Conclusion of Hydraulic Analyses for Nimishillen Creek.

J. Reemsnyder Ditch

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, “1+”-[12], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Reemsnyder Ditch flows generally southeast through west central Stark County within Canton, Ohio. The downstream limit of this study is the confluence with McDowell Ditch and the upstream limit is Whipple Avenue Northwest. The stream reach is approximately 0.9 mile in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with McDowell Ditch).

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

The USGS surveyed 11 cross sections at 2 hydraulic structures and 3 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 34 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0063 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 248 and 327. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,042.55 feet was

[12] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 44) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.040 to 0.042 for the main channel, and from 0.060 to 0.068 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 140 feet.

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 (energy equation based or based 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 J1 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 1-percent annual exceedance probability flood profile.

Table J1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
301	Private drive	Culvert	Yes	Energy
601	Hiram Road NW	Culvert	Yes	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Reemsnyder Ditch is subject to backwater from McDowell Ditch. A backwater elevation of 1,045.85 feet was obtained from cross sections 2,788.854 and 3,128.613 of the 100-year flood-profile model of McDowell Ditch from the 2012 FIS (Federal Emergency Management Agency, 2012). This backwater elevation will be in effect up through cross section 273 (water-surface elevation equal to 1,045.00 feet) of Reemsnyder Ditch. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Reemsnyder Ditch.

K. Sherrick Run

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[13], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Sherrick Run flows generally west through central Stark County in and near Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is approximately 0.8 mile upstream from the confluence of Hayden Ditch. The stream reach is approximately 3.9 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with Nimishillen Creek).

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

The USGS surveyed 42 cross sections at 10 hydraulic structures and 4 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 115 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0051 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 76 and 2,202. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 997.71 feet was

[13] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 76) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.040 to 0.042 for the main channel and were set to 0.050 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 178 feet.

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 (energy equation based or based 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 K1 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 1-percent annual exceedance probability flood profile.

Table K1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
590	Allen Avenue SE	Bridge	No	Energy
2,141	CSX Railroad	Bridge	No	Energy
4,726	Cherry Avenue SE	Culvert	No	Energy
8,694	Warner Road SE	Bridge	No	Energy
9,927	Private drive	Bridge	Yes	Pressure/Weir
11,139	Moore Avenue SE	Bridge	No	Energy
11,215	Abandoned railroad	Bridge	No	Energy
13,753	Private drive	Bridge	No	Energy
13,856	State Route 43 (Waynesburg Drive SE)	Bridge	No	Energy
14,030	Private drive	Bridge	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Sherrick Run is subject to backwater from Nimishillen Creek. A backwater elevation of 1,003.49 feet was obtained from cross sections 60,132 and 60,262 of the 100-year flood-profile model of Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 1,110 (water-surface elevation equal to 1,002.73 feet) of Sherrick Run. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Sherrick Run.

L. Unnamed Stream

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, “1+”-[14], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Unnamed Stream flows generally south through east central Stark County in and near Louisville, Ohio. The downstream limit of this study is the confluence with East Branch Nimishillen Creek and the upstream limit is approximately 1,100 feet downstream from U.S Route 62. The stream reach is approximately 2.2 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with East Branch Nimishillen Creek).

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

The USGS surveyed 30 cross sections at 7 hydraulic structures and 2 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 81 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0037 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 356 and 4,363. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,103.68 feet was

[14] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 93) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.040 to 0.044 for the main channel, and from 0.042 to 0.068 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 145 feet.

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 (energy equation based or based 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 L1 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 1-percent annual exceedance probability flood profile.

Table L1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
265	Private drive	Culvert	Yes	Energy
1,981	Walkway bridge	Bridge	Yes	Energy
2,774	Reno Drive E	Bridge	No	Energy
3,854	Private drive	Bridge	Yes	Energy
4,574	Private drive	Bridge	Yes	Energy
6,716	Private drive	Culvert	Yes	Energy
7,653	Private drive	Bridge	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Unnamed Stream is subject to backwater from East Branch Nimishillen Creek. A backwater elevation of 1,105.53 feet was obtained from cross section 40,295 of the 100-year flood-profile model of East Branch Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 231 (water-surface elevation equal to 1,104.18 feet) of Unnamed Stream. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Unnamed Stream.

M. West Branch Nimishillen Creek

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[15], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

West Branch Nimishillen Creek flows generally south through central Stark County in Canton, Ohio. The downstream limit of this study is the confluence with Nimishillen Creek and the upstream limit is the confluence of McDowell Ditch. The stream reach is approximately 4.5 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with Nimishillen Creek).

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

The USGS surveyed 94 cross sections at 24 hydraulic structures and 6 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 168 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0016 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 244 and 1,544. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,007.05 feet was

---

[15] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 7) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.038 to 0.046 for the main channel, and from 0.040 to 0.064 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 142 feet.

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 (energy equation based or based 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 M1 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 1-percent annual exceedance probability flood profile.

Table M1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.
[N/A, not applicable]

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
47	Wheeling and Lake Erie Railroad	Bridge	No	Energy
239	Market Avenue S	Bridge	No	Energy
416	Cleveland Avenue SW	Bridge	No	Energy
433	Stone weir	Dam	N/A	Energy
1,082	Walkway bridge	Bridge	No	Energy
1,653	15th Street SW	Bridge	Yes	Energy
3,485	Navarre Road SW	Bridge	No	Energy
3,962	Norfolk and Southern Railroad	Bridge	No	Energy
5,692	9th Street SW	Bridge	No	Energy
6,892	6th Street SW	Bridge	No	Energy
8,408	Tuscarawas Street W	Bridge	No	Energy
9,398	Walkway bridge	Bridge	Yes	Energy
9,784	7th Street NW	Bridge	No	Energy
10,893	Walkway bridge	Bridge	Yes	Energy

11,812	12th Street NW	Multiple Opening	No	Energy
12,263	Walkway bridge	Bridge	Yes	Energy
13,778	Walkway bridge	Multiple Opening	Yes	Energy
15,645	Walkway bridge	Bridge	Yes	Energy
15,980	Low head dam	Dam	N/A	Energy
16,218	Walkway bridge	Bridge	No	Energy
17,187	State Route 687 (Fulton Drive NW)	Bridge	Yes	Energy
17,484	Walkway bridge	Bridge	Yes	Energy
19,331	U.S. Route 62	Bridge	No	Energy
22,902	Interstate Route 77	Bridge	No	Energy

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

West Branch Nimishillen Creek is subject to backwater from Nimishillen Creek. A backwater elevation of 1,008.29 feet was obtained from cross sections 64,314 and 64,652 of the 100-year flood-profile model of Nimishillen Creek included as part of this study. This backwater elevation will be in effect up through cross section 120 (water-surface elevation equal to 1,007.56 feet) of West Branch Nimishillen Creek. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for West Branch Nimishillen Creek.

N. Zimber Ditch

Work conducted by the USGS

Cross sections surveyed in the field and synthetic cross sections derived from a digital 2-foot contour map developed by Stark County (refer to the Mapping Information section of this documentation for a discussion on the digital contour maps) were used as channel geometry inputs to develop a step-backwater model to establish the 10-, 4-, 2-, 1-, "1+"-[16], and 0.2-percent annual-exceedance probability flood profiles and the regulatory floodway profile. Estimates of the flood-peak streamflows were used with cross-sectional geometry data as input to develop the step-backwater profiles.

Scope of Work

Zimber Ditch flows generally south through north central Stark County in and near North Canton, Ohio. The downstream limit of this study is the confluence with McDowell Ditch and the upstream limit is approximately 275 feet upstream from Mayfair Road. The stream reach is approximately 4.2 miles in length.

Hydraulic Baseline

Stationing used for the hydraulic baseline for this stream is referenced to feet upstream from the mouth (confluence with McDowell Ditch).

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

The USGS surveyed 42 cross sections at 10 hydraulic structures and 2 open-channel locations. 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

Using a geographic information system (GIS), the USGS generated a triangular irregular network (TIN) from contours, breaklines, and spot elevations to obtain supplemental cross-sectional data. A total of 110 synthetic cross-sectional profiles were generated by use of the TIN at desired locations along the stream reach. In-channel data for all synthetic cross sections were estimated by interpolation from field surveyed cross-sectional data.

Starting Water-Surface Elevation

The starting water-surface elevation at the initial section for all profiles was obtained by means of a slope-conveyance calculation. A slope of 0.0012 foot per foot (ft/ft) was calculated from the river stations and minimum-channel elevations for cross sections at stations 211 and 2,925. These cross sections were obtained from field surveys and provide a representative slope for the channel. Based on the calculated slope, a starting water-surface elevation of 1,056.53 feet was

[16] The 1 percent plus flood elevation is defined by the Federal Emergency Management Agency (2019) as a flood elevation derived by using streamflows that include the average predictive error for the regression equation streamflow calculation for the Flood Risk project. This error is then added to the 1 percent annual chance streamflow to calculate the new 1 percent plus streamflow.

determined at the initial section (river station 19) for the 1-percent annual exceedance probability flood profile.

Manning's Roughness Coefficients

Manning's roughness coefficients (*n*) for the main channel and overbank areas were initially determined from field observation and aerial photography by experienced personnel, and later adjusted during model calibration. Estimates of Manning's roughness coefficients range in value from 0.040 to 0.044 for the main channel, and from 0.050 to 0.054 for the overbank areas.

Flow Lengths

Main channel and overbank flow lengths were computed through the use of HEC-GeoRAS (U.S. Army Corps of Engineers, 2002). Flow paths are drawn in a GIS by the user for both the main channel and overbanks. HEC-GeoRAS computes all flow lengths based on the flow paths drawn by the user. All main channel flow lengths were limited to a maximum of 500 feet and are on average 203 feet.

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 (energy equation based or based 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 N1 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 1-percent annual exceedance probability flood profile.

Table N1. Summary of hydraulic structure solutions for the 1-percent annual exceedance probability flood profile.

River station (feet)	Location Description	Structure type	Presence of road overflow	Solution type
173	Metro RTA Railroad	Bridge	No	Energy
3,004	Glenwood Street SW	Bridge	No	Energy
4,241	Walkway bridge	Bridge	Yes	Energy
5,742	Whipple Avenue NW	Bridge	No	Energy
9,043	Portage Street NW	Culvert	No	Energy
11,406	Applegrove Street NW	Culvert	No	Energy
15,147	Shuffel Street NW	Culvert	No	Energy
18,232	Mount Pleasant Road	Culvert	No	Energy
19,930	Brookline Road	Culvert	Yes	Energy
21,675	Mayfair Road	Culvert	Yes	Energy

Split Flow Analysis

During initial model runs, it was noticed that a portion of the Zimber Ditch 100-year peak streamflow will bypass the main channel and pass into a culvert and return to the main channel (between river stations 41 and 211). The area of interest is located approximately at the mouth of Zimber Ditch (confluence with McDowell Ditch).

To estimate the amount of streamflow escaping the main channel, a split-flow energy-based (solution) analysis was performed. This analysis involved creating a separate channel and cross-sectional data for the overflow channel. The main channel was split into a lower (from river station 19 to 41), middle (85 to 189), and upper (211 to 21,918) reach. The overflow channel was connected to the main channel using "junction nodes" at the points where it deviated from (labeled "Split") and rejoined (labeled "Join") with the main channel.

A series of discharge combinations that summed to the total discharge above and below the split were routed along the middle reach of the main and overflow reach channels until a balanced water surface was obtained at their respective uppermost cross sections. The flow apportionment was estimated to be 676 ft^3/s for the overflow channel and 514 ft^3/s for the middle reach of the main channel with a common water-surface elevation of 1,058.88 ft for both the main channel and the overflow channel. This represents approximately 57% of the total flow being conveyed by the overflow channel.

Floodway

Initial floodway computations were based upon equal conveyance reduction. In some cases, subsequent floodway boundaries were then modified, to reduce significant variation in floodway widths or undesirable fluctuation in surcharges, using best engineering judgment to produce the final floodway for the reach. All floodway profiles for this study were computed using HEC-RAS. Surcharges for all cross sections in the final HEC-RAS floodway run were 1.0 foot or less.

Backwater Elevation

Zimber Ditch is subject to backwater from McDowell Ditch. A backwater elevation of 1,061.52 feet was obtained from cross section 11,814.88 of the 100-year flood-profile model of McDowell Ditch from the 2012 FIS. This backwater elevation will be in effect up through cross section 5,646 (water-surface elevation equal to 1,061.42 feet) of Zimber Ditch. This backwater elevation will be shown on all applicable profile plots.

Conclusion of Hydraulic Analyses for Zimber Ditch.

KEY TO CROSS-SECTION LABELING

A. Broad-Monter Creek

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: BROAD-MONTER CREEK

RUN DATE: 02/13/2019

A. Broad-Monter Creek, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		392		
583		583		
718		718		
B		908		
1,062		1,062		
1,282		1,282		
1,417		1,417		
C		1,529		
1,609		1,609		
D		1,657		
State Route 44 (Ravenna Road)		1,723		
E		1,732		
1,843		1,843		
F		1,977		
G		2,205		
2,454		2,454		
2,678		2,678		
2,822		2,822		
H		2,846		
South Chapel Street		2,885		
I		2,892		
J		2,923		
K		2,962		
High school driveway		3,032		
L		3,045		
3,070		3,070		
M		3,175		
N		3,255		
O		3,290		
Nickel Plate Trail (old railroad)		3,387		
P		3,399		
3,425		3,425		
3,498		3,498		
3,580		3,580		
Q		3,688		

3,810		3,810		
3,904		3,904		
R		3,950		
S		3,993		
T		4,014		
Private driveway		4,033		
U		4,041		
4,069		4,069		
V		4,122		
5th Street		4,138		
W		4,146		
4,181		4,181		
X		4,291		
4,484		4,484		
Y		4,656		
4,816		4,816		
Z		4,990		
5,075		5,075		
5,151		5,151		
5,240		5,240		
AA		5,295		
AB		5,346		
South Street		5,459		
AC		5,469		
5,517		5,517		
5,665		5,665		
AD		5,694		
Private driveway		5,718		
AE		5,725		
5,761		5,761		
5,923		5,923		
AF		5,999		
6,089		6,089		
AG		6,112		
Nickel Plate Road		6,166		
AH		6,176		
6,219		6,219		
AI		6,487		
AJ		6,658		
6,804		6,804		
6,979		6,979		
AK		7,244		
7,589		7,589		
AL		7,642		
East Broad Street		7,784		
AM		7,804		
7,843		7,843		
AN		8,062		
8,223		8,223		
AO		8,384		
AP		8,556		
8,728		8,728		

AQ		8,892		
9,044		9,044		
9,176		9,176		
9,364		9,364		
9,541		9,541		
9,632		9,632		
AR		9,663		
Private driveway		9,787		
AS		9,795		
AT		9,852		
9,924		9,924		
AU		10,039		
10,192		10,192		
10,282		10,282		
AV		10,307		
Brookfield Street		10,363		
AW		10,373		
AX		10,412		
AY		10,544		
10,620		10,620		
10,689		10,689		
10,767		10,767		
10,840		10,840		
AZ		10,924		

B. Chatham Ditch

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: CHATHAM DITCH

RUN DATE: 02/11/2019

B. Chatham Ditch, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		1,017		
1,142		1,142		
1,263		1,263		
B		1,404		
1,535		1,535		
1,669		1,669		
1,913		1,913		
C		2,139		
D		2,155		
Marquardt Avenue		2,315		
E		2,319		
F		2,336		
G		2,483		
2,646		2,646		
H		2,808		
2,984		2,984		
3,125		3,125		
I		3,243		
3,402		3,402		
J		3,538		
3,633		3,633		
K		3,691		
L		3,709		
Laurel Green Drive NE		3,812		
M		3,820		
N		3,856		
O		3,970		
4,084		4,084		
P		4,183		
Q		4,307		
R		4,429		
4,582		4,582		
S		4,709		
4,900		4,900		
T		5,050		
5,205		5,205		
U		5,379		

C. East Branch Nimishillen Creek

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:

SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: EAST BRANCH NIMISHILLEN CREEK

RUN DATE: 07/29/2019

C. East Branch Nimishillen Creek, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		195		
B		552		
682		682		
C		708		
Walkway bridge		721		
D		726		
811		811		
E		1,126		
1,369		1,369		
F		1,614		
G		1,684		
Beldon Road		1,748		
H		1,759		
1,792		1,792		
I		2,254		
Low head dam		2,287		
J		2,317		
K		2,658		
3,057		3,057		
3,362		3,362		
3,837		3,837		
L		4,109		
4,380		4,380		
M		4,432		
Norfolk and Southern Railroad		4,519		
N		4,528		
4,687		4,687		
5,017		5,017		
O		5,099		
P		5,199		
Republic Steel railroad		5,251		
Q		5,254		
5,273		5,273		
R		5,283		
Republic Steel railroad		5,306		
S		5,310		
5,376		5,376		

T		5,604		
5,660		5,660		
U		5,680		
Republic Steel railroad / driveway		5,740		
V		5,744		
Low head dam		5,767		
W		5,800		
5,969		5,969		
6,273		6,273		
X		6,551		
Y		6,781		
7,005		7,005		
7,238		7,238		
Z		7,601		
7,907		7,907		
8,249		8,249		
AA		8,570		
8,912		8,912		
9,331		9,331		
AB		9,586		
9,925		9,925		
10,142		10,142		
AC		10,326		
AD		10,355		
Private road		10,402		
AE		10,404		
AF		10,433		
AG		10,458		
Trump Avenue NE		10,511		
AH		10,515		
10,591		10,591		
10,695		10,695		
10,864		10,864		
11,086		11,086		
11,281		11,281		
AI		11,494		
AJ		11,520		
Norfolk and Southern Railroad		11,539		
AK		11,546		
11,647		11,647		
12,083		12,083		
AL		12,566		
AM		12,993		
AN		13,413		
13,880		13,880		
AO		14,210		
AP		14,498		
AQ		14,619		
Norfolk and Southern Railroad		14,644		
AR		14,650		
14,759		14,759		

14,835		14,835		
15,107		15,107		
AS		15,300		
15,656		15,656		
16,151		16,151		
AT		16,589		
AU		16,875		
AV		17,143		
AW		17,416		
AX		17,589		
Low head dam		17,600		
AY		17,607		
17,869		17,869		
AZ		18,084		
18,350		18,350		
BA		18,563		
18,803		18,803		
18,944		18,944		
BB		18,965		
Broadway Avenue NE		19,025		
BC		19,040		
19,121		19,121		
BD		19,266		
19,503		19,503		
19,784		19,784		
20,187		20,187		
20,642		20,642		
20,968		20,968		
BE		21,215		
21,536		21,536		
BF		22,034		
22,440		22,440		
BG		22,806		
23,099		23,099		
BH		23,156		
Beck Avenue		23,198		
BI		23,239		
BJ		23,299		
23,521		23,521		
23,908		23,908		
BK		24,259		
24,455		24,455		
24,762		24,762		
25,142		25,142		
25,368		25,368		
BL		25,642		
25,864		25,864		
26,150		26,150		
BM		26,616		
BN		26,898		
27,184		27,184		
BO		27,229		

Energy Drive		27,296		
BP		27,310		
27,399		27,399		
27,630		27,630		
BQ		28,062		
28,525		28,525		
28,761		28,761		
28,992		28,992		
BR		29,222		
29,578		29,578		
29,951		29,951		
30,170		30,170		
30,363		30,363		
30,762		30,762		
30,977		30,977		
BS		31,203		
BT		31,552		
31,967		31,967		
32,439		32,439		
32,701		32,701		
32,921		32,921		
33,134		33,134		
BU		33,456		
BV		33,800		
34,063		34,063		
34,358		34,358		
BW		34,518		
34,666		34,666		
BX		34,762		
Access Road		34,804		
BY		34,833		
34,955		34,955		
BZ		35,018		
Norfolk and Southern Railroad		35,059		
CA		35,086		
35,174		35,174		
CB		35,442		
35,608		35,608		
35,928		35,928		
36,072		36,072		
CC		36,151		
State Route 153 (West Main Street)		36,201		
CD		36,228		
36,231		36,231		
CE		36,238		
Norfolk and Southern Railroad		36,274		
CF		36,387		
36,465		36,465		
36,688		36,688		
36,941		36,941		
CG		37,206		

37,397		37,397		
CH		37,679		
38,043		38,043		
CI		38,343		
CJ		38,656		
CK		38,744		
SR 44 (North Chapel Street)		38,799		
CL		38,839		
38,928		38,928		
39,229		39,229		
CM		39,498		
39,831		39,831		
CN		40,096		
40,295		40,295		
40,551		40,551		
40,873		40,873		
CO		41,133		
41,298		41,298		
CP		41,509		
41,957		41,957		
42,392		42,392		
42,562		42,562		
CQ		42,626		
North Nickel Plate Street		42,681		
CR		42,687		
42,773		42,773		
CS		42,928		
CT		43,245		
43,644		43,644		
CU		43,935		
44,258		44,258		
44,526		44,526		
CV		44,861		
CW		45,206		
45,645		45,645		
45,922		45,922		
46,157		46,157		
46,370		46,370		
CX		46,625		
CY		46,873		
47,105		47,105		
CZ		47,305		
DA		47,396		
Meese Road NE		47,436		
DB		47,442		
DC		47,489		

D. Fairhope Ditch

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: FAIRHOPE DITCH

RUN DATE: 02/13/2019

E. Fairhope Ditch, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		20		
B		24		
Norfolk and Southern Railroad		382		
C		395		
408		408		
484		484		
558		558		
D		567		
Norfolk and Southern Railroad		813		
E		818		
830		830		
1,009		1,009		
1,138		1,138		
1,439		1,439		
1,769		1,769		
2,252		2,252		
2,453		2,453		
2,883		2,883		
F		3,058		
3,266		3,266		
G		3,471		
3,613		3,613		
H		3,801		
I		3,840		
State Route 153 (Louisville St NE)		3,922		
J		3,927		
3,954		3,954		
K		4,248		
L		4,537		
M		4,708		
N		4,952		
5,219		5,219		
5,482		5,482		
5,860		5,860		
6,055		6,055		
6,338		6,338		
6,600		6,600		
6,908		6,908		

7,175		7,175		
O		7,371		
P		7,395		
Private driveway		7,427		
Q		7,441		
7,474		7,474		
7,706		7,706		
7,937		7,937		
8,083		8,083		
R		8,119		
Lesh Street NE		8,182		
S		8,192		
8,242		8,242		
8,386		8,386		
8,619		8,619		
8,794		8,794		
T		8,830		
Willis Street NE		8,874		
U		8,881		
8,926		8,926		
9,134		9,134		
9,492		9,492		
V		9,513		
Peach Street NE		9,570		
W		9,575		
9,606		9,606		
10,000		10,000		
X		10,374		
10,398		10,398		
Francesca Street NE		10,498		
Y		10,508		
10,533		10,533		
10,695		10,695		
Z		10,710		
US Route 62 (Atlantic Blvd NE)		10,967		
AA		10,977		
11,003		11,003		
11,148		11,148		
11,606		11,606		
AB		11,639		
Private driveway		11,658		
AC		11,671		
11,708		11,708		
11,981		11,981		
12,231		12,231		
AD		12,537		
AE		12,821		
AF		12,841		
Broadview Street NE		12,897		
AG		12,906		
12,939		12,939		
13,310		13,310		

13,538		13,538		
AH		13,784		
AI		14,021		
AJ		14,330		
14,686		14,686		
AK		14,993		
AL		15,340		

E. Firestone Ditch

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: FIRESTONE DITCH

RUN DATE: 07/29/2019

E. Firestone Ditch, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		23		
260		260		
434		434		
B		538		
Weir		542		
C		554		
677		677		
1,002		1,002		
D		1,303		
E		1,453		
F		1,617		
G		1,696		
Amsel Avenue NE		1,786		
H		1,792		
1,861		1,861		
2,006		2,006		
I		2,032		
Private walkway		2,050		
J		2,057		
2,087		2,087		
K		2,256		
L		2,277		
Middlebranch Avenue NE		2,355		
M		2,361		
2,387		2,387		
2,498		2,498		
N		2,511		
Private walkway		2,517		
O		2,523		
2,551		2,551		
2,717		2,717		
P		2,743		
Aspen Street NE		2,803		
Q		2,813		
2,838		2,838		
R		3,212		
3,446		3,446		
3,701		3,701		

S		3,731		
Wheeling and Lake Erie Railroad		3,841		
T		3,854		
3,900		3,900		
4,075		4,075		
U		4,302		
V		4,327		
Firestone Ave NE		4,377		
W		4,393		
4,421		4,421		
4,573		4,573		
4,777		4,777		
5,051		5,051		
5,303		5,303		
X		5,580		
5,818		5,818		
5,986		5,986		
6,140		6,140		
6,304		6,304		
6,449		6,449		
6,671		6,671		
Y		6,881		

F. Hayden Ditch

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: HAYDEN DITCH

RUN DATE: 02/11/2019

G. Hayden Ditch, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		223		
341		341		
435		435		
B		475		
SR 43 / Waynesburg Drive SE		584		
C		589		
602		602		
D		716		
894		894		
1,213		1,213		
1,569		1,569		
E		1,789		
1,977		1,977		
F		2,175		
G		2,384		
E		2,618		
H		2,632		
Farm road		2,666		
I		2,674		
2,699		2,699		
2,810		2,810		
2,929		2,929		
J		3,057		

G. Middle Branch Nimishillen Creek

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:

SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: MIDDLE BRANCH NIMISHILLEN CREEK

RUN DATE: 02/12/2019

G. Hayden Ditch, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		120		
B		166		
Walkway bridge		192		
C		213		
Low head dam		237		
D		260		
489		489		
602		602		
E		626		
State Route 153 (Mahoning Road NE)		709		
F		714		
801		801		
G		1,034		
1,240		1,240		
H		1,326		
Low head dam		1,347		
I		1,367		
1,505		1,505		
J		1,568		
Private driveway		1,607		
K		1,612		
1,688		1,688		
L		1,809		
1,952		1,952		
M		2,078		
Union Metal Corporation building		2,478		
N		2,489		
2,642		2,642		
O		2,764		
Private driveway		2,819		
P		2,830		
2,863		2,863		
3,354		3,354		
3,739		3,739		
Q		4,038		

4,307		4,307		
R		4,348		
19th Street NE		4,410		
S		4,420		
4,527		4,527		
4,674		4,674		
4,917		4,917		
5,077		5,077		
5,331		5,331		
5,576		5,576		
5,748		5,748		
T		5,789		
Wheeling and Lake Erie Railroad		5,830		
U		5,850		
5,912		5,912		
6,058		6,058		
V		6,345		
6,616		6,616		
6,904		6,904		
7,270		7,270		
W		7,574		
7,872		7,872		
8,085		8,085		
8,231		8,231		
X		8,284		
Spangler Street NE		8,340		
Y		8,353		
8,397		8,397		
8,687		8,687		
8,981		8,981		
Z		9,056		
U.S. Route 62		9,183		
AA		9,189		
AB		9,328		
9,456		9,456		
9,882		9,882		
10,326		10,326		
10,647		10,647		
10,880		10,880		
AC		11,181		
11,560		11,560		
11,936		11,936		
AD		12,327		
12,645		12,645		
AE		12,905		
AF		13,183		
13,530		13,530		
AG		13,562		
Martindale Road NE		13,606		
AH		13,616		
13,639		13,639		

AI		13,823		
14,015		14,015		
14,288		14,288		
14,495		14,495		
AJ		14,556		
Middle Branch Trail walkway		14,576		
AK		14,581		
14,614		14,614		
14,765		14,765		
14,921		14,921		
AL		14,949		
Wheeling and Lake Erie Railroad		14,980		
AM		15,002		
AN		15,059		
15,384		15,384		
15,688		15,688		
15,984		15,984		
AO		16,256		
16,536		16,536		
16,741		16,741		
AP		17,226		
17,403		17,403		
17,604		17,604		
AQ		17,623		
Private driveway		17,645		
AR		17,648		
AS		17,656		
Private dam		17,691		
AT		17,708		
17,983		17,983		
AU		18,037		
Middle Branch Avenue NE		18,076		
AV		18,083		
AW		18,125		
18,398		18,398		
18,836		18,836		
AX		19,252		
19,597		19,597		
19,997		19,997		
20,388		20,388		
AY		20,628		
21,039		21,039		
21,466		21,466		
21,770		21,770		
22,045		22,045		
22,451		22,451		
22,905		22,905		
23,273		23,273		
AZ		23,528		
23,857		23,857		
24,250		24,250		

24,652		24,652		
BA		25,025		
25,209		25,209		
25,522		25,522		
25,767		25,767		
BB		25,962		
26,122		26,122		
BC		26,201		
55th Street NE		26,286		
BD		26,296		
26,351		26,351		
26,781		26,781		
27,060		27,060		
27,424		27,424		
27,776		27,776		
27,944		27,944		
28,164		28,164		
28,387		28,387		
28,652		28,652		
28,920		28,920		
29,239		29,239		
BE		29,615		
29,909		29,909		
30,124		30,124		
30,511		30,511		
BF		30,879		
31,194		31,194		
BG		31,460		
31,819		31,819		
32,168		32,168		
32,608		32,608		
33,003		33,003		
BH		33,341		
BI		33,603		
33,949		33,949		
34,299		34,299		
34,625		34,625		
35,101		35,101		
BJ		35,166		
Easton Street NE		35,208		
BK		35,217		
BL		35,261		
35,753		35,753		
36,163		36,163		
36,578		36,578		
36,851		36,851		
37,114		37,114		
37,363		37,363		
37,736		37,736		
38,215		38,215		
38,489		38,489		
BM		38,813		

39,232		39,232		
39,549		39,549		
39,972		39,972		
40,237		40,237		
BN		40,676		
BO		41,031		
41,409		41,409		
BP		41,493		
41,534		41,534		
41,624		41,624		
BQ		41,852		
42,087		42,087		
BR		42,421		
BS		42,512		
Applegrove Street		42,600		
BT		42,615		
BU		42,710		
43,023		43,023		
BV		43,390		
BW		43,618		
43,900		43,900		
44,242		44,242		
BX		44,427		
44,655		44,655		
BY		44,909		
45,185		45,185		
45,486		45,486		
45,821		45,821		
BZ		46,077		
46,323		46,323		
46,534		46,534		
46,785		46,785		
47,259		47,259		
CA		47,607		
47,863		47,863		
48,174		48,174		
48,505		48,505		
CB		48,842		
49,170		49,170		
49,476		49,476		
49,806		49,806		
CC		50,159		

H. Middle Branch Nimishillen Creek Tributary Number 1

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:

SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: MIDDLE BRANCH NIMISHILLEN CREEK TRIBUTARY NUMBER 1

RUN DATE: 02/11/2019

I. Middle Branch Nimishillen Creek Tributary Number 1, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		38		
B		215		
553		553		
C		710		
824		824		
956		956		
D		1,147		
1,487		1,487		
E		1,531		
South Pointe Circle		1,584		
F		1,592		
G		1,618		
H		1,700		
1,945		1,945		
I		2,177		
2,431		2,431		
2,715		2,715		
J		2,951		
3,102		3,102		
3,246		3,246		
3,392		3,392		
K		3,779		

I. Nimishillen Creek

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: NIMISHILLEN CREEK

RUN DATE: 07/30/2019

J. Nimishillen Creek, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		43,048		
43,161		43,161		
43,323		43,323		
B		43,348		
CSX Railroad		43,382		
C		43,392		
D		43,476		
E		43,609		
43,923		43,923		
F		44,099		
G		44,191		
Cheyenne Street SE		44,240		
H		44,248		
44,334		44,334		
44,610		44,610		
44,946		44,946		
I		45,423		
45,866		45,866		
46,246		46,246		
J		46,471		
46,753		46,753		
46,948		46,948		
47,279		47,279		
47,711		47,711		
K		47,777		
Baum Street SE		47,819		
L		47,828		
M		47,967		
N		48,368		
48,736		48,736		
O		49,197		
49,491		49,491		
49,926		49,926		
P		50,319		
Q		50,656		
R		51,086		
51,437		51,437		
51,718		51,718		

S		51,785		
Faircrest Street SE		51,855		
T		51,868		
U		52,068		
52,304		52,304		
52,713		52,713		
53,128		53,128		
V		53,547		
53,962		53,962		
54,224		54,224		
W		54,433		
54,680		54,680		
54,946		54,946		
X		55,322		
Y		55,657		
55,901		55,901		
56,292		56,292		
Z		56,653		
56,966		56,966		
AA		57,306		
AB		57,551		
AC		57,869		
58,115		58,115		
AD		58,435		
58,827		58,827		
AE		59,180		
AF		59,479		
59,943		59,943		
AG		60,003		
Mill Street SE		60,064		
AH		60,090		
AI		60,132		
AJ		60,262		
60,432		60,432		
60,725		60,725		
61,123		61,123		
AK		61,479		
AL		61,872		
62,182		62,182		
62,563		62,563		
AM		62,616		
I-77		62,781		
AN		62,801		
AO		62,884		
AP		63,126		
63,375		63,375		
63,663		63,663		
AQ		63,941		
AR		64,314		
AS		64,652		
64,961		64,961		
AT		64,993		

Kimball Road SE		65,049		
AU		65,060		
65,128		65,128		
AV		65,407		
65,707		65,707		
AW		65,797		
I-77		65,910		
AX		65,931		
66,081		66,081		
AY		66,174		
CSX Railroad		66,196		
AZ		66,211		
66,274		66,274		
BA		66,333		
Allen Avenue SE		66,390		
BB		66,395		
66,515		66,515		
66,829		66,829		
BC		67,127		
BD		67,461		
BE		67,752		
68,115		68,115		
BF		68,427		
BG		68,846		
BH		68,981		
Cherry Avenue SE		69,039		
BI		69,046		
BJ		69,149		
69,490		69,490		
69,724		69,724		
70,071		70,071		
BK		70,369		
70,658		70,658		
BL		70,967		
71,112		71,112		
BM		71,176		
11th Street SE		71,247		
BN		71,256		
71,358		71,358		
71,699		71,699		
72,017		72,017		
72,329		72,329		
BO		72,650		
BP		72,733		
Abandoned railroad		72,759		
BQ		72,770		
72,821		72,821		
72,954		72,954		
BR		73,024		
Wheeling and Lake Erie Railroad		73,045		
BS		73,052		

73,087		73,087		
BT		73,324		
BU		73,547		
BV		73,749		
BW		73,817		
4th Street SE		73,881		
BX		73,888		
73,942		73,942		
74,049		74,049		
74,176		74,176		
BY		74,217		
3rd Street SE		74,265		
BZ		74,270		
74,352		74,352		
CA		74,530		
74,699		74,699		
CB		74,760		
State Route 172 (Tuscarawas Street E)		74,829		
CC		74,832		
74,915		74,915		
75,194		75,194		
CD		75,282		
3rd Street NE		75,345		
CE		75,350		
75,415		75,415		
CF		75,618		
CG		75,827		
CH		75,916		
5th Street NE		75,962		
CI		75,975		
76,069		76,069		
CJ		76,199		
6th Street NE		76,253		
CK		76,265		
76,403		76,403		
CL		76,465		
Norfolk and Southern Railroad		76,558		
CM		76,573		
76,652		76,652		
CN		76,973		
CO		77,050		
8th Street NE (abandoned)		77,098		
CP		77,105		
77,146		77,146		
CQ		77,296		
77,752		77,752		
78,183		78,183		
CR		78,664		
CS		78,946		
CT		79,384		

CU		79,429		
Ira Turpin Way NE		79,497		
CV		79,508		
CW		79,589		

J. Reemsnyder Ditch

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: REEMSNYDER DITCH

RUN DATE: 02/11/2019

K. Reemsnyder Ditch, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		44		
B		177		
C		248		
D		273		
Private Drive		301		
E		307		
327		327		
548		548		
F		561		
Hiram Road NW		601		
G		606		
615		615		
818		818		
1,014		1,014		
1,179		1,179		
1,338		1,338		
1,492		1,492		
1,686		1,686		
1,887		1,887		
2,054		2,054		
2,188		2,188		
2,399		2,399		
2,598		2,598		
2,788		2,788		
2,963		2,963		
3,135		3,135		
H		3,318		
3,513		3,513		
3,694		3,694		
I		3,862		
J		4,054		
K		4,217		
4,357		4,357		
4,490		4,490		
L		4,616		
M		4,663		

K. Sherrick Run

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: SHERRICK RUN

RUN DATE: 02/11/2019

L. Sherrick Run, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		76		
287		287		
409		409		
B		499		
C		553		
Allen Avenue SE		590		
D		597		
631		631		
876		876		
E		1,110		
1,335		1,335		
1,558		1,558		
1,804		1,804		
1,932		1,932		
F		2,077		
G		2,112		
CSX Railroad		2,141		
H		2,151		
2,202		2,202		
I		2,344		
J		2,544		
2,769		2,769		
3,023		3,023		
K		3,271		
3,522		3,522		
3,727		3,727		
3,932		3,932		
4,182		4,182		
4,358		4,358		
4,549		4,549		
L		4,615		
Cherry Avenue SE		4,726		
M		4,732		
4,771		4,771		
4,899		4,899		
5,036		5,036		
N		5,214		
O		5,417		

5,628		5,628		
5,795		5,795		
P		5,980		
Q		6,225		
6,432		6,432		
R		6,706		
6,947		6,947		
S		7,276		
7,623		7,623		
7,833		7,833		
8,037		8,037		
8,451		8,451		
T		8,619		
U		8,654		
Warner Road SE		8,694		
V		8,699		
8,740		8,740		
W		9,056		
9,323		9,323		
X		9,579		
Y		9,888		
Z		9,905		
Private drive		9,927		
AA		9,935		
9,959		9,959		
AB		10,216		
AC		10,508		
10,627		10,627		
AD		10,769		
AE		10,901		
11,085		11,085		
AF		11,098		
Moore Avenue SE		11,139		
AG		11,146		
11,181		11,181		
AH		11,200		
Abandoned railroad		11,215		
AI		11,221		
11,264		11,264		
11,466		11,466		
AJ		11,682		
11,948		11,948		
12,218		12,218		
12,551		12,551		
AK		12,794		
13,013		13,013		
13,281		13,281		
AL		13,581		
AM		13,707		
AN		13,727		
Private drive		13,753		
AO		13,758		

13,785		13,785		
AP		13,817		
State Route 43 (Waynesburg Drive SE)		13,856		
AQ		13,861		
13,891		13,891		
13,969		13,969		
AR		14,003		
Private drive		14,030		
AS		14,036		
AT		14,095		
14,229		14,229		
14,358		14,358		
14,557		14,557		
AU		14,718		
14,885		14,885		
15,088		15,088		
15,379		15,379		
15,588		15,588		
AV		15,858		
16,304		16,304		
16,450		16,450		
16,629		16,629		
AW		16,911		
AX		17,159		
17,340		17,340		
17,627		17,627		
AY		17,929		
AZ		18,141		
18,389		18,389		
18,687		18,687		
18,996		18,996		
BA		19,335		
19,710		19,710		
20,033		20,033		
BB		20,341		

L. Unnamed Stream

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: UNNAMED STREAM

RUN DATE: 07/30/2019

M. Unnamed Stream, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		93		
151		151		
B		231		
Private drive		265		
C		268		
356		356		
D		593		
986		986		
1,205		1,205		
1,435		1,435		
1,651		1,651		
E		1,834		
F		1,964		
Walkway bridge		1,981		
G		1,989		
2,028		2,028		
2,334		2,334		
H		2,487		
I		2,569		
J		2,668		
Reno Drive E		2,774		
K		2,784		
2,801		2,801		
L		2,966		
3,230		3,230		
M		3,459		
3,646		3,646		
3,802		3,802		
N		3,832		
Private drive		3,854		
O		3,861		
3,956		3,956		
4,038		4,038		
4,194		4,194		
P		4,363		
4,447		4,447		
Q		4,509		
R		4,545		

Private drive		4,574		
S		4,583		
T		4,684		
4,814		4,814		
5,028		5,028		
U		5,237		
5,474		5,474		
5,695		5,695		
V		5,893		
6,017		6,017		
W		6,120		
X		6,219		
Y		6,359		
6,536		6,536		
6,622		6,622		
Z		6,676		
Private drive		6,716		
AA		6,720		
6,745		6,745		
6,859		6,859		
6,998		6,998		
AB		7,144		
7,267		7,267		
AC		7,391		
7,506		7,506		
AD		7,636		
Private drive		7,653		
AE		7,663		
7,685		7,685		
AF		7,891		
8,182		8,182		
AG		8,325		
AH		8,451		
AI		8,579		
8,810		8,810		
AJ		9,036		
9,228		9,228		
9,435		9,435		
AK		9,549		
9,781		9,781		
9,916		9,916		
AL		10,056		
10,235		10,235		
10,418		10,418		
AM		10,657		
AN		10,866		
11,016		11,016		
AO		11,193		
11,475		11,475		
AP		11,700		

M. West Branch Nimishillen Creek

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:

SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: WEST BRANCH NIMISHILLEN CREEK

RUN DATE: 07/30/2019

N. West Branch Nimishillen Creek, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		7		
B		30		
Wheeling and Lake Erie Railroad		47		
C		52		
D		120		
E		185		
Market Avenue S		239		
F		244		
281		281		
G		342		
Cleveland Avenue SW		416		
H		422		
Stone Weir		433		
I		434		
J		543		
824		824		
1,039		1,039		
K		1,068		
Walkway bridge		1,082		
L		1,087		
M		1,135		
N		1,338		
O		1,439		
P		1,544		
Q		1,587		
15th Street SW		1,653		
R		1,660		
1,759		1,759		
1,846		1,846		
1,885		1,885		
1,902		1,902		
2,044		2,044		
2,257		2,257		
2,417		2,417		
S		2,589		
2,909		2,909		

3,006		3,006		
3,136		3,136		
3,232		3,232		
3,316		3,316		
T		3,418		
Navarre Road SW		3,485		
U		3,490		
3,572		3,572		
3,620		3,620		
V		3,710		
W		3,843		
X		3,903		
Norfolk and Southern Railroad		3,962		
Y		3,969		
4,021		4,021		
Z		4,405		
4,768		4,768		
5,004		5,004		
5,242		5,242		
5,555		5,555		
AA		5,611		
9th Street SW		5,692		
AB		5,702		
5,796		5,796		
5,865		5,865		
AC		6,000		
6,239		6,239		
6,392		6,392		
6,534		6,534		
6,633		6,633		
6,719		6,719		
AD		6,825		
6th Street SW		6,892		
AE		6,912		
AF		7,036		
7,232		7,232		
7,539		7,539		
7,774		7,774		
7,886		7,886		
8,021		8,021		
8,098		8,098		
8,176		8,176		
8,280		8,280		
AG		8,330		
Tuscarawas Street West		8,408		
AH		8,418		
AI		8,486		
8,649		8,649		
8,804		8,804		
9,098		9,098		
9,322		9,322		

AJ		9,374		
Walkway bridge		9,398		
AK		9,402		
9,470		9,470		
9,552		9,552		
9,634		9,634		
AL		9,720		
7th Street NW		9,784		
AM		9,793		
9,863		9,863		
AN		9,961		
10,093		10,093		
10,330		10,330		
10,620		10,620		
10,814		10,814		
AO		10,866		
Walkway bridge		10,893		
AP		10,895		
10,949		10,949		
11,178		11,178		
11,455		11,455		
AQ		11,673		
AR		11,730		
12th Street NW		11,812		
AS		11,818		
11,879		11,879		
12,192		12,192		
AT		12,241		
Walkway bridge		12,263		
AU		12,271		
12,370		12,370		
12,541		12,541		
12,858		12,858		
13,131		13,131		
13,402		13,402		
13,711		13,711		
AV		13,755		
Walkway bridge		13,778		
AW		13,787		
13,828		13,828		
14,193		14,193		
14,489		14,489		
14,788		14,788		
15,027		15,027		
15,249		15,249		
15,490		15,490		
15,563		15,563		
AX		15,633		
Walkway bridge		15,645		
AY		15,646		
15,718		15,718		
15,802		15,802		

AZ		15,877		
Low head Dam		15,890		
BA		15,894		
BB		15,938		
BC		16,141		
BD		16,205		
Walkway bridge		16,218		
BE		16,223		
16,246		16,246		
BF		16,307		
BG		16,489		
16,708		16,708		
17,026		17,026		
BH		17,111		
State Route 687 (Fulton Drive NW)		17,187		
BI		17,189		
17,239		17,239		
17,416		17,416		
BJ		17,453		
Walkway bridge		17,484		
BK		17,491		
17,548		17,548		
17,654		17,654		
BL		17,934		
18,235		18,235		
18,466		18,466		
BM		18,727		
19,035		19,035		
19,143		19,143		
BN		19,214		
U.S. Route 62		19,331		
BO		19,332		
BP		19,407		
19,599		19,599		
BQ		19,778		
20,035		20,035		
BR		20,348		
20,644		20,644		
20,961		20,961		
21,217		21,217		
21,469		21,469		
BS		21,688		
21,937		21,937		
22,190		22,190		
22,418		22,418		
22,655		22,655		
BT		22,714		
Interstate Route 77		22,902		
BU		22,907		
22,981		22,981		
BV		23,199		

23,517		23,517		
BW		23,751		

N. Zimber Ditch

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: ZIMBER DITCH

RUN DATE: 07/29/2019

O. Zimber Ditch, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		19		
41		41		
85		85		
B		153		
Metro RTA Railroad		173		
C		184		
D		189		
E		211		
276		276		
572		572		
900		900		
1,204		1,204		
1,450		1,450		
1,818		1,818		
2,125		2,125		
2,351		2,351		
2,600		2,600		
2,925		2,925		
F		2,957		
Glenwood Street SW		3,004		
G		3,012		
3,052		3,052		
3,395		3,395		
3,725		3,725		
4,176		4,176		
H		4,218		
Walkway bridge		4,241		
I		4,249		
4,302		4,302		
4,547		4,547		
4,906		4,906		
5,313		5,313		
5,534		5,534		
J		5,646		
Whipple Avenue NW		5,742		
K		5,744		
5,788		5,788		
6,165		6,165		

L		6,395		
6,807		6,807		
7,098		7,098		
M		7,452		
7,729		7,729		
N		7,951		
O		8,259		
8,531		8,531		
8,759		8,759		
P		8,905		
Q		8,941		
Portage Street NW		9,043		
R		9,054		
9,094		9,094		
9,181		9,181		
9,458		9,458		
9,763		9,763		
10,110		10,110		
S		10,450		
10,886		10,886		
11,268		11,268		
T		11,295		
Applegrove St NW		11,406		
U		11,418		
11,449		11,449		
V		11,637		
W		11,808		
12,058		12,058		
12,319		12,319		
X		12,607		
12,883		12,883		
Y		13,273		
Z		13,658		
14,065		14,065		
AA		14,308		
AB		14,651		
15,027		15,027		
AC		15,051		
Shuffel Street NW		15,147		
AD		15,159		
15,188		15,188		
15,483		15,483		
AE		15,901		
AF		16,249		
16,588		16,588		
AG		16,781		
16,987		16,987		
17,160		17,160		
17,361		17,361		
AH		17,505		
AI		17,676		
AJ		17,882		

18,138		18,138		
AK		18,175		
Mount Pleasant Road		18,232		
AL		18,239		
18,280		18,280		
18,601		18,601		
AM		18,894		
19,030		19,030		
AN		19,197		
AO		19,329		
AP		19,457		
19,624		19,624		
19,849		19,849		
AQ		19,866		
Brookline Road		19,930		
AR		19,935		
19,946		19,946		
AS		20,290		
20,459		20,459		
AT		20,585		
20,925		20,925		
21,254		21,254		
21,479		21,479		
AU		21,578		
AV		21,598		
Mayfair Road		21,675		
AW		21,682		
21,726		21,727		
21,799		21,799		
AX		21,918		

N’. Zimber Ditch overflow

PREPARED BY:
SC: USGS, OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

DATE PREPARED:
SC: OHIO-KENTUCKY-INDIANA WSC
TEC:______________________

COMMUNITY NAME: STARK COUNTY, OHIO
STATE: OHIO
FEMA CID NO: 39151CV001B

STREAM NAME: ZIMBER DITCH OVERFLOW

RUN DATE: 07/29/2019

O’. Zimber Ditch Overflow, Stark County, Ohio				
STUDY CONTRACTOR: U.S. GEOLOGICAL SURVEY			TECHNICAL EVALUATION CONTRACTOR	
MODEL CROSS-SECTION DESIGNATION	XS LETTER DRAFT FIS	RIVER STATIONING (DISTANCE IN FEET UPSTREAM FROM MOUTH)	EPA REACH FILE NUMBER	XS LETTER FINAL FIS
A		13		
B		15		
Metro RTA Railroad		105		
C		106		
D		107		

MAPPING INFORMATION

BASE MAP DELINEATION SUMMARY

In 2006, digital mapping (contour information) was developed for Stark County. The USGS obtained the digital files from Stark County in the form of shapefiles[17] and orthophotography. The data were imported into the geographic information system (GIS) ArcView[18] and served as the base map features for this 2019 study for Stark County.

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).

The horizontal datum for the survey is the North American Datum of 1983 (NAD 83), Ohio State Plane (Ohio North) 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 Real-Time Network (RTN) surveying techniques. Control for the USGS survey was established using National Geodetic Survey (NGS) and USGS monuments with known horizontal and/or vertical coordinates. A comparison of the published coordinates and surveyed coordinates are shown in the table 8. A total of 10 benchmarks were used for this 2019 FIS. The root mean square error in elevation for the surveyed benchmarks was 0.05 feet.

---

[17] Shapefiles are groups of files sharing a common root file name. Shapefiles minimally consist of a main file, an index file, and a database file. Geometric features are stored as a set of vector coordinates with associated attribute information. Shapefiles do not explicitly store topological relations.
[18] The use of trade or product names is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Table 8. Comparison of published coordinates to USGS surveyed coordinates. All data shown in feet, North American Datum of 1983 (NAD 83), and North American Vertical Datum of 1988 (NAVD 88).

Benchmark Permanent Identifier	Published Easting	Published Northing	Published Elevation	Surveyed Easting	Surveyed Northing	Surveyed Elevation	Delta Easting	Delta Northing	Delta Elevation
KY1247			1,157.36			1,157.38			0.02
KY1250			1,111.96			1,111.96			0.00
KY2913	2,248,086.85	433,490.33	1,077.87	2,248,086.81	433,490.32	1,077.85	0.04	0.01	-0.02
KY1263			1,037.31			1,037.33			0.02
KY1267			1,055.11			1,055.14			0.03
KY1270			1,046.77			1,046.83			0.06
KY2911			1,146.47			1,146.57			0.10
21 RHP 1956 1134			1,133.53			1,133.53			0.00
25 RHP 1956 1183			1,182.15			1,182.24			0.08
35 RHP 1956 1064			1,063.09			1,063.08			-0.01

Accuracy of Mapping Data

Selected data collected during the GPS field surveys were used by the USGS to perform quality-control checks of the mapping data. The root mean square error (RMSE) of the selected data was used to assess the horizontal accuracy of the mapping data. $RMSE_X$ (RMSE along the abscissa) and $RMSE_Y$ (RMSE along the ordinate) of easting and northing coordinate data obtained from field GPS surveys and the 2-foot contour topographic data (planimetric features) were 0.93 and 0.95 foot, respectively. Combining these two values results in an $RMSE_R$ (radial RMSE) of 1.59 feet. The $RMSE_Z$ (vertical RMSE) of the elevation data obtained from field GPS surveys and the topographic mapping data was 0.40 foot.

According to the National Standard for Spatial Data Accuracy (NSSDA) (Federal Geographic Data Committee, 1998) horizontal accuracy requirements for a map produced at 1 inch equal to 500 feet, the $RMSE_R$ must be less than 11.0 feet. For a 2-foot contour interval map, the NSSDA vertical accuracy requirements state that the $RMSE_Z$ must be less than 0.6 foot. Based on the NSSDA standards, both the $RMSE_R$ and $RMSE_Z$ are lower than the maximum acceptable error. Therefore, the digital mapping data for this study meets the horizontal and vertical criteria for the NSSDA applicable to FIRM Work Maps (FEMA, 2003) as established by the Federal Geographic Data Committee (Federal Geographic Data Committee, 1998).

MISCELLANEOUS REFERENCES

REFERENCES AND BIBLIOGRAPHY

Bartlett, W.P., Webber, E.E., 1976, Floods in Ohio - Magnitude and frequency: U.S. Geological Survey Open File Report 76-768, 73 p.

Federal Emergency Management Agency, 2003, Guidelines and specifications for flood hazard mapping partners, April 2003, 1779 p.

Federal Emergency Management Agency, 2012, Flood Insurance Study Number 39151CV001B, Stark County, Ohio, and incorporated areas, February 16, 2012, [variously paged]

Federal Emergency Management Agency, 2019, Guidance for Flood Risk Analysis and Mapping: Washington D.C., 20 p. accessed February 14, 2019, at https://www.fema.gov/media-library-data/1556727028010-090889650cfe5ad6845c3f2f39863053/General_Hydrologic_Considerations_Guidance_Feb_2019.pdf.

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

Federal Geographic Data Committee, 1998, FGDC-STD-007.3-1998, Geospatial Positioning Standards, Part 3: Nation Standard for Spatial Data Accuracy, FGDC, 28 p, accessed on February 13, 2019, at https://www.fgdc.gov/standards/projects/accuracy/part3/chapter3.

Koltun, G.F., Kula, S.P., and Puskas, B.M., 2006, A Streamflow Statistics (StreamStats) Web Application for Ohio: U.S. Geological Survey Scientific Investigations Report 2006-5312, 62 p, accessed on February 13, 2019, at https://doi.org/10.3133/sir20065312.

Ostheimer, C.J., and Whitehead, M.T., 2020, Geospatial data sets and hydraulic models for selected streams in Stark County, Ohio: U.S. Geological Survey data release, https://doi.org/10.5066/P9YQJ8B7.

Sauer, V.B., Thomas, W.O., Jr., Stricker, V.A., and Wilson, K.V., 1983, Flood characteristics of urban watersheds in the United States: U.S. Geological Survey Water-Supply Paper 2207, 63 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-86-108, 112 p.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2002, HEC-GeoRAS, accessed on February 13, 2019, at URL http://www.hec.usace.army.mil/software/hec-georas/.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2010a: HEC-RAS River Analysis System, Applications Guide, Version 4.1, 351 p., accessed on February 13, 2019, at URL http://www.hec.usace.army.mil/software/hec-ras/documentation/hec-ras_4.1_applications_guide.pdf.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2010b: HEC-RAS River Analysis System, User's Manual, Version 4.1, 790 p., accessed on February 13, 2019, at URL http://www.hec.usace.army.mil/software/hec-ras/documentation/hec-ras_4.1_users_manual.pdf.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, 2010c: HEC-RAS River Analysis System, Hydraulic Reference Manual, Version 4.1, 417 p., accessed on February 13, 2019, at URL http://www.hec.usace.army.mil/software/hec-ras/documentation/HEC-RAS_4.1_Reference_Manual.pdf.

ELEVATION REFERENCE MARKS

```
KY1247 ***********************************************************************
KY1247  DESIGNATION -  1158.47
KY1247  PID         -  KY1247
KY1247  STATE/COUNTY-  OH/STARK
KY1247  COUNTRY     -  US
KY1247  USGS QUAD   -  ROBERTSVILLE (1994)
KY1247
KY1247                         *CURRENT SURVEY CONTROL
KY1247  ______________________________________________________________________
KY1247* NAD 83(1986) POSITION- 40 50 54.7     (N) 081 12 38.9     (W)   HD_HELD2
KY1247* NAVD 88 ORTHO HEIGHT -    352.765 (meters)     1157.36   (feet) ADJUSTED
KY1247  ______________________________________________________________________
KY1247  GEOID HEIGHT    -         -33.422 (meters)                      GEOID12B
KY1247  DYNAMIC HEIGHT  -         352.598 (meters)     1156.82   (feet) COMP
KY1247  MODELED GRAVITY -     980,140.0   (mgal)                        NAVD 88
KY1247
KY1247  VERT ORDER      -  FIRST     CLASS I
KY1247
KY1247.The horizontal coordinates were established by autonomous hand held GPS
KY1247.observations and have an estimated accuracy of +/- 10 meters.
KY1247.
KY1247.The orthometric height was determined by differential leveling and
KY1247.adjusted by the NATIONAL GEODETIC SURVEY
KY1247.in June 1991.
KY1247
KY1247.Significant digits in the geoid height do not necessarily reflect accuracy.
KY1247.GEOID12B height accuracy estimate available here.
KY1247
KY1247.Photographs are available for this station.
KY1247
KY1247.The dynamic height is computed by dividing the NAVD 88
KY1247.geopotential number by the normal gravity value computed on the
KY1247.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY1247.degrees latitude (g = 980.6199 gals.).
KY1247
KY1247.The modeled gravity was interpolated from observed gravity values.
KY1247
KY1247;                    North         East    Units  Estimated Accuracy
KY1247;SPC OH N     -   132,044.      708,705.      MT  (+/- 10 meters HH2 GPS)
KY1247
KY1247_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF8223021963(NAD 83)
KY1247
KY1247                          SUPERSEDED SURVEY CONTROL
KY1247
KY1247  NGVD 29 (??/??/92)  352.944  (m)         1157.95   (f) ADJ UNCH    1 1
KY1247
KY1247.Superseded values are not recommended for survey control.
KY1247
KY1247.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY1247.See file dsdata.pdf to determine how the superseded data were derived.
KY1247
KY1247_MARKER: DD = SURVEY DISK
KY1247_SETTING: 36 = SET IN A MASSIVE STRUCTURE
KY1247_SP_SET: BRIDGE
KY1247_STAMPING: 1158.47
KY1247_MARK LOGO: OH-151
KY1247_MAGNETIC: N = NO MAGNETIC MATERIAL
KY1247_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY1247_SATELLITE: THE SITE LOCATION WAS REPORTED AS NOT SUITABLE FOR
KY1247+SATELLITE: SATELLITE OBSERVATIONS - March 31, 2018
KY1247
KY1247  HISTORY     - Date     Condition        Report By
KY1247  HISTORY     - 1966     MONUMENTED       OH-151
KY1247  HISTORY     - 1966     GOOD             CGS
KY1247  HISTORY     - 19921229 GOOD             OHDT
KY1247  HISTORY     - 20040521 MARK NOT FOUND   USPSQD
KY1247  HISTORY     - 20060803 GOOD             GEOCAC
```

```
KY1247  HISTORY     - 20180331 GOOD             USPSQD
KY1247
KY1247                          STATION DESCRIPTION
KY1247
KY1247'DESCRIBED BY COAST AND GEODETIC SURVEY 1966
KY1247'2.6 MI NE FROM LOUISVILLE.
KY1247'ABOUT 2.6 MILES NORTHEAST ALONG THE PENNSYLVANIA RAILROAD FROM
KY1247'THE CROSSING OF STATE HIGHWAY 44 AT LOUISVILLE, IN SECTION 24,
KY1247'R 7 W, T 19 N, ABOUT 0.15 MILE SOUTHWEST OF MILEPOST 92, 89 1/2
KY1247'FEET SOUTH OF THE CENTER OF THE CROSSING OF MAPLE GROVE AVENUE, SET
KY1247'ON THE TOP OF THE NORTH END OF THE NORTHEAST WING WALL FOR A
KY1247'30-FOOT CONCRETE AND STEEL BRIDGE OVER NIMISHILLEN CREEK, 13 FEET
KY1247'EAST OF THE CENTER LINE OF THE AVENUE AND 2 FEET BELOW THE LEVEL
KY1247'OF THE TRACK, ABOUT LEVEL WITH THE AVENUE.
KY1247
KY1247                          STATION RECOVERY (1992)
KY1247
KY1247'RECOVERY NOTE BY OHIO DEPARTMENT OF TRANSPORTATION 1992 (PM)
KY1247'------REPORT BY ODOT------YEAR 1992-------CONDITION--GOOD--------
KY1247
KY1247                          STATION RECOVERY (2004)
KY1247
KY1247'RECOVERY NOTE BY US POWER SQUADRON 2004 (KEN)
KY1247'MARK NOT FOUND.
KY1247
KY1247                          STATION RECOVERY (2006)
KY1247
KY1247'RECOVERY NOTE BY GEOCACHING 2006 (RLM)
KY1247'RECOVERED IN GOOD CONDITION.
KY1247
KY1247                          STATION RECOVERY (2018)
KY1247
KY1247'RECOVERY NOTE BY US POWER SQUADRON 2018 (TJH)
KY1247'RECOVERED IN GOOD CONDITION.
```

```
KY1250 ***********************************************************************
KY1250  DESIGNATION -  1112.81
KY1250  PID         -  KY1250
KY1250  STATE/COUNTY-  OH/STARK
KY1250  COUNTRY     -  US
KY1250  USGS QUAD   -  ROBERTSVILLE (1994)
KY1250
KY1250                         *CURRENT SURVEY CONTROL
KY1250  ______________________________________________________________________
KY1250* NAD 83(1986) POSITION- 40 50 42.     (N) 081 14 49.     (W)   SCALED
KY1250* NAVD 88 ORTHO HEIGHT -   338.925 (meters)     1111.96  (feet) ADJUSTED
KY1250  ______________________________________________________________________
KY1250  GEOID HEIGHT    -        -33.397 (meters)                     GEOID12B
KY1250  DYNAMIC HEIGHT  -        338.765 (meters)     1111.43  (feet) COMP
KY1250  MODELED GRAVITY -    980,141.6   (mgal)                       NAVD 88
KY1250
KY1250  VERT ORDER      -  FIRST     CLASS I
KY1250
KY1250.The horizontal coordinates were scaled from a topographic map and have
KY1250.an estimated accuracy of +/- 6 seconds.
KY1250.
KY1250.The orthometric height was determined by differential leveling and
KY1250.adjusted by the NATIONAL GEODETIC SURVEY
KY1250.in June 1991.
KY1250
KY1250.Significant digits in the geoid height do not necessarily reflect accuracy.
KY1250.GEOID12B height accuracy estimate available here.
KY1250
KY1250.The dynamic height is computed by dividing the NAVD 88
KY1250.geopotential number by the normal gravity value computed on the
KY1250.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY1250.degrees latitude (g = 980.6199 gals.).
KY1250
KY1250.The modeled gravity was interpolated from observed gravity values.
KY1250
KY1250;                    North         East     Units  Estimated Accuracy
KY1250;SPC OH N     -   131,610.      705,660.      MT  (+/- 180 meters Scaled)
KY1250
KY1250_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF791215(NAD 83)
KY1250
KY1250                          SUPERSEDED SURVEY CONTROL
KY1250
KY1250  NGVD 29 (??/??/92)  339.106  (m)         1112.55   (f) ADJ UNCH    1 1
KY1250
KY1250.Superseded values are not recommended for survey control.
KY1250
KY1250.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY1250.See file dsdata.pdf to determine how the superseded data were derived.
KY1250
KY1250_MARKER: DD = SURVEY DISK
KY1250_SETTING: 36 = SET IN A MASSIVE STRUCTURE
KY1250_SP_SET: BRIDGE
KY1250_STAMPING: 1112.81
KY1250_MARK LOGO: OH-151
KY1250_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY1250
KY1250  HISTORY     - Date     Condition        Report By
KY1250  HISTORY     - UNK      MONUMENTED       OH-151
KY1250  HISTORY     - 1966     GOOD             CGS
KY1250  HISTORY     - 20070325 GOOD             USPSQD
KY1250  HISTORY     - 20070802 POOR             GEOCAC
KY1250
KY1250                          STATION DESCRIPTION
KY1250
KY1250'DESCRIBED BY COAST AND GEODETIC SURVEY 1966
KY1250'0.7 MI NE FROM LOUISVILLE.
KY1250'ABOUT 0.7 MILE NORTHEAST ALONG THE PENNSYLVANIA RAILROAD FROM
KY1250'THE CROSSING OF STATE HIGHWAY 44 AT LOUISVILLE, IN SECTION 22,
KY1250'R 7 W, T 19 N, ABOUT 110 YARDS WEST OF MILEPOST 94, ABOUT 70 YARDS
KY1250'NORTH ALONG NICKLEPLATE AVENUE FROM THE TRACKS, SET ON THE TOP OF
KY1250'THE NORTH END OF THE WING WALL AT THE NORTHWEST CORNER OF A
```

```
KY1250'45-FOOT BRIDGE OVER NIMISHILLEN CREEK, 18 FEET WEST OF THE CENTER
KY1250'LINE OF THE AVENUE, 1 FOOT SOUTH OF THE NORTH END OF THE WING WALL
KY1250'AND ABOUT LEVEL WITH THE AVENUE.
KY1250
KY1250                          STATION RECOVERY (2007)
KY1250
KY1250'RECOVERY NOTE BY US POWER SQUADRON 2007
KY1250'RECOVERED IN GOOD CONDITION.
KY1250
KY1250                          STATION RECOVERY (2007)
KY1250
KY1250'RECOVERY NOTE BY GEOCACHING 2007 (RLM)
KY1250'THE MARK HAS BEEN MUTILATED. USE WITH CAUTION.
```

```
KY2913 ***********************************************************************
KY2913  CBN         -  This is a Cooperative Base Network Control Station.
KY2913  DESIGNATION -  Y 337
KY2913  PID         -  KY2913
KY2913  STATE/COUNTY-  OH/STARK
KY2913  COUNTRY     -  US
KY2913  USGS QUAD   -  CANTON WEST (1985)
KY2913
KY2913                         *CURRENT SURVEY CONTROL
KY2913  ______________________________________________________________________
KY2913* NAD 83(2011) POSITION- 40 51 07.46150(N) 081 29 21.50257(W)   ADJUSTED
KY2913* NAD 83(2011) ELLIP HT-   295.260 (meters)        (06/27/12)   ADJUSTED
KY2913* NAD 83(2011) EPOCH   -  2010.00
KY2913* NAVD 88 ORTHO HEIGHT -   328.536 (meters)     1077.87  (feet) ADJUSTED
KY2913  ______________________________________________________________________
KY2913  GEOID HEIGHT    -        -33.213 (meters)                     GEOID12B
KY2913  NAD 83(2011) X  -    715,044.236 (meters)                     COMP
KY2913  NAD 83(2011) Y  - -4,778,371.812 (meters)                     COMP
KY2913  NAD 83(2011) Z  -  4,150,204.291 (meters)                     COMP
KY2913  LAPLACE CORR    -          -1.60  (seconds)                   DEFLEC12B
KY2913  DYNAMIC HEIGHT  -        328.387 (meters)     1077.38  (feet) COMP
KY2913  MODELED GRAVITY -    980,159.3   (mgal)                       NAVD 88
KY2913
KY2913  VERT ORDER      -  FIRST     CLASS II
KY2913
KY2913  Network accuracy estimates per FGDC Geospatial Positioning Accuracy
KY2913  Standards:
KY2913         FGDC (95% conf, cm)     Standard deviation (cm)     CorrNE
KY2913            Horiz  Ellip           SD_N   SD_E   SD_h      (unitless)
KY2913  -------------------------------------------------------------------
KY2913  NETWORK    0.57   1.61           0.26   0.20   0.82     -0.02447952
KY2913  -------------------------------------------------------------------
KY2913  Click here for local accuracies and other accuracy information.
KY2913
KY2913
KY2913.The horizontal coordinates were established by GPS observations
KY2913.and adjusted by the National Geodetic Survey in June 2012.
KY2913
KY2913.NAD 83(2011) refers to NAD 83 coordinates where the reference frame has
KY2913.been affixed to the stable North American tectonic plate. See
KY2913.NA2011 for more information.
KY2913
KY2913.The horizontal coordinates are valid at the epoch date displayed above
KY2913.which is a decimal equivalence of Year/Month/Day.
KY2913
KY2913.The orthometric height was determined by differential leveling and
KY2913.adjusted by the NATIONAL GEODETIC SURVEY
KY2913.in June 1991.
KY2913
KY2913.Significant digits in the geoid height do not necessarily reflect accuracy.
KY2913.GEOID12B height accuracy estimate available here.
KY2913
KY2913.Photographs are available for this station.
KY2913
KY2913.The X, Y, and Z were computed from the position and the ellipsoidal ht.
KY2913
KY2913.The Laplace correction was computed from DEFLEC12B derived deflections.
KY2913
KY2913.The ellipsoidal height was determined by GPS observations
KY2913.and is referenced to NAD 83.
KY2913
KY2913.The dynamic height is computed by dividing the NAVD 88
KY2913.geopotential number by the normal gravity value computed on the
KY2913.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY2913.degrees latitude (g = 980.6199 gals.).
KY2913
KY2913.The modeled gravity was interpolated from observed gravity values.
KY2913
KY2913. The following values were computed from the NAD 83(2011) position.
KY2913
KY2913;                   North         East     Units Scale Factor Converg.
```

```
KY2913;SPC OH N     -   132,128.117   685,218.243   MT  0.99994619   +0 39 50.3
KY2913;SPC OH N     -   433,490.33  2,248,086.85   sFT  0.99994619   +0 39 50.3
KY2913;UTM  17      - 4,522,451.129   458,756.653   MT  0.99962094   -0 19 12.2
KY2913
KY2913!             -  Elev Factor  x  Scale Factor =   Combined Factor
KY2913!SPC OH N     -   0.99995369  x   0.99994619  =   0.99989988
KY2913!UTM  17      -   0.99995369  x   0.99962094  =   0.99957464
KY2913
KY2913_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF5875622451(NAD 83)
KY2913
KY2913                          SUPERSEDED SURVEY CONTROL
KY2913
KY2913  NAD 83(2007)-  40 51 07.46165(N)    081 29 21.50333(W) AD(2002.00) 0
KY2913  ELLIP H (02/10/07)  295.273  (m)                       GP(2002.00)
KY2913  NAD 83(1995)-  40 51 07.46166(N)    081 29 21.50337(W) AD(       ) A
KY2913  ELLIP H (09/23/04)  295.274  (m)                       GP(       ) 4 1
KY2913  NAVD 88 (09/23/04)  328.4    (m)  GEOID03 model used   GPS OBS
KY2913  NGVD 29 (06/03/92)  328.727  (m)         1078.50   (f) ADJUSTED    1 2
KY2913
KY2913.Superseded values are not recommended for survey control.
KY2913
KY2913.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY2913.See file dsdata.pdf to determine how the superseded data were derived.
KY2913
KY2913_MARKER: F = FLANGE-ENCASED ROD
KY2913_SETTING: 49 = STAINLESS STEEL ROD W/O SLEEVE (10 FT.+)
KY2913_STAMPING: Y 337 1983
KY2913_MARK LOGO: NGS
KY2913_PROJECTION: FLUSH
KY2913_MAGNETIC: N = NO MAGNETIC MATERIAL
KY2913_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY2913_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
KY2913+SATELLITE: SATELLITE OBSERVATIONS - November 14, 2018
KY2913_ROD/PIPE-DEPTH: 9.4  meters
KY2913
KY2913  HISTORY     - Date     Condition        Report By
KY2913  HISTORY     - 1983     MONUMENTED       NGS
KY2913  HISTORY     - 19930422 GOOD             OHDT
KY2913  HISTORY     - 2003     GOOD             OH-151
KY2913  HISTORY     - 20091227 GOOD             GEOCAC
KY2913  HISTORY     - 20161112 GOOD             USPSQD
KY2913  HISTORY     - 20181114 GOOD             USPSQD
KY2913
KY2913                          STATION DESCRIPTION
KY2913
KY2913'DESCRIBED BY NATIONAL GEODETIC SURVEY 1983
KY2913'6.5 KM (4.05 MI) NORTH FROM MASSILLON.
KY2913'6.5 KM (4.05 MI) NORTH ALONG STATE HIGHWAY 241 FROM THE JUNCTION OF
KY2913'STATE HIGHWAY 172 (LINCOLN WAY) IN MASSILLON TO THE MARK ON THE LEFT,
KY2913'ON THE EAST SIDE OF THE SHADY HOLLOW COUNTRY CLUB SIGN, ALSO 9.9 KM
KY2913'(6.2 MI) SOUTH ALONG STATE HIGHWAY 241 FROM THE POST OFFICE IN
KY2913'GREENSBURG, 10.21 METERS (33.5 FT) WEST OF THE CENTERLINE OF THE
KY2913'HIGHWAY, 3.35 METERS (11.0 FT) SOUTHEAST OF THE NORTH FLOOD LIGHT FOR
KY2913'THE SIGN, 0.30 METER (1.0 FT) EAST OF THE EAST END OF THE SIGN.
KY2913'THE MARK IS 0.91 M ABOVE HIGHWAY.
KY2913
KY2913                          STATION RECOVERY (1993)
KY2913
KY2913'RECOVERY NOTE BY OHIO DEPARTMENT OF TRANSPORTATION 1993 (BM)
KY2913'----REPORT BY ODOT ------YEAR 1993-------CONDITION - GOOD--------
KY2913
KY2913                          STATION RECOVERY (2003)
KY2913
KY2913'RECOVERY NOTE BY STARK COUNTY OHIO 2003 (BW)
KY2913'RECOVERED AS DESCRIBED.
KY2913
KY2913                          STATION RECOVERY (2009)
KY2913
KY2913'RECOVERY NOTE BY GEOCACHING 2009 (RLM)
KY2913'RECOVERED IN GOOD CONDITION.
KY2913
```

```
KY2913                          STATION RECOVERY (2016)
KY2913
KY2913'RECOVERY NOTE BY US POWER SQUADRON 2016 (JTH)
KY2913'RECOVERED IN GOOD CONDITION.
KY2913
KY2913                          STATION RECOVERY (2018)
KY2913
KY2913'RECOVERY NOTE BY US POWER SQUADRON 2018 (TJH)
KY2913'RECOVERED IN GOOD CONDITION.
```

```
KY1263 ***********************************************************************
KY1263  DESIGNATION -  Q 305
KY1263  PID         -  KY1263
KY1263  STATE/COUNTY-  OH/STARK
KY1263  COUNTRY     -  US
KY1263  USGS QUAD   -  CANTON EAST (1985)
KY1263
KY1263                         *CURRENT SURVEY CONTROL
KY1263  ______________________________________________________________________
KY1263* NAD 83(1986) POSITION- 40 47 58.8    (N) 081 21 31.4    (W)   HD_HELD2
KY1263* NAVD 88 ORTHO HEIGHT -   316.174 (meters)     1037.31  (feet) ADJUSTED
KY1263  ______________________________________________________________________
KY1263  GEOID HEIGHT    -        -33.317 (meters)                     GEOID12B
KY1263  DYNAMIC HEIGHT  -        316.024 (meters)     1036.82  (feet) COMP
KY1263  MODELED GRAVITY -    980,141.9   (mgal)                       NAVD 88
KY1263
KY1263  VERT ORDER      -  FIRST     CLASS I
KY1263
KY1263.The horizontal coordinates were established by autonomous hand held GPS
KY1263.observations and have an estimated accuracy of +/- 10 meters.
KY1263.
KY1263.The orthometric height was determined by differential leveling and
KY1263.adjusted by the NATIONAL GEODETIC SURVEY
KY1263.in June 1991.
KY1263
KY1263.Significant digits in the geoid height do not necessarily reflect accuracy.
KY1263.GEOID12B height accuracy estimate available here.
KY1263
KY1263.Photographs are available for this station.
KY1263
KY1263.The dynamic height is computed by dividing the NAVD 88
KY1263.geopotential number by the normal gravity value computed on the
KY1263.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY1263.degrees latitude (g = 980.6199 gals.).
KY1263
KY1263.The modeled gravity was interpolated from observed gravity values.
KY1263
KY1263;                    North         East    Units  Estimated Accuracy
KY1263;SPC OH N     -   126,445.      696,304.      MT  (+/- 10 meters HH2 GPS)
KY1263
KY1263_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF6973916580(NAD 83)
KY1263
KY1263                          SUPERSEDED SURVEY CONTROL
KY1263
KY1263  NGVD 29 (??/??/92)  316.360  (m)         1037.92   (f) ADJ UNCH    1 1
KY1263
KY1263.Superseded values are not recommended for survey control.
KY1263
KY1263.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY1263.See file dsdata.pdf to determine how the superseded data were derived.
KY1263
KY1263_MARKER: DB = BENCH MARK DISK
KY1263_SETTING: 36 = SET IN A MASSIVE STRUCTURE
KY1263_SP_SET: ABUTMENT
KY1263_STAMPING: Q 305 1966
KY1263_MARK LOGO: CGS
KY1263_MAGNETIC: O = OTHER; SEE DESCRIPTION
KY1263_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY1263_SATELLITE: THE SITE LOCATION WAS REPORTED AS NOT SUITABLE FOR
KY1263+SATELLITE: SATELLITE OBSERVATIONS - April 24, 2018
KY1263
KY1263  HISTORY     - Date     Condition        Report By
KY1263  HISTORY     - 1966     MONUMENTED       CGS
KY1263  HISTORY     - 19911122 GOOD             OHDT
KY1263  HISTORY     - 20041106 GOOD             USPSQD
KY1263  HISTORY     - 20100320 GOOD             GEOCAC
KY1263  HISTORY     - 20180424 GOOD             USPSQD
KY1263
KY1263                          STATION DESCRIPTION
KY1263
KY1263'DESCRIBED BY COAST AND GEODETIC SURVEY 1966
```

```
KY1263'AT CANTON.
KY1263'AT CANTON, ABOUT 1.1 MILES EAST ALONG THE PENNSYLVANIA RAILROAD
KY1263'FROM THE STATION AT CANTON, ABOUT 0.3 MILE EAST OF MILEPOST
KY1263'101, ABOUT 112 YARDS NORTHEAST OF THE CROSSING OF 6 TH STREET
KY1263'NORTHEAST, SET IN THE TOP OF THE NORTHWEST END OF THE SOUTHWEST
KY1263'STONE ABUTMENT OF A BRIDGE OVER THE NIMISHILLEN CREEK, 12 FEET
KY1263'NORTHWEST OF THE NORTHWEST RAIL OF THE NEAR TRACK, 6 FEET
KY1263'SOUTHEAST OF THE NORTHWEST END OF THE ABUTMENT AND 4 FEET
KY1263'BELOW THE LEVEL OF THE TRACK.  IN SECTION 10, R 8 W, T 10 N.
KY1263
KY1263                          STATION RECOVERY (1991)
KY1263
KY1263'RECOVERY NOTE BY OHIO DEPARTMENT OF TRANSPORTATION 1991 (PT)
KY1263'----- REPORT BY ODOT ---------1991---------- CONDITION - GOOD -------
KY1263
KY1263                          STATION RECOVERY (2004)
KY1263
KY1263'RECOVERY NOTE BY US POWER SQUADRON 2004
KY1263'LOCATED ON THE NW SIDE OF THE NORTH STONE ABUTMENT OF NIMISHILLEN
KY1263'CREEK.
KY1263
KY1263                          STATION RECOVERY (2010)
KY1263
KY1263'RECOVERY NOTE BY GEOCACHING 2010 (RLM)
KY1263'RECOVERED IN GOOD CONDITION. THE MARK IS IN THE NORTHWEST STONE
KY1263'ABUTMENT OF THE RAILROAD BRIDGE OVER NIMISHILLEN CREEK.
KY1263
KY1263                          STATION RECOVERY (2018)
KY1263
KY1263'RECOVERY NOTE BY US POWER SQUADRON 2018 (TJH)
KY1263'RECOVERED IN GOOD CONDITION.
```

```
KY1267 ***********************************************************************
KY1267  DESIGNATION -  N 305
KY1267  PID         -  KY1267
KY1267  STATE/COUNTY-  OH/STARK
KY1267  COUNTRY     -  US
KY1267  USGS QUAD   -  CANTON WEST (1985)
KY1267
KY1267                         *CURRENT SURVEY CONTROL
KY1267  ______________________________________________________________________
KY1267* NAD 83(1986) POSITION- 40 47 49.1    (N) 081 22 38.3    (W)   HD_HELD2
KY1267* NAVD 88 ORTHO HEIGHT -   321.598 (meters)     1055.11  (feet) ADJUSTED
KY1267  ______________________________________________________________________
KY1267  GEOID HEIGHT    -        -33.302 (meters)                     GEOID12B
KY1267  DYNAMIC HEIGHT  -        321.446 (meters)     1054.61  (feet) COMP
KY1267  MODELED GRAVITY -    980,142.6   (mgal)                       NAVD 88
KY1267
KY1267  VERT ORDER      -  FIRST     CLASS I
KY1267
KY1267.The horizontal coordinates were established by autonomous hand held GPS
KY1267.observations and have an estimated accuracy of +/- 10 meters.
KY1267.
KY1267.The orthometric height was determined by differential leveling and
KY1267.adjusted by the NATIONAL GEODETIC SURVEY
KY1267.in June 1991.
KY1267
KY1267.Significant digits in the geoid height do not necessarily reflect accuracy.
KY1267.GEOID12B height accuracy estimate available here.
KY1267
KY1267.Photographs are available for this station.
KY1267
KY1267.The dynamic height is computed by dividing the NAVD 88
KY1267.geopotential number by the normal gravity value computed on the
KY1267.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY1267.degrees latitude (g = 980.6199 gals.).
KY1267
KY1267.The modeled gravity was interpolated from observed gravity values.
KY1267
KY1267;                    North         East    Units  Estimated Accuracy
KY1267;SPC OH N     -   126,126.      694,740.      MT  (+/- 10 meters HH2 GPS)
KY1267
KY1267_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF6817016287(NAD 83)
KY1267
KY1267                          SUPERSEDED SURVEY CONTROL
KY1267
KY1267  NGVD 29 (??/??/92)  321.786  (m)         1055.73   (f) ADJ UNCH    1 1
KY1267
KY1267.Superseded values are not recommended for survey control.
KY1267
KY1267.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY1267.See file dsdata.pdf to determine how the superseded data were derived.
KY1267
KY1267_STAMPING: N 305 1966
KY1267_MARK LOGO: CGS
KY1267
KY1267  HISTORY     - Date     Condition        Report By
KY1267  HISTORY     - 1966     MONUMENTED       CGS
KY1267  HISTORY     - 19930422 GOOD             OHDT
KY1267  HISTORY     - 19981031 GOOD             USPSQD
KY1267  HISTORY     - 20000804 GOOD             AEP
KY1267  HISTORY     - 20051105 GOOD             USPSQD
KY1267  HISTORY     - 20060627 GOOD             GEOCAC
KY1267  HISTORY     - 20070310 GOOD             USPSQD
KY1267  HISTORY     - 20160402 GOOD             USPSQD
KY1267  HISTORY     - 20180424 MARK NOT FOUND   USPSQD
KY1267
KY1267                          STATION DESCRIPTION
KY1267
KY1267'DESCRIBED BY COAST AND GEODETIC SURVEY 1966
KY1267'AT CANTON.
KY1267'AT CANTON, AT THE INTERSECTION OF CLEVELAND AVENUE AND FOURTH
KY1267'STREET SOUTHWEST, AT THE SOUTHWEST CORNER OF THE OHIO POWER
```

```
KY1267'COMPANY BUILDING, (A THREE STORIED BRICK BUILDING), SET IN THE
KY1267'TOP OF THE WEST END OF THE SOUTH WALL OF THE AIR VENT TO THE
KY1267'UNDERGROUND TRANSFORMERS (THE VENT IS 40 FEET LONG- 8 FEET WIDE
KY1267'AND 15 FEET DEEP) 65 FEET NORTH OF THE NORTH CURB OF 4 TH STREET
KY1267'SW, 15 FEET WEST OF THE WEST CURB LINE OF CLEVELAND AVENUE, 5
KY1267'FEET NORTH OF THE SOUTHEAST CORNER OF THE BUILDING AND ABOUT
KY1267'LEVEL WITH CONCRETE SIDEWALK.
KY1267
KY1267                          STATION RECOVERY (1993)
KY1267
KY1267'RECOVERY NOTE BY OHIO DEPARTMENT OF TRANSPORTATION 1993 (BM)
KY1267'-----REPORT BY ODOT-----YEAR 1993---------CONDITION-GOOD-----------
KY1267
KY1267                          STATION RECOVERY (1998)
KY1267
KY1267'RECOVERY NOTE BY US POWER SQUADRON 1998
KY1267'RECOVERED IN GOOD CONDITION.
KY1267
KY1267                          STATION RECOVERY (2000)
KY1267
KY1267'RECOVERY NOTE BY AMERICAN ELECTRIC POWER 2000 (MAB)
KY1267'NOTES
KY1267'1. THE BUILDING IS NOW A FIVE STORIED BUILDING (1970) AND THE NAME HAS
KY1267'BEEN CHANGED TO THE AMERICAN ELECTRIC POWER BUILDING (1996). IT IS
KY1267'LOCATED DIRECTLY ACROSS AND SOUTH OF THIRD STREET SOUTHWEST FROM THE
KY1267'FRANK T. BOW FEDERAL BUILDING.
KY1267'2. THE CORNER ON WHICH THE BM IS LOCATED SHOULD CHANGED TO READ 'AT
KY1267'THE SOUTHEAST CORNER OF THE AMERICAN ELECTRIC POWER BUILDING...'
KY1267
KY1267                          STATION RECOVERY (2005)
KY1267
KY1267'RECOVERY NOTE BY US POWER SQUADRON 2005
KY1267'RECOVERED IN GOOD CONDITION.
KY1267
KY1267                          STATION RECOVERY (2006)
KY1267
KY1267'RECOVERY NOTE BY GEOCACHING 2006 (RLM)
KY1267'RECOVERED AS DESCRIBED.
KY1267
KY1267                          STATION RECOVERY (2007)
KY1267
KY1267'RECOVERY NOTE BY US POWER SQUADRON 2007
KY1267'RECOVERED IN GOOD CONDITION.
KY1267
KY1267                          STATION RECOVERY (2016)
KY1267
KY1267'RECOVERY NOTE BY US POWER SQUADRON 2016 (JTH)
KY1267'RECOVERED IN GOOD CONDITION.
KY1267
KY1267                          STATION RECOVERY (2018)
KY1267
KY1267'RECOVERY NOTE BY US POWER SQUADRON 2018 (TJH)
KY1267'MARK PRESUMED DESTROYED WITH THE REPLACEMENT OF SIDEWALK AND AIR VENT.
```

```
KY1270 ***********************************************************************
KY1270  DESIGNATION -  S 305
KY1270  PID         -  KY1270
KY1270  STATE/COUNTY-  OH/STARK
KY1270  COUNTRY     -  US
KY1270  USGS QUAD   -  CANTON WEST (1985)
KY1270
KY1270                         *CURRENT SURVEY CONTROL
KY1270  ______________________________________________________________________
KY1270* NAD 83(1986) POSITION- 40 47 13.83   (N) 081 23 43.53   (W)   HD_HELD1
KY1270* NAVD 88 ORTHO HEIGHT -   319.055 (meters)     1046.77  (feet) ADJUSTED
KY1270  ______________________________________________________________________
KY1270  GEOID HEIGHT    -        -33.287 (meters)                     GEOID12B
KY1270  DYNAMIC HEIGHT  -        318.904 (meters)     1046.27  (feet) COMP
KY1270  MODELED GRAVITY -    980,143.1   (mgal)                       NAVD 88
KY1270
KY1270  VERT ORDER      -  FIRST     CLASS I
KY1270
KY1270.The horizontal coordinates were determined by differentially corrected
KY1270.hand held GPS observations or other comparable positioning techniques
KY1270.and have an estimated accuracy of +/- 3 meters.
KY1270.
KY1270.The orthometric height was determined by differential leveling and
KY1270.adjusted by the NATIONAL GEODETIC SURVEY
KY1270.in June 1991.
KY1270
KY1270.Significant digits in the geoid height do not necessarily reflect accuracy.
KY1270.GEOID12B height accuracy estimate available here.
KY1270
KY1270.The dynamic height is computed by dividing the NAVD 88
KY1270.geopotential number by the normal gravity value computed on the
KY1270.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY1270.degrees latitude (g = 980.6199 gals.).
KY1270
KY1270.The modeled gravity was interpolated from observed gravity values.
KY1270
KY1270;                    North         East     Units  Estimated Accuracy
KY1270;SPC OH N     -   125,018.1     693,224.9     MT  (+/- 3 meters HH1 GPS)
KY1270
KY1270_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF6663715207(NAD 83)
KY1270
KY1270                          SUPERSEDED SURVEY CONTROL
KY1270
KY1270  NGVD 29 (??/??/92)  319.242  (m)         1047.38   (f) ADJ UNCH    1 1
KY1270
KY1270.Superseded values are not recommended for survey control.
KY1270
KY1270.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY1270.See file dsdata.pdf to determine how the superseded data were derived.
KY1270
KY1270_MARKER: DB = BENCH MARK DISK
KY1270_SETTING: 46 = COPPER-CLAD STEEL ROD W/O SLEEVE (10 FT.+)
KY1270_STAMPING: S 305 1966
KY1270_MARK LOGO: CGS
KY1270_MAGNETIC: O = OTHER; SEE DESCRIPTION
KY1270_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY1270_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
KY1270+SATELLITE: SATELLITE OBSERVATIONS - January 10, 2010
KY1270
KY1270  HISTORY     - Date     Condition        Report By
KY1270  HISTORY     - 1966     MONUMENTED       CGS
KY1270  HISTORY     - 19911129 GOOD             OHDT
KY1270  HISTORY     - 20070325 POOR             USPSQD
KY1270  HISTORY     - 20100110 GOOD             GEOCAC
KY1270  HISTORY     - 20110713 GOOD             JCLS
KY1270
KY1270                          STATION DESCRIPTION
KY1270
KY1270'DESCRIBED BY COAST AND GEODETIC SURVEY 1966
KY1270'AT CANTON.
KY1270'AT CANTON, ABOUT 1.0 MILE WEST ALONG THE PENNSYLVANIA RAILROAD
```

```
KY1270'FROM THE STATION, ABOUT 0.2 MILE EAST OF MILEPOST 103, IN
KY1270'SECTION 17, R 8 W, T 10 N, ABOUT 6 1/2 RAILS WEST OF THE CENTER
KY1270'OF THE CROSSING OF DUBBER AVENUE SW, NEAR THE NORTHEAST CORNER
KY1270'OF A STEEL FENCE AROUND A RESTRICTED AREA, 29.2 FEET SOUTH OF
KY1270'AND ACROSS A SIDE TRACK FROM THE SOUTH RAIL OF THE EASTBOUND
KY1270'TRACK, 16.5 FEET WEST OF A FENCE CORNER, 1.3 FEET NORTH OF
KY1270'EAST-WEST FENCE LINE, 0.7 FOOT EAST OF A METAL WITNESS POST,
KY1270'2 FEET BELOW THE LEVEL OF THE TRACK AND IS A DISK ON THE TOP
KY1270'OF A COPPER COATED STEEL ROD 0.3 FOOT UNDERGROUND AND PROTECTED
KY1270'BY A 6-INCH TILE WHICH IS FLUSH WITH THE GROUND.  THE ROD WAS
KY1270'DRIVEN TO A DEPTH OF 24 FEET.
KY1270
KY1270                          STATION RECOVERY (1991)
KY1270
KY1270'RECOVERY NOTE BY OHIO DEPARTMENT OF TRANSPORTATION 1991 (SJ)
KY1270'----- REPORT BY ODOT --------1991-------- CONDITION - GOOD ---------
KY1270
KY1270                          STATION RECOVERY (2007)
KY1270
KY1270'RECOVERY NOTE BY US POWER SQUADRON 2007
KY1270'MARK RECOVERED IN POOR CONDITION.
KY1270
KY1270                          STATION RECOVERY (2010)
KY1270
KY1270'RECOVERY NOTE BY GEOCACHING 2010 (RLM)
KY1270'RECOVERED IN GOOD CONDITION.  THE MARK IS ABOUT 260 FEET WEST OF THE
KY1270'CROSSING OF DUEBER AVENUE SW.
KY1270
KY1270                          STATION RECOVERY (2011)
KY1270
KY1270'RECOVERY NOTE BY JOHN CHANCE LAND SURVEYS INC 2011
KY1270'RECOVERED IN GOOD CONDITION.
```

```
KY2911 ***********************************************************************
KY2911  DESIGNATION -  X 337
KY2911  PID         -  KY2911
KY2911  STATE/COUNTY-  OH/STARK
KY2911  COUNTRY     -  US
KY2911  USGS QUAD   -  NORTH CANTON (1994)
KY2911
KY2911                         *CURRENT SURVEY CONTROL
KY2911  ______________________________________________________________________
KY2911* NAD 83(1986) POSITION- 40 53 36.8    (N) 081 28 40.5    (W)   HD_HELD2
KY2911* NAVD 88 ORTHO HEIGHT -   349.445 (meters)     1146.47  (feet) ADJUSTED
KY2911  ______________________________________________________________________
KY2911  GEOID HEIGHT    -        -33.231 (meters)                     GEOID12B
KY2911  DYNAMIC HEIGHT  -        349.286 (meters)     1145.95  (feet) COMP
KY2911  MODELED GRAVITY -    980,157.5   (mgal)                       NAVD 88
KY2911
KY2911  VERT ORDER      -  FIRST     CLASS II
KY2911
KY2911.The horizontal coordinates were established by autonomous hand held GPS
KY2911.observations and have an estimated accuracy of +/- 10 meters.
KY2911.
KY2911.The orthometric height was determined by differential leveling and
KY2911.adjusted by the NATIONAL GEODETIC SURVEY
KY2911.in June 1991.
KY2911
KY2911.Significant digits in the geoid height do not necessarily reflect accuracy.
KY2911.GEOID12B height accuracy estimate available here.
KY2911
KY2911.Photographs are available for this station.
KY2911
KY2911.The dynamic height is computed by dividing the NAVD 88
KY2911.geopotential number by the normal gravity value computed on the
KY2911.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KY2911.degrees latitude (g = 980.6199 gals.).
KY2911
KY2911.The modeled gravity was interpolated from observed gravity values.
KY2911
KY2911;                    North         East     Units  Estimated Accuracy
KY2911;SPC OH N     -   136,745.      686,125.      MT  (+/- 10 meters HH2 GPS)
KY2911
KY2911_U.S. NATIONAL GRID SPATIAL ADDRESS: 17TMF5974127050(NAD 83)
KY2911
KY2911                          SUPERSEDED SURVEY CONTROL
KY2911
KY2911  NGVD 29 (06/03/92)  349.635  (m)         1147.09   (f) ADJUSTED    1 2
KY2911
KY2911.Superseded values are not recommended for survey control.
KY2911
KY2911.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KY2911.See file dsdata.pdf to determine how the superseded data were derived.
KY2911
KY2911_MARKER: F = FLANGE-ENCASED ROD
KY2911_SETTING: 49 = STAINLESS STEEL ROD W/O SLEEVE (10 FT.+)
KY2911_STAMPING: X 337 1983
KY2911_MARK LOGO: NGS
KY2911_PROJECTION: FLUSH
KY2911_MAGNETIC: N = NO MAGNETIC MATERIAL
KY2911_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
KY2911_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
KY2911+SATELLITE: SATELLITE OBSERVATIONS - October 27, 2018
KY2911_ROD/PIPE-DEPTH: 7.9  meters
KY2911
KY2911  HISTORY     - Date     Condition        Report By
KY2911  HISTORY     - 1983     MONUMENTED       NGS
KY2911  HISTORY     - 19930416 GOOD             OHDT
KY2911  HISTORY     - 19991030 GOOD             USPSQD
KY2911  HISTORY     - 20091227 GOOD             GEOCAC
KY2911  HISTORY     - 20161204 GOOD             USPSQD
KY2911  HISTORY     - 20181027 GOOD             USPSQD
KY2911
KY2911                          STATION DESCRIPTION
```

```
KY2911
KY2911'DESCRIBED BY NATIONAL GEODETIC SURVEY 1983
KY2911'5.0 KM (3.10 MI) SOUTH FROM GREENSBURG.
KY2911'4.9 KM (3.05 MI) SOUTH ALONG STATE HIGHWAY 241 FROM THE POST OFFICE IN
KY2911'GREENSBURG, THENCE 0.08 KM (0.05 MI) WEST ALONG STRAUSSER ROAD TO THE
KY2911'MARK ON THE RIGHT, IN THE FRONT LAWN OF THE JACKSON TOWNSHIP VOLUNTEER
KY2911'FIRE DEPARTMENT, 7.16 METERS (23.5 FT) NORTH OF THE CENTERLINE OF
KY2911'STRAUSSER ROAD, 16.70 METERS (54.7 FT) SOUTH-SOUTHWEST OF THE
KY2911'SOUTHEAST CORNER OF THE BUILDING, 2.65 METERS (8.7 FT) NORTHWEST OF
KY2911'TELEPHONE POLE 98, 1.06 METERS (3.5 FT) SOUTHEAST OF THE SOUTHEAST
KY2911'CORNER OF THE CONCRETE BASE OF THE FLAGPOLE.
KY2911'THE MARK IS ABOVE LEVEL WITH STRAUSSER ROAD.
KY2911
KY2911                          STATION RECOVERY (1993)
KY2911
KY2911'RECOVERY NOTE BY OHIO DEPARTMENT OF TRANSPORTATION 1993 (MS)
KY2911'RECOVERED IN GOOD CONDITION.
KY2911
KY2911                          STATION RECOVERY (1999)
KY2911
KY2911'RECOVERY NOTE BY US POWER SQUADRON 1999
KY2911'RECOVERED IN GOOD CONDITION.
KY2911
KY2911                          STATION RECOVERY (2009)
KY2911
KY2911'RECOVERY NOTE BY GEOCACHING 2009 (RLM)
KY2911'RECOVERED IN GOOD CONDITION.
KY2911
KY2911                          STATION RECOVERY (2016)
KY2911
KY2911'RECOVERY NOTE BY US POWER SQUADRON 2016 (JTH)
KY2911'THE MARK IS 1 FT (0.3 M) NORTH OF METAL WITNESS POST.
KY2911
KY2911                          STATION RECOVERY (2018)
KY2911
KY2911'RECOVERY NOTE BY US POWER SQUADRON 2018 (TJH)
KY2911'RECOVERED IN GOOD CONDITION.
```

North Canton, 5.1 miles east of; 260 feet south of crossroads; 14 feet north and 17 feet east of centerline road at junction of T-road west; 3 feet east of power pole; in concrete post; standard tablet stamped “21 RHP 1956 1134”

Elevation (NGVD 29) 1134.129
Elevation (NAVD 88) 1133.525

North Industry, 0.2 mile east of, thence 0.7 mile north, thence 0.2 mile west; 0.2 mile west of Nimishillen Creek; in section 28, township 10 N, range 7 west; 400 feet east of State Highway 8; 105 feet south of 41st Street; 1 ft west of northwest corner of Canton South High School; in concrete post; standard tablet stamped “25 RHP 1956 1010”

Elevation (NGVD 29) 1182.766
Elevation (NAVD 88) 1182.152

North Canton, 3.6 miles east of thence 2.1 mile south along Middlebranch Road; at bridge over Middle Branch Nimishillen Creek; in northwest end of southwest concrete abutment; standard tablet stamped “35 RHP 1956 1064”

Elevation (NGVD 29) 1063.715
Elevation (NAVD 88) 1063.095