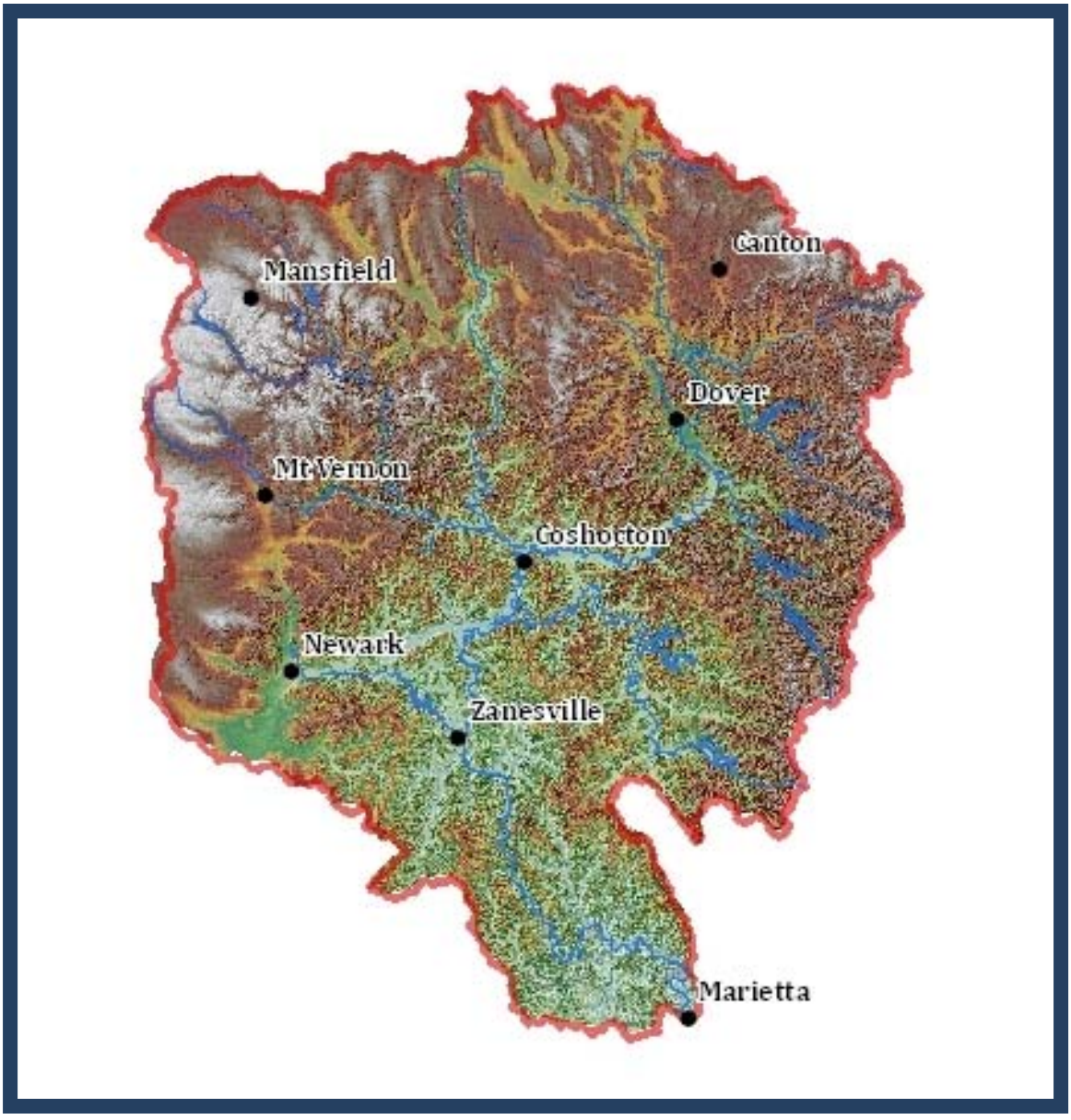
State of Ohio June 2012

DRAFT Muskingum River Basin Initial Watershed Assessment



US Army Corps of Engineers

Huntington District — Huntington, West Virginia

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ABBREVIATIONS

APAP — Agricultural Pollution Abatement Program (of Ohio)

BFE — Base Flood Elevation

BMP — Best Management Practice

CAP — Continuing Authorities Program

cfs — Cubic Feet Per Second

CREP — Conservation Reserve Enhancement Program

CRP — Conservation Reserve Program

CRS — Community Rating System

DOI — US Department of Interior

DSAC — Dam Safety Action Classification

EC — Engineering Circular

EPA — Environmental Protection Agency

ER — Engineering Regulation

FEMA — Federal Emergency Management Agency

FWA — Final Watershed Assessment

GIS — Geographic Information System

HAZUS — HAZards US

HUC — Hydrologic Unit Code

IWA — Initial Watershed Assessment

MWCD — Muskingum Watershed Conservancy District

NDCD — National Climatic Data Center

NFIP — National Flood Insurance Program

NOAA — National Oceanic and Atmospheric Administration

NPDES — National Pollutant Discharge Elimination System

NRCS —Natural Resources Conservation Service (of USDA)

OAC — Ohio Administrative Code

ODNR — Ohio Department of Natural Resources

ODOT — Ohio Department of Transportation

Penna — Penn Central Railroad Bridge

PWA — Public Works Administration

Recon Report — *Ohio River Basin Comprehensive Reconnaissance Report*

TMDL — Total Maximum Daily Loads

US — United States

USACE — US Army Corps of Engineers

USGS — US Geological Survey

WAMP — Watershed Assessment Management Plan

WRDA — Water Resources Development Act

WRP — Wetlands Reserve Program

WWTP — Wastewater Treatment Plant

EXECUTIVE SUMMARY

The *Ohio River Basin Comprehensive Reconnaissance Report* (commonly referred to as the "recon report"), which examined the entire Ohio River basin, was completed in December of 2009. That report identified problems, issues, and opportunities throughout the basin; formulated numerous alternatives for future studies; and recommended 20 separate actions. The report also recommended development of a programmatic management plan as well as an unspecified number of Initial Watershed Assessments (IWAs) throughout the Ohio River basin. One of those watershed assessments was assigned to the Muskingum River basin within the Huntington District of the Corps of Engineers.

During the development of the recon report and the collection of Geographic Information System (GIS) data to support the planning process, the basin was divided into 18 hydrologic sub-regions [each assigned a Hydrologic Unit Code (HUC) having four digits (HUC-4), per the naming convention of the US Geological Survey (USGS)]. These 18 regions were referred to as "sub-basins" in the recon report; thus, the recon report referred to the Muskingum River HUC-4 drainage area as the "Muskingum River sub-basin." However, this IWA will use the term "Muskingum River basin" (instead of "sub-basin") to identify the study area. Further, any additional reports prepared under the same authority as this IWA also will use the term "Muskingum River basin."

The Muskingum River basin lies entirely within the state of Ohio and encompasses all or portions of the following counties:

- Ashland
- Athens
- Belmont
- Carroll
- Columbiana
- Coshocton
- Fairfield
- Guernsey
- Harrison
- Holmes
- Knox
- Licking
- Medina
- Monroe
- Morgan
- Morrow
- Muskingum
- Noble
- Perry
- Portage
- Richland
- Stark
- Tuscarawas
- Washington
- Wayne

The drainage area associated with the Muskingum River basin is classified as a HUC-4 watershed and comprises approximately 8,000 square miles.

The authority to study issues related to water resources within the Muskingum River basin derived from two sources:

- A resolution (adopted May 16, 1955) of the US Senate Committee on Public Works.
- Section 729 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), which later was amended by Section 202 of WRDA 2000 and Section 2010 of WRDA 2007.

Throughout the development of this IWA, professional and technical judgment was employed to determine whether further Corps participation was warranted. Special attention was given to identifying problems and opportunities, defining existing conditions,

and developing potential alternatives. The water resource planning process outlined in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, 1983, generally was followed.

To better define problems, needs, and opportunities, a broad spectrum of stakeholders were engaged (ranging from Federal, state, and local government entities to nonprofit watershed associations). Overall, the primary concerns raised were related to water quality, flooding, and floodplain management.

This IWA recommends, based on stakeholder input and technical research, preparation of Watershed Assessment Management Plans and subsequent comprehensive watershed assessments for the following areas:

- Muskingum River basin
- Nimishillen Creek, Headwaters Tuscarawas River and Chippewa Creek sub-watersheds

The Muskingum Watershed Conservancy District has indicated willingness to participate in the watershed assessment for the Muskingum River basin as a non-Federal cost share partner. County and local officials in the Headwaters of the Tuscarawas River and Chippewa Creek sub-watersheds have indicated a willingness to participate in an in-depth watershed assessment; however, no non-Federal cost share partner has been identified.

1. STUDY AUTHORITY, APPLICABLE GUIDANCE, PROCESS, AND FUNDING

1.1 INTRODUCTION

The *Ohio River Basin Comprehensive Reconnaissance Report* (commonly referred to as the "recon report"), which examined the entire Ohio River basin, was completed in December of 2009. That report identified problems, issues, and opportunities throughout the basin; formulated numerous alternatives for future studies; and recommended 20 separate actions. The report also recommended development of a programmatic management plan as well as an unspecified number of Initial Watershed Assessments (IWAs) throughout the Ohio River basin. One of those watershed assessments was assigned to the Muskingum River basin within the Huntington District of the Corps of Engineers.

During the development of the recon report and the collection of Geographic Information System (GIS) data to support the planning process, the basin was divided into 18 hydrologic sub-regions [each assigned a Hydrologic Unit Code (HUC[1]) having four digits (HUC-4), per the naming convention of the US Geological Survey (USGS)]. These 18 regions were referred to as "sub-basins" in the recon report; thus, the recon report referred to the Muskingum River HUC-4 drainage area as the "Muskingum River sub-basin." However, this IWA will use the term "Muskingum River basin" (instead of "sub-basin") to identify the study area. Further, any additional reports prepared under the same authority as this IWA also will use the term "Muskingum River basin."

1.2 STUDY AUTHORITY

The authority to study issues related to water resources within the Muskingum River basin derives from two sources (see Appendix B):

- A resolution (adopted May 16, 1955) of the US Senate Committee on Public Works.
- Section 729 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), which later was amended by Section 202 of WRDA 2000 and Section 2010 of WRDA 2007.

In general terms, Section 729, as amended, allows USACE to assess the water-resources needs of entire river basins and watersheds of the United States, in consultation with appropriate Federal, state, and local agencies and stakeholders:

> *"The Secretary may assess the water resources needs of river basins and watersheds of the United States, including needs relating to ecosystem protection and restoration; flood damage reduction; navigation and ports; watershed protection; water supply; and drought preparedness."*

[1] Watersheds in the United States and the Caribbean were delineated by the US Geological Survey using a national standard hierarchical system (based on surface hydrologic features) and are identified by unique hydrologic unit codes (HUCs).

In contrast to most traditional USACE plans, which typically identify a USACE project (usually for flood damage reduction, erosion control, or navigation), the watershed plan will make a series of recommendations that may or may not identify a specific USACE project.

1.3 APPLICABLE GUIDANCE

Engineering Regulation (ER) 1105-2-100, *The Planning Guidance Notebook*, governs the overall direction by which USACE civil works projects are formulated, evaluated, and recommended for implementation. In addition to describing the Corps' missions and programs, planning process, and applicable policies, ER 1105-2-100 provides clear guidance regarding preparation and review of decision documents.

While ER 1105-2-100 served as the primary resource for development of this report, Engineering Circular (EC) 1105-2-411, *Watershed Plans*, served as the foundation for applying a comprehensive watershed approach. Watershed planning (1) addresses problems, needs, and opportunities within a watershed or regional context; (2) strives to achieve integrated water resources management; and (3) results generally in non-project specific, holistic plans or strategies to address watershed needs. Watershed planning goes beyond planning for specific Corps projects and focuses on comprehensive and strategic evaluations, analyses, and solutions. In addition, EC 1105-2-411 broadens the planning horizon to address issues pertaining to both land and water resources as well as the multiple, interconnected systems that frequently come into play within watersheds. Watershed planning may consider:

- river and drainage systems;
- geomorphic and subterranean systems;
- weather (including climate change);
- transportation systems;
- power grids;
- water supply and wastewater systems;
- economic systems;
- recreation systems;
- institutional systems and legal frameworks;
- regulatory frameworks;
- floodplain management;
- ecosystems;
- water management systems;
- navigation systems;
- human resources; and
- any other system pertinent to the needs of the watershed effort.

This "broadening" of traditional emphases on water resources provides opportunities to assess the complex interactions of the landscape and both surface water systems and sub-surface water systems at work in the watershed.

1.4 PROCESS

Two report phases lead to the development of a Watershed Management Plan. The first phase, which involves the development of an IWA (documented in this report), is similar to a traditional reconnaissance-level planning phase. The second phase, which involves development of a Final Watershed Assessment (FWA), is similar to a traditional feasibility-level planning phase.

ER 1105-2-100 defines a six-step planning process that provides a systematic approach to problem solving and a rational framework for sound decision-making. The iterative planning process is designed not only to stimulate creative thought and generate innovative solutions but also to accommodate dynamic problems and opportunities. The steps include:

1. identifying problems and opportunities;
2. inventorying and forecasting conditions;
3. formulating alternative plans;
4. evaluating alternative plans;
5. comparing alternative plans; and
6. selecting a plan.

EC 1105-2-411 defines a watershed planning process that is similar to the conventional two-step (reconnaissance and feasibility study) approach to Corps decision documents. The watershed planning process essentially follows the same six-step planning process defined in ER 1105-2-100 (Section 8 of EC 1105-2-411 indentifies those six planning steps). However, watershed planning conducted under EC 1105-2-411 goes beyond the evaluation of a specific Corps project and moves toward a more comprehensive and strategic plan for managing land and water resources and addressing problems through a holistic process (that is, one that reflects the interdependency of land and water uses, competing demands, and the desires of a wide range of stakeholders). Such integrated watershed approaches often span diverse political, geographic, physical, institutional, technical, and stakeholder considerations and are valuable to both project planning and watershed planning.

1.5 STAKEHOLDER INVOLVEMENT

To better define problems, needs, and opportunities, a broad spectrum of stakeholders were engaged (ranging from Federal, state, and local government entities to nonprofit watershed associations). Six separate stakeholders meetings were held throughout the

basin during the week of June 28, 2011, to accommodate the basin's large size and variety of water-resources issues. The meetings were held at the following locations (see Figure 1):

- Loudonville, Ohio (June 28, 2011)
- New Philadelphia, Ohio (June 29, 2011)
- Canton, Ohio (June 29, 2011)
- Zanesville, Ohio (June 30, 2011)
- Granville, Ohio (June 30, 2011)
- Marietta, Ohio (July 1, 2011)

During each of the stakeholder meetings, the Huntington District presented an overview of the basin and spoke about programs and projects that could address problems and opportunities. Afterward, attendees were invited to discuss issues pertaining to land and water resources. The meetings were well attended and stimulated dialogue about problems and solutions among participants as well as the District. All concerns voiced by attendees were documented and included in this IWA (Appendix E contains notes from the stakeholders meetings).

1.6 FUNDING

This IWA was conducted at full Federal expense and limited to $100,000 (per EC 1105-2-411 guidance). Should the study move forward to the next phase, a non-Federal sponsor would be required to provide cash or work in kind that satisfies 25% of the total phase two study costs. During preparation of the FWA, the total amount of required non-Federal contribution may be provided by work-in-kind contributions, as described in a jointly prepared Watershed Assessment Management Plan (WAMP).

2. STUDY PURPOSE

The IWA phase has several primary purposes, the first of which is to determine whether stakeholders have sufficient interest to proceed to an FWA. Specifically, the purposes of an IWA include:

- identify a non-Federal sponsor;
- define the scope and objective(s) of the Section 729 Assessment;
- prepare a WAMP; and
- negotiate a cost-sharing agreement.

Figure 1 – Map of Stakeholder Meeting Locations

The IWA phase also identifies watershed problems, needs, and opportunities within the Muskingum River basin, through stakeholder outreach. The IWA serves as the basis for a comprehensive Final Watershed Assessment and Watershed Plan, which provides strategic guidance to watershed management from a system-wide approach.

The WAMP is analogous to a Project Management Plan (PMP) that is prepared for all USACE studies and projects. The WAMP outlines in considerable detail the tasks and costs associated with conducting a detailed assessment of the Muskingum River basin.

3. STUDY AREA AND CONGRESSIONAL DISTRICTS

3.1 GENERAL

In accordance with EC 1105-2-411 and Corps of Engineers Policy Guidance Letter #61, dated January 1999, watershed planning focuses on a specific watershed (a geographic area defined by a drainage basin and often described using the USGS's HUC system). Defining the appropriate watershed size or study area is critical; the study area needs to be broad enough to:

- Capture the impacts and influences of problems and likely solutions for the significant resources under study, to ensure complete analysis of potential impacts and interactions.
- Identify regional man-made and natural systems and assess complex interactions that influence the use and development of land and water resources.

EC 1105-2-411 suggests using the "hydrologic cataloguing units" (8-digit HUC watersheds) as the basic planning unit for watershed assessments, but unique conditions within the basin, and the needs of the sponsor and public, may dictate a departure from that basic planning unit for study purposes. The Muskingum River basin encompasses six HUC-8 watersheds, described in more detail below.

3.2 STUDY AREA

As seen in Figure 2 and Figure 3, the Muskingum River basin lies in the eastern portion of Ohio, covering about 1/5 of the state. The Muskingum River is the largest stream in the state and drains 8,038 square miles. The drainage area, classified as a HUC-4 watershed (0504), has an extreme width of about 100 miles from east to west and a length of 120 miles from north to south.

The Muskingum River itself forms at the confluence of the Walhonding and Tuscarawas Rivers (near Coshocton) and flows 112 miles to the south and east, entering the Ohio River at Marietta. The principal tributaries of the river are the Walhonding, Tuscarawas, and Licking Rivers, and Wills Creek; smaller tributaries include Moxahala Creek, Wakatomika Creek, and Wolf Creek.

Figure 2 – Location of the Muskingum River Basin

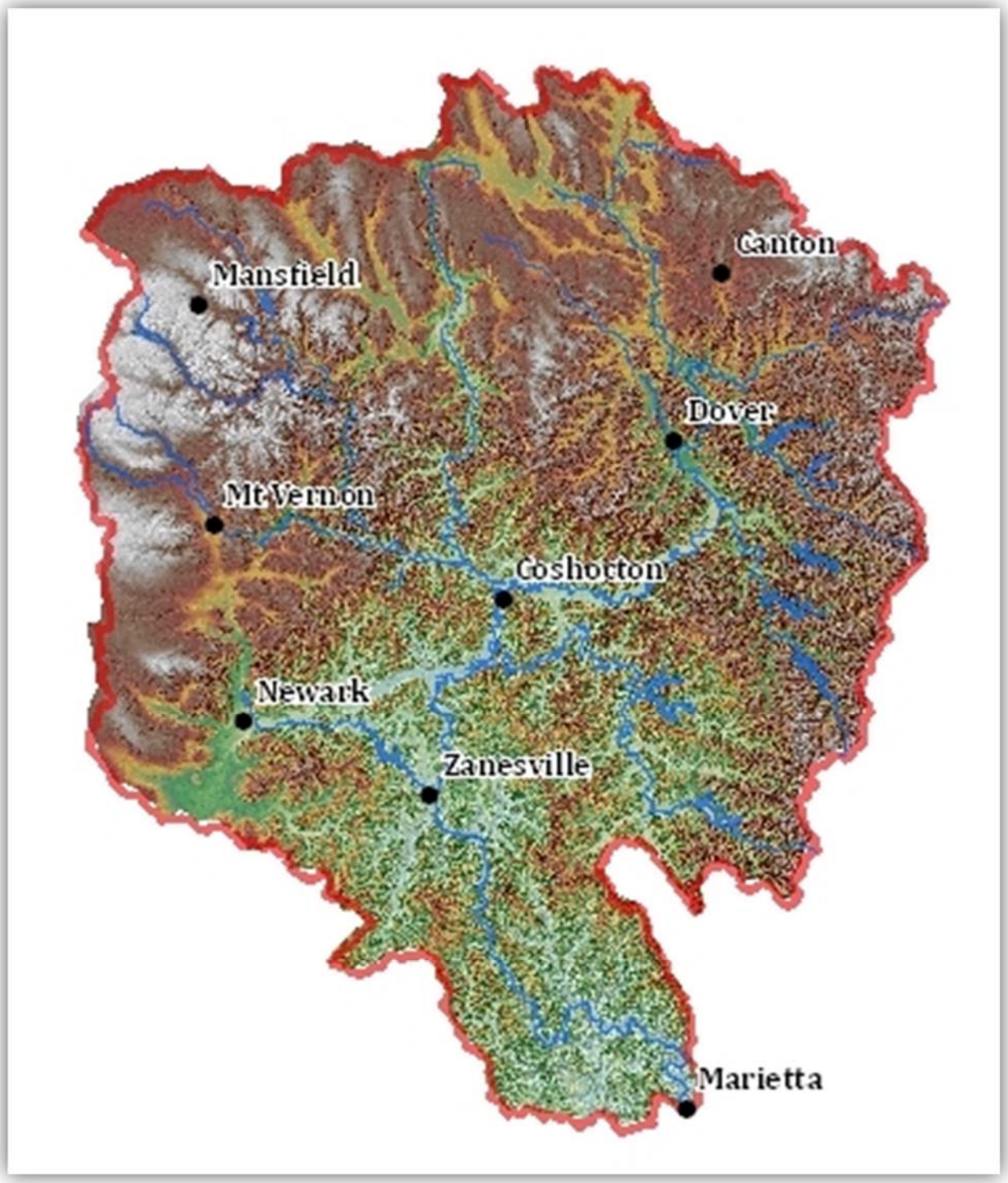


Figure 3 – Muskingum River Basin

The Walhonding River drains 2,252 square miles north and west of Coshocton; the Tuscarawas River drains 2,590 square miles north and east of Coshocton; the Licking River drains 780 square miles of the west central part of the watershed; and Wills Creek drains 853 square miles of the east-central part of the watershed.

The banks of the Muskingum River average about 20 to 30 feet in height, with extreme variations from less than 10 feet to more than 60 feet. The width between banks varies between 300 and 1,000 feet. From its source at Coshocton to its mouth at Marietta, the Muskingum River has a total fall of about 160 feet, or an average slope of about 1.4 feet per mile. The flows at the mouth approximate the following:

- Minimum flow at mouth = 250 cubic feet per second (cfs).
- Mean flow at mouth = 8,000 cfs.
- Maximum flow at mouth = 276,000 cfs.

The mean annual precipitation throughout the watershed averages slightly greater than 39 inches. June and July ordinarily have the greatest precipitation, but March and April are the normal high water months (largely because the basin receives ample snowmelt during those months).

As previously stated, the Muskingum River basin lies entirely within the state of Ohio and encompasses portions of, or all of, the following counties (see Table 1):

- Ashland
- Athens
- Belmont
- Carroll
- Columbiana
- Coshocton
- Fairfield
- Guernsey
- Harrison
- Holmes
- Knox
- Licking
- Medina
- Monroe
- Morgan
- Morrow
- Muskingum
- Noble
- Perry
- Portage
- Richland
- Stark
- Tuscarawas
- Washington
- Wayne

The Muskingum River basin is a HUC-4 watershed, which breaks down into six HUC-8 watersheds (see Figure 4):

1. Tuscarawas River watershed (05040001)
2. Mohican River watershed (05040002)
3. Walhonding River watershed (05040003)
4. Muskingum River watershed (05040004)
5. Wills Creek watershed (05040005)
6. Licking River watershed (05040006)

The larger of the two primary tributaries of the Muskingum River, the Tuscarawas River, forms southwest of Hartville in northern Stark County (see Table 1) and flows westward

through Uniontown and into southern Summit County. It then runs to the south of Akron and the city of Barberton, where it turns southward to continue its run through Stark and Tuscarawas Counties, including the towns of Clinton, Canal Fulton, Massillon, Navarre, Bolivar, Zoar, Dover, and New Philadelphia. Once past New Philadelphia, it bends southwest once more, flowing past Tuscarawas, Gnadenhutten, Port Washington, and New Comerstown in Coshocton County, to meet the Walhonding River (for a total of 129 river miles).

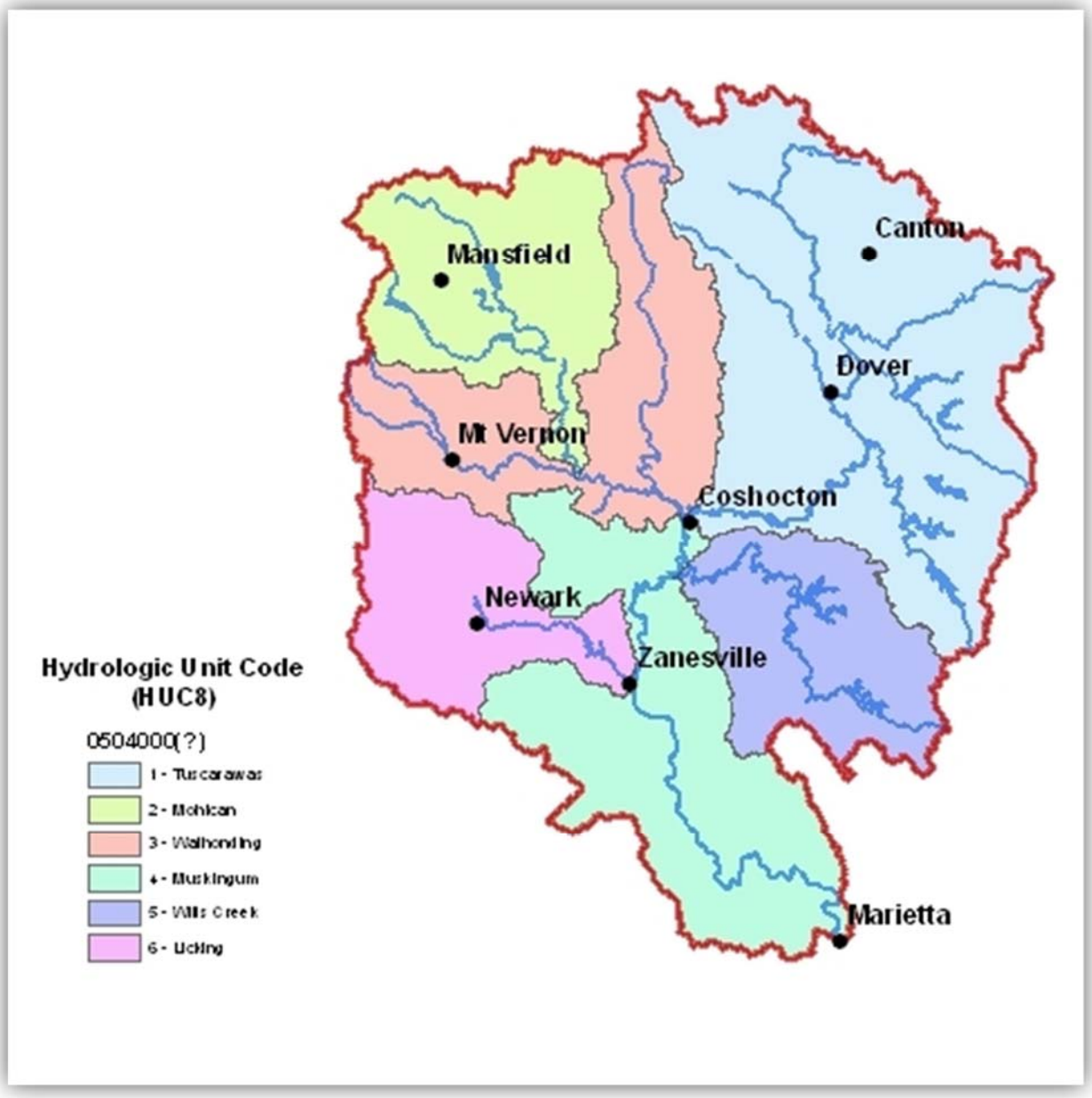


Figure 4 – HUC-8 Watersheds in the Muskingum River Basin

Table 1 – Counties Contributing to the Muskingum River Basin

County	Square Miles in Basin	Percent in Basin	County	Square Miles in Basin	Percent in Basin
Ashland	335	82.2	Monroe	41	8.6
Athens	4	0.6	Morgan	383	83.1
Belmont	118	21.7	Morrow	150	34.6
Carroll	333	79.3	Muskingum	691	100
Columbiana	51	9.7	Noble	219	52.2
Coshocton	574	100	Perry	171	43.2
Crawford	6	1.5	Portage	2	0.4
Fairfield	19	4.1	Richland	443	88.2
Guernsey	540	99.2	Stark	423	87.6
Harrison	317	73.2	Summit	91	37.5
Holmes	452	100	Tuscarawas	588	100
Knox	538	98.9	Washington	230	34.6
Licking	626	93.7	Wayne	566	100
Medina	140	33.9			

The other primary tributary of the Muskingum River is the Walhonding River (which is much smaller than the Tuscarawas River, measuring 23 river miles). The Walhonding, located entirely in Coshocton County, forms at the confluence of the Mohican and Kokosing Rivers and flows east to southeast through the towns of Nellie and Warsaw, to meet the Tuscarawas River at Coshocton — forming the Muskingum River.

The Muskingum River itself flows a meandering course south through Conesville, Trinway, and Dresden to Zanesville, where it turns southeast to run past South Zanesville, Philo, Malton, McConnelsville, Beverely, Lowell, Stockport, and Divola. At 109 river miles, the Muskingum joins the Ohio River at Marietta. Table 2 shows all the principal streams in the Muskingum River basin.

3.3 CONGRESSIONAL DISTRICTS

As shown in Figure 5, the Muskingum River basin lies within the geographical area of the following congressional interests and districts:

- Ohio District 4 (Jim Jordan – R)
- Ohio District 5 (Robert Latta – R)
- Ohio District 6 (Bill Johnson – R)
- Ohio District 7 (Steve Austria – R)
- Ohio District 12 (Patrick Tiberi – R)

- Ohio District 13 (Betty Sutton – D)
- Ohio District 16 (Jim Renacci – R)
- Ohio District 17 (Timothy Ryan – D)
- Ohio District 18 (Bob Gibbs – R)
- Senator Sherrod Brown (D)
- Senator Robert Portman (R)

Table 2 – Principal Streams in the Muskingum Basin

Stream Name	Length (Miles)	Drainage area (sq. mi)	Stream Name	Length (Miles)	Drainage area (sq. mi)
Muskingum River	111.9	8038	Moxahala Creek	29.1	301
Tuscarawas River	129.9	2590	S. Fork Licking River	33.9	288
Walhonding River	23.5	2252	Conotton Creek	38.7	286
Mohican River	64.2	999	N. Fork Licking River	38.4	239
Wills Creek	92.2	853	Wakatomika Creek	42.6	234
Licking River	67.5	781	Wolf Creek	47.4	231
Killbuck Creek	81.7	613	Clear Fork/Mohican	36.6	219
Sandy Creek	41.3	503	Jonathan Creek	26.1	193
Stillwater Creek	63.5	485	Chippewa Creek	26.7	188
Kokosing River	57.2	482	Nimishillen Creek	24.5	187
Sugar Creek	45.0	356	Salt Fork	32.0	161
Black Fork/Mohican	58.4	351	Jerome Fork	24.5	159
Lake Fork	14.7	344	Seneca Fork	30.3	151

4. PRIOR STUDIES, REPORTS, AND EXISTING PROJECTS

Several investigations concerning the Muskingum River basin have been made by the Corps of Engineers and other agencies since the 1930s. To gain a better understanding of problems, needs, and opportunities within the basin, the findings and results of prior studies and reports — along with implemented water-resources projects — were considered as part of this IWA. Given the history and size of the basin, an exhaustive list of all studies, reports, and projects undertaken within its boundaries would be nearly impossible to compile. However, the most applicable studies and reports — which explore existing problems and opportunities in the basin — are summarized below.

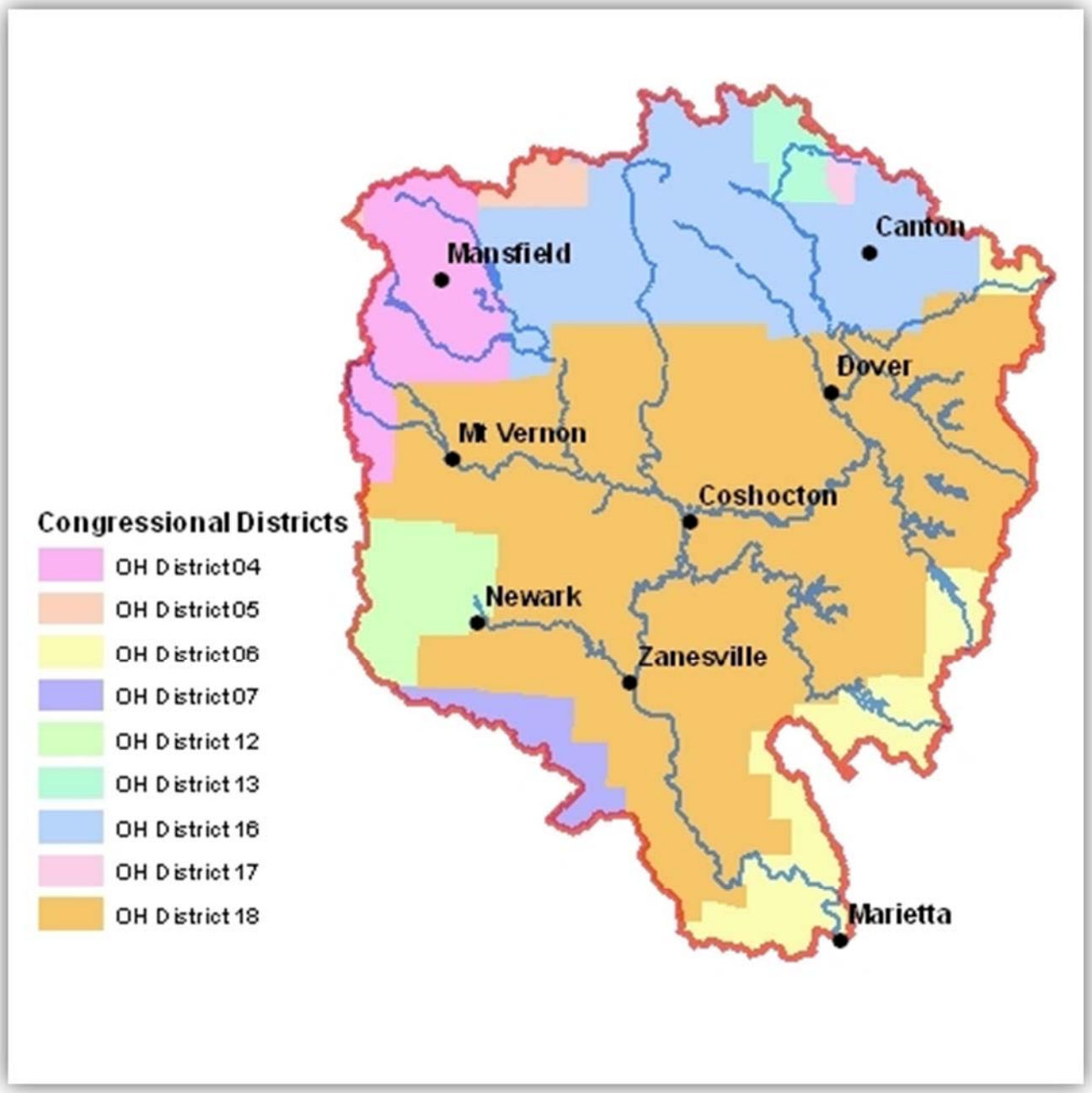


Figure 5 – Congressional Districts in Study Area

4.1 EXISTING CORPS PROJECTS

4.1.1 Reservoirs

4.1.1.1 The Muskingum River System

In 1914, the Ohio legislature enacted the Conservancy Act of Ohio, after the great flood of 1913. The Act, which is presumed to be the first legislation of its kind enacted in America, has since been copied by other states. The Act authorized the creation of conservancy districts, authorized use of eminent domain to accomplish stated public objectives, established the procedure for financial administration for local participation, and authorized the conservancy districts to enter into contracts with state and Federal governments. Subsequently, pioneers of the project created various organizations, such as the Muskingum-Tuscarawas Improvement Association — whose efforts caused the Ohio Department of Public Works to initiate a preliminary investigation of the Muskingum and Tuscarawas Rivers in 1930, with reference to the use and control of the drainage area's waters. The survey revealed that it would be feasible to plan and execute a comprehensive flood-control and water-conservation program for the entire watershed. The control measures would cost more than local interests could afford; however, the investigation further revealed that controlling the Muskingum River basin flood waters would measurably reduce flood crests on the Ohio River and benefit navigation — a benefit of interest to other states and the Federal government. Interested local citizens raised $25,000 to pay for development of a comprehensive flood-control and water-conservation plan to present to the Public Works Administration (PWA).

On June 3, 1933, Ohio created the Muskingum Watershed Conservancy District (MWCD) for perpetual existence, by Conservancy Court decree, under authority of the Ohio Conservancy Act. The MWCD was responsible for flood control, water conservation, soil-erosion control, and development of water resources in the area. The MWCD covers almost all of the 8,038 square miles of drainage area of the Muskingum River and its tributaries.

The previously referenced plan was now titled *A Plan of Flood Control and Water Conservation Reservoirs for the Muskingum Watershed Conservancy District*. Upon completion of the plan in August 1933, the MWCD applied to the Administrator of the Federal Emergency Administration of PWA, to include the project in the comprehensive program of public works and to obtain aid for financing and construction.

In December of that same year, PWA allocated $22 million to USACE to help finance construction of a flood-control system and water-conservation reservoirs. On March 29, 1934, MWCD and PWA signed a formal agreement, and the Zanesville District of USACE began work immediately. Surveys and foundation investigations were made at approximately 150 tentative dam sites, 14 of which were selected to provide maximum flood protection and conservation, consistent with available funds and legislative authority. The Official Plan was prepared by the Corps and approved by the Conservancy Court on November 19, 1934; meanwhile, detailed designs and contract drawings were prepared,

and bids were accepted on three dams by the end of the year. Construction began in 1935, and the completed system of 14 dams was turned over to MWCD in 1938. The following year, however, the Flood Control Act of 1939 returned the original 14 dams to the Federal government and returned flood-control operations to USACE. This arrangement has resulted in a unique partnership where the Corps owns and operates the dam, as well as the immediate footprint around the dam, while MWCD continues to own and operate the reservoirs and surrounding lands for authorized purposes. Two more dams were added to the system later — Dillon Dam in 1961, and North Branch of Kokosing Dam in 1972. However, these two dams are not considered part of MWCD's system. Table 3 lists the dams, as well as their locations, drainage areas, and other pertinent information.

Of the original 14 dams, four are "dry" dams (that is, dams that do not maintain permanent conservation pools) — Mohicanville, Bolivar, Dover, and Mohawk. These dams retain water only during high-flow events; otherwise, they are operated as "run of river" structures. Additionally, Beach City's recreation pool has been silted in with sediment so that it only functions for flood control. (Subsequent sections of this report discuss siltation at Beach City in depth.)

In June of 2005, the Corps began evaluating the Nation's reservoirs and lock-and-dam projects known to have dam-safety concerns, to develop relative ratings for human and economic risk. The effort, called the Screen Portfolio Risk Analysis, was used as a tool to help shape USACE budget decisions regarding reservoirs and lock-and-dam infrastructure improvements. The SPRA initially evaluated more than 60 USACE projects nationwide and ranked 4 Muskingum projects in the top 20 for highest risk. The respective rankings were:

- Mohawk (#7),
- Dover (#9),
- Bolivar (#11), and
- Beach City (#18).

Since that time, a new ranking system has been established, known as the Dam Safety Action Classification (DSAC) system. All of the previously mentioned dams were designated as DSAC II (Urgent) projects; however, a DSAC I (Urgent and Compelling) rating was given to Zoar Levee, an appurtenant structure to Dover Dam. The Corps is studying these projects under its Dam Safety Program.

4.1.1.2 North Branch Kokosing Dam

Authorized by the Flood Control Act of 1938, the dam creating North Branch Kokosing River Lake is located about 2 miles northwest of Fredericktown, in Knox County. Funds to initiate construction were appropriated in 1966, and the dam was completed in 1971. The project is operated for flood control, recreation, and wildlife management in the North Branch and lower Kokosing River valleys.

Table 3 – Muskingum River Basin Reservoirs

Project Name	Location	Drainage Area (Sq. Miles)	Flood Control Storage (Ac-Ft)	Conservation Storage (Ac-Ft)	Lake Surface (Acres)
Tuscarawas River Watershed					
Dover	Mainstem	777	203,000	0	0
Bolivar	Sandy Creek	502	149,6000	0	0
Leesville	McGuire Creek	48	17,900	19,500	1,000
Atwood	Indian Fork	70	26,100	23,600	1,540
Beach City	Sugar Creek	300	70,000	1,700	420
Tappan	Little Stillwater	71	26,500	35,100	2,350
Clendening	Stillwater Creek	70	27,500	26,500	1,800
Piedmont	Stillwater Creek	84	31,400	33,600	2,270
Walhonding River Watershed					
Mohawk	Mainstem	817	285,000	0	0
Mohicanville	Lake Fork	269	102,000	0	0
Charles Mill	Black Fork	216	80,600	7,400	1,350
Pleasant Hill	Clear Fork	199	74,200	13,500	850
North Branch of Kokosing	North Branch	45	13,800	3,850	150
Licking River Watershed					
Dillon	Mainstem	748	260,900	32,800	2,2440
Wills Creek Watershed					
Wills Creek	Mainstem	723	190,000	6,000	900
Senecaville	Seneca Fork	121	45,000	43,500	3,554

4.1.1.3 Dillon Dam

Dillon Dam is located on Licking River, 6 miles above the confluence with the Muskingum at Zanesville. The project was constructed under the authority of the Flood Control Act of 1938 and controls the runoff from a drainage area of 748 square miles. The project is operated for flood control, recreation, and wildlife management in the downriver portion of the Licking River Valley.

4.1.2 Local Flood Protection Projects

4.1.2.1 Massillon Local Flood Protection Project

Massillon, Ohio, is located in Stark County along the Tuscarawas River. The Huntington District of USACE completed a Local Protection Project in 1944; the project consisted of:

- 12,800 feet of improved channel;
- 4,300 feet of new channel;
- 15,900 feet of earth levee;
- 200 feet of concrete wall;
- four pump stations;
- three gate openings;
- two pressure conduits; and
- three bridge relocations.

The project provides protection, with 3 feet of freeboard, from a flood that has peak discharge 20% greater than the maximum flood of record. When the project was completed, maintenance of the bridges was turned over to the Massillon Conservancy District and was later transferred to Stark County, Ohio.

4.1.2.2 Mount Vernon Local Protection Project

Mount Vernon, the county seat and only city of Knox County, is located on the Kokosing River. A Local Protection Project there complements the North Branch Kokosing River Lake project and provides a high degree of protection to the Village of Mount Vernon against flood waters of the Kokosing River. The project involved the snagging and clearing of 23,200 feet of river channel through Mount Vernon. Other improvements included the provision of a large culvert near the West High Street highway bridge. The project was completed and turned over to local interest for maintenance and operation in 1966.

4.1.2.3 Newark Local Flood Protection Project

Newark, the county seat and largest city of Licking County is located on the Licking River. As originally constructed under authority of the Flood Control Act of 1938, the Local Protection Project there involved 31,500 feet of channel improvement, 5,450 feet of earthen levee, two pump stations, two levee openings, and a ramp. The protective works contain three levee openings to facilitate traffic movement during non-flood periods. The improvement was designed to protect about 560 acres in the city against a flood with 20% greater discharge than that estimated to have occurred in 1913. The Federal government maintains the channel, whereas the local sponsor maintains and operates the project's remaining features.

The flood of January 1959 caused extensive damage in the city and underscored the need for remedial channel work, extension of the levee, the addition of a pump station, and modification of the levee openings — completed in 1963. Additional protective works for the city were authorized in the Flood Control Act of 1968. The plans called for the diversion of Log Pond Run and modifications of the existing North Fork channel. The Log Pond Run diversion was completed in 1981; a contract for deficiency corrections to the levee was awarded in 1992.

4.1.2.4 Roseville Local Flood Protection Project

Roseville is located on Moxahala Creek in Muskingum and Perry counties, about 10 miles southwest of Zanesville. The project, completed in 1960, consisted of 7.291 feet of channel improvements; 5,370 feet of earthen levee; one pump station; relocation of one railroad bridge; and alterations to two highway bridges. The project protects the Village of Roseville from a design flood having a peak discharge one-third greater than the maximum flood of record (in June 1950), with a 3-foot freeboard incorporated into the levee. The Federal government maintains the improved and relocated channel of Moxahala Creek; the local sponsor operates and maintains the other works.

4.2 CORPS PLANNING STUDIES

4.2.1 Detailed Project Report for Channel Improvement at Moxahala Creek at Crooksville, Ohio, 1971

A Detailed Project Report for Moxahala Creek was prepared under Section 205 of the 1948 Flood Control Act, as amended, and concurred with the findings in the Reconnaissance Report for the same project (which was prepared in 1968). It called for channel modification starting at a point near the northern corporation limits of Crooksville and extending upstream for a distance of 9,055 feet to a point about 100 feet above the Penn Central (Penna) Railroad Bridge. The bottom width of 75 feet would be maintained for the entire length of the improved channel. The existing channel would be improved for a distance of 6,055 feet, and the remaining 3,000 feet of the project would be straightened and realigned. The estimated Federal cost was $630,000; the non-Federal contribution was $30,000. The benefit-to-cost ratio was only 1.03, so the project was not constructed.

4.2.2 Muskingum River Basin Study, 1975

The Muskingum River Basin Study was initiated in 1964. All phases of water and related resource development were considered, including a review of existing projects and operations, to determine whether additions or modifications to the basin plan were warranted. A report was submitted to the Ohio River Division Engineer in December 1975. The report recommended authorization for the construction of Local Flood Protection Projects at Killbuck and Mansfield. The report was forwarded to Congress in April 1979, and the recommended projects were authorized in 1986, although neither was ever constructed.

4.2.3 Mansfield Flood Damage Reduction Study, 1986

The Mansfield Flood Damage Reduction Study, prepared under authority of Section 205 of the Flood Control Act of 1948, investigated a Local Protection Project at Mansfield, Ohio, to address flooding problems along Rocky Fork and Touby Run. Alternative plans considered included a reservoir and channel modifications, but only the latter option was economically justifiable. The proposed project consisted of channel modifications along Rocky Fork, extending downstream from the railway bridges near Touby Run to 1,000 feet below the Park Avenue Bridge — a total length of 7,600 feet. The channel would have been widened along one side as a floodway, to avoid disturbing the existing stream bottom. The project would have cost $1.2 million (June 1986 price level), and the benefit to cost ratio was 2.1. However, the project was never implemented.

4.2.4 Barberton/Norton Flood Damage Reduction Study, 1991

A cost-shared feasibility study of flooding problems along Wolf Creek in Summit County was prepared by the Huntington District. The cities of Barberton and Norton agreed to provide 50% of the cost of the feasibility phase. The study was conducted pursuant to the authority of Section 205 of the 1948 Flood Control Act, as amended. Reconnaissance level studies indicated that modifying 21,000 feet of channel along Wolf Creek would provide the most cost-effective means of flood protection for Barberton and Norton. The study was completed in December 1991; the project was never implemented.

4.2.5 Section 905(b) Reconnaissance Study, Muskingum River Basin, Ohio System Study, 2000

A Section 905(b) reconnaissance study for the Muskingum River basin was conducted under USACE's General Investigations Program and was authorized by the US House of Representatives' Resolution Comprehensive Flood Control Plan for Ohio and Lower Mississippi Rivers, Committee on Flood Control, House of Representatives Committee Document No. 1, 75th Congress, 1st session. The purpose of the study was to evaluate potential Federal interest in implementing solutions to flooding, ecosystem degradation, water supply, recreation and other related water resource problems and opportunities in the Muskingum River basin, Ohio. This study identified (in addition to infrastructure issues with existing Corps reservoirs) as significant issues in the basin: Residual flood damages and lack of floodplain management enforcement, ecosystem degradation, and recreation issues stemming from sedimentation resulting in loss of recreation pool acreage. Some potential flood damage reduction measures included a limited nonstructural project and an early flood warnings system. The reconnaissance study went on to identify several Local Flood Protection Projects for further study, as described below (to date, none of these projects have been implemented).

- Canton Local Protection Project — Located on the East Branch of Nimishillen Creek upstream of the mouth of West Branch. All alternatives for the Local Protection Project consisted of varying levels of channel modifications.

- Crooksville Local Protection Project — Located on Moxahala Creek. All alternatives included channel improvements.
- Killbuck Village Local Protection Project — One of the measures considered was a levee project, which would provide protection to the community of Killbuck to the 1% annual chance flood.
- Millersburg Local Protection Project — Alternatives considered included a levee/floodwall system, as well as channel improvements.

Cambridge Local Protection Project — The project focused on a levee through the downtown residential and business reach of Wills Creek. Non-structural aspects of the project also were proposed to protect structures in areas of Cambridge and Guernsey County, where damages were not as concentrated. The report discussed several ecosystem restoration projects as well — including water release modification, restoration and watershed management, acid mine drainage abatement, and comprehensive riparian system restoration. Finally, the report identified several recreation development alternatives in the form of flow augmentation, lake depth modification, and expanded facilities at existing projects.

4.2.6 Licking River Watershed and Dillon Lake Ecosystem Restoration Project, Feasibility Report and Environmental Assessment, 2005

The Corps, in cooperation with the Ohio Department of Natural Resources (ODNR), sponsored a feasibility study for the Licking River Watershed and Dillon Lake. The purpose of the study was to develop, evaluate and recommend aquatic and riparian ecosystem projects within the major drainages of the watershed, and to enhance the lacustrine environment of Dillon Lake. The study considered two components of restoration opportunities. The first involved Dillon Lake and considered lake improvements such as conversion of sediment flats within the lake to wetland habitat and dredging portions of the lake. The second involved major drainages and considered stream corridor improvements such as riparian buffer zones with conservation easements and bank stabilization. None of these actions were implemented.

4.2.7 Muskingum River Basin System Operations Study, 2006

The goal of the study was to develop a comprehensive plan to revitalize the aging flood control system through infrastructure renewal, to ensure public safety and to improve water quality and other environmental resources through ecosystem restoration. The report served as the initial phase of work in the basin; its purpose was to develop a preliminary plan of action for proceeding with projects under existing Corps authorities, as well as supporting a legislative initiative for a comprehensive study with General Investigations funding. The report identified a number of water-resources problems in the basin, many associated with USACE dams and reservoirs. These issues currently are being addressed under the Dam Safety Modification Program, which is discussed in more detail later in this IWA. Other watershed problems identified by the report include acid mine

drainage, residual flood damages, floodplain development, and water and sewer infrastructure needs. The study also identified a number of potential measures for improving water resources within the basin, such as:

- improve stream channels that have extensive erosion problems through a comprehensive program of bank stabilization and environmental restoration;
- reduce flood damages at several identified locations in the Muskingum basin by implementing feasible structural or non-structural measures;
- renovate water and sewage treatment plants where infrastructure problems exist, if facilities are inadequate;
- review the accuracy of ten river gages downstream of the Muskingum reservoirs and determine whether floods have higher stages now than originally established, because of changes in downstream channel capacity;
- determine the need for and the economic feasibility of installing a flood warning system in the Muskingum River basin in cooperation with State and local officials; and
- conduct surveys of the Muskingum River basin to identify environmental problems or needs that can be addressed as part of a comprehensive environmental restoration program.

The scope of the renewal and revitalization program was described as "robust and multi-faceted," estimated to cost more than $2.4 billion (FY 06 price level) and to take several decades to complete. The report recommended that the Corps move on to a more detailed phase of study, to further define and quantify the potential scope of problems and opportunities. A more detailed study phase was never undertaken, and none of the projects are currently budgeted.

4.2.8 Muskingum Waterway Study, 1991

A Reconnaissance Study to determine Federal interest in rehabilitating the Muskingum River Waterway navigation system was completed in December of 1991. The system comprises ten locks and dams located within the Muskingum River Parkway State Park (see Table 4). The State of Ohio constructed the navigation structures in 1841 and operated them until 1886; then, the Corps operated the locks and dams for commercial navigation until 1952. In 1958, ODNR took control of the system and now operates the structures for recreational navigation. The locks and dams on the Muskingum River have deteriorated, jeopardizing pool levels for industrial water supplies and recreational navigation. ODNR is in the process of preparing a detailed engineering report to address the current state of disrepair of the system. The reconnaissance report states that present administration policy allows the Corps to budget only for commercial navigation and flood control projects. While the Corps cannot participate in system rehabilitation, it does support the efforts of the Muskingum River Parkway State Park and ODNR in obtaining funds to rehabilitate and enhance the system for continued operation.

Table 4 – Locations of Locks and Dams on the Muskingum River

Lock	Location	River Mile	Bank
2	Devola	5.8	Right
3	Lowell	14.2	Right
4	Beverly	25.1	Right
5	Luke Chute	34.1	Left
6	Stockport	40.2	Right
7	McConnelsville	49.4	Right
8	Rokeby	57.4	Right
9	Philo	68.3	Left
10	Zanesville	77.4	Right
11	Ellis	85.9	Left

4.2.9 Black Fork of the Mohican River Shelby, Ohio — Section 205 Reconnaissance Report

A Reconnaissance Report was prepared under authority of Section 205 of the Flood Control Act of 1948, as amended. The purpose of the study was to make a determination of whether planning should proceed further based on a preliminary appraisal of Federal Interest and whether potential solutions were in concert with current policies and budgetary priorities (at the time). The City of Shelby agreed to act as the non-Federal sponsor of a project if one were identified. Significant flooding was experienced during March 1913, January 1959, and July 1987. Early alternative measures included channel improvements, a levee/floodwall system, a reservoir, and various nonstructural measures. Screening of the alternatives found two channel modifications that were economically feasible, and the Reconnaissance Report concluded with the recommendation that a feasibility study be undertaken. The tentatively selected plan was a 30-foot channel improvement, which had net benefits of $81,100 and a benefit-to-cost ratio of 1.3. A project never was implemented.

4.2.10 Rittman Flood Damage Reduction Study

A detailed project report was developed under authority of Section 205 of the Flood Control Act of 1948, as amended, addressing the flood problems along about half a mile of Landis Ditch in the Rittman, Wayne County, vicinity. The ditch is a tributary to the River Styx, which in turn is a tributary to Chippewa Creek of the Tuscarawas River. Actual project construction was never implemented.

4.3 PROPOSED RESERVOIRS

4.3.1 Utica Lake

The building of Utica Lake was authorized by the Flood Control Act of 1968. The project would have been located on the North Fork of Licking River in Knox County, Ohio. Its authorized purposes were to provide water supply and water quality control for the Licking basin, to reduce flood crests along the North Fork, and to meet general fish, wildlife, and recreational needs. The dam would have controlled runoff from a drainage area of 113.8 square miles. The project has been placed in inactive status because of its marginal economic feasibility and the lack of a compelling need for water supply storage, both of which led the State of Ohio to withdraw its support for the project.

4.3.2 Frazeysburg Lake

Frazeysburg Lake, a proposed reservoir, was authorized under the Flood Control Act of 1938 for construction on the Wakatomika Creek in Muskingum, Licking, and Coshocton counties. However, the project later was found to be infeasible and was de-authorized in May of 1981.

4.3.3 Millersburg Lake

A Millersburg Lake project was authorized by the Flood Control Act of 1938, to be built on Killbuck Creek upstream from Millersburg. The project was re-evaluated in the Muskingum River Basin Study and found to be infeasible; it was de-authorized May 6, 1981.

4.4 OTHER AGENCIES, STUDIES, AND REPORTS

4.4.1 Other Agencies and Groups at Work in the Basin

Aside from the Corps of Engineers, many other agencies are at work in the Muskingum River basin, including other Federal agencies as well as state, local, and non-governmental groups. Applicable resource agencies are listed below, by Federal and state association. (Examples of some of these resource agency programs are detailed in Section 8.5 of this report.)

4.4.1.1 Federal Agencies

- USDA Farm Service Agency
- US Forest Service
- Natural Resources Conservation Agency
- US Fish and Wildlife Service
- USGS
- US Department of Interior (DOI) Mineral Management Service

- US National Park Service
- DOI Office of Surface Mining, Reclamation and Enforcement
- Bureau of Land Management
- Bureau of Reclamation

4.4.1.2 State Agencies

- Department of Agriculture
- Clean Ohio Fund
- Ohio Emergency Management Agency
- Ohio Environmental Protection Agency
- Ohio Department of Natural Resources
- Ohio Department of Transportation
- Ohio Water Development Authority

4.4.1.3 Non-Governmental Organizations

- East Branch Sugar Creek Watershed
- Huff Run Watershed Restoration Partnership, Inc.
- Nimishillen Creek Watershed Partners
- North Fork Task Force
- Upper Sugar Creek Farmer Partners
- Friends of Lower Muskingum River
- Moxahala Watershed Restoration Commission
- Salt Creek Watershed
- Wolf Creek Awareness and Resource Evaluation Project
- Wills Creek Watershed
- Mohican Watershed
- Owl Creek Conservancy

4.4.2 Upper Mohican Watershed Muskingum River Basin Watershed Plan, 1992

In 1992, the United States Department of Agriculture completed a watershed plan for the Upper Mohican watershed in the Muskingum River basin. The plan was authorized by the Watershed Protection and Flood Prevention Act (Public Law 83-566); its goal was to develop a management framework that balanced natural resources usage with enhancement and preservation. The framework included improving water quality, enhancing recreational opportunities, maintaining flood control capacity, reducing erosion and sedimentation, and improving quality of life. The report listed as primary concerns:

- erosion,
- sedimentation,
- removal of riparian corridors,
- floodplain encroachment,
- flooding, and
- timber management.

Alternatives identified included:

- implement rotational grazing and pastureland management on pastureland with an erosion rate greater than 1 ton per acre per year;
- fence livestock out of forested areas, encouraging the buildup of the duff layer and encouraging the growth of saplings;
- install grass waterways, water and sediment control basins, and other structural practices;
- stabilize lake shorelines with tree revetments, willow posting, live stakes, fascines, or other vegetative means;
- institute nutrient management for both cropland and pastureland;
- re-establish the riparian corridor on 50 miles of stream bank and lakeshore for land outside of MWCD ownership;
- establish a better way to control unauthorized access around Charles Mill Lake;
- establish a program to help educate landowners about better forest management practices;
- prepare a comprehensive community forestry plan;
- establish a flood-proofing program for the towns of Shelby and Bellville;
- establish a plan to help quickly remove critically situated logjams, to reduce flood damage from small frequency storms; and
- produce a fact sheet on the safe use of pesticides.

4.4.3 Amendment to the MWCD Plan

The amendment to the MWCD Official Plan identified the maintenance needs (at the reservoirs and throughout the basin) to be addressed by the MWCD to ensure continued optimum performance of this system for basin residents. The amendment was intended to agree with the Muskingum River Basin Initiative, a multi-agency project let by led by the Corps and the MWCD to emphasize the importance of the Muskingum River basin and how changes and demands within the basin have generated the need for renewal. The improvements and maintenance planned include:

- upgrades to dams for safety and flood protection;
- upgrades to culverts and bridges, raising and relocating of critical roads, and other infrastructure projects;
- sediment removal through dredging;
- shoreline protection to reduce erosion;
- water quality improvements, to be achieved by monitoring water quality, reducing pollution, addressing acid mine drainage problems, providing environmental education, and improving sewer systems;
- watershed management (through planning and assistance for local interest groups and private property owners), with programs to reduce sediment and pollution;
- reservoir maintenance and inspection on a regular schedule; and
- partnering with local, State, and Federal agencies and other individuals and organizations, thereby sharing the responsibility and costs of these projects.

Based on preliminary estimates, the MWCD began to collect a yearly assessment of approximately $12 per parcel for residential and agricultural property in the jurisdiction of the MWCD. Commercial, industrial, and other non-residential parcels would be charged an assessment based on the size of the parcel, its property use code, and the estimated contribution to runoff to the watershed.

5. EXISTING CONDITIONS

To better understand problems, opportunities, and forecast changes within the Muskingum River basin, the existing conditions of the study area were examined and inventoried in the following sections of the report. During this analysis, HAZUS [(HAZards US — a nationally accepted model based on Geographic Information System (GIS) technology] is being used to estimate physical, economic, and social impacts associated with natural disasters, and was used as a source of readily available information. HAZUS was developed by FEMA and is commonly used by communities and states during their All Hazards Mitigation planning process, which is the foundation for a community's long term strategy for reducing disaster losses. In addition to HAZUS, data was obtained from many different agencies, including the US Environmental Protection Agency (EPA), USGS, US Census Bureau, and US Fish and Wildlife Service.

As previously stated in Section3.2, the Muskingum River basin is a HUC-4 watershed of the Ohio River basin, which USGS has subdivided into six HUC-8 watersheds (see Figure 4).

- Tuscarawas River watershed (05040001)
- Mohican River watershed (05040002)
- Walhonding River watershed(05040003)
- Muskingum River watershed (05040004)

- Wills Creek watershed (05040005)
- Licking River watershed(05040006)

Figure 4 (Repeated) – HUC-8 Watersheds within the Muskingum River Basin

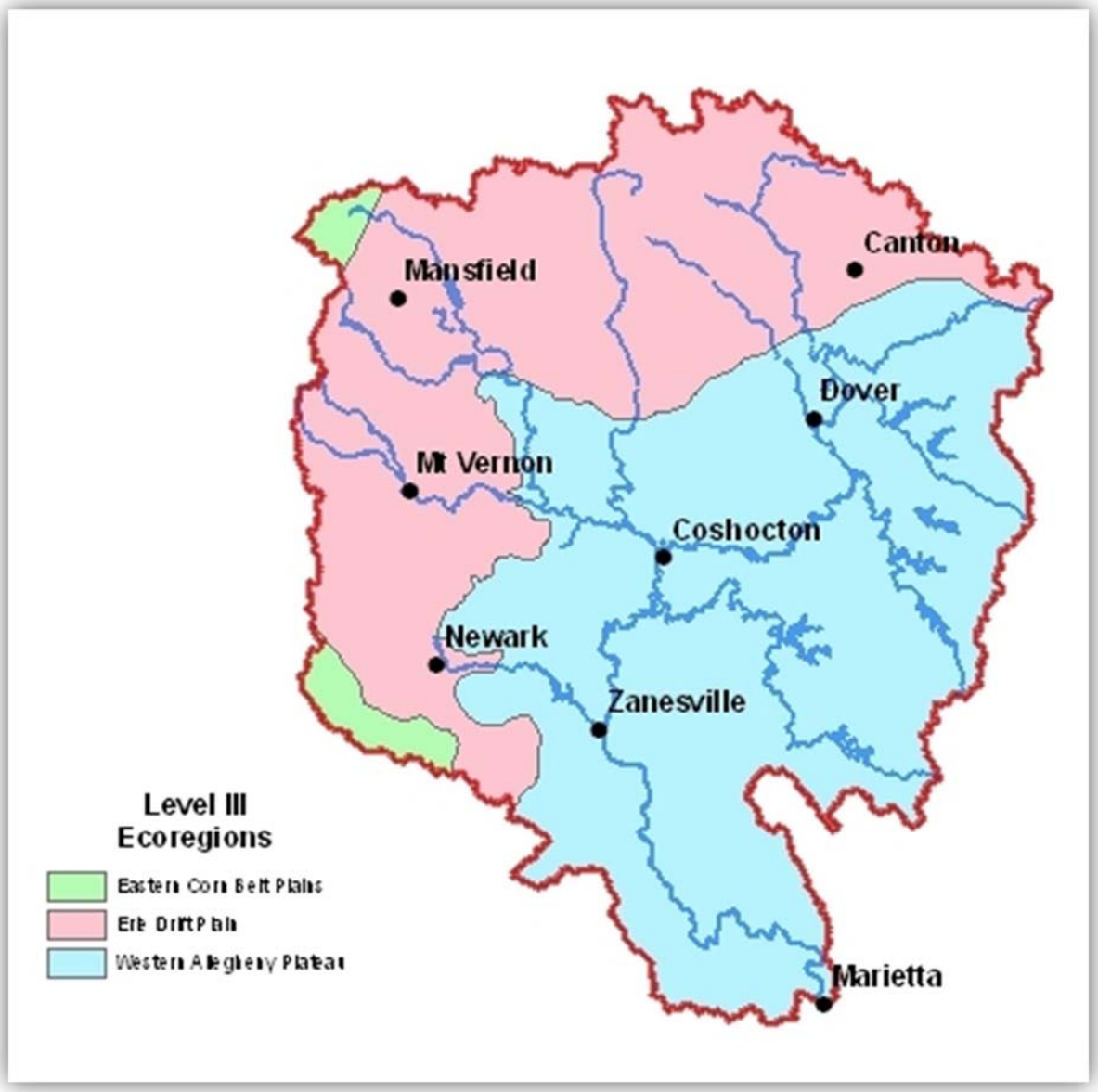


Figure 6 – EPA Ecoregions within Muskingum River Basin

Table 5 – Sizes of EPA Ecoregions within Muskingum River Basin

Ecoregion Name	Area (Square Miles)	Percentage of Watershed
Western Allegheny Plateau	7,228.1	56.4%
Erie Drift Plains	5,703.3	41.1%
Eastern Corn Belt Plains	345.4	2.5%

5.1 PHYSIOGRAPHIC AREA

According to EPA, the Muskingum River basin is comprised of three Level III ecoregions — Eastern Corn Belt Plains, Erie Drift Plain, and Western Allegany Plateau.

As seen in Figure 6, approximately 56% of the Muskingum River basin lies within the Western Allegheny Plateau. The Western Allegheny Plateau ecoregion — which covers portions of eastern Ohio, southwestern Pennsylvania, northwestern West Virginia, and a small piece of northeastern Kentucky — consists of a mixture of deciduous forest and agricultural land cover. The forest area is mostly mixed oak and mixed temperate forests. Dairy, livestock, and general farming (as well as rural residential or isolated urban developments) are concentrated in the valleys. The river systems in the ecoregion have been adversely affected by acid mine drainage and industrial pollution, which have caused historical degradation of the stream habitats and loss of aquatic species. More recently, water quality has improved somewhat, and a few aquatic species have been re-established.

The Erie Drift Plains ecoregion is located mainly in northeastern Ohio and extends into the northwestern corner of Pennsylvania and the southwestern corner of New York. Common geographic features in the ecoregion include low round hills, scattered end moraines, kettles, and wetlands, some of which are remaining landforms from past glaciations of the region. The ecoregion is a mix of agricultural, forested, and developed land. Agriculture includes livestock and dairy farms in rural areas; major crops include wheat, corn, oats, hay, and soybeans. Market produce also is grown, such as sweet corn, sweet peppers, pumpkins, onions, mustard greens, kale, and herbs. Apple and peach orchards, as well as maple syrup from sugar maples, contribute to the diversity of agricultural goods produced. Other hardwood trees are harvested for pulp.

Agricultural production in the basin is noted to have a negative impact on water resources. The large annual amounts of fertilizer, pesticides, and sedimentation from nonpoint source runoff, as well as loss of riparian buffers from cultivation practices that encroach into riparian habitat, have increased nutrient loading in the basin. Nutrient loading has decreased water quality in most of the streams in the basin that adjoin agricultural land, as well downstream from these nonpoint sources. Water quality issues will discussed in depth in Section 5.4 of this report.

The smallest of the ecoregions in the basin is the Eastern Corn Belt Plains, which is primarily a rolling plain with local end moraines. Another area affected by past glaciations, this region has loamy, well drained soils. Today, extensive cultivation for corn, soybean, and livestock production, along with their management practices have caused negative affects to stream chemistry and turbidity.

5.2 SOILS

The soils in the glaciated area of the basin are generally developed from late Wisconsin drift. Over large areas of the upland in the north the soils are predominantly well drained

and moderately permeable Wooster and the moderately well drained, slowly permeable Canfield. Moderately large areas of slowly permeable Rittman and Wadsworth silt loams occur in the northern part of the glaciated area. Amanda and Alexandria silt loams and associated soils are prevalent along the western part of the glaciated area. The permeability of these soils varies from moderate to slow. More permeable soils are found in the valleys. Chili, Chagrin, and Tioga loams and silt loams are the more important soils there. Below the glacial boundary, the principal upland soils are the Gilpin, Brownsville, Berks, Westmoreland, Coshocton, Keene, and Wellston loams and silt loams, with Upshur in some areas of reddish clay shale in the southern part of the basin. These are moderately deep or deep residual soils developed on a variety of contrasting bedrock. Their profile characteristics depend almost entirely on the kind of parent rock on which the soils developed. Generally these soils are moderately to slowly permeable. In the broader valleys, there are areas of alluvial and terrace soils which are well drained and permeable.

5.3 LAND USE AND DEVELOPMENT

Based on land cover data from 2006 supplied by USGS, the Muskingum River basin is predominately comprised of natural cover and lands used for agricultural purposes. As seen in Figure 7, Figure 8, and Table 6, the natural cover within the watershed is composed primarily of deciduous forest, accounting for 43%, or 3,492 square miles of the basin. Other, less prevalent forms of natural cover include grasslands, evergreen forests, mixed forests, wetlands and scrubland, as well as open water. Overall natural cover represents approximately 3,853 square miles, or 48% of the land within the basin, providing habitat for a variety of flora and fauna.

Agricultural lands within the basin are largely used for cultivating crops, raising livestock or cutting hay. These land cover types comprise about 3,234 square miles or 40% of the watershed. The remaining 12% of land cover represents developed land consisting of open space, and urban and suburban development, and a small amount of barren land. The developed land is separated into four categories — open space and low, medium, and high intensities. Low and medium intensity levels are typically associated with residential areas. While scattered commercial activity may occur within the low and medium intensity levels, urban areas consisting of highly developed infrastructure and commercial and industrial lands fall within the high intensity category. Table 6 and Figure 8 illustrate the square mileage and percentages for each of the land covers found in the basin.

5.4 WATER QUALITY

US waters always are threatened by different sources and types of pollution. Under the Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimmable/fishable" waters. Water quality standards are ambient standards as opposed to discharge-type standards. These ambient standards, through a process of back calculation procedures known as total maximum daily loads or waste-load allocations form the basis of water quality based permit limitations

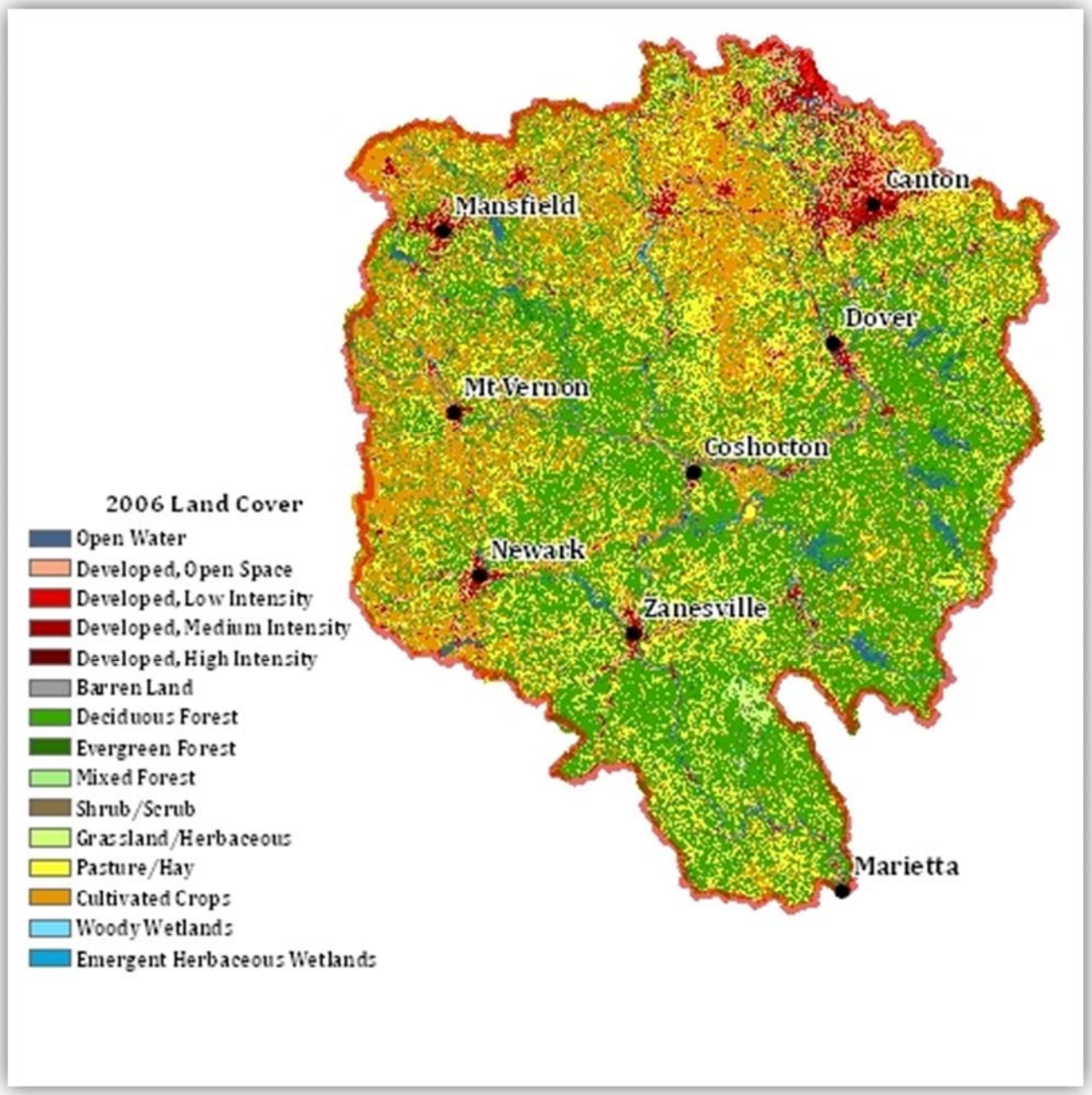


Figure 7 – Land Cover in the Muskingum River Basin

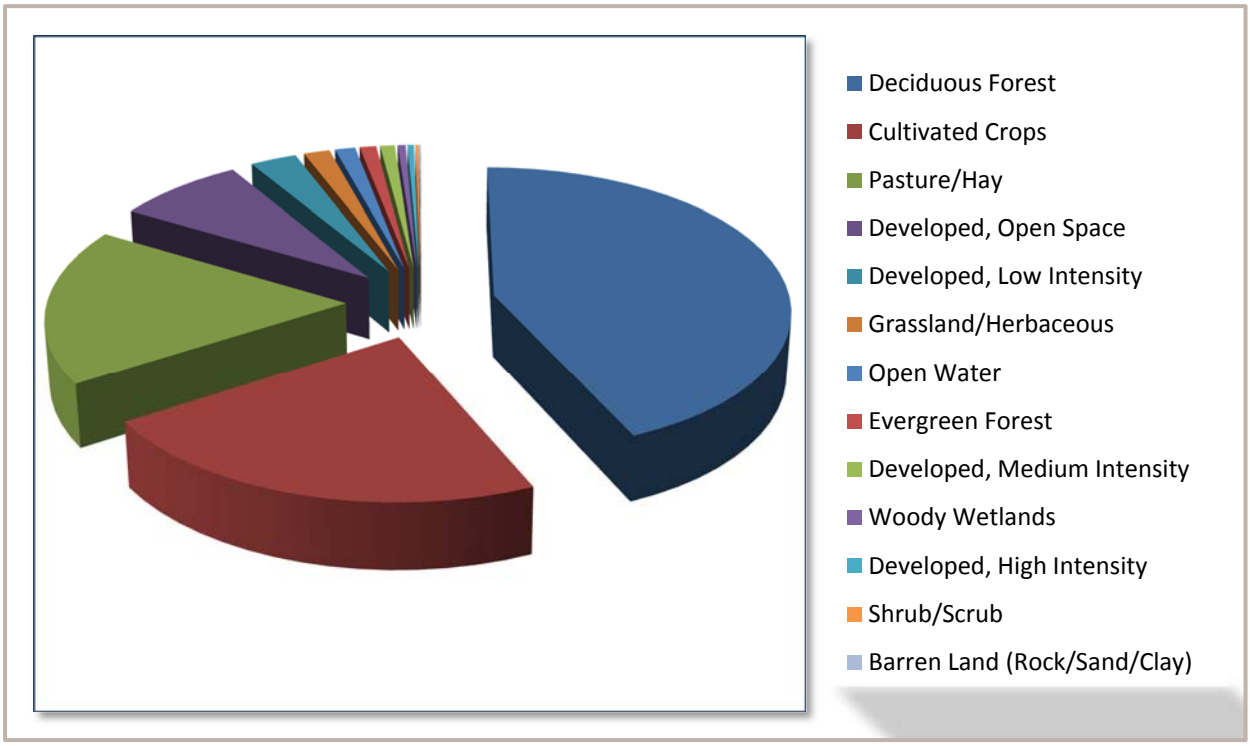


Figure 8 – Distribution of Land Cover in the Muskingum River Basin (USGS, 2006)

Table 6 – Land Use in the Muskingum River Basin (USGS, 2006)

Description	Square Miles	Percentage of Basin
Deciduous Forest	3,492.58	43.39%
Cultivated Crops	1,810.70	22.49%
Pasture/Hay	1,423.15	17.68%
Developed, Open Space	627.15	7.79%
Developed, Low Intensity	226.35	2.81%
Grassland/Herbaceous	126.10	1.57%
Open Water	98.24	1.22%
Evergreen Forest	80.59	1.00%
Developed, Medium Intensity	71.21	0.88%
Woody Wetlands	38.51	0.48%
Developed, High Intensity	32.15	0.40%
Shrub/Scrub	14.27	0.18%
Barren Land (Rock/Sand/Clay)	5.36	0.07%
Emergent Herbaceous Wetlands	2.51	0.03%
Mixed Forest	1.09	0.01%

that regulate the discharge of pollutants into the waters under the National Pollutant Discharge Elimination System (NPDES) permit program.

Ohio's water quality standards, set forth in Chapter 372-1 of the Ohio Administrative Code (OAC), include four major components — beneficial use designations, narrative "free froms,"[2] numeric criteria, and anti-degredation provisions.

Streams not meeting State water quality standards are placed on the EPA's 303(d) Impaired Waters List. Of the 11,735 miles of streams in the Muskingum River basin, 7,242 miles are listed as impaired (see Table **7**).

Based on the 303(d) list, the most prevalent impairments in the basin include pathogens, siltation, habitat alterations, PCBs (polychlorinated biphenyls) in fish tissue, organic enrichment/low dissolved oxygen, nutrients, flow alterations, metals, hexachlorobenzene, and ammonia. The likely sources of these impairments are as follows:

- Pathogens — primarily from human and animals wastes, including runoff from agricultural land and feedlots, seepage or discharge from septic tanks, sewage treatment facilities and natural soil and plant bacteria.
- Siltation — likely from stream-bank erosion and soil degradation from inadequate agricultural practices in rural areas, and in urban areas from construction activities such as land clearing.
- Habitat alterations — resulting from land use changes, hydrologic modification, climate change, altered biologic diversity, and introduction of non native species.
- PCBs in fish tissue — resulting from commercial manufacture, use, storage and disposal of industrial chemicals, primarily from historic releases.
- Organic enrichment/low dissolved oxygen — usually resulting from human activities that introduce large quantities of biodegradable organic materials into surface waters.
- Nutrients — resulting from fertilizer application, livestock waste, atmospheric deposition and various point sources.
- Flow alterations — primarily from the introduction of manmade structures such as dams, bridge supports/abutments, and agricultural stream crossings.
- Metals — primarily from industrial processes and mining operations.
- Hexachlorobenzene — primarily from the manufacture of other chlorine containing compounds and pesticides as well as in the incineration of municipal and hazardous wastes.

[2] Narrative "free froms," located in rule 3745-1-04 of the Ohio Administrative Code, are general water quality criteria that apply to all surface waters. These criteria state that all waters shall be free from sludge; floating debris; oil and scum; color- and odor-producing materials; substances that are harmful to human, animal, or aquatic life; and nutrients in concentrations that may cause algal blooms.

Table 8 lists impacted streams, by type of impairment and number of occurrences.

Table 7 – Impaired Streams in the Muskingum River Basin

Stream Name	Listed Contaminants	Miles Impaired
Tuscarawas River Watershed		
Tuscarawas River Mainstem (Downstream Sippo Creek To Mouth)	Hexachlorobenzene, Nutrients, Organic Enrichment/Low Dissolved Oxygen, PCBs In Fish Tissue, Pathogens, Salinity/Total Dissolved Solids/Chlorides, Suspended Solids	89.39
Tuscarawas River (Headwaters To Downstream Wolf Creek)	Hexachlorobenzene, Flow Alterations, Habitat Alterations, Natural Limits, Organic Enrichment/Low Dissolved Oxygen, PCBs In Fish Tissue, Siltation	146.88
Chippewa Creek	Hexachlorobenzene, Flow Alterations, Habitat Alterations, Nutrients, Organic Enrichment/Low Dissolved Oxygen, PCBs In Fish Tissue, Pathogens, Siltation	231.7
Tuscarawas River (Downstream Wolf Creek To Downstream Sippo Creek), Excluding Chippewa	Hexachlorobenzene, Flow Alterations, Habitat Alterations, Nutrients, Organic Enrichment/Low Dissolved Oxygen, PCBs In Fish Tissue, Pathogens, Siltation, Salinity/Total Dissolved Solids/Chlorides	200.81
Sandy Creek (Headwaters To Downstream Still Fork)	PCBs In Fish Tissue	169.15
Nimishillen Creek	Ammonia, Dissolved Oxygen, Flow Alterations, Habitat Alterations, Nitrates, Nutrients, Organic Enrichment (Sewage) Biological Indicators, PCBs In Fish Tissue, Pathogens, Sedimentation, Siltation, Sulfates, Temperature, Acidity	175.22
Sandy Creek (Downstream Still Fork To Mouth), Excluding Nimishillen Creek	Habitat Alterations, PCBs In Fish Tissue, Siltation	222.99
Tuscarawas River (Downstream Sippo Creek To Upstream Sugar Creek), Excluding Tuscarawas R. Mainstem	Flow Alterations, Metals, Nutrients, Pathogens, Ph, Siltation	139.29
Tuscarawas River (Downstream Sugar Cr. To Upstream Stillwater Cr.), Excluding Tuscarawas R. Mainstem	Flow Alterations, Metals, Organic Enrichment/Low Dissolved Oxygen, Direct Habitat Alterations, Pathogens, Ph, Siltation	86.45
Stillwater Creek (Downstream Boggs Fork To Downstream Brushy Fork)	Habitat Alterations, Siltation	152.64
Tuscarawas River (Downstream Stillwater Cr. To Upstream Evans Cr.), Excluding Tuscarawas R. Mainstem	Metals, Organic Enrichment/Low Dissolved Oxygen, Direct Habitat Alterations, Pathogens, Siltation	120.65
Tuscarawas River (Upstream Evans Creek To Mouth); Excluding Tuscarawas R.	Pathogens, Cause Unknown, Nutrients, Unionized Ammonia	137.55

Stream Name	Listed Contaminants	Miles Impaired
Mainstem		

Stream Name	Listed Contaminants	Miles Impaired
Mohican River Watershed		
Black Fork Mohican River (Headwaters To Downstream Whetstone Creek)	Habitat Alterations, Nutrients, Pathogens, Siltation	230.84
Black Fork Mohican River (Downstream Whetstone Creek To Downstream Rocky Fork)	Habitat Alterations, Metals, Nutrients, Organic Enrichment/Low Dissolved Oxygen, PCBs In Fish Tissue, Pathogens, Priority Organic Compounds	197.12
Clear Fork Mohican River (Headwaters To Downstream Cedar Fork)	Pathogens, Siltation	160.59
Jerome Fork Mohican River	Nutrients, Pathogens	250.26
Walhonding River Watershed		
Walhonding River Mainstem (Entire Length)	PCBs In Fish Tissue	11.71
Kokosing River (Downstream North Branch To Upstream Jelloway Creek)	Organic Enrichment/Low Dissolved Oxygen	268.74
Kokosing River (Upstream Jelloway Creek To Mouth)	Flow Alterations	128.3
Killbuck Creek (Headwaters To Upstream Apple Creek)	Habitat Alterations, Organic Enrichment/Low Dissolved Oxygen, Pathogens	202.89
Killbuck Creek (Upstream Apple Creek To Downstream Salt Creek)	Habitat Alterations, Organic Enrichment/Low Dissolved Oxygen, Pathogens	247.23
Killbuck Creek (Downstream Salt Creek To Downstream Black Creek)	Flow Alterations, Cause Unknown, Pathogens	187.49
Killbuck Creek (Downstream Black Creek To Mouth)	Organic Enrichment/Low Dissolved Oxygen, Pathogens	169.19
Muskingum River Mainstem (Entire Length)	PCBs In Fish Tissue	109.74
Muskingum River Watershed		
Wakatomika Creek (Headwaters To Downstream Brushy Fork)	PCBs In Fish Tissue	149.68
Wakatomika Creek (Downstream Brushy Fork To Mouth)	PCBs In Fish Tissue	144.9
Moxahala Creek (Excluding Jonathan Creek)	Pathogens	135.85
Salt Creek	Pathogens	214.53
Meigs Creek	Pathogens, Siltation	213.26
Wolf Creek; West Branch Wolf Creek	Nutrients, Pathogens	263.71

Stream Name	Listed Contaminants	Miles Impaired
Muskingum River Watershed, cont.		
South Branch Wolf Creek	Flow Alterations, Siltation	124.83
Wills Creek Watershed		
Wills Creek Mainstem (Downstream Leatherwood Creek To Mouth)	Siltation	58.09
Wills Creek (Headwaters To Upstream Leatherwood Creek), Excluding Seneca Fork	Ammonia, Habitat Alterations, Metals, Pathogens, Siltation	245.95
Salt Fork	Habitat Alterations, Sediment	173.94
Licking River Mainstem (Entire Length)	Ammonia	23.42
North Fork Licking River (Headwaters To Downstream Sycamore Creek)	Habitat Alterations, Nutrients, Pathogens, Siltation	194.84
Raccoon Creek	Flow Alterations, Habitat Alterations, Nutrients, Organic Enrichment/Low Dissolved Oxygen, Siltation	166.77
South Fork Licking River (Excluding Raccoon Creek)	Pathogens, Priority Organics	294.1
Licking River (South Fork/North Fork To Downstream Rocky Fork), Excluding Licking R. Mainstem	PCBs In Fish Tissue	152.33
Licking River (Downstream Rocky Fork To Mouth), Excluding Licking R. Mainstem	PCBs In Fish Tissue	142.28

5.5 FLOODPLAIN

The Federal Emergency Management Agency (FEMA) is responsible for administering the National Flood Insurance Program (NFIP), which is a Federal program enabling property owners to purchase subsidized flood insurance. NFIP is based on a formal partnership between local jurisdictions (counties/communities) and the Federal government. Under this program, counties and communities adopt floodplain management regulations in order to reduce flood risks associated with future floodplain growth and rehabilitated floodplain structures and the Federal government in turn subsidizes flood insurance for property owners within the community.

Table 8 – Occurrences by Type of Impairment in the Muskingum River Basin

Impairment	Occurrences
Pathogens	25
Siltation	19
Habitat Alterations	19
PCBs in Fish Tissue	14
Organic Enrichment/Low Dissolved Oxygen	14
Nutrients	12
Flow Alterations	10
Metals	6
Hexachlorobenzene	4
Ammonia	4
Salinity/Total Dissolved Solids/Chlorides	2
Ph	2
Sedimentation	2
Priority Organic Compounds	2
Suspended Solids	1
Dissolved Oxygen	1
Nitrates	1
Organic Enrichment (Sewage) Biological Indicators	1
Sulfates	1
Temperature	1
Acidity	1

NFIP is based on the established 1% annual chance flood, better known as the 100-year flood or Base Flood Elevation (BFE), which serves as the national standard for virtually every Federal and most state agencies. Flood Insurance Rate Maps produced by FEMA provide the official record of special flood hazard areas. The areal extent of the official special flood hazard area was determined for the Muskingum basin. Using digital flood data corresponding with published FIRMs, the 100-year floodplain was overlaid on a basic map of the basin. While flooding is a reoccurring problem within the Muskingum River basin, only 618 square miles or about 8% of the watershed lies within the 100-year floodplain. As seen in

Figure 9, the 100-year floodplain is nearly equally distributed along the basin. Larger, more prominent areas of the 100-year floodplain displayed on the map indicate the locations of USACE-operated lakes.

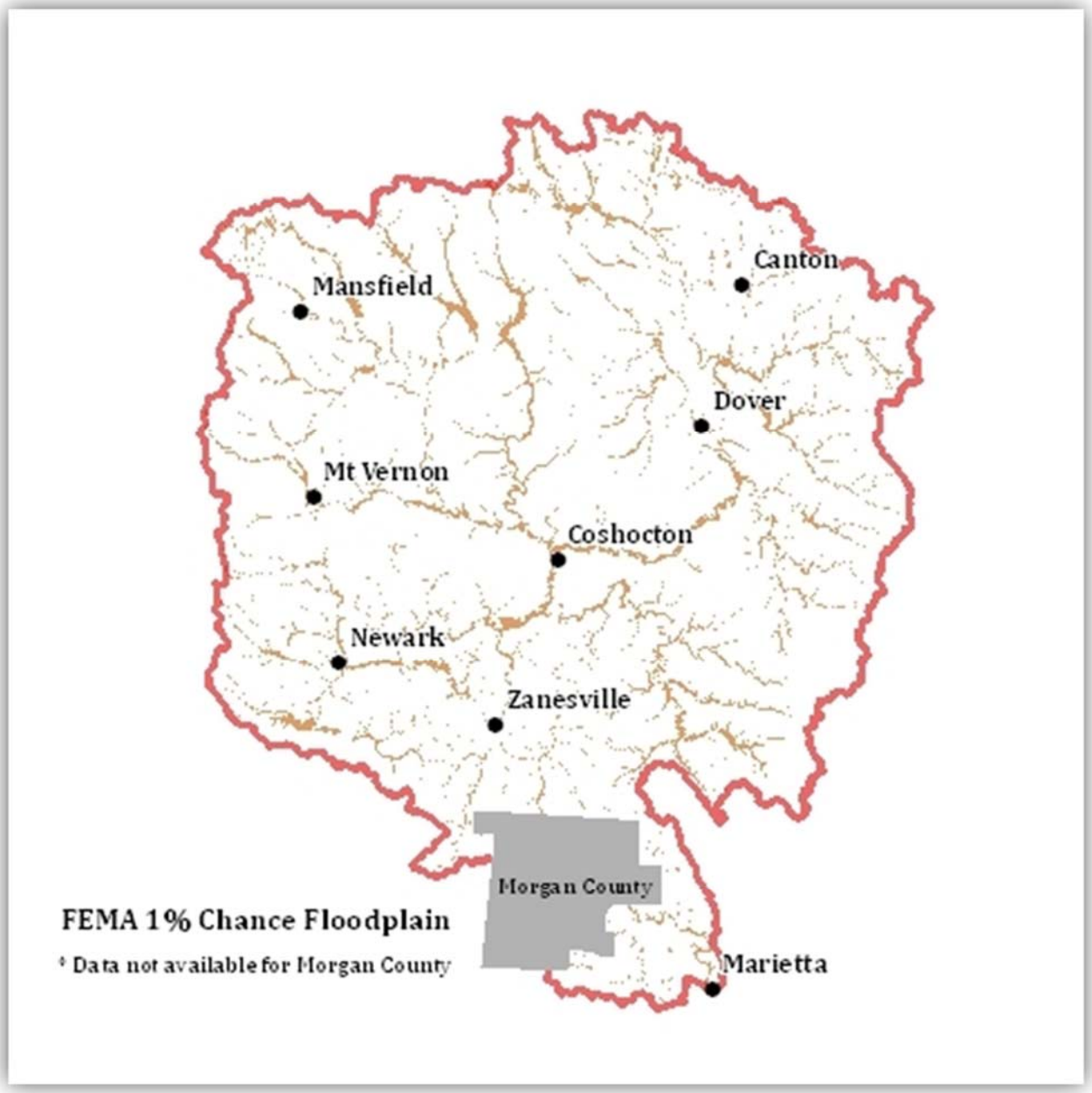


Figure 9 – 100-year Floodplain in the Muskingum River Basin[3]

[3] Floodplain data for Morgan County was unavailable.

5.6 DEMOGRAPHICS

Based on data collected in 2000 by the US Census Bureau, approximately 1. 5 million people live within the Muskingum River basin; Table 9 shows population distribution and income ranges for each HUC-8 watershed (shown once more in

Figure 10), and Figure 11 shows population density for the basin. As seen in Table 9, the majority of the population falls within the Tuscarawas River watershed.

Table 9 – Population and Income Data in Muskingum River Basin, Distributed by HUC-8 Watersheds

Watershed	Population	Income (in Thousands of Dollars)			
		Less than 20k	20k to 50k	50k to 100k	Over 100k
Tuscarawas	792,619	65,681	124,704	88,873	23,410
Mohican	185,321	16,196	28,790	19,374	4,367
Walhonding	143,593	10,578	20,961	14,303	3,508
Muskingum	127,611	12,800	20,459	12,075	1,792
Wills Creek	52,030	5,963	8,140	3,811	524
Licking	167,030	13,223	24,593	20,122	5,378
Totals	*1,468,204*	*124,441*	*227,647*	*158,558*	*38,979*

The primary centers of population within the Muskingum River basin include the cities of Akron, Mansfield, Canton, Newark, Massillon, Barberton, Zanesville, Medina, Wooster, and Green [not all of the cities mentioned are shown on that map of the basin. Table 10 reflects population and per capita income data for each of these areas. As seen in Table 10, all but four cities saw an increase in population between 2000 and 2009, reflecting the general growth of urbanized areas in the basin. With the exception of the city of Green, the average per capita income from 2009 for each of these areas was slightly less than the average per capita income of $24,830 for the state of Ohio. Only the cities of Green and Medina exceed the per capita income average of $27,041 for the United States.

According to HAZUS data, approximately 673,359 structures are located within the study area. Of these structures, roughly 92% are classified as residential structures while the remaining 8% fall within the commercial, industrial or public categories. As seen in Table 11, the majority of residential, commercial, industrial and public structures fall within the Tuscarawas River watershed.

5.7 INDUSTRY

The Muskingum River basin includes various types of industries that support the local and regional economies. The Bureau of Labor Statistics regularly publishes employment statistics reported by employers covering 98% of jobs within the United States. This

Figure 10 – HUC-8 Watersheds in the Muskingum River Basin

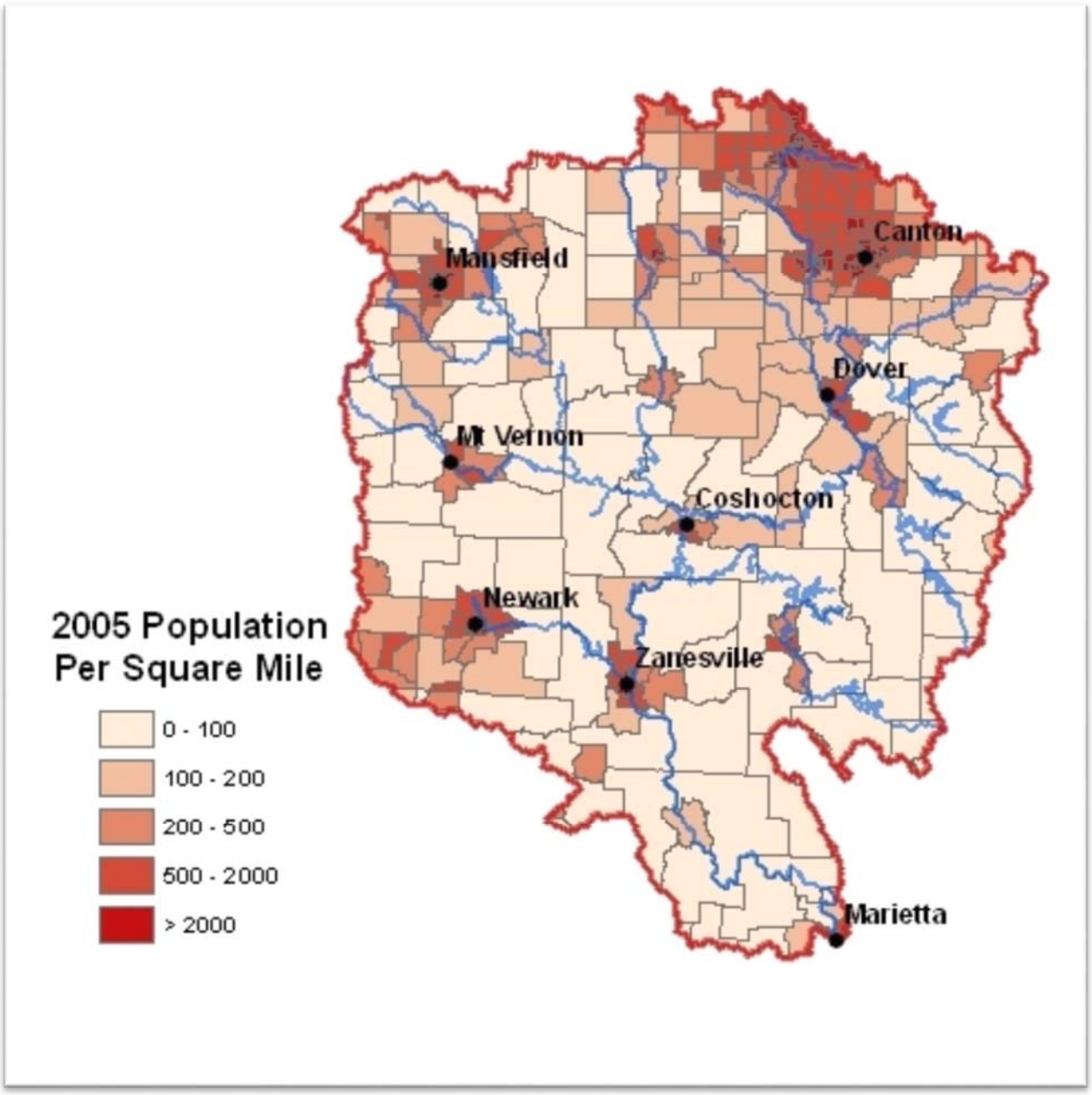


Figure 11 – Population Density in the Muskingum River Basin

Table 10 – Population and Per Capita Income for the Largest Cities in the Muskingum River Basin

City	Population 2000	Population 2009	Per Capita Income 2009
Akron	217,074	207,209	$20,047
Mansfield	49,346	49,414	$17,361
Canton	80,806	78,379	$16,881
Newark	46,279	47,415	$21,941
Massillon	31,325	32,734	$20,016
Barberton	27,899	26,533	$18,992
Zanesville	25,586	24,902	$17,349
Medina	25139	26168	$27,481
Wooster	24,811	26,214	$23,362
Green	22,817	23,428	$30,831

Table 11 – Structure Data Within the Muskingum River Basin, Distributed by HUC-8 Watersheds

Watershed	Structures				
	Residential	Commercial	Industrial	Public	Total
Tuscarawas	331,171	17,250	8,048	2,732	359,201
Mohican	77,191	4,023	2,009	848	84,071
Walhonding	59,280	3,206	1,909	596	64,991
Muskingum	58,563	2,778	1,456	627	63,424
Wills Creek	25,723	1,396	615	283	28,017
Licking	67,215	3,858	1,901	681	73,655
Totals	*619,143*	*32,511*	*15,938*	*5,767*	*673,359*

information is readily available at the county level. Table 12 reflects the distribution of employment types in 2009 within the counties comprising the Muskingum River basin. Athens, Belmont, Columbiana, Crawford, Delaware, Fairfield, Franklin, and Monroe Counties were excluded in this analysis due to their small geographic footprint in the basin. As seen in Table 12, the predominant source (29%) of employment within the watershed is wholesale trade, followed by health care and social assistance (19%) and information technology (17%).

5.8 TRANSPORTATION AND PUBLIC INFRASTRUCTURE

5.8.1 Roadways

Three interstate routes transect the basin — Interstates 70 (east-west), 71 (east-west), and 77 (north-south) (see Figure 12). The interstate system connects many of the main population centers in the basin, as well as connecting the basin area to larger metropolitan areas like Pittsburgh, Pennsylvania and Cleveland, Ohio. Currently there are no plans by the Ohio Department of Transportation (ODOT) to extend or expand the current interstate routes in the basin.

5.8.2 Railways

The freight rail system in Ohio comprises three Class I railroads, 16 regional and short line railroads, and 15 terminal carriers (see

Figure 13). Three of these railroads transect the basin, connecting major population centers with larger metropolitan areas. The majority of trains passing through the basin carry freight, although Amtrak operates several passenger lines that move through the area as well. The Ohio Rail Development Commission released the Ohio Statewide Rail Plan in May of 2010; the plan evaluated the current railway system in Ohio and recommended several upgrades to lines. The report is available online at http://www.dot.state.oh.us/Divisions/Rail/Programs/StatewideRailPlan/Documents/Ohio%20Statewide%20Rail%20Plan%20-%20Final%20Report%20Complete.pdf.

5.8.3 Airports

The only commercial airport in the basin is Akron-Canton Regional Airport located in North Canton.

In addition to transportation resources, HAZUS provides an inventory of hospitals, Wastewater Treatment Plants (WWTPs), dams[4], schools, and fire stations. Due to the size

[4] As previously stated, there are 16 Corps of Engineers owned and operated FRM dams located in the basin. Other dams shown in the following figures belong to the Ohio DNR, NRCS, and local municipalities for water supply. With the exception of the Muskingum River basin system, none of these dams are located for flood control.

Table 12 – Employment Statistics in the Major Contributing Counties of the Muskingum River Basin (BLS 2002)

Counties	Industries											
	Wholesale trade	Retail Trade	Information	Finance and Insurance	Real Estate	Professional, Scientific and Technical Services	Administrative, Support, Waste Management and Remediation Services	Educational Services	Health Care and Social Assistance	Arts, Entertainment and Recreation	Acommadation and Food Services	Other Services (Except Public Administration)
Ashland	5,322	368	2,058	458	163	657	2,500-4,999	20-99	2,041	250-499	1,562	569
Carroll	1,611	100-249	779	58	26	20-99	118	1-19	789	100-249	469	235
Coshocton	3,818	529	1,319	108	44	285	1,169	N/A	1,949	249	747	296
Guernsey	3,257	407	2,149	217	233	273	992	14	2,450	100-249	1450	250-499
Harrison	738	163	366	29	1-19	20-99	20-99	1-19	552	20-99	247	86
Holmes	5,237	465	1,818	82	31	211	376	N/A	1,267	75	1,179	203
Knox	4,373	250-499	2107	100-249	140	250-499	305	20-99	1,955	83	1,486	500-999
Licking	7,774	1,561	6,745	597	443	1,000-2,499	3,245	129	5,846	646	4,926	1,306
Medina	9,537	3,130	7,721	493	493	1,758	3,556	100-249	6,234	685	4,366	1,674
Morgan	N/A	20-99	295	20-99	1-19	40	20-99	N/A	319	7	198	43
Morrow	1000-2499	20-99	631	48	31	81	209	1-19	941	1-19	339	103
Muskingum	7,530	1,109	4,961	336	358	538	1,179	53	5,964	396	3,360	1,198
Noble	619	35	387	15	1-19	20-99	1-19	N/A	409	1-19	170	20-99
Perry	1,486	111	712	64	34	103	56	100-249	684	46	419	172
Portage	11,178	2,887	6,026	396	497	1,000-2,499	1,441	100-249	4,913	794	4,330	1,194
Richland	13,896	2,923	7,734	1,480	497	1,000-2,499	3,682	76	6,821	1,000-2,499	4,685	1,797
Stark	34,491	5,000-9,999	22,862	2,265	1,520	2,500-4,999	8,018	100-249	24,909	1,000-2,499	13,682	5,216
Summit	38,394	13,283	32,247	5,067	3,358	10k-24k	15,878	1,000-2,499	37,642	3,358	21,593	8,477
Tuscarawas	9,231	966	5,057	538	339	500-999	1,787	33	4,630	437	3,948	1,113
Washington	5,009	787	3,122	234	287	500-999	811	100-249	3,855	100-249	1,907	663
Wayne	14,934	1,293	5,311	901	284	500-999	13,931	40	4,500	256	3,445	1,109

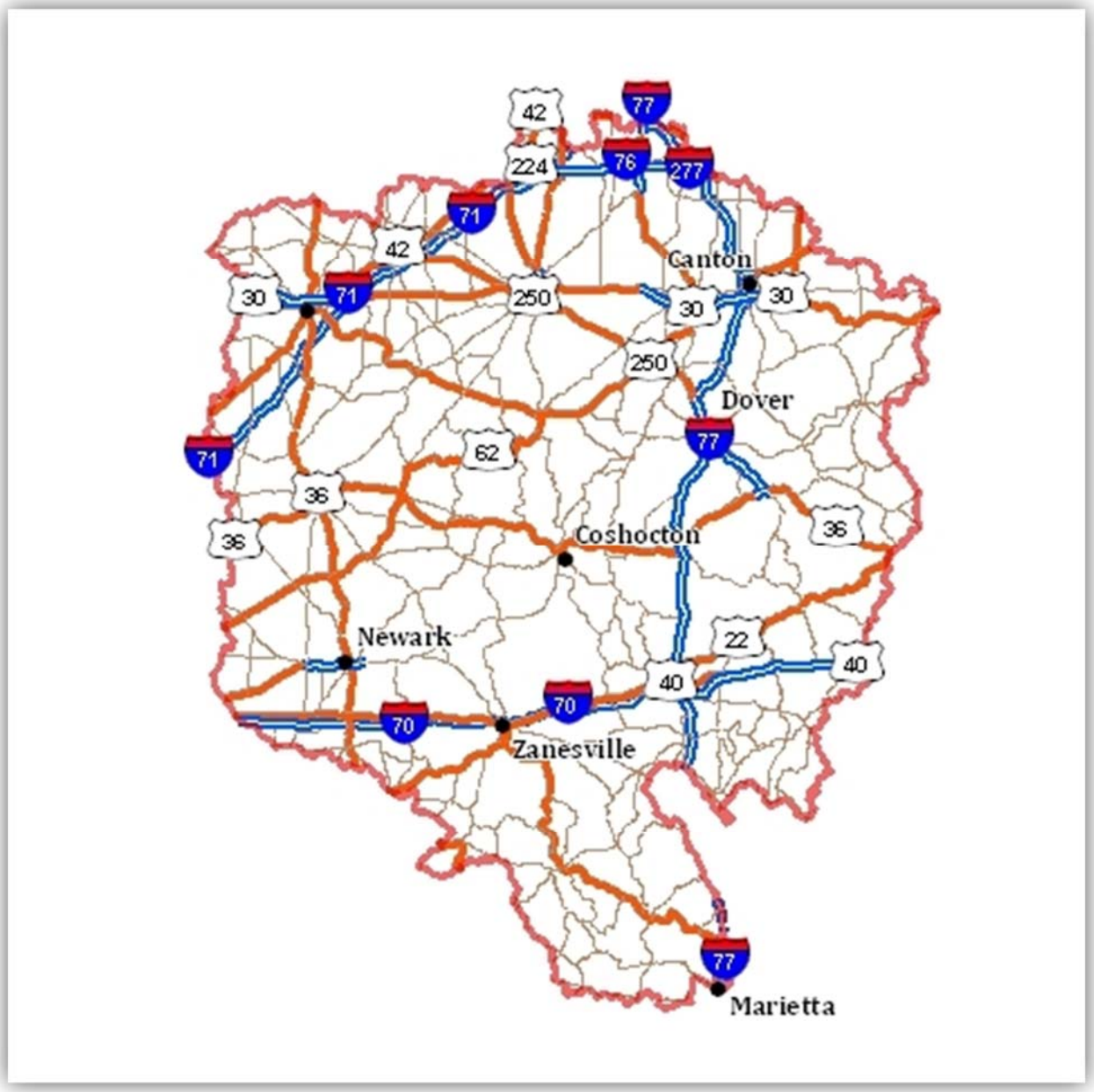


Figure 12 – Interstates, US Routes, and County Roads in the Muskingum River Basin

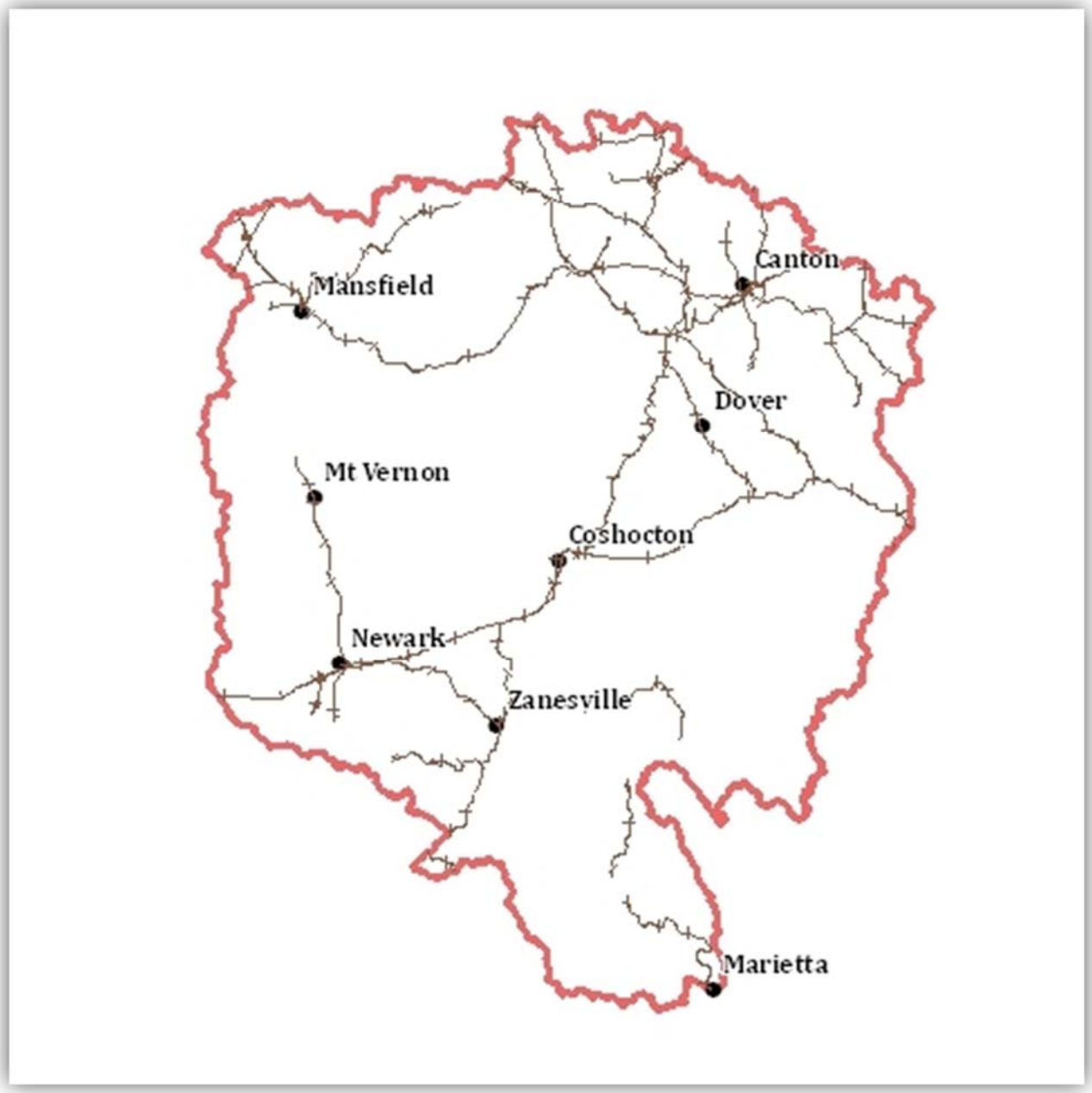


Figure 13 – Railroads in the Muskingum River Basin

of the basin and the number of these features therein, these facilities are displayed at the HUC-8 level in

Figure 14 through

Figure 19 below. Schools and WWTPs predominantly are concentrated around the primary centers of population, while fire stations are scattered throughout the watershed and typically have quick access to state highways.

5.9 CLIMATE

The climate of the Muskingum basin is classified as humid with warm summers and mildly cold winters. Many factors interact to influence the climate as it varies with the season. Among those factors is latitude, elevation, proximity to large bodies of water, ocean currents, topography, vegetation and prevailing winds. The basin lies between latitudes 39.5 and 41 degrees. There are no abrupt changes in topography such as significant mountain ranges to cause great differences in climate.

Other factors which have a major influence in causing change in the climate are prevailing winds, cloudiness and snow cover. The basin is located in the belt of prevailing westerly winds. Storm traces from western Canada and the Rockies move eastward by way of the Great Lakes and the Ohio Valley. In passing over large land masses the air becomes greatly chilled in winter due to snow cover and heated in summer, thus subjecting the basin to temperature extremes.

In the Muskingum River basin the mean annual temperature varies from 53 degrees near the Ohio River to 49 degrees in the north, as illustrated in

Figure 20. Maximum temperatures record in the area range from 103 degrees Fahrenheit to 107 degrees Fahrenheit, and minimum temperatures range from –33 degrees in the highlands to –17 degrees in the low areas.

Most of the moisture which falls as rain or snow over the basin has its origins from the Pacific Ocean. It is estimated 12% to 14% of the atmospheric moisture is acquired over land as air masses move from west to east. Passage of cold or warm fronts and their associated centers of low pressure occur frequently and precipitation often results.

Annual precipitation data for Ohio is available from the National Climatic Data Center for the years 1930–2011. Throughout this 80-year period, the average annual precipitation for the state was 38.9 inches. Average annual precipitation for the Muskingum River basin itself varies by location from 37 to 43 inches. Yearly precipitation for the state of Ohio is recorded below in

Table 13, while a map of the average annual precipitation for the basin is shown in Figure 21.

5.10 ECOLOGY

Land uses in the Muskingum River basin provide ample and diverse habitats for a variety of wildlife species. In the northern and western basin counties where farmland is prevalent, cottontail rabbits, fox squirrels, mourning doves, bobwhite quail, and ring-necked pheasants are the most abundant game species. White-tailed deer, ruffed grouse, and gray

Figure 14 – Infrastructure in the Licking River Watershed

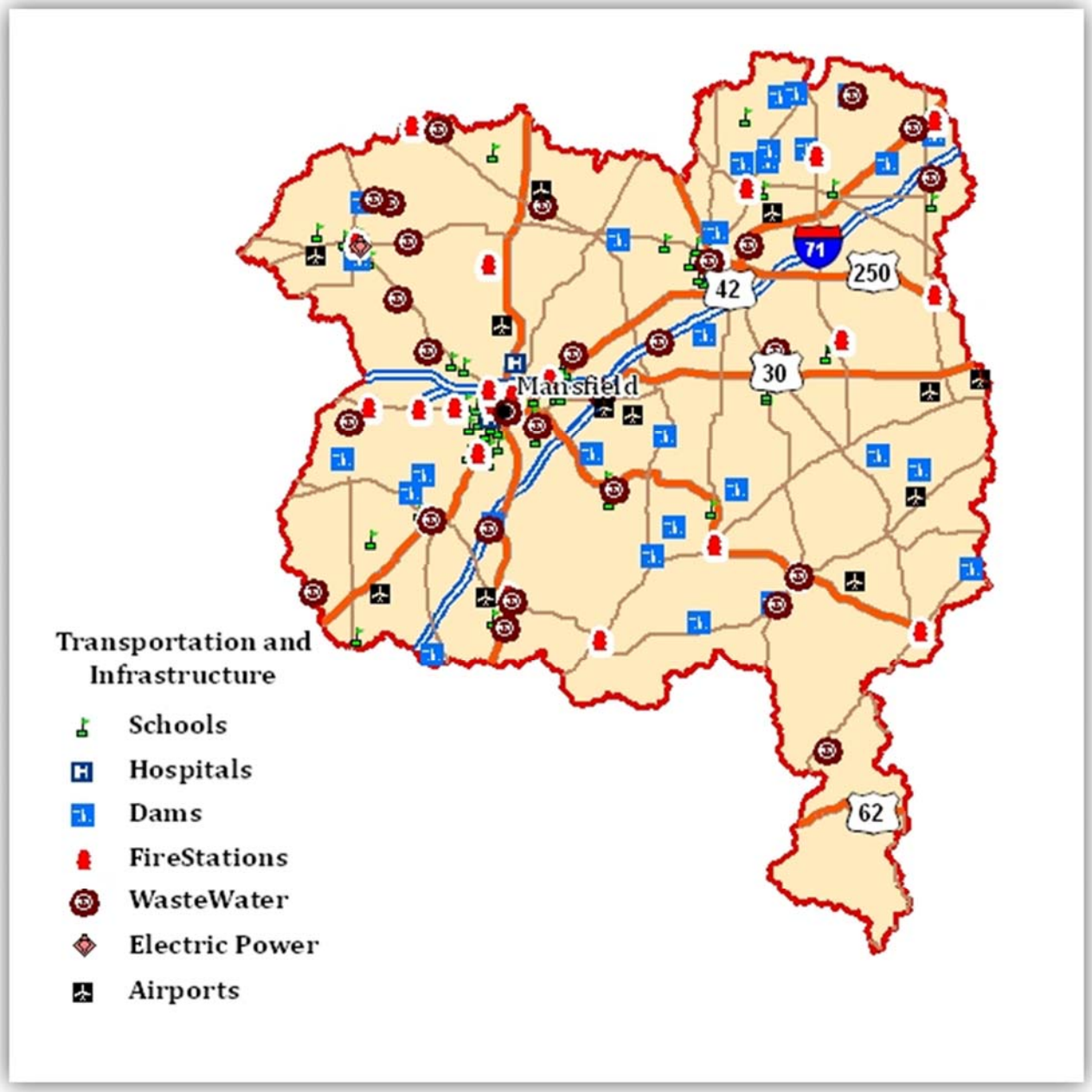


Figure 15 – Infrastructure in the Mohican River Watershed

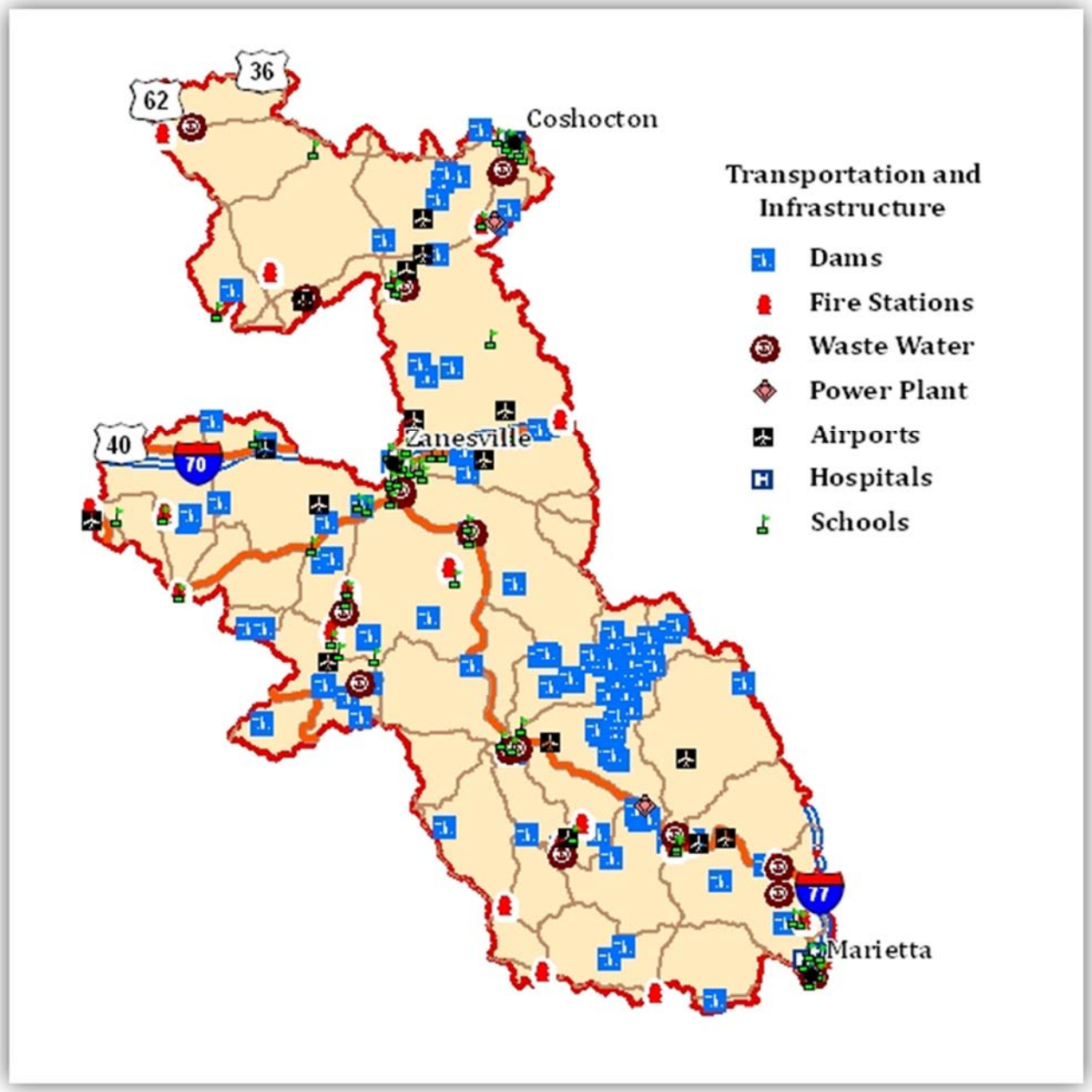


Figure 16 – Infrastructure in the Muskingum River Watershed

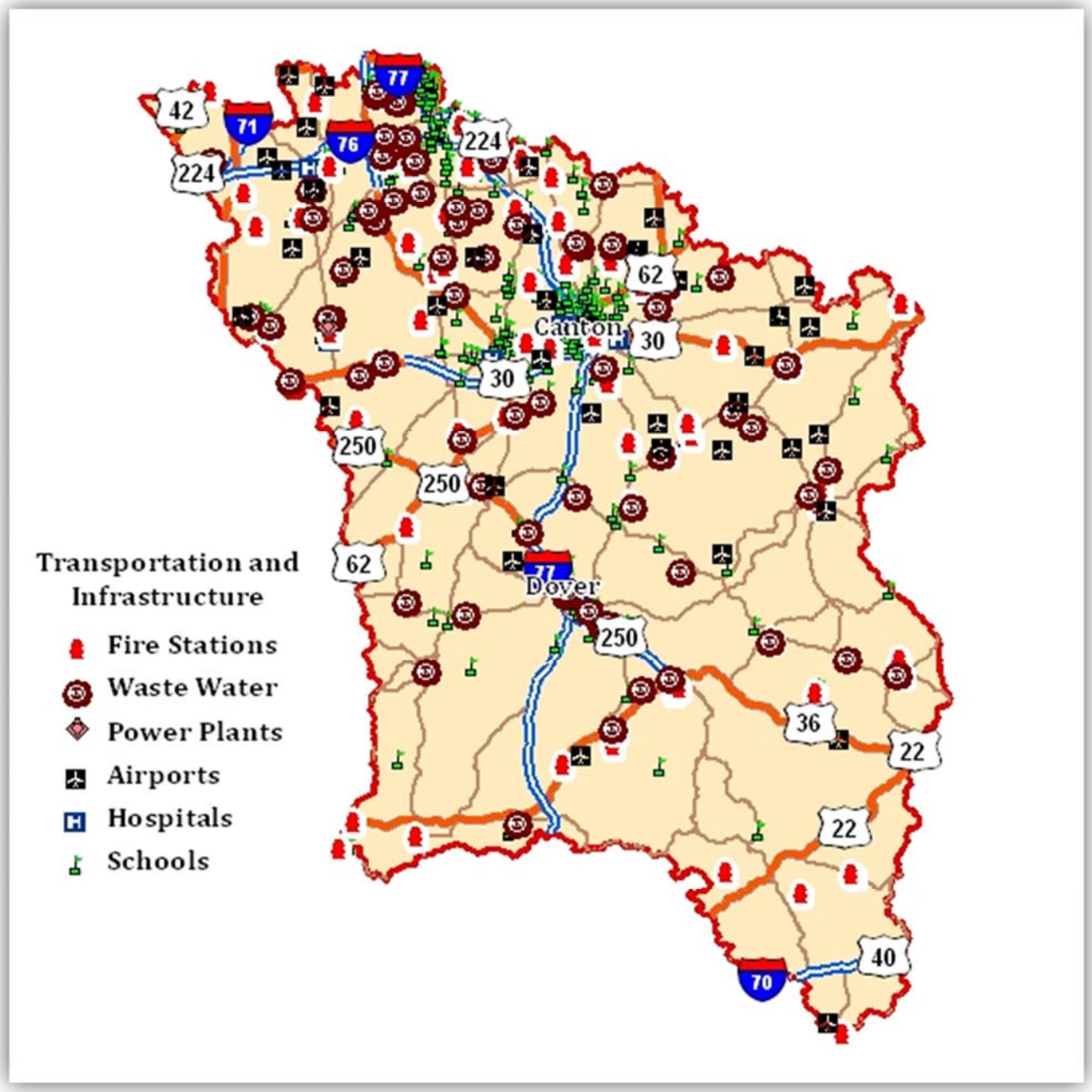


Figure 17 – Infrastructure in the Tuscarawas River Watershed

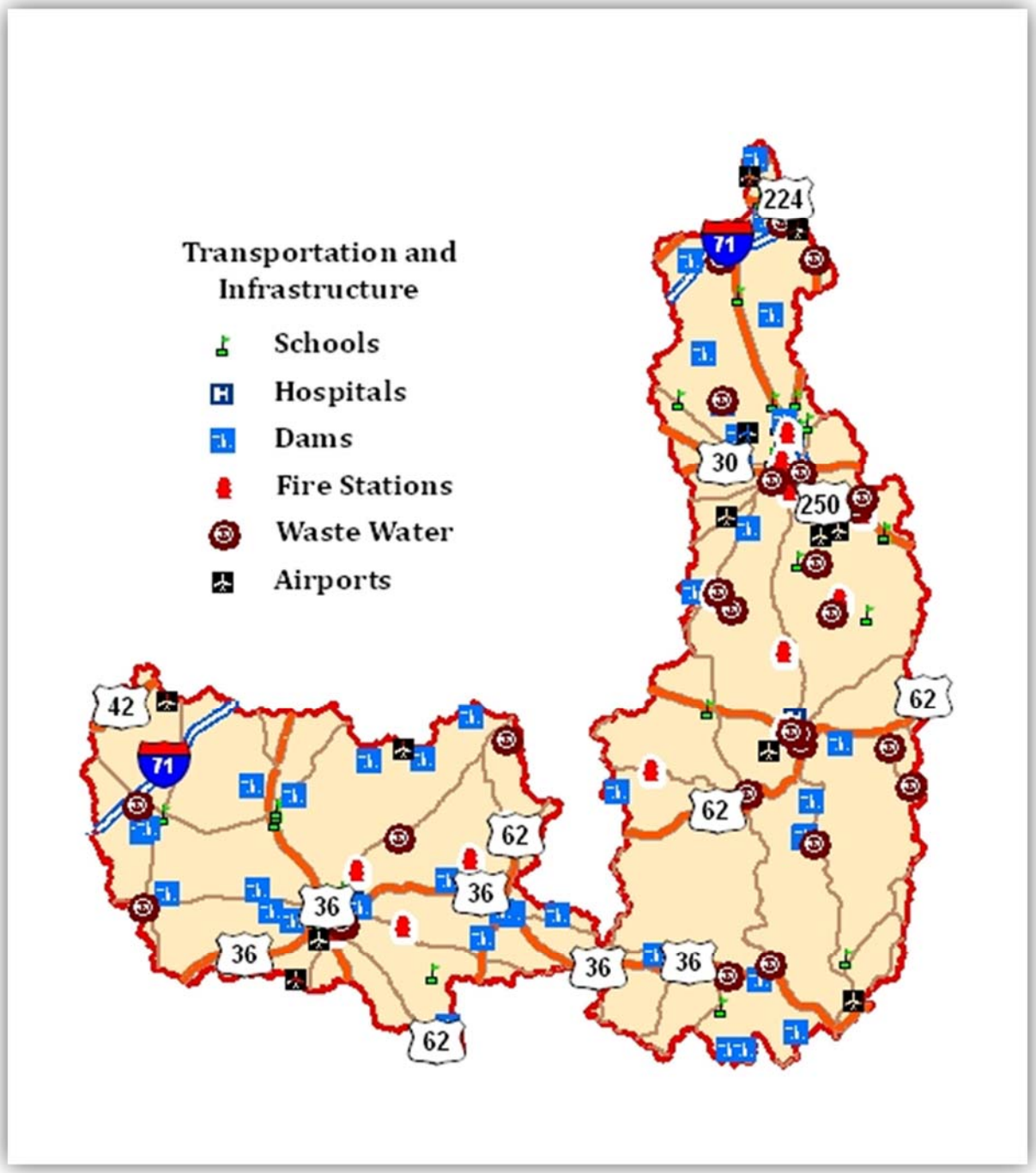


Figure 18 – Infrastructure in the Walhonding River Watershed

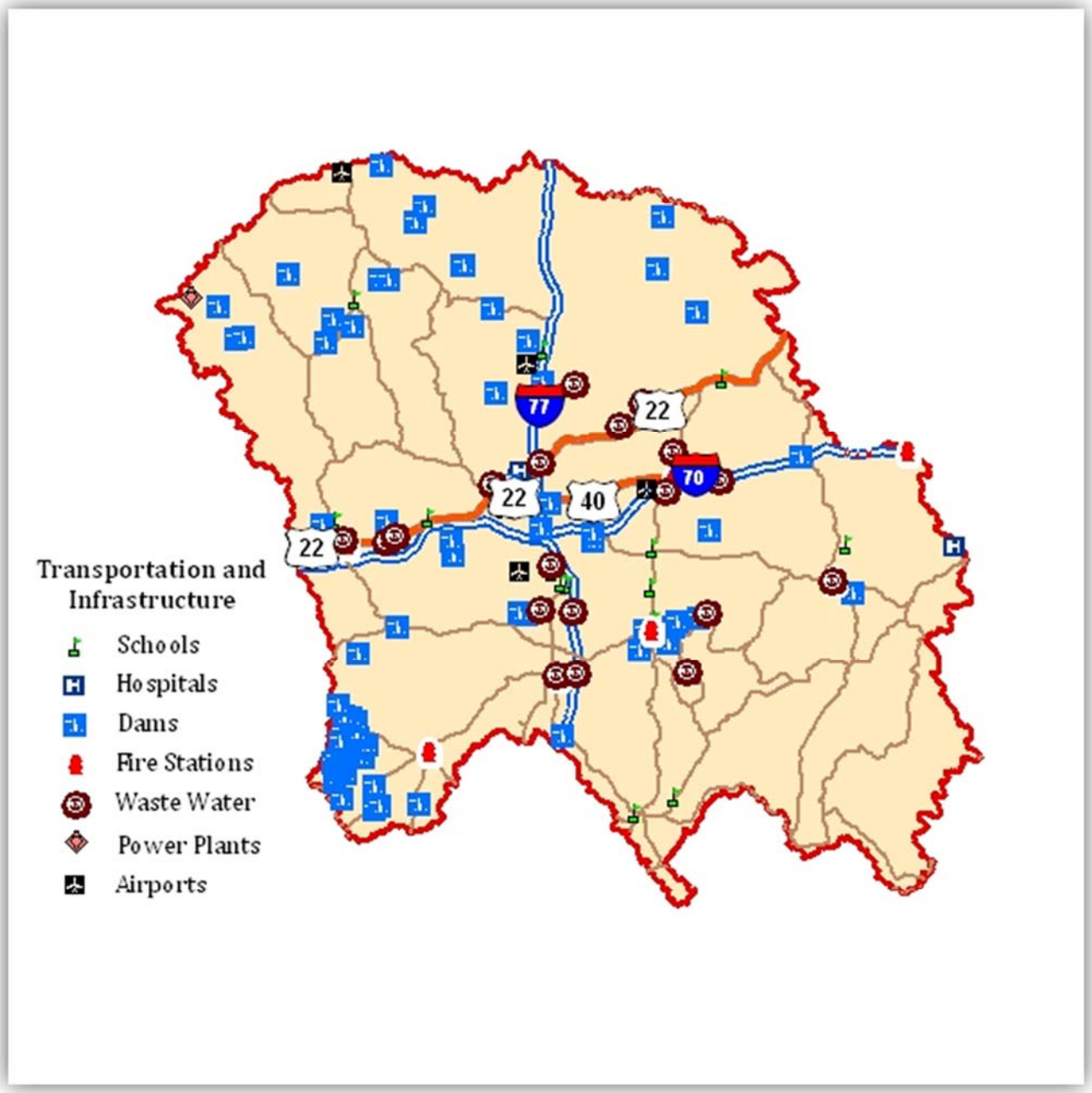


Figure 19 – Infrastructure in the Wills Creek Watershed

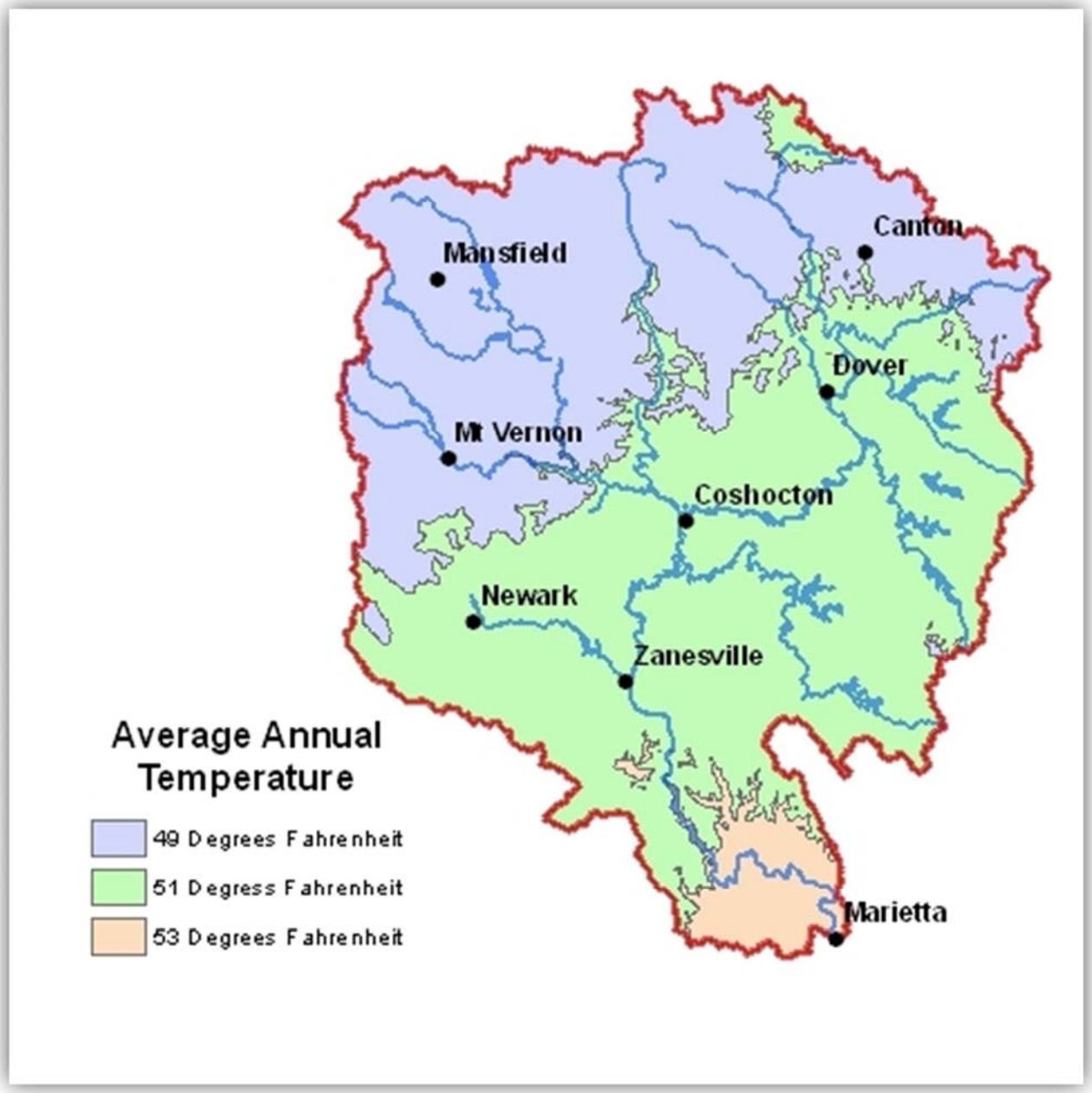


Figure 20 – Average Annual Temperatures in the Muskingum River Basin

Table 13 – Yearly Precipitation, in Inches, for the State of Ohio (NCDC, 2011)

Year	Precipitation	Year	Precipitation	Year	Precipitation	Year	Precipitation
1930	46.39	1951	42.49	1972	32.12	1993	42.22
1931	22.46	1952	40.41	1973	42.21	1994	38.74
1932	41.37	1953	33.25	1974	43.22	1995	35.36
1933	34.13	1954	27.67	1975	42.46	1996	39.97
1934	37.04	1955	37.52	1976	41.72	1997	45.53
1935	28.52	1956	37.24	1977	30.25	1998	40.21
1936	40.16	1957	38.53	1978	41.35	1999	41.11
1937	40.65	1958	38.25	1979	40.04	2000	32.48
1938	37.52	1959	44.77	1980	41.51	2001	37.64
1939	41.83	1960	37.71	1981	41.07	2002	38.81
1940	34.89	1961	28.83	1982	41.53	2003	40.12
1941	36.15	1962	42.43	1983	33.92	2004	48.09
1942	32.99	1963	29.22	1984	41.5	2005	50.03
1943	38.04	1964	28.16	1985	37.19	2006	37.3
1944	35.41	1965	40.37	1986	41.12	2007	45.89
1945	34.36	1966	35.96	1987	36.61	2008	42.73
1946	43.92	1967	34.15	1988	34.1	2009	42.73
1947	36.69	1968	35.54	1989	32.76	2010	36.51
1948	40.57	1969	39.71	1990	44.45	2011	38.92
1949	44.84	1970	35.46	1991	48.96		
1950	41.84	1971	39.85	1992	31.06		

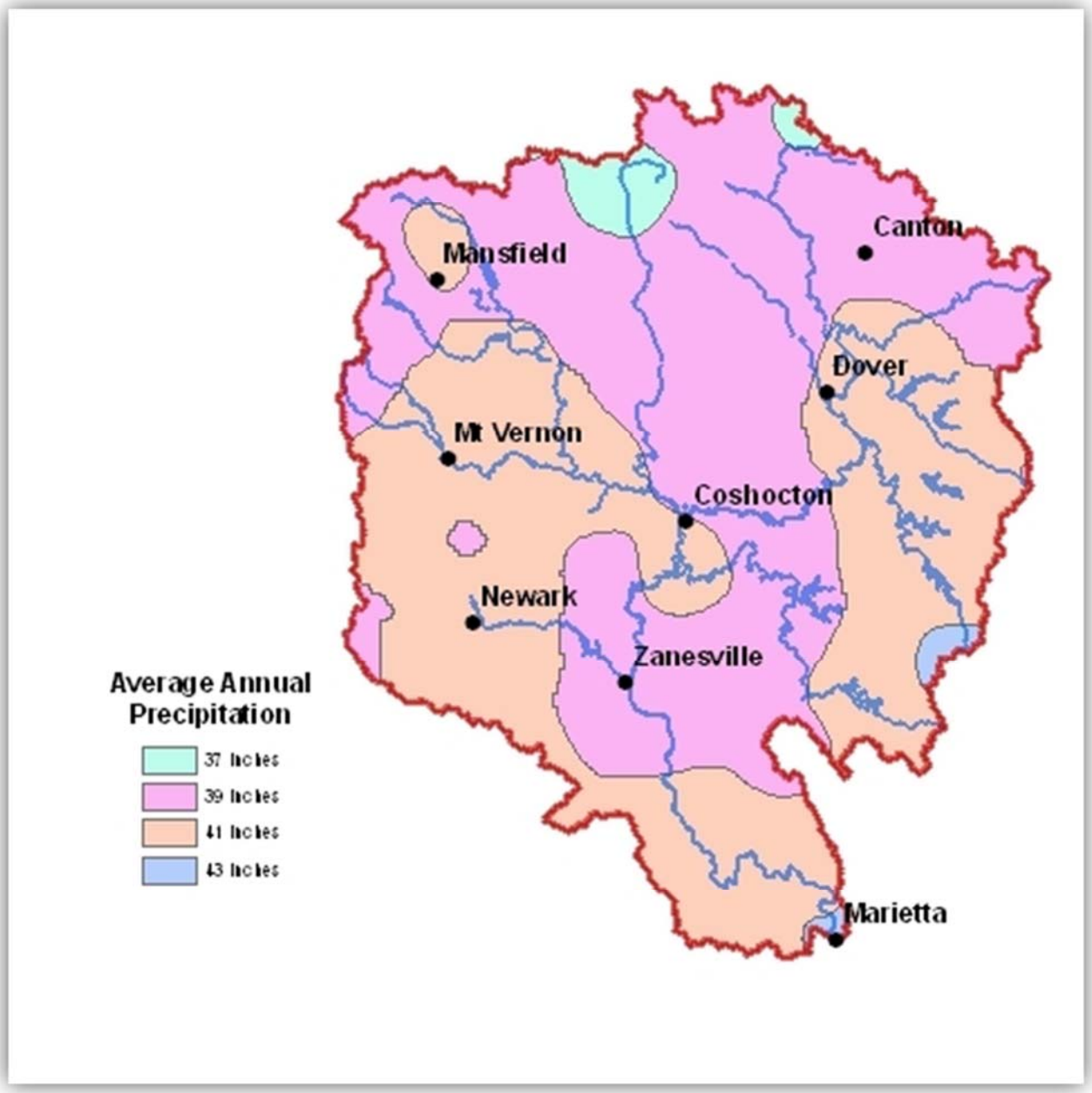


Figure 21 – Average Annual Precipitation in the Muskingum River Basin (NRCS, 1971–2000)

squirrels also are present in these counties but are more abundant in the larger tracts of forest in the southern portion of the basin.

Wild turkey was introduced in southeastern Ohio in 1952 and has become re-established to a large degree. Wild turkeys have been found in the Perry, Morgan, and Washington County portions of the Muskingum River basin. Major furbearers in the basin are muskrat, raccoon, opossum, mink, red fox, skunk, weasel, gray fox, and beaver.

Ohio has about 250,000 acres of waterfowl habitat, much of which is found in the Muskingum River basin. The Ohio Division of Wildlife reports that mallards, black ducks, wood ducks, and greenwinged teal constitute about 70% of Ohio's annual harvest of waterfowl. Other ducks which pass through the Muskingum River basin include greater scaup, bufflehead, widgeon, pintail, blue-winged teal, and redhead. Canada geese are found in the basin as well.

The abundance of streams, reservoirs, and farm ponds well distributed throughout the basin provide much high quality warm water fish habitat. Game fish found in this area of Ohio include: Smallmouth bass, largemouth bass, white bass, bluegill, sunfish, white crappie, black crappie, channel catfish, muskellunge, northern pike, and walleye.

5.10.1 Endangered and Threatened Species

In accordance with the Endangered Species Act, the US Fish and Wildlife Service maintains a national list of endangered and threatened species. Species are added to the list when in danger of becoming extinct. Common factors threatening continued existence include destruction or modification of habitat, disease, and over-harvesting. Table 14 displays the Federally listed endangered and threatened species in the Muskingum River basin.

While the bald eagle (*haliaeetus leucocephalus*) was removed from the Federal list of endangered and threatened species in 2007, after many years of preservation efforts, this species remains protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Several nesting pairs of bald eagles can be found around Beach City and Bolivar Dams in Tuscarawas Counties.

5.11 RECREATION

Recreational opportunities are plentiful throughout the Muskingum River basin, and are of great economic significance to the local economy. Common recreational opportunities include hunting, fishing, boating, camping, biking, canoeing, and hiking.

Table 14 – Federally Listed Endangered and Threatened Species in the Muskingum River Basin

Common Name	Scientific Name	Status
Indiana bat	*Myotis sodalis*	Endangered
American burying beetle	*Nicrophorus americanus*	Endangered
Fanshell	Cyprogenia stegaria	Endangered
Pink mucket pearly	*Lampsilis abrupta*	Endangered
Clubshell	*Pleurobema clava*	Endangered
Purple cat's paw pearlymussel	*Endangeredpioblasma obliquata obliquata*	Endangered
Scioto madtom	*Noturus trautmani*	Endangered
Northern riffleshell	*Epioblasma torulosa rangiana*	Endangered
Mitchell's satyr butterfly	*Neonympha mitchellii mitchellii*	Endangered
Rayed bean	*Villosa fabalis*	Proposed as Endangered
Sheepnose	*Plethobasus cyphyus*	Proposed as Endangered
Snuffbox	*Epioblasma triquetra*	Proposed as Endangered
Eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened
Northern monkshood	*Aconitum noveboracense*	Threatened
Rabbitsfoot	*Quadrula cylindrica cylindrica*	Candidate
Eastern massasauga	*Sistrurus catenatus*	Candidate

5.11.1 Recreation at MWCD-Owned Property

As previously mentioned, the Flood Control Act of 1939 returned the 14 reservoirs built as part of the Muskingum River system to the Federal government, and the operation of those dams to USACE. The MWCD, however, retained all the property and easements associated with the reservoirs and continues to operate them for other authorized project purposes, including recreation (which draws millions of visitors every year).

The MWCD manages approximately 54,000 acres of property in the basin, including 16,000 acres of surface water on lakes and 38,000 acres of forest and open lands around the lakes, the majority of which is open to the public. Additionally, the MWCD has developed five parks located at Atwood, Charles Mill, Pleasant Hill, Seneca, and Tappan lakes, where overnight camping and cabins are available. The parks run a full schedule of activities from

Memorial Day to Labor Day. Camping also is available adjacent to the marina areas at Clendening, Leesville, Piedmont, and the North Branch of Kokosing Lakes. Several of the reservoirs host various youth and organizational camps, attracting thousands of visitors each year. Most notable of these is the Alive Christian Musical festival held at Atwood Lake each summer.

5.11.2 State Parks

Another source of recreational opportunities in the basin is the various state parks. The basin plays host to ten state parks, including Portage Lakes, Quail Hollow, Wolf Run, Dillon, Muskingum River Parkway, Blue Rock, Mohican, Malabar Farms, Burr Oak, and Salt Fork. These parks offer a variety of outdoor recreational activities that include camping, boating, fishing, swimming, hiking, picnicking, and hunting. Most of the parks also offer the opportunity for winter recreational activities, which include ice skating, ice boating, ice fishing, snowmobiling, and cross-country skiing.

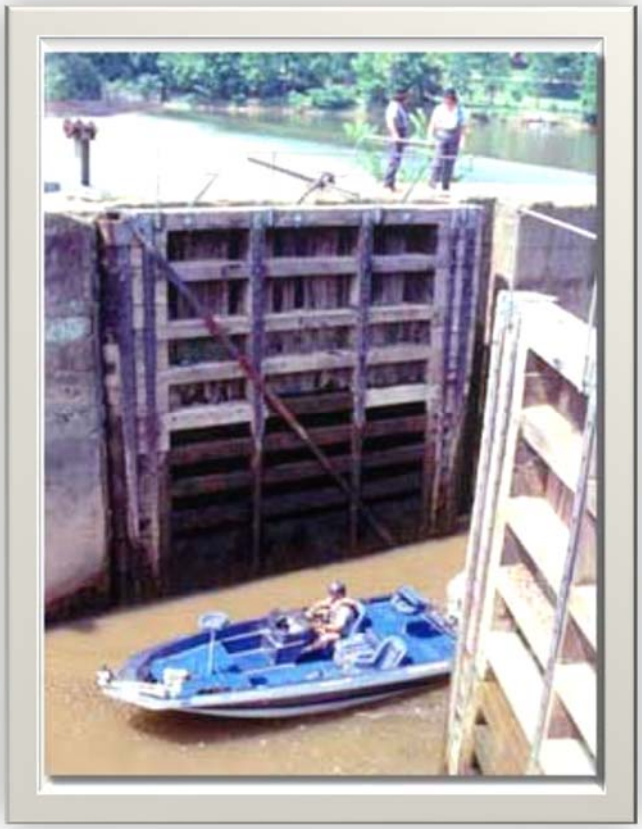


Figure 24 – A Pleasure Craft Uses One of the Historic Muskingum River Locks

Several of the state parks have specialized recreational opportunities above and beyond those listed. For example, Portage Lakes State Park has several teepees for rent, while Salt Fork, Burr Oak, and Mohican state parks all have a lodge on site (Burr Oak and Salt Fork state parks also offer cottages for rent). In addition to a lodge and cottages, Salt Fork State Park also has an 18-hole golf course.

Quail Hollow State Park specializes in recreational study and programs that teach appreciation of Ohio's cultural and natural history. The H.B. Stewart family home on site is used for educational and community activities, while the Carriage House Nature Center features live animals and hands-on educational activities. The Park also holds workshops and events year round, including the Craft and Herb Fair, Reptile Day, and Christmas at the Hollow.

Dillon State Park features disc golf an archery course, and a modern sportsman's area that includes lighted trap and skeet fields, a 100-yard rifle range, and a 25-yard pistol range.

Finally, the Muskingum River Parkway State Park sits in an area that has been placed on the National Register of Historic Places and soon will be recognized as the Muskingum River Navigation Historic District. The State Park offers boaters a chance to pass through one of the Muskingum River's historic dam locks.

5.11.3 The Wilds

The Wilds, located in Muskingum County on 9,154 acres of reclaimed coal mine land, operates as a private, non-profit wildlife conservation center. Home to more than 25 non-native species and hundreds of native species, The Wilds is the largest conservation center for endangered species in North America. It is open to the public for a variety of tours from May through October.

The Wilds seeks to contribute to and enhance conservation medicine; animal management, husbandry, and health; restoration ecology; conservation science training; and conservation education. Some of the animals making their home at The Wilds include camels, bison, giraffes, cheetahs, zebras, and rhinos.

5.11.4 The Ohio and Erie Canalway Coalition

The Ohio & Erie Canalway Coalition was formed in 1989 as a private, non-profit organization working on development of the Ohio & Erie National Heritage Canalway. In

addition to providing educational programs, events, and publications about the Heritage Canalway, the Coalition also owns and operates the Towpath Trail (see Figure 26), which follows the old Ohio & Erie Canal (originally, the trail served as a path for the horses and mules pulling canal boats). Today the Towpath Trail is 25 miles long and facilitates biking, hiking, and horseback riding from Lake Erie south to New Philadelphia, Ohio.

6. FUTURE WATERSHED CONDITIONS

The land uses of the Muskingum River Basin are a mixture of agriculture, forest and urban uses. This mixture has led to water quality deterioration through sedimentation and nutrient/bacterial loading from agricultural and livestock practices and increased impervious cover and stormwater management issues from urban sprawl. Although agricultural acreage has been reduced during the past 10 years and little growth in that sector of the economy is anticipated, water quality impacts due to land cultivation and livestock continue with limited abatement. Likewise, urban stormwater runoff and Combined Sewer Overflows (CSO) issues remain largely unabated in many watersheds. Future reductions in federal spending (national deficit reduction) for abatement programs promises continued water resources impacts.

US Census projections show the population in the 21 basin counties increasing by 2,500 persons through 2030. This increase distributed over 8,038 square miles would not spur substantial growth in residential and commercial uses which exacerbate pressures for additional water supplies or generate significant additional stormwater runoff across the basin. Any growth in household formation would be absorbed by the current vacant housing stock. Vacant commercial space, due to the recent recession, could be used to accommodate any increases in retail purchases.

Of more concern are the future effects of anticipated climate change on the land and water resources of the basin and its population. Current science-based predictions indicate that climatic changes in this region may include higher temperatures in summer and winter with measurably less annual rainfall, but more intensive rainfall events when they do occur.

Higher summer temperatures would generate greater rates of evaporation at Corps reservoirs and greater water supply needs for irrigation and potable water from those same shrinking resources. Higher summer temperatures raise the threat of reduced recreation usage on the waterways and reservoirs and higher temperatures throughout the year increase the threat of migration northward of warm-weather invasive terrestrial and aquatic species. The onslaught of both floral and faunal invasive species could wreak havoc on watershed and reservoir ecosystems and endanger potential ecosystem restoration projects. Higher winter temperatures would reduce any spring thaw benefits from accumulated snowpack in the upper portions of the basin.

Decreases in annual precipitation could endanger aquatic ecosystems and threaten groundwater supplies and conservation pools at reservoirs. The potential threat to aquatic ecosystems from sustained drought conditions would be increased for all watersheds in the basin. Increased intensity of rainfall events would raise the risks of flash flooding (and associated loss of life risks) in the sub-watersheds in the Upper Tuscarawas and increase the frequency of channel-modifying, bank full flows – flows that lead to bank instability, armoring and channel instability. Riparian resources throughout the basin could be threatened by these larger flows and their effects on the stream channel environment.

7. IDENTIFICATION OF PROBLEMS AND NEEDS

Early in the development of the IWA, water resource related problems and needs were identified and defined, primarily through stakeholder outreach. As previously mentioned, six stakeholder meetings were held throughout the basin during the week of June 28, 2011. The stakeholders consisted of Federal, State, and local government officials as well as resource agencies and nonprofit watershed associations. The meeting locations are marked once again in
Figure 27; Appendix E contains meeting notes.

The main areas of concern can be roughly divided into the following categories:

- Water quality/ecosystem restoration,
- Land use/floodplain management,
- Flooding issues, and
- Infrastructure issues

7.1 WATER QUALITY/ECOSYSTEM RESTORATION

US waters are always threatened by various sources and types of pollution. Under the Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimmable/fishable" waters and are ambient rather than discharge-type standards. These ambient standards, through a process of back-calculation procedures known as Total Maximum Daily Loads (TMDLs), or waste-load allocations, form the basis of limitations that regulate the discharge of pollutants into waters under the NPDES permit program. (A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant.)

Ohio's water quality standards, set forth in Chapter 372-1 of OAC, include four major components:

1. beneficial use designations,
2. narrative "free froms" (see Section 5.4),

3. numeric criteria, and
4. anti-degradation provisions.

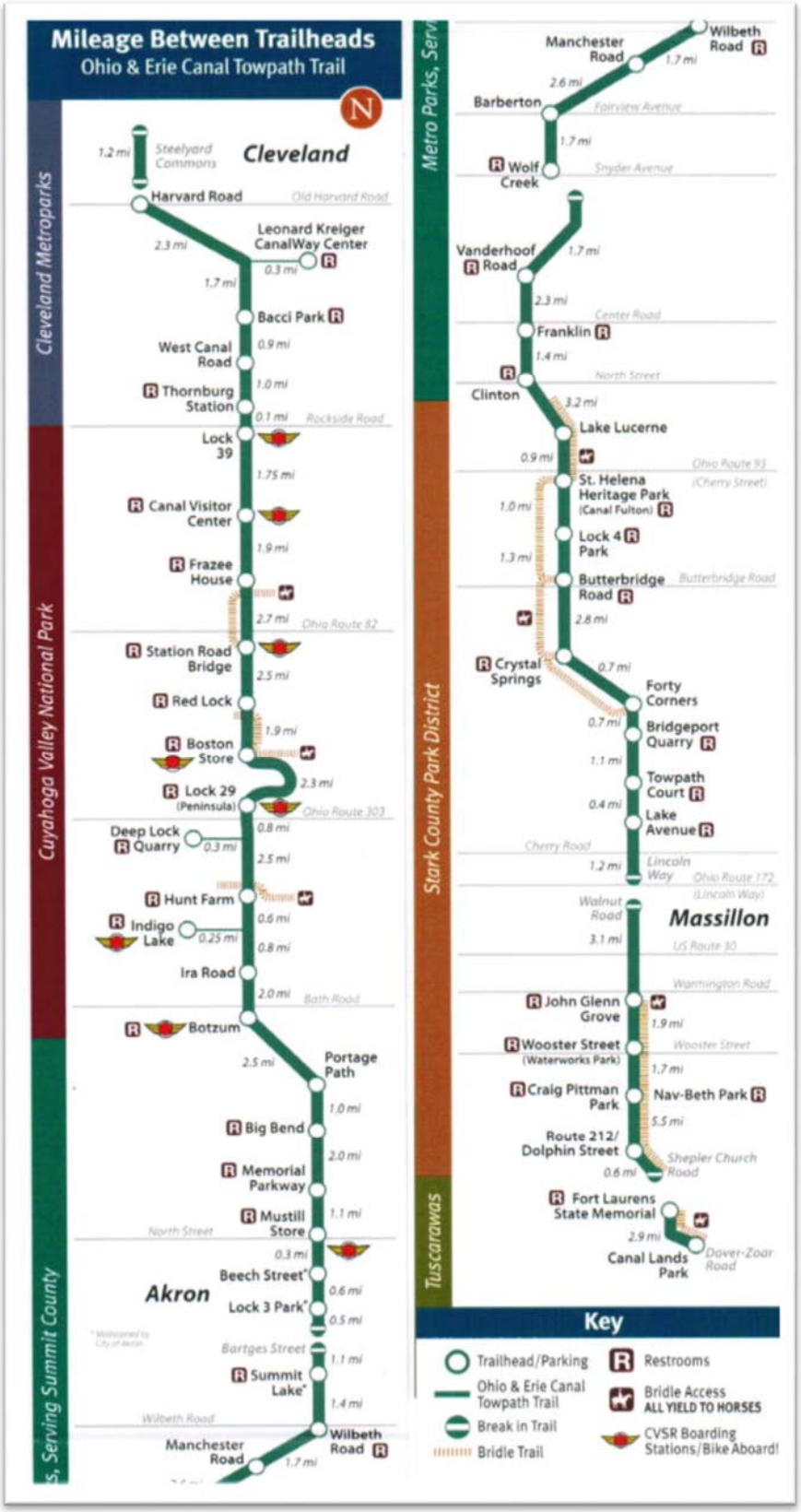


Figure 26 – Map of Towpath Trail

Figure 27 – Locations of Stakeholder Meetings

Streams not meeting State water-quality standards are placed on EPA's 303(d) Impaired Waters List. Of 11,108 miles of streams in the Muskingum River basin, 7,242 are listed as impaired.

Overarching water-quality concerns voiced on behalf of stakeholders during outreach sessions included:

- Acid mine drainage,
- Lack of septic system standards (not only the basin but also in the state),
- Oil and gas development, and
- Removal of (or lack of) riparian buffer zones, and stream-bank stabilization issues.

7.1.1 Acid Mine Drainage

Acid mine drainage is polluted runoff from areas that have been mined for coal or other mineral ores. It often contains dilute sulfuric acid and high levels of heavy metals such as iron, aluminum and manganese. The water has a low pH because of its contact with sulfur-bearing material and thus is harmful to aquatic organisms.

Several small watersheds within the Muskingum River basin have been identified as having issues related to acid mine drainage. Some of these watersheds include: Wills Creek; Wolf Creek (in the Muskingum River watershed); Stillwater and Sugar creeks; and Mud, Morgan, and Huff runs (in the Tuscarawas River watershed).

7.1.2 Septic System Standards

At the majority of the stakeholder meetings, attendees voiced concerns about a lack of septic system inspection standards — not only within the basin but across the state of Ohio as well. In most states, septic systems must be inspected upon change of land ownership (buying/selling).

OAC 3701-29-07 specifies requirements for construction of new septic systems, and OAC 3701-29-17 contains inspection requirements:

> *"(A) The health commissioner may at any reasonable time during the course of construction or any time thereafter inspect any household sewage disposal system or part thereof, sample the effluent, or take any other steps which he deems necessary to insure proper compliance with rules 3701-29-01 to 3701-29-21 of the Administrative Code (Ohio*

Sanitary Code). The health commissioner may utilize inspection reports or other data submitted or obtained from reliable sources to determine compliance.

(B) No household sewage disposal system or part thereof shall be covered or put into operation until the system has been inspected and approved by the health commissioner."

Although the Code states that a health commissioner may inspect any household sewage disposal system at any time, it does not mandate a standard inspection schedule (that is, periodic inspections on a recurring basis). If a septic inspection is conducted during original construction, and the system is not checked again for 10 or 15 years, it stands to reason that owners may be unaware of damage (e.g., crushed or corroded pipes) or needed maintenance (e.g., clogged drain field or buildup of solid wastes in the tank).

Failing septic systems can contribute nitrates and salts to groundwater. Nitrates, which will migrate with groundwater to nearby water bodies, are toxic to humans in high concentrations and can render a water source (surface or groundwater) unfit for human use. The failing septic system also can spread viruses and pathogens, negatively affecting aquatic and terrestrial species as well as humans.

7.1.3 Oil and Gas Development

Oil and gas development is prevalent in Ohio, especially in the Muskingum River basin (Figure 29 illustrates the density of oil and gas development across the basin counties). For comparison purposes, a map of the Muskingum River basin is included again as Figure 30.

At nearly all of the stakeholder meetings conducted by the Huntington District, resource agencies and watershed groups voiced their concerns about impacts to water quality stemming from oil and gas development. Some of water-related concerns included:

- drilling operations (acids from stimulation of clogged formations, corrosion inhibitors, biocides, and other additives; organics and metals from formation; and radionuclides in some areas),
- drilling-mud reserve pits (leaching of contaminants and pit closure),
- drilling in ecologically sensitive areas,
- contamination from spills, leaks, blowouts, and deliberate releases (reinjection and discharge of separated water to percolation pit),
- subsurface migration of contaminants among aquifers, and
- faulty remediation methods.

In addition to concerns stemming from active mines, stakeholders also voiced concerns about idle and "orphan" wells. Idle wells no longer produce but have not yet been plugged; orphan wells have been abandoned (the owner either is untraceable or insolvent). Such

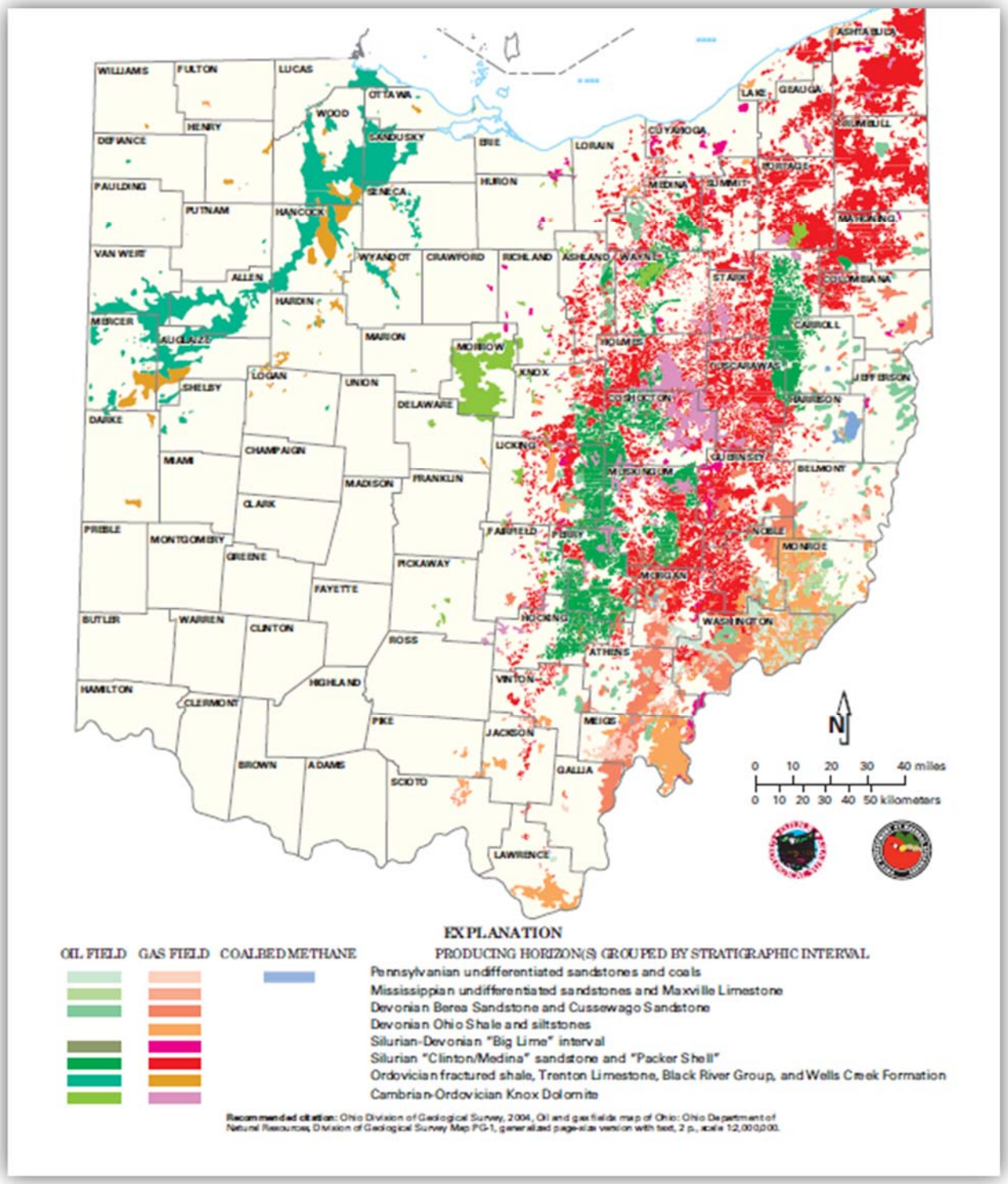


Figure 29 – Oil and Gas Fields Map of Ohio

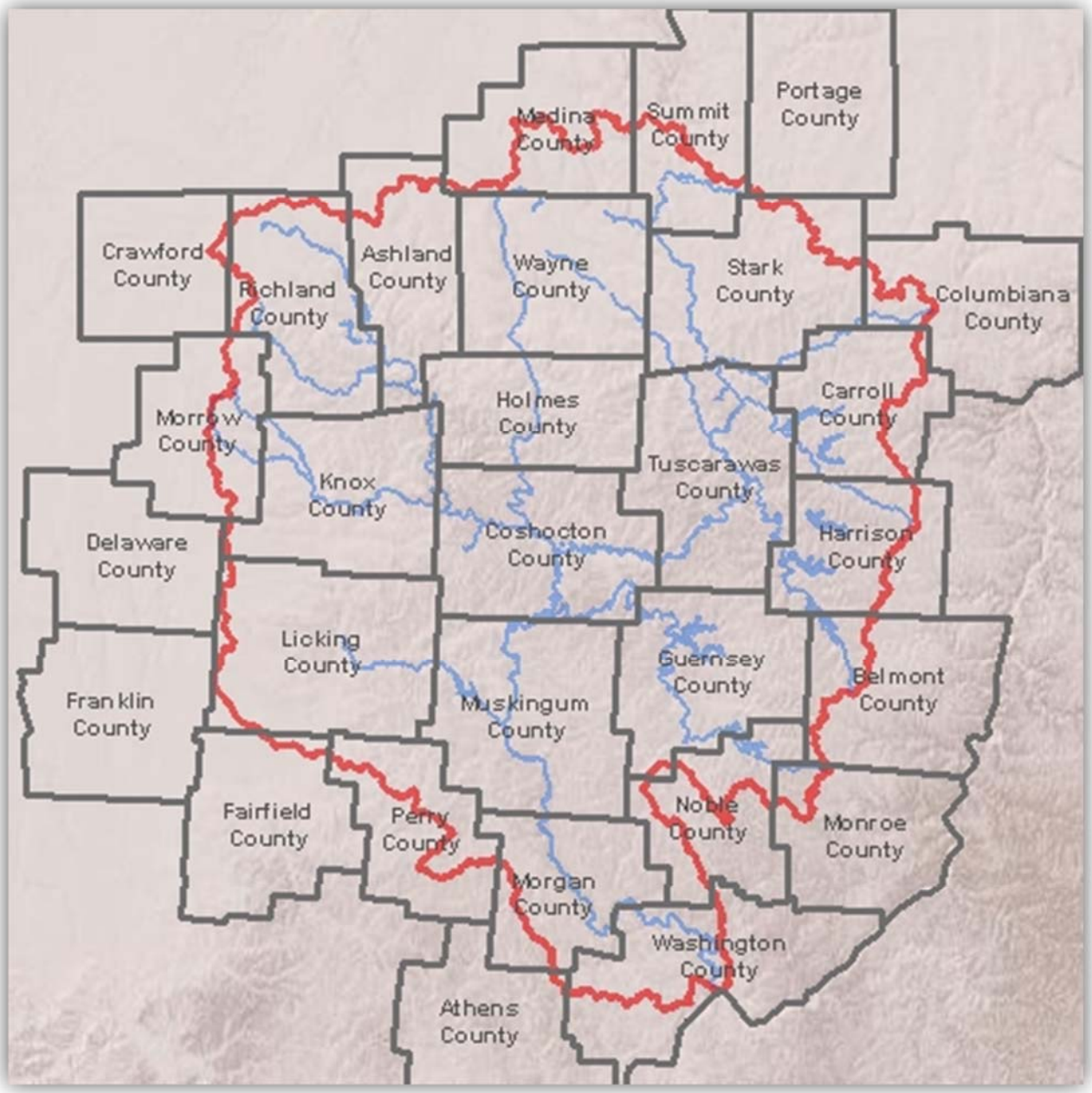


Figure 30 – The Muskingum River Basin by County

wells are prone to failure from ground sliding and subsidence, which can flush hazardous materials into nearby water bodies.

7.1.3.1 Utica and Marcellus Shale Hydraulic Fracturing

In terms of oil and gas production, hydraulic fracturing is a relatively new process; costs and benefits continue to undergo debate in Ohio and neighboring states.

Hydraulic fracturing is the process of fracturing a rock layer by applying the pressure of fluid as a source of energy. Fracturing is accomplished by using a wellbore drill to bore into reservoir rock formations, with the objective of increasing extraction rates for oil, natural gas, or coal seam gas. Fluid-driven fractures are formed at depth in a borehole and extend into targeted formations. The fracture typically is held open after the injection by adding a "proppant" to the injected fluid. (Proppant is a particulate that prevents the fracture from closing when the injection stops.) Horizontal or directional drilling methods allow drilling to extend long distances from the original bore location, resulting in a larger affected area.

Due to its relatively recent implementation in the area, hydraulic fracturing lacks the strict regulations and permitting processes that accompany traditional oil and gas wells. For instance, EPA's Office of Water has jurisdiction over the waste disposal of flow-back fluids but limited jurisdiction over the fracturing fluids injected. The Energy Policy Act of 2005 went as far as to state that "underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities" are excluded from EPA jurisdiction. The uncertainty surrounding the hydraulic fracturing process has led many agencies to voice concerns over its potential impacts to basin water quality.

Many environmental and human health concerns are associated with hydraulic fracturing — chief among them is the risk of groundwater contamination. The potential costs associated with the environmental cleanup process are largely undetermined at this time. A 2010 EPA study found contaminants in drinking water (including arsenic, copper, vanadium, and adamantanes) adjacent to drill operations. The report went on to list a broad range of potential sources, but noted hydraulic fracturing operations as a potential cause. Other concerns focus on the possibility that fracturing fluid (unregulated by the

EPA) pumped under high pressure beneath the earth's surface may pollute aquifers and surface water, impact the rock shelf (causing seismic events), or lead to surface subsidence.

The enormous amount of water needed to complete the process — estimated to range from a few hundred thousand gallons to two million gallons per well — poses another concern. That amount of water taken from smaller watercourses could seriously jeopardize aquatic resources and surface water supplies for human consumption. Also, many people noted that drillers may damage roads and surface resources, and fracturing may affect private wells.

As previously mentioned, associated fluids (see

Table 15) remain largely unregulated by the EPA and have the potential to pollute aquifers and surface water.

Table 15 – Examples of Fluids Associated with Hydraulic-Fracturing Operations

Class	Purpose	Examples
Acid	Facilitates entry into rock formation	Hydrochloric acid
Breaker	Facilitates proppant entry	Peroxodisulfates
Clay stabilizer	Clay stabilization	Tetramethylammonium chloride
Corrosion inhibitor	Well maintenance	Methanol
Crosslinker	Facilitates proppant entry	Potassium hydroxide
Friction reducers	Improves surface pressure	Sodium acrylate, polyacrylamide
Gelling agents	Proppant placement	Guar gum
Iron control	Well maintenance	Citric acid, thioglycolic acid
Scale inhibitor	Prevention of precipitation	Ammonium chloride, ethylene glycol, polyaccrylate
Surfactant	Reduction in fluid tension	Methanol, isopropanol

As seen in Table 16, the basin counties contain 57 hydraulic fracturing wells.

7.1.4 Riparian Buffers

Riparian buffers are strips of grass, trees, shrubs, and other vegetation that thrive adjacent to streams, ditches, wetlands, and other water bodies. Riparian buffers consist of plant materials adapted to that water-rich environment and contribute to the water detrital matter that is important for the aquatic food chain. The buffers benefit the environment by filtering nutrients from surface-water runoff, as well as intercepting and trapping

contaminants from surface water and ground water. Riparian buffers provide important habitat and corridors for fish and wildlife, and ultimately help stabilize stream banks.

Table 16 – Hydraulic-Fracturing Wells in the Muskingum River Basin

County	Type of Shale	Status	Well Type		County	Type of Shale	Status	Well Type
Belmont	Marcellus	Permitted	Horizontal		Columbiana	Utica/Point Pleasant	Permitted	Horizontal
Belmont	Marcellus	Drilled	Horizontal		Columbiana	Utica/Point Pleasant	Permitted	Vertical
Belmont	Marcellus	Drilled	Horizontal		Guernsey	Utica/Point Pleasant	Permitted	Horizontal
Belmont	Marcellus	Permit Expired	Horizontal		Guernsey	Utica/Point Pleasant	Permitted	Vertical
Belmont	Marcellus	Permit Expired	Horizontal		Guernsey	Utica/Point Pleasant	Permitted	Horizontal
Belmont	Marcellus	Producing	Horizontal		Guernsey	Utica/Point Pleasant	Permitted	Vertical
Carroll	Utica/Point Pleasant	Permitted	Vertical		Guernsey	Utica/Point Pleasant	Permitted	Horizontal
Carroll	Utica/Point Pleasant	Permitted	Vertical		Guernsey	Utica/Point Pleasant	Drilling	Vertical
Carroll	Utica/Point Pleasant	Permitted	Horizontal		Harrison	Utica/Point Pleasant	Producing	Horizontal
Carroll	Utica/Point Pleasant	Permitted	Vertical		Harrison	Utica/Point Pleasant	Drilled	Horizontal
Carroll	Utica/Point Pleasant	Permitted	Horizontal		Harrison	Utica/Point Pleasant	Permitted	Horizontal
Carroll	Utica/Point Pleasant	Drilled	Horizontal		Harrison	Marcellus	Permitted	Vertical
Carroll	Utica/Point Pleasant	Drilling	Horizontal		Monroe	Marcellus	Permitted	Vertical
Carroll	Utica/Point Pleasant	Drilling	Vertical		Monroe	Marcellus	Permitted	Vertical
Carroll	Utica/Point Pleasant	Permitted	Horizontal		Monroe	Marcellus	Permitted	Horizontal
Carroll	Utica/Point Pleasant	Permitted	Vertical		Monroe	Marcellus	Permitted	Vertical
Carroll	Utica/Point Pleasant	Drilling	Horizontal		Monroe	Marcellus	Permitted	Horizontal
Carroll	Utica/Point Pleasant	Drilled	Vertical		Monroe	Marcellus	Producing	Horizontal
Carroll	Utica/Point Pleasant	Drilled	Horizontal		Monroe	Marcellus	Drilled	Vertical
Carroll	Utica/Point Pleasant	Drilled	Horizontal		Portage	Utica/Point Pleasant	Permitted	Horizontal
Carroll	Utica/Point Pleasant	Drilled	Horizontal		Portage	Utica/Point Pleasant	Permitted	Vertical
Carroll	Utica/Point Pleasant	Drilled	Vertical		Portage	Utica/Point Pleasant	Drilling	Horizontal
Carroll	Utica/Point Pleasant	Completed	Horizontal		Portage	Utica/Point Pleasant	Drilling	Vertical
Carroll	Utica/Point Pleasant	Producing	Horizontal		Stark	Utica/Point Pleasant	Permitted	Horizontal
Carroll	Marcellus	Drilled	Horizontal		Stark	Utica/Point Pleasant	Permitted	Vertical
Carroll	Marcellus	Drilled	Vertical		Stark	Utica/Point Pleasant	Permitted	Horizontal
Columbiana	Utica/Point Pleasant	Permitted	Vertical		Tuscarawas	Utica/Point Pleasant	Permitted	Horizontal
Columbiana	Utica/Point Pleasant	Permitted	Horizontal		Tuscarawas	Utica/Point Pleasant	Permitted	Vertical
Columbiana	Utica/Point Pleasant	Permitted	Vertical					

According to Bellows, degraded and unhealthy riparian areas have at least some of the following characteristics:

- Patchy or scrubby plant growth with bare ground;
- Vegetation dominated by upland plants and noxious weeds;
- Compacted and eroded soil, with bare trails and pathways;
- Eroded or undercut stream banks;
- Turbid stream water; or
- Limited biodiversity.

The primary source of lost riparian buffer in the basin seems to stem primarily from agricultural land-use practices. As EPA stated, "Agriculture has a greater impact on stream and river contamination than any other nonpoint source." Inappropriate cultivation techniques and improper grazing practices along riparian areas contribute to nonpoint source pollution.

Animals have grazed along and around bodies of water for thousands of years; however, the original grazing animals were roamers such as bison, moose, and deer. Their intermittent use allowed riparian areas to re-grow following grazing periods. Today, however, the majority of grazers are domestic livestock (such as horses, cows, and sheep), which graze continually in the same area. Livestock tend to congregate along streams, where temperatures are cooler and lush riparian vegetation grows — trampling the stream bank and overgrazing the surrounding vegetation. This continual-use pattern leaves no period of renewal and re-growth for the riparian areas. Further, livestock tend to stand in cool streams and ponds during hot weather (to cool off), thus adding nutrients and pathogens to the water through feces and urine.

This overuse and misuse of the riparian zone leads to compacted soil, stream-bank failure, reduction in infiltration, increased surface runoff, erosion, sediments, and nutrient loading. All these problems were noted throughout the Muskingum River basin and also were brought up at each stakeholder meeting held by the District. Additionally, all of these causes of water-quality impacts appear on EPA's 303(d) List of Impaired Waters, under the Causes of Impairments (see Table **7** for a list of impaired waters in the Muskingum basin).

7.2 LAND USE/FLOODPLAIN MANAGEMENT

As previously stated in Section 5.3, the basin predominantly is composed of natural cover and lands used for agricultural purposes. Natural land cover represents approximately 3,853 square miles, or 48%, of the basin. Agricultural lands in the basin comprise about 3,234 square miles, or 40%, of the watershed. Less than 12% of the watershed is classified as developed land.

Attendees at each stakeholder meeting voiced concerns over both land use and floodplain management within the basin. Their concerns can be categorized as issues with changes in land use, and floodplain management.

7.2.1 Changes in Land Use

For the most part, land use in the basin has remained fairly stable during the past decade or so. Data for changes in land use is readily available for the years 2001–2006. During that period of time, a total of 6 square miles changed from natural land cover to developed land cover, and a total of 8 square miles changed from agricultural use to developed land cover. The qualitative data available for this short time frame show a continuing trend from past years. A 2003 model from the Department of Agricultural, Environmental, and Development Economics, in cooperation with Ohio State University, showed that between

the years 1992–1997, Ohio ranked 8th nationally in the amount of land converted to urban uses (364,000 acres). During that same time period, Ohio ranked 2nd nationally in the conversion of prime agricultural land to urban development.

The increase in urban development was mentioned as a concern during all of the stakeholder meetings, with significant emphasis in the northern portion of the basin, around areas such as Canton and Akron. Concerns about the increase in urbanized land centered around increased runoff from impervious surfaces like paved roads, rooftops, and parking lots.

An EPA study released in February 2011 titled, "Urbanization and Streams: Studies of Hydrologic Impacts," stated that documented cases link urbanization and increased watershed imperviousness. The study cited the lack of quantitative data defining urban development's contribution to water quality problems that include sedimentation, habitat changes, loss of fish population, and increased water temperatures. Areas with increased urban development also frequently report more flooding, higher peak flows, and changes in stream characteristics like channel width and depth.

7.2.2 Floodplain Management

Lack of floodplain enforcement is a problem recognizable not just within the Muskingum River basin, but across the state of Ohio and the nation. Floodplain management usually takes the form of a community program that employs corrective and preventative measures to reduce flood damages. Such programs typically include requirements for zoning, building codes, and floodplain ordinances.

Enforcement of floodplain requirements is critical to protecting the community, businesses, and citizens from repetitive flood damages, which are costly and can hamper new development. This concern was mentioned at each stakeholder meeting.

As an example of floodplain ordinances in the basin, Tuscarawas County's floodplain regulations are provided as an Appendix to this IWA. They originally were adopted by the Board of Tuscarawas County Commissioners as resolution 736-2007; they were revised May 13, 2010, as resolution 502-210. The purposes of the ordinance include:

- protect human life and health;
- minimize expenditure of public money for costly flood control projects;
- minimize rescue and relief efforts;
- minimize business interruptions;
- minimize damage to public facilities and utilities;
- ensure flood storage and conveyance functions of floodplain are maintained;
- minimize environmental impacts of development on the natural benefits of the floodplain; and

- meet the NFIP's community participation requirements.

The ordinance states that its means of achieving these goals are:

- restricting/prohibiting uses that are dangerous to health, safety, and property — including activities that increase flood heights and velocities;
- requiring that uses vulnerable to floods, including facilities that serve such uses, be protected against flood damage at the time of initial construction;
- controlling the alteration of natural floodplains, stream channels, and natural protective barriers that help accommodate or channel flood waters;
- controlling activities — such as filling, grading, dredging, or excavating — that may increase flood damage; and
- preventing or regulating the construction of flood barriers that will unnaturally divert flood waters or increase flood hazards in other areas.

These are typical goals and measures laid out by floodplain ordinances across the state; however, they may be enforced differently by different communities. The lack of consistency in application of floodplain-management measures caused the most concern during public-participation meetings. Many officials stated that businesses often were allowed to build in the floodplain, to increase a village's or town's tax base. In other areas, it was stated that businesses often would develop directly outside of a community's city limits, thereby avoiding all of the local floodplain-management ordinances during construction — but as soon as construction was complete, the land that had been developed in the floodplain would be annexed into the city limits.

7.3 FLOODING

Despite the presence of the 16 USACE dams in the basin, nearly 50% of the basin's streams are uncontrolled, or undammed. The locations of the Corps' 16 Flood Risk Management dams are displayed again in Figure 32.

Given the amount of uncontrolled streams within the basin, flooding continues to be an issue for many communities. Since 1968, eight Federally declared disasters related to flooding have occurred in the basin. Table 17 provides details on each disaster, including the dates and counties impacted.

Numerous other floods also have occurred across the basin that have not resulted in a Federally-declared disaster. Several locations where repetitive flooding is an issue include the towns/villages of Clinton, Marietta, Coshocton, Newark, Shelby, Mansfield, Bellville, and Millersburg (including flooding along Killbuck, Pigeon, Brewster, and Wolf creeks and Black Fork). These specific locations will be discussed in depth in subsequent watershed portions of the IWA.

The perceived causes of flooding are numerous. They include:

- changed operations of USACE FRM structures,
- improperly working stream and rain gages,
- increased sedimentation in waterways and upstream of dams,
- upstream development increasing runoff downstream, and
- climate change.

According to the National Climatic Data Center and the National Oceanic and Atmospheric Administration's (NOAA's) Satellite and Information Service, approximately 1,200 floods have occurred in the counties contributing to the Muskingum River basin during the past 61 years. These floods caused 45 deaths, 15 injuries, $826 million in property damages, and $88 million in agricultural damages.

Figure 32 – Names and Locations of USACE Dams in the Muskingum River Basin

Table 17 – Federally Declared Disasters in the Muskingum Basin (Flood Related)

Disaster Number	Declaration Date	Classification of Storm	Incident Begin Date	Declared County/Area
243	6/5/1968	Heavy Rains and Flooding	6/5/1968	Adams, Athens, Fairfield, Guernsey, Licking, Monroe, Morgan, Noble, Perry, Washington
345	7/19/1972	Tropical Storm Agnes	7/19/1972	Belmont, Monroe
480	9/11/1975	Winds, Tornadoes, Heavy Rains and Flooding	9/11/1975	Belmont (County)
630	8/23/1980	Severe Storms and Flooding	8/23/1980	Belmont, Columbiana, Guernsey, Monroe, Muskingum, Noble
796	7/17/1987	Severe Storms and Flooding	7/1/1987	Morrow, Richland
831	6/10/1989	Severe Storms and Flooding	5/23/1989	Coshocton, Franklin, Licking
1097	1/27/1996	Severe Storms and Flooding	1/20/1996	Adams, Belmont, Columbiana, Monroe, Washington
1122	6/24/1996	Flooding	5/2/1996	Adams, Belmont, Monroe

Of these events, 51% were classified as flash floods, while 49% were large river floods (which reach peak discharge more gradually).

Flash floods typically result from heavy rains over a short time period, normally occur on small streams and creeks, and last only a few hours (however, they also can be caused by river ice jams, snowmelt, and dam or levee failures). Flash floods can occur with little or no warning, move at extremely high speeds, erode stream banks, wash buildings off of foundations, and sweep vehicles off roadways.

By contrast, flooding (or "river flooding"), takes half a day or longer to develop; streams stay at or about flood stage for several days. The main threat posed by river flooding is duration; rather than a building being washed off its foundation, it is more likely to be damaged in place due to the amount of time it spends under water. The hydraulic effects of long-duration flooding at bank-full conditions can dramatically reshape river channels and lead to significant erosion and accretion of sediments in the channel.

Table 18 displays all flood events in the Muskingum River basin (by county) from 1950 to March 2011.

Table 18 – Flooding in the Basin From 1950 to 2011

County	Total Flood Events	Flash Floods	Other Floods	Deaths	Injuries	Property Damage	Crop Damage
Ashland	39	20	19	0	0	$15,134,000	$2,790,000
Athens	44	25	19	22	11	$51,634,000	$0
Belmont	91	47	44	2	0	$31,302,000	$5,000,000
Carroll	46	22	24	0	0	$1,591,000	$0
Columbiana	63	39	24	0	0	$9,221,000	$0
Coshocton	72	25	47	0	0	$5,854,000	$10,000,000
Crawford	31	19	12	0	0	$68,785,000	$4,270,000
Fairfield	39	10	29	2	1	$2,792,000	$3,000
Guernsey	59	19	40	0	0	$5,824,000	$14,000,000
Harrison	29	15	14	0	0	$982,000	$5,000,000
Holmes	38	16	22	0	0	$16,770,000	$1,340,000
Knox	24	13	11	0	0	$15,452,000	$1,530,000
Licking	39	12	27	0	1	$3,003,000	$0
Medina	39	22	17	0	0	$22,547,000	$3,040,000
Monroe	44	21	23	1	0	$12,292,000	$10,000,000
Morgan	21	9	12	3	0	$46,153,000	$0
Morrow	24	13	11	0	0	$8,145,000	$565,000
Muskingum	56	27	29	0	0	$10,695,000	$14,000,000
Noble	51	30	21	5	0	$11,085,000	$10,000,000
Perry	27	14	13	1	0	$47,566,000	$0
Portage	25	16	9	0	1	$36,640,000	$20,000
Richland	44	27	17	1	1	$83,275,000	$6,105,000
Stark	57	34	23	2	0	$64,972,000	$303,000
Summit	48	30	18	3	0	$164,365,000	$25,000
Tuscarawas	62	31	31	1	0	$20,934,000	$0
Washington	38	24	14	2	0	$55,370,000	$0
Wayne	28	18	10	0	0	$13,842,000	$40,000
Totals	*1,178*	*598*	*580*	*45*	*15*	*$826,225,000*	*$88,031,000*

7.4 INFRASTRUCTURE ISSUES

Each stakeholder meeting also revealed concerns over public infrastructure, with aging Corps projects and WWTPs eliciting the most concern. (Subsequent sections address infrastructure issues specific to particular communities.)

7.4.1 Aging Corps Infrastructure

Of the 16 FRM dams owned and operated by USACE in the basin, 14 were built in the mid-1930s. The remaining two projects — Dillon Dam and North Branch of Kokosing River — were built in the 1960s and 1970s respectively. Corps projects typically are formulated and built for a 50-year project life. According to that logic, the original 14 structures have exceeded their expected life spans, and Dillon and North Branch of Kokosing River are quickly approaching the end of theirs.

With aging infrastructure in mind, in June of 2005 the Corps began evaluating the nation's reservoir and lock and dam projects that had known dam safety concerns, to develop relative ratings for human and economic risk. This effort was described above in Section 4.1.1.1, "The Muskingum River System." As previously stated, the Screen Portfolio Risk Analysis (SPRA) helped shape USACE's budget decisions regarding reservoir and lock and dam infrastructure improvements. The newer classification system, the DSAC system, assigns safety ratings to each dam based on probabilities of satisfactory performance and downstream consequences (including loss of life and property damage). The DSAC ratings of each of the projects and their associated levees and dikes are displayed in Table 19.

The majority of the issues faced by basin projects (particularly those in the northern area) are not caused by the structures themselves, but rather the materials on which the structures were founded. The soil generally is composed of glacial till, which is permeable and lends itself to seepage and piping of water under the dam or levee. Subsidence caused by seepage transporting material from underneath the structure can become a failure concern.

These problems are being addressed by the Corps' Dam Safety Program, under the Dam Safety Modification guidance of ER 1110-2-1156. The costs are shared under the terms of the original cost-sharing agreement with MWCD, the project sponsor.

7.4.2 Wastewater Treatment Plants (WWTPs)

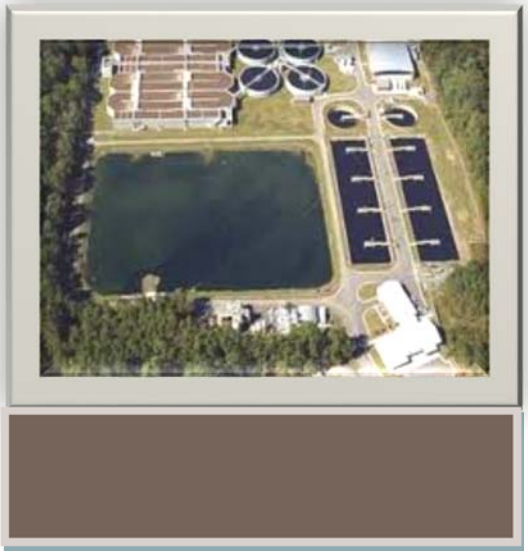
Like concerns over aging Corps infrastructure, concerns about existing WWTPs also were voiced across the basin. WWTPs are used to remove and treat human waste brought to the plant by a sanitary sewer collection system. The first step in the treatment process is screening, which removes debris like wood, rock, and trash from the influent water. Next, the wastewater is pumped into aeration tanks so the sewage is exposed to air, which helps remove a variety of dissolved gasses (such as hydrogen sulfide) from the water.

Table 19 – DSAC Ratings in the Muskingum River Basin

Project	DSAC Rating
Flood Risk Management Dam	
Atwood	III – High Priority
Beach City	II – Urgent
Bolivar	II – Urgent
Charles Mill	IV – Priority
Clendening	III – High Priority
Dillon	IV – Priority
Dover	II – Urgent
Leesville	IV – Priority
Mohawk	II – Urgent
Mohicanville	IV – Priority
North Branch of Kokosing	IV – Priority
Piedmont	IV – Priority
Pleasant Hill	IV – Priority
Senecaville	III – High Priority
Tappan	II – Urgent
Wills Creek	IV – Priority
Brewster Levee	II – Urgent
Corundite Levee	III – High Priority
Fairfield Levee	III – High Priority
Magnolia Levee	II – Urgent
Pleasant Valley Dike	III – High Priority
Silica Sand Levee	III – High Priority
Somerdale Levee	II – Urgent
US Brick Levee	III – High Priority
Zoar Levee	I – Urgent & Compelling

From there, the water goes through a series of long, parallel concrete tanks. In the first section of the tank, air is pumped through the water to replace oxygen that was depleted as organic matter in the water decayed and to help keep material in the water suspended (allowing small particles to settle out so they can be pumped out and sent to landfills). In the second tank — the sedimentation tank — the organic portion of the sewage settles out of the water and is removed. In a step called "thickening," some of the water is removed, and the remaining sludge is moved to large tanks called "digesters." During this time, lighter materials float to the surface of the wastewater; this scum usually includes grease,

oils, plastics, and soap. The scum is removed by slow-moving rakes on the surface of the water, thickened, and moved to the digesters as well. Some cities use filtration in the process. During this step, liquid sewage is filtered through a substance like sand or carbon to remove almost all of the remaining bacteria, reduce turbidity and color, remove odor, and reduce iron and any remaining solid particles. Finally, the water is moved to a chlorine contact tank, where chlorine is added to kill pathogens. The chlorine is neutralized by the addition of other chemicals. This treated water, or effluent, is discharged into local streams according to the provisions of a State permit.



In 2004, EPA released the "Recommended Standards for Wastewater Facilities," which includes policies for the design, review, and approval of plans and specifications for wastewater-collection and -treatment facilities. This plan covers 11 states, including Ohio. The design criteria included in the Standards are intended for conventional municipal wastewater collection and treatment systems.

The concerns over WWTPs highlighted the need for upgrades to WWTPs across the basin and the water-quality issues related to threatened and failing WWTP components. The concerns over needed upgrades stem from expanding urban and suburban development and fears that the existing WWTPs cannot meet current or future demands. Funding to complete the repairs and upgrades usually presents a financial burden greater than a village or town can shoulder, preventing them from making the repairs and upgrades on their own.

7.5 FINDINGS

As previously stated, the main areas of concern in the Muskingum River basin can be divided into the following categories:

- water quality/ecosystem restoration,
- land use/floodplain management,
- flooding issues, and
- infrastructure issues.

All of these issues occur basinwide, though they may be more concentrated in some areas. Specific areas of concern and potential treatment of these issues are discussed in subsequent sections of this IWA.

8. RECOMMENDATIONS

8.1 WATERSHED ASSESSMENT AND GENERAL RECOMMENDATIONS

8.1.1 Watershed Assessment for the Muskingum River Basin

Given the findings of this IWA, the USACE Huntington District recommends moving ahead with the second phase of this study, to develop an FWA for the entire Muskingum River basin. The FWA would build on the recommendations of this IWA would fully explore the alternatives identified herein, and would determine which alternatives should move forward to a feasibility phase (notwithstanding whether USACE could implement the alternatives). In this manner, watershed problems, needs, and opportunities could be addressed by comprehensive and strategic plans and water-resources management. The MWCD has expressed interest in cost-sharing the FWA phase of the study.

8.1.2 Watershed Assessment for the Headwaters Tuscarawas River Sub-Watershed and the Chippewa Creek Sub-Watershed

Throughout scoping for the IWA, the Barberton/Norton area (in the northern part of the basin) repeatedly was brought up due to flooding issues. Individually the city of Barberton is located in the HUC-12 Portage Lakes-Tuscarawas River sub-watershed, and the city of Norton in the HUC-12 Wolf Creek sub-watershed. Together, they are located in the HUC-10 Headwaters Tuscarawas River sub-watershed (see Figure 33), along with three other HUC-12 sub-watersheds (see

Figure 34). In addition to Portage Lakes and Headwaters Tuscarawas River, scoping also identified flooding issues for Pigeon and Wolf creeks.

Additionally, a meeting with Barberton and Norton city officials revealed that other nearby cities experience the same problems — including Green, New Franklin, and Copley, as well as bordering areas in the Chippewa Creek sub-watershed to the south. The Chippewa Creek sub-watershed is composed of seven HUC-12 sub-watersheds, including:

- Headwaters of the Chippewa Creek,
- Hubbard Creek–Chippewa Creek,
- Little Chippewa Creek,
- Red Run,
- River Styx,
- Silver Creek–Chippewa Creek, and
- Tommy Run–Chippewa Creek.

The Chippewa Creek sub-watershed is shown in Figure 35.

Figure 33 – Location of the HUC-10 Headwaters Tuscarawas River Sub-Watershed

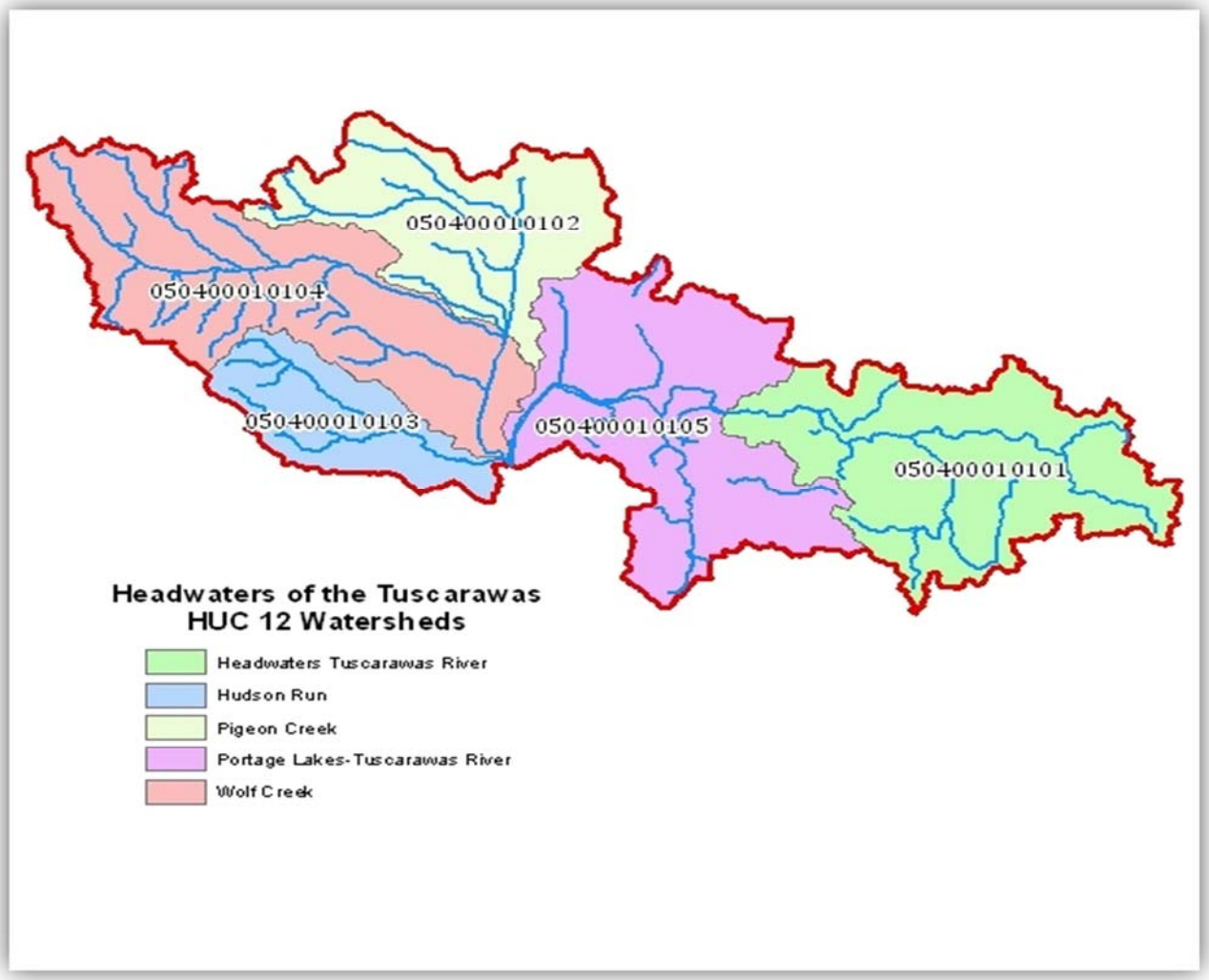


Figure 34 – HUC-12 Headwaters Tuscarawas River Sub-Watersheds

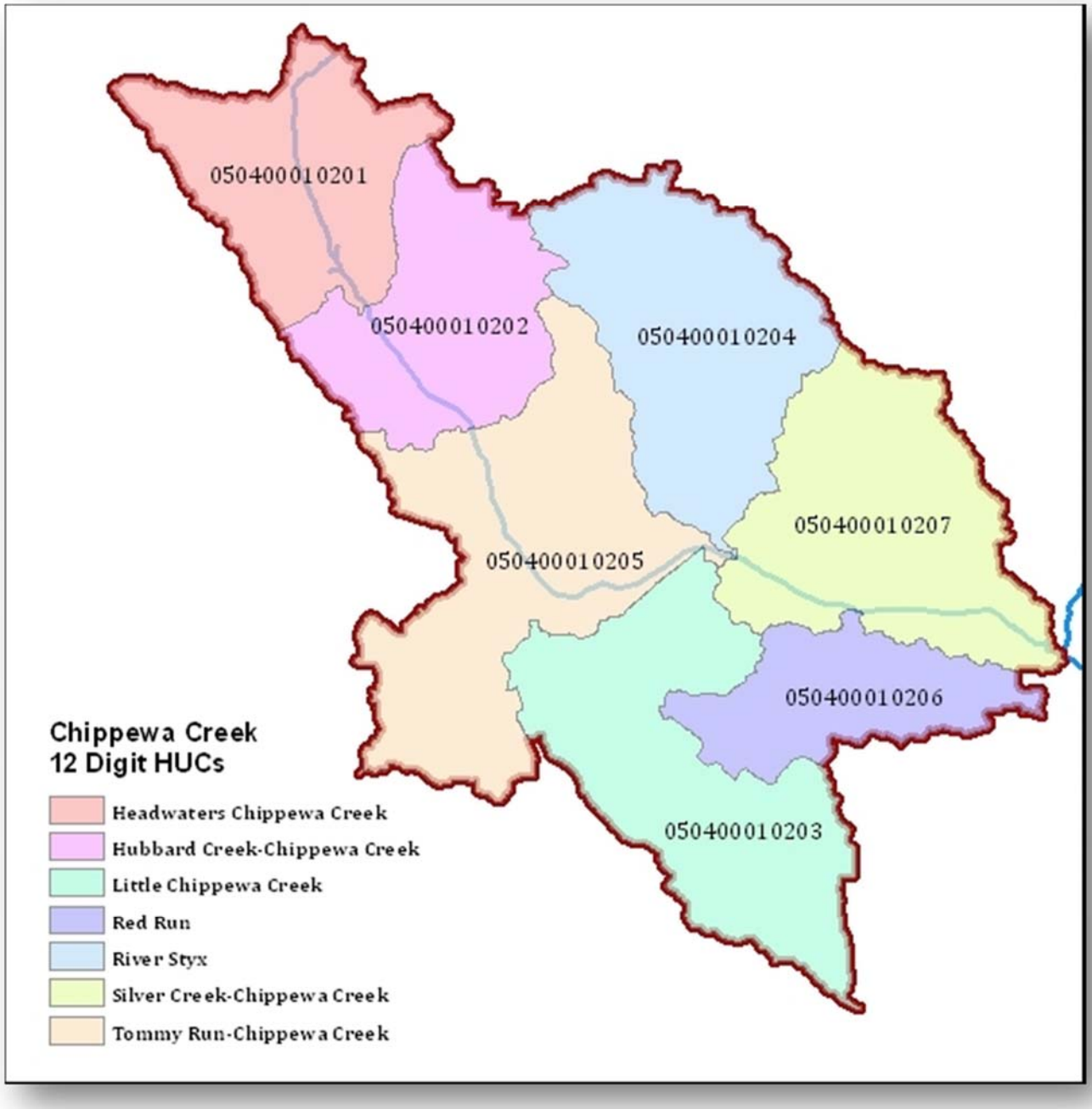


Figure 35 – Chippewa Creek Sub-Watershed

Aside from flood-related problems, water-quality issues also affect both watersheds. The main group of streams in the area is listed on the 303(d) Impaired Waters List. The causes of impairment include hexachlorobenzene, flow alterations, habitat alterations, natural Limits, organic enrichment/low dissolved oxygen, PCBs in fish tissue, and siltation. Given the land use in this area, the sources of the listed impairments could be urban development and agricultural land usage or a combination thereof.

A search of data at the Ohio EPA's Division of Surface Water did not reveal any biological or water quality reports for streams in this area. The Ohio EPA does have a TMDL factsheet for the HUC-8 Tuscarawas watershed showing that TMDLs for the HUC-10 Tuscarawas River Headwaters sub-watershed area are under development. Additionally, a comprehensive watershed management plan is in place for the Upper Tuscarawas River. At this time, however, no agencies appear to have action plans in place to address water-quality issues in this area.

Given the flooding issues in the Headwaters Tuscarawas River sub-watershed and Chippewa Creek sub-watershed, as well as the widespread water quality issues in the area, a watershed assessment on these two HUC-10 sub-watersheds is warranted. That watershed assessment will look at flooding and water quality issues, with specific attention paid to identifying likely sources as well as measures that could address the problems in a holistic manner. The combined, proposed study area is shown in Figure 36. Further information on the scope of the watershed assessment is available in Section 10 of this report.

8.1.3 Further Study of the Killbuck Creek Sub-Watershed

The Killbuck Creek sub-watershed covers four separate HUC-10 sub-watersheds: (1) Doughty Creek– Killbuck Creek, (2) Paint Creek–Killbuck Creek, (3) Apple Creek–Killbuck Creek, and (4) Headwaters Killbuck Creek. The watershed covers the northern and eastern portions of the Walhonding River watershed, as seen in

Figure 37 below.

Like the Headwaters Tuscarawas River sub-watershed before, this watershed also has notable issues with flooding and poor water quality.

The flooding issues were brought up at most of the stakeholder outreach meetings during scoping for this IWA. The frequent flooding impacts the area around the confluence of the Tuscarawas and Walhonding rivers, where the Muskingum River forms, and often causes road and school closures. One area frequently impacted by flooding is the town of Millersburg in Coshocton County. Residents and officials reported not only increase frequency of flooding, but also increased severity.

As mentioned in Section 4.3, "Proposed Reservoirs," the Flood Control Act of 1938 authorized a previous study for a Millersburg Lake project that was to be built on Killbuck

Creek, upstream from Millersburg. Unfortunately, the project was re-evaluated in the Muskingum River basin study and found to be economically infeasible. This, however,

Figure 36 – Proposed Study Area

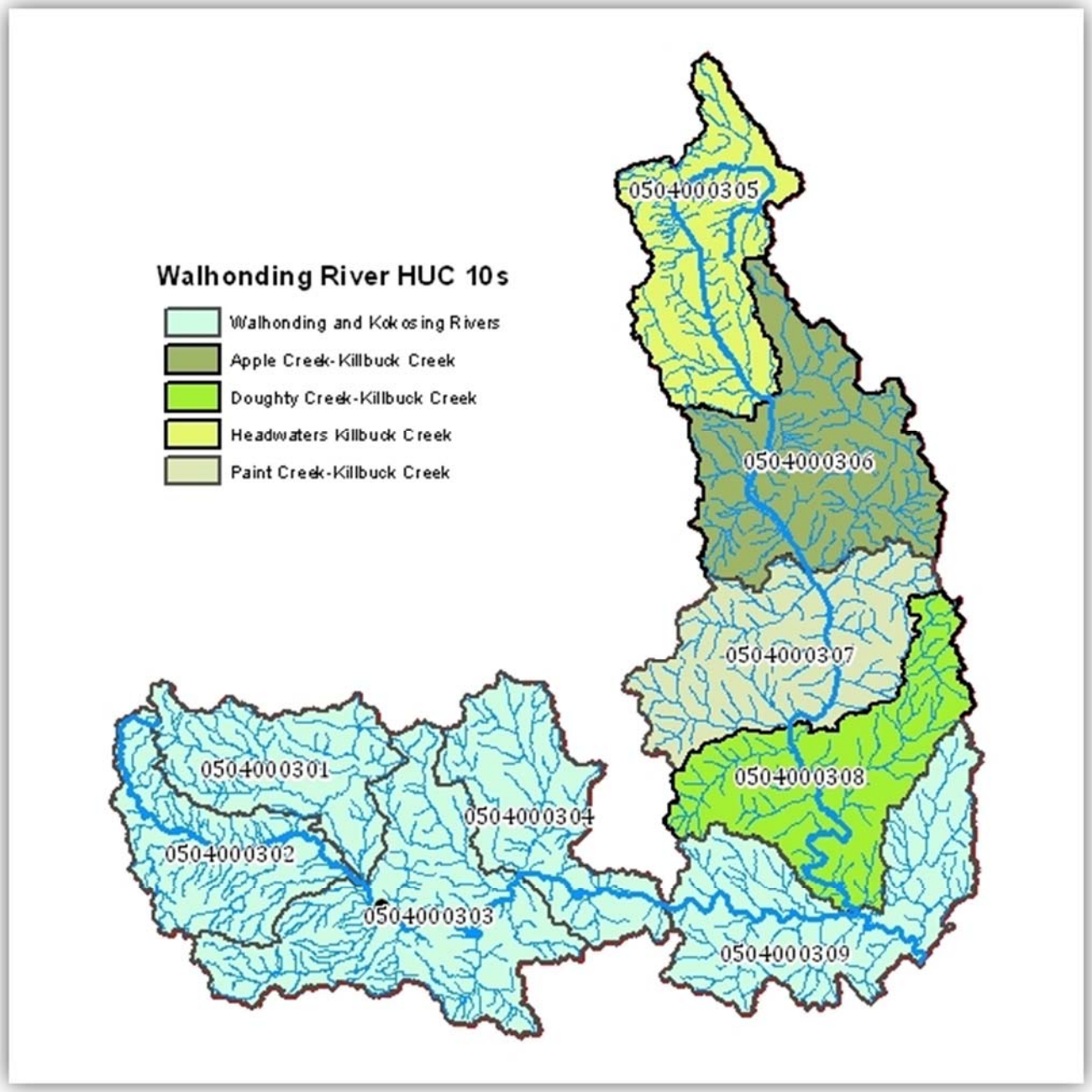


Figure 37 – The Killbuck Creek Sub-Watershed

would not preclude the Corps or other agencies from re-evaluating the need for, and Federal interest in, a Flood Risk Management project that considers other measures.

Water-quality issues in the watershed are widespread and diverse. The Ohio EPA's Division of Surface Water released the *Biological and Water Quality Study of the Killbuck Creek Watershed* in 2009. The objectives of the study were to:

- monitor and assess the chemical, physical, and biological integrity of the water bodies within the Killbuck Creek area;
- assess the physical habitat conditions in streams listed in the study plan, to identify their potential to support aquatic biological communities;
- characterize the amount of aquatic resource degradation attributable to point sources and various land uses, including agricultural practices, rural development, and urban and suburban community development; and
- evaluate the appropriateness of existing beneficial use designations, and assign uses to undesignated streams.

The recommendations of the report included changes in use determinations and improvements to water quality (including, but not limited to, improvement of riparian buffers, proper fertilizer and pesticide applications, and the cessation of "stream cleaning"). The report also included measures to improve water quality that is impacted by urban development. These measures included a combination of regulatory, educational, and funding actions that would improve WWTPs, failing septic systems, storm-water management, controlled development and alternatives to traditional stream channelization and riparian removal.

A 2011 report by the Ohio EPA titled *Biological and Water Quality Study of the Killbuck Creek Watershed* provides results from an extensive 2009 analysis of Killbuck Creek that identified areas for improvement. The watershed showed improvement over past years; more than 80% of the sites sampled for water chemistry, physical habitat, fish, and macroinvertebrates were in full attainment of designated aquatic life uses. The remaining issues are associated with human recreational use.

The concern for humans revolves around the high levels of bacteria, such as *E. coli*, found throughout the watershed. All of the sites sampled exceeded the primary contact standards associated with swimming, boating, water skiing, and canoeing. Typically, an elevated level of *E. coli* indicates the presence of a pathogenic organism that can cause disease or infection. Sources of bacteria may include agriculture, failing septic systems, and improperly functioning WWTPs.

Given the improving water quality in the watershed, as well as the number of measures in place to ensure continual improvement, a watershed assessment for the Killbuck Creek sub-watershed does not seem warranted at this time. The Corps has three options to address flooding issues in the watershed:

- a Section 22 Planning Assistance to States study,
- a Section 205 Flood Damage Reduction study [under the Continuing Authorities Program (CAP)], and
- a 905(b) Reconnaissance Study.

Any of these three programs/studies (discussed in Sections 8.1.3.1, 8.1.3.2, and 8.1.3.3) could be used to address flooding issues in the Killbuck Creek sub-watershed. Currently, however, no potential local sponsors have stepped forward to indicate interest in further study.

8.1.3.1 Planning Assistance to States

Section 22 of the WRDA1974, as amended, provides authority for the Corps to help states, local governments, and other non-Federal entities prepare comprehensive plans for the development, utilization, and conservation of water and related land. The program can encompass many types of studies dealing with water-resources issues, including flood damage reduction studies and floodplain management studies. Individual states determine needed planning assistance. Every year, each State and Tribal Nation can request studies from USACE under the program, and USACE then accommodates as many studies as possible within the funding allotment. Typical studies are only at the planning level of detail; they do not include detailed designs for project construction. The studies generally involve the analysis of existing data for planning purposes, using standard engineering techniques, although some data collection often is necessary. Most studies become the basis for State or Tribal and local planning decisions. Information on how to request planning assistance activities, including a sample letter and Cost-Sharing Agreement, are included as Appendix D to this IWA.

8.1.3.2 Section 205 Flood Damage Reduction Projects

Section 205 of the 1948 Flood Control Act, as amended, provides authority to the Corps to plan and construct small flood damage reduction projects that have not already been specifically authorized by Congress. A project is accepted for construction only after detailed investigation clearly shows its engineering feasibility, environmental acceptability, and economic justification. Each project must be complete within itself, not part of a larger project. The maximum federal expenditure per project is $7 million, which includes both planning and construction costs. Costs of lands, easements, and operation and maintenance must be non-Federal.

There are two types of projects — structural and nonstructural. Structural projects may include levees, flood walls, diversion channels, pumping plants, and bridge modifications. Nonstructural alternatives, which have little or no effect on water surface elevations, might include such measures as floodproofing, relocation of structures, and flood warning systems.

After a State or local agency requests a potential project, the Corps will conduct a feasibility study if it appears the problem may have a Federal interest and if funds are available. The feasibility study begins at Federal expense; after approximately $20,000 has been expended, a decision is made whether to continue the study and if cost-sharing is required. Study costs in excess of $100,000 are shared 50/50 with a non-Federal sponsor, according to a Feasibility Study Cost-Sharing Agreement. In the feasibility study the problem is defined, the Federal interest is determined, potential solutions are identified, and the most feasible plan is chosen. The costs, benefits, and environmental impacts of the potential project are analyzed. A draft Project Cooperation Agreement is drawn up by which the Federal government and the sponsor agree to share project costs. No more than 3 years should pass between the start of the feasibility study and start of construction.

Costs for Section 205 flood-damage–reduction projects are shared between the Federal government and a non-Federal sponsor in accordance with WRDA 1986, as amended. During construction, the local sponsor must (1) contribute at least 35% of the total cost of a project, with credit granted toward this amount for providing lands, easements, and rights-of-way, and (2) pay a minimum cash requirement of 5% of the total project cost. The local sponsor (a state or local government) must have the legal and financial capability to fulfill the requirements of cost sharing and local cooperation. The sponsor generally must agree to:

- Contribute in cash the local share of project planning and construction costs.
- Provide all lands, easements, rights-of-way, relocations, and dredged material disposal areas.
- Provide any additional cash contributions needed to make the local sponsor's share of the flood damage reduction cost at least 35%.
- Hold and save the United States free from damages due to the construction and maintenance of the project, except damages due to fault or negligence of the United States or its contractors.
- Make all alterations and relocations of buildings, transportation facilities, storm drains, utilities, and other structures and improvements made necessary by the construction of the project (excluding approaches and facilities necessary for the normal interception and disposal of local interior drainage at the line of protection).
- Prepare a floodplain management plan designed to reduce the impact of future flood events in the project area.
- Comply with provisions of pertinent Federal acts in carrying out the specified non-federal responsibilities of the project.
- Operate, maintain, repair, replace, and rehabilitate the project as long as the project is authorized.

Information on requesting a Section 205 study can be found in Appendix D to this IWA.

8.1.3.3 905(b) Reconnaissance Study

A 905(b) Reconnaissance Study is the first part of a two-phase study process leading to implementation of a Corps project. Studies performed under 905(b) guidance do not have previous construction authorization and must be authorized by Congress prior to project implementation. The study is performed to determine whether project planning should proceed to the more detailed feasibility stage. The reconnaissance phase is Federally funded, and the target for completion is 6 to 12 months from the initial obligation of funds. Specifically, the objectives of the reconnaissance phase are to:

- determine whether the water resource(s) problems warrant Federal participation in feasibility studies;
- define the Federal interest;
- complete a 905(b) Analysis [refers to Section 905(b) of WRDA 1986] or a Reconnaissance Report;
- prepare a PMP;
- assess the level of interest and support from non-Federal entities; and
- negotiate and execute a Feasibility Cost-Sharing Agreement.

The objective of feasibility studies, on the other hand, is to investigate and recommend solutions to water-resources problems. Costs of feasibility studies, except single-purpose inland navigation studies, are 50% Federal and 50% non-Federal (as defined in Section 105 of WRDA 1986). Typically, feasibility studies should be completed in 18 to 36 months. The results are documented in a feasibility report that includes documentation of environmental compliance.

8.1.4 Further Study of the Nimishillen Creek Sub-Watershed

The Nimishillen Creek, which runs into Sandy Creek south of East Sparta, is a HUC-10 sub-watershed that encompasses six individual HUC-12 sub-watersheds (see Figure 38 and Figure 39). The sub-watershed, located centrally in the HUC-8 Tuscarawas watershed, encompasses the Canton area (see Figure 38).

Increased development along Nimishillen Creek, specifically in the floodplain, has had negative impacts on the watershed — including more frequent flood events as well as water quality impacts. The flooding, believed to result from increased floodplain encroachment, is of particular concern along the East Branch of Nimishillen Creek, between Louisville and Canton. Water quality issues are believed to stem from runoff (the stream passes through heavily urbanized areas and agricultural lands) as well as failing septic systems. Impairments to water quality in the watershed include ammonia, dissolved

oxygen, flow alterations, habitat alterations, nitrates, nutrients, organic enrichment (sewage) biological indicators, PCBs in fish tissue, pathogens, sedimentation, siltation, sulfates, temperature, and acidity.

Unlike the Headwaters Tuscarawas River watershed, Nimishillen Creek has been studied significantly. The Nimishillen Creek Watershed Partners — a local watershed group consisting of volunteers (ranging from citizens to local and government officials) — raise public awareness about the watershed and organize local events such as the Nimishillen Creek LEAP Clean-up, where volunteers clean up heavily littered sections of the creek.

Figure 38 – Location of Nimishillen Creek Sub-Watershed

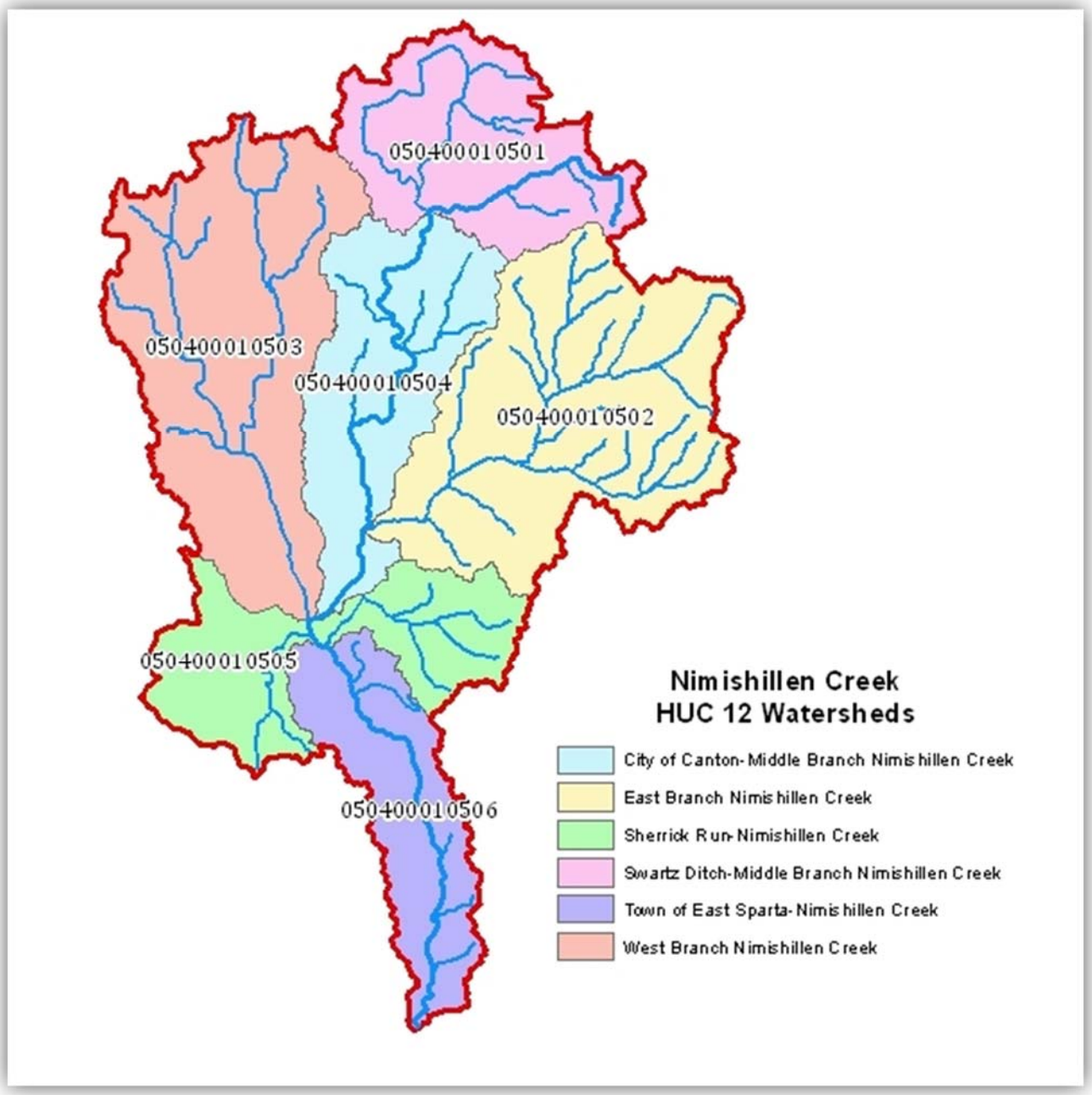


Figure 39 – HUC-12 Sub-Watersheds in the Nimishillen Sub-Watershed

In 2007, the Ohio EPA Division of Surface Water began work on TMDL requirements for the stream. The TMDLs were published in draft form in February of 2009 and approved in December of the same year. The TMDL recommendations include:

- total phosphorus limits for wastewater faculties discharging more than 100,000 gallons per day;
- agricultural conservation practices for abating sediment, nutrient, and manure pollution;
- local health departments identify and address septic system failures and provide educational opportunities; and
- stream setbacks, controls for subsurface drainage, less damaging methods of channel maintenance, and stream restoration to improve or protect habitat quality.

In January of 2006, the Northeast Ohio Four County Regional Planning and Development Organization released the Nimishillen Creek Watershed State Action Plan. The issues addressed by the Plan include:

- promoting environmental education and outreach,
- protecting and restoring riparian corridors,
- reducing pollution from failing wastewater treatment systems,
- ameliorating impacts from acid mine drainage,
- diminishing impacts from storm water runoff from urban, suburban, agriculture, and industrial areas; and
- protecting and restoring the floodplain.

The action plan includes sub-watershed action plans for each of the six sub-watersheds. The sub-plans recommend actions to address impairments, including data such as responsible parties, funding information, time frame, methods of evaluation and estimated load reductions.

Although much work has been done on the Nimishillen Creek sub-watershed with regard to water quality, no study or analysis has been performed for flood damage reduction. As with the previously discussed Killbuck Creek sub-watershed, pursuing a watershed assessment for this watershed does not seem prudent at this time; however, the watershed does continue to experience and report flooding. Also similar to the Killbuck Creek sub-watershed, the Corps has three options to address flooding issues in the watershed:

- a Section 22 "Planning Assistance to States" study,
- a Section 205 "Flood Damage Reduction Study" under the CAP authority, and
- a 905(b) "Reconnaissance Study."

Details on these programs and studies can be found in Sections 8.1.3.1 through 8.1.3.3 of this report.

8.1.5 Continuing Authorities Program (CAP)

The US Congress has delegated to the Corps several standing authorities to study and build water-resources projects for various purposes, without the need for further Congressional approval. However, these continuing authorities specify limits on the amount of Federal money that can be spent for a project. The project-development process is similar to individually authorized studies and projects, including cost-sharing requirements. However, the process is streamlined, since specific individual Congressional authorization is not required. Reduced development and approval time subsequently reduces the time required to respond to small water resources challenges and opportunities. Authorities exist for the following purposes:

- Section 14 — Emergency Stream Bank and Shoreline Protection
- Section 107 — Navigation
- Section 205 — Flood Damage Reduction (previously discussed in Section 8.1.3.2)
- Section 206 — Aquatic Ecosystem Restoration
- Section 208 — Snagging and Clearing for Flood Control
- Section 1135 — Environmental Protection and Restoration, Project Modifications for Improvement of the Environment

To initiate a project under the CAP, the Corps must first receive a letter of intent from a non-Federal sponsor seeking Federal assistance. This letter documents the sponsor's willingness to cost-share the implementation of the project and meet operation and maintenance requirements following completion. Given that funding under the CAP is limited, projects are prioritized locally and regionally with respect to each authority. Once funding is received, a decision document examining the feasibility and environmental acceptability of various alternative measures is completed. Should a feasible alternative be identified, the design and implementation phase is initiated after the execution of a formal cost-sharing agreement.

Cost-share rates and total Federal expenditures vary based by each respective authority. Under Section 14 authority, the Federal government pays 65% of the costs for projects to protect stream banks and shorelines, and the non-Federal sponsor pays 35%. The annual appropriation limit under the Section 14 is limited to $15 million nationally, while Federal expenditures per project may not exceed $1.5 million.

Likewise, small flood-risk–management measures implemented under the Section 205 authority are cost shared 65% Federal and 35% non-Federal. The annual appropriation ceiling under Section 205 is limited to $55 million nationally, and the Federal contribution to implementation of individual projects may not exceed $7 million.

Aquatic ecosystem restoration efforts completed under the Section 206 authority also are cost shared 65% Federal and 35% non-Federal. The annual appropriation limit under this

authority is $50 million nationally, while Federal expenditures per project are limited to $5 million.

8.1.5.1 Potential CAP Projects

The following areas were identified as problematic during stakeholder involvement and may be eligible for a CAP project.

8.1.5.1.1 Section 206

8.1.5.1.1.1 Huff Run Stream Mine Drainage and Acid-Mine Drainage Abatement

The Huff Run Watershed Restoration Partnership, sponsored by Rural Action, currently is overseeing a stream channel restoration project in the Huff Run watershed. Acid mine drainage has damaged the stream, and the watershed group is attempting to restore the natural integrity of the steam by constructing a more natural serpentine channel, as well as expanding on an existing, naturally occurring wetland to help filter metals from the water. They are about to begin a similar project on nearby Mud Run but are in the early planning phases.

8.1.5.1.1.2 Zanesville, Muskingum County

At the stakeholder meeting in Newark, stakeholders reported that areas around Zanesville suffer stream-bank erosion and subsidence from abandoned mines, which create acid mine drainage issues, affect aquatic species' habitat, and create other water quality problems.

8.1.5.1.1.3 New Lexington and Summerset, Perry County

Similar issues to those reported in Zanesville were documented in the New Lexington and Summerset areas located in Perry County. The majority of issues at this location pertain to acid mine drainage from abandoned and improperly sealed mines.

8.1.5.1.1.4 Mount Vernon, Knox County

The town of Mount Vernon has been having stream-channel issues associated with old levees and erosion; town members are interested in bringing the old levees up to current standards. The Huntington District will assess the levees and advise local officials; the Section 206 program could be used to mitigate sand bars that negatively affect levee performance.

8.1.5.1.2 Section 205

The Section 205 studies for the Killbuck Creek sub-watershed and the Nimishillen Creek sub-watershed are discussed above, in Sections 8.1.3 and 8.1.4 respectively.

8.1.5.1.3 Section 14

Section 14 of the 1946 Flood Control Act provides authority for USACE to prevent damages or failure of public facilities, such as bridges, roads, public buildings, sewage treatment plants, water wells, schools, etc. due to stream bank erosion. Private facilities and property are not eligible. The maximum Federal cost for project development and construction of any one project is $1 million, and each project must be economically justified, environmentally sound, and technically feasible. The costs for Section 14 projects are shared 50% Federal and 50% non-Federal.

The areas below potentially are eligible for the Section 14 program; however, it must be stated that at the time of the stakeholders' meeting it was unclear whether any eligible public facilities or property were threatened. Before any further action could be taken, clarification is needed regarding whether threatened properties in the areas listed below were public or private:

- North Zanesville
- Tributaries of the Salt Creek watershed
- South Zanesville

Fact sheets about individual CAP authorities and sample Letters of Intent can be found in Appendix D to this IWA.

8.2 WATER QUALITY/ECOSYSTEM RESTORATION RECOMMENDATIONS

8.2.1 Development of TMDLs

Even though most of the streams in the Tuscarawas watershed are on the 303(d) Impaired Waters List, none has TMDL requirements in place yet. (A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant.) Pollutant sources are characterized as either a point source that receive a waste-load allocation or a nonpoint source that receive a load allocation. This would in turn allow for better decision making when resource agencies are issuing and managing water-related permits.

8.2.2 Construction or Upgrading of WWTPs

As previously stated, inadequate WWTP resources need to be addressed throughout the basin. Solutions may require construction of new WWTPs or upgrading of existing facilities

— extremely costly activities often beyond the capability of small communities such as those found in the watershed. The Corps, however, offers a program to help alleviate financial burdens.

The primary objective of the Section 594 Program is to provide design-and-construction assistance to non-Federal interests, for carrying out water-related environmental infrastructure and resource protection and development projects in Ohio. The authority for this program is derived from WRDA 1999 (Public Law 106-53), Section 594. Projects costs usually are shared at a 75% Federal, 25% non-Federal split. Projects are prioritized by the State of Ohio and Congressional additions to the Federal Budget. If annual funding is available that is not allocated to a specific project, then a selection process is in place (based on a Program Management Plan), with an application period established. Congressionally listed projects are approved immediately. Solicited applications go through an approval process that should take no more than 1 month after the submittal deadline. The amount available per fiscal year changes, as it is allocated by Congressional Adds (to the budget). The total amount that can be allocated in the program currently stands at $240 million, of which approximately $60 million has been appropriated. There is no cutoff year for this funding, and it doesn't have to be expended in a single year. To learn more about this program, visit http://www.lrh.usace.army.mil/projects/current/section594/.

8.2.3 Development of Riparian/Wetland Areas

Riparian zones along streams and wetlands help filter toxins from surface water. Often, these natural buffers are damaged or destroyed by agriculture. Maintaining or restoring the riparian buffer and associated wetlands can greatly help water quality. Programs available to help maintain riparian zones include:

- USDA Natural Resources Conservation Service (NRCS) Wetlands Reserve Program (WRP) — A voluntary conservation program that offers landowners the means and opportunity to protect, restore, and enhance wetlands on their property through perpetual easements, 30-year easements, or Land Treatment Contracts. NRCS manages the program and provides technical and financial support to participating landowners.
- Ohio's Agricultural Pollution Abatement Program (APAP) — Provides farmers with cost share assistance to develop and implement Best Management Practices (BMPs) to protect Ohio's streams, creeks, and rivers. This program has been successful in helping to alleviate concerns associated with agricultural production and silvicultural operations which can create soil erosion and manure runoff.
- Conservation Reserve Enhancement Program (CREP) — A Federal/State natural resource conservation program targeted to address state and nationally significant agricultural related environmental problems. Through CREP, program participants receive financial incentives from USDA to voluntarily enroll in the Conservation Reserve Program (CRP) in contracts of a minimum 14 to 15 years. Participants

remove cropland from agricultural production and convert the land to native grasses, trees and other vegetation. CRP is authorized by the Food Security Act of 1985, as amended. Several watersheds in Ohio have already been enrolled in the CREP and CRP programs.

Specific areas where riparian zone protection and re-establishment are needed include the Marietta area Washington County, the North Zanesville area in Muskingum County, and the Loudonville area in Ashland and Holmes County.

8.2.4 Improvements to Land Use Zoning

Significant areas of urban development lie in the northern part of the watershed. To address stream quality impairments stemming from upstream development practices, cities should establish better land-use zoning restrictions — which could take the form of green space along stream corridors, to promote a healthy riparian corridor for filtering pollutants and to stabilize stream flow and habitat. Such green spaces potentially could (1) lessen stream-bank erosion and downstream water quality impairments and (2) protect the floodplain from unnecessary encroachment, reducing flooding issues for the community.

Better zoning practices should be established now within the basin, as land use in the northern part of the basin has been trending more toward urbanized development. Properly zoning these new areas of development could decrease impacts associated with sedimentation and runoff.

8.2.5 Education on Land Management Practices

Pathogens and nutrient loading are two of the biggest threats to water quality in the Mohican River watershed. The likely sources of these two impairments are human and animal waste (pathogens) and agricultural practices (nutrients). Educating the public on the water quality threats associated with agricultural practices could go a long way toward enlisting farmers' help to improve water quality. This information can be developed at a local level and made available through a wide variety of venues, such as chambers of commerce, county fairs, 4-H clubs, and local feed stores.

8.3 FLOOD ISSUE RECOMMENDATIONS

8.3.1 905(b) Reconnaissance Study for Bellville, Ohio

Belleville is located in Richland County, on the banks of the Clear Fork River. Residents and officials believe that damaging floods now occur more frequently because of upstream urban development. Flooding frequently affects State Route 13 (the main route into and out of town) and State Route 97 (en route to the Interstate 71 interchange). Flooding frequently also shuts down local schools, which are isolated when floodwaters rise. Reportedly, the flooding is caused by railroad lines that have been converted to bike trails (the trails, which are raised, now impound water and push it north and south along the toe of the raised embankment).

During the past 18 years, NOAA and the National Climatic Data Center have recorded 29 floods, which have caused $10.9 million in property damages.

The highly localized nature of flooding makes Bellville a good candidate for a traditional USACE Reconnaissance Study, which would determine whether a Federal (Corps) interest existed for a cost-shared feasibility study (which in turn would whether an economically feasible FRM solution exists for flooding problems).

8.3.2 905(b) Reconnaissance Study for Shelby, Ohio

Shelby, Ohio, lies in central Richland County, on the Black Fork of the Mohican River. During the past 18 years, NOAA and the National Climatic Data Center have recorded 29 floods, which have caused $75 million in property damage. Approximately $70 million of that property damage was caused by one storm event in August 2007.

The verbatim narrative from the National Climatic Data Center reads:

> *"Heavy rain producing thunderstorms affected Richland County during the late evening hours of August 20th and early morning hours of August 21st. Rainfall rates with the strongest storms exceeded three inches per hour… Runoff from this rain combined with ground already saturated from earlier rains led to catastrophic flooding across portions of Richland County. Local officials stated that the flooding in the county was some of the the [*sic*] worst ever! The Shelby area was especially hard hit as was the northern portion of Mansfield. In Shelby, the Black Fork of the Mohican River left it's banks and flooded most of downtown Shelby. Flood waters in some areas were as much as 8 feet deep. The Municipal Courthouse was a total loss and the Fire Department building was heavily damaged. Damage to city buildings in Shelby topped $1 million. Two schools in Shelby sustained an additional $1.5 million in damages. Dozens of people had to be rescued by boat in Shelby. Water rescue teams from surrounding areas assisted in the rescues. A Coast Guard helicopter from Detroit rescued several people from the roofs of homes...*

Around 100 homes in the county were damaged enough to be declared destroyed with at least 250 homes heavily damaged. Another 1500 homes in the county sustained lesser damages. Dozens of business in the county were also damaged by the flooding. Most of these were along Main and North Gamble Streets in Shelby. Dozens of roads and streets had to be closed because of flooding. Damage to roads, bridges and culverts were extensive. Cleanup and overtime costs incurred by local government agencies was substantial. Finally, standing water and erosion from the runoff caused damage to agricultural interests in the county…"

Recent flooding in Shelby reportedly is more frequent and severe than in the past. Of particular concern is the impact on emergency resources — the hospital is located on the west side of the stream, and emergency responders cannot reach it during flooding. Since the 2007 flood, if warning time is adequate, emergency equipment and personnel are placed on either side of the stream.

Shelby has taken steps to alleviate flooding issues, with the help of the MWCD. The MWCD used a snagging and clearing program to remove log jams upstream on the Black Fork. The town also has sought and received permission to remove an abandoned railroad bridge; that work has been completed, and town members are seeking permission to remove another. (They believe that during high flow events, debris backs up behind the bridges, forming a temporary dam that causes stream banks to overflow and inundate the town.) The town recently asked MWCD to reactivate the Black Fork sub-district, to study flooding issues. The MWCD agreed, and the town has 2 years to prepare a plan for presentation to the MWCD.

Like Bellville, the flooding in Shelby is highly localized, also making Shelby a good candidate for a traditional Corps Reconnaissance Study. As previously stated, the purpose of the reconnaissance phase study is to determine whether a Federal (Corps) interest exists for a cost-shared feasibility phase study (which would determine whether an economically feasible FRM solution exists for flooding problems).

8.3.3 Installation of Early Flood-Warning Systems

A typical flood warning system consists of rain gages, stream gages (or a combination thereof), computer monitoring equipment, transmitters, and associated equipment enclosures. This equipment all ties together to keep local emergency officials apprised of any upcoming flood threats.

A flood warning system is a low-cost way (compared with other options) way to prevent damages and loss of life resulting from high-water events. When given enough warning, citizens can move their more expensive and precious possessions to higher elevations and also have time to evacuate their families, their vehicles, and themselves as well.

A flood warning system already is being installed in the southern half of the basin, in the Duck Creek watershed (part of the Muskingum watershed), as a Section 205 Project (in partnership between the Huntington District and the MWCD).

Other areas in the basin that have voiced interest in a flood warning system include: Marietta in Washington County; Richland, Knox, Ashland, Holmes, and Crawford counties in the northeastern part of the basin; and Licking County.

Marietta already has in place a reverse 911 system, modeled after a similar system in Finely, Ohio. City officials have met with the National Weather Service and would like to tie

in to the in-progress Duck Creek flood warning system (eventually expanding it to include the entire Muskingum watershed).

Richland, Knox, Ashland, Holmes, and Crawford counties have begun working together to install a system that would cover all of their counties. Their goals are to reduce flooding (particularly in the Shelby, Mansfield, and Loudonville areas), make better use of their rain and stream gages, and better prepare for mitigation and emergency response during high-water events.

Licking County has been working with the USGS and the NWS to put a warning system in place but is still in the early planning process.

The Corps may be able to help with the study, design, and installation of these systems through the Section 205 program (discussed in depth in Section 8.1.5.1.2).

8.3.4 Log-Jam Removal

Log jams consist of woody vegetation, with or without other debris, that obstructs a stream channel and creates a backwater condition. Log jams occur naturally and provide beneficial stream structure, provide cover for fish and wildlife, and allow nutrient-rich sediment to be deposited on adjacent floodplains. However, Ohio's streams also are expected to function as efficient drainage outlets, conveying water off the land in a timely manner; log jams may inhibit this drainage function, causing flooding issues in the vicinity (especially during small-scale events).

Several areas in the basin have persistent issues with log jams — North Zanesville area in Muskingum County, the upper Tuscarawas watershed, and Wayne and Ashland (countywide). Educating property owners on stream maintenance and log-jam removal may help alleviate the problem.

The ODNR's Ohio Streamwater Management Guide (Guide #18; see Appendix F of this report) covers questions such as why log jams should be removed, who is responsible for removing them, and needed tools and permits.

8.3.5 Addressing Sedimentation at Corps Projects

Given that siltation and sedimentation, which both are listed water quality impairments in the watershed, it is correct to think that these two factors may affect storage capacity behind USACE dams. One dam specifically mentioned was Beach City dam, located on Sugar Creek in Beach City, Ohio. It was reported that the sediment is causing influent streams to flood even more during high-water events and possibly rise above the established flowage easement. Beach City is a reservoir project with a year-round conservation pool. The Corps is aware that the reservoir has silted in to the point that a recreation pool is no longer available; however, the sediment has not affected the flood control storage pool. To date, the Huntington District has not conducted any studies that

suggest flood storage capacity has been significantly affected by sedimentation at any of the dams in the watershed or basin. However, an ongoing Dam Safety Modification Study is being conducted at the Beach City reservoir to address reliability issues associated with the dam. As part of this study, the issue of sedimentation behind the dam is being analyzed as a potential dam safety hazard. If sedimentation is found to be a hazard, the reservoir likely will be dredged as part of the study recommendations.

8.4 FLOODPLAIN MANAGEMENT PRACTICES

8.4.1 Improved Enforcement of Floodplain Management Practices

During scoping, consistent enforcement of floodplain ordinances was identified as a basinwide problem. Consistent enforcement is critical to maintaining a floodplain that does not morph into a repetitive damage area. People that manage, live, and work in the floodplain need to be educated about flood hazards and actions to reduce or prevent property damage and loss of life.

The Corps developed a Floodplain Management Services Program specifically to address this need. The program's authority stems from Section 206 of the1960 Flood Control Act (PL 86-645), as amended. Its objective is to foster public understanding of the options for dealing with flood hazards and to promote prudent use and management of the Nation's flood plains. Land use adjustments based on proper planning and the employment of techniques for controlling and reducing flood damages provide a rational way to balance the advantages and disadvantages of human settlement on floodplains. These adjustments are the key to sound floodplain management.

The floodplain management program provides a full range of technical services and planning guidance needed to support effective floodplain management:

- General Technical Services — The program develops or interprets site-specific data on obstructions to flood flows, flood formation, and timing; flood depths or stages; flood-water velocities; and the extent, duration, and frequency of flooding. It also provides information on natural and cultural floodplain resources of note, and flood loss potentials before and after the use of floodplain management measures.
- General Planning Guidance — The program provides assistance and guidance in the form of "Special Studies" on all aspects of floodplain management planning, including the possible impacts of off-floodplain land use changes on the physical, socio-economic, and environmental conditions of the floodplain.
- Guides, Pamphlets, and Supporting Studies — The program enables studies to be conducted to improve methods and procedures for mitigating flood damages . The program also allows for preparation of guides and pamphlets on flood-proofing techniques, floodplain regulations, floodplain occupancy, natural floodplain resources, and other related aspects of flood plain management.

On request, program services are provided to State, regional, and local governments, American Indian Tribes, and other non-Federal public agencies without charge. Program services also are offered to non–water resources Federal agencies and to the private sector on a 100% cost recovery basis. For more information, please see Appendix D of this report.

Additionally, Corps-certified floodplain managers are available to answer any questions that local floodplain managers or officials may have. The Corps may be reached at 1-866-401-3980 (toll free).

8.4.2 Community Rating System

The NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed minimum NFIP requirements. As a result, flood insurance premium rates are discounted, to reflect the reduced flood risk resulting from community actions meeting the three goals of the CRS — reduce flood losses, facilitate accurate insurance ratings, and promote awareness of flood insurance. Appendix F of this document contains CRS's brochure.

8.4.3 Better Public Education on Flowage Easements and Permitting Processes

8.4.3.1 Flowage Easements

As previously stated, the flowage easements in the basin have been in place since the 1930s. As it is likely that the properties covered by the flowage easement have changed ownership several times, there is some natural confusion about how the easements operate or that one exists. Such confusion could be rectified through better public outreach by the Corps of Engineers. Currently, flowage easement maps are available on request from the Huntington District office, or the Muskingum Area Office. The Huntington District could make these maps available at county courthouses or city hall as well, in addition to some general information on restrictions on building, buying, and selling land covered by a flowage easement.

8.4.3.2 Permitting Process

The permitting process that governs impacts to environmental resources can be confusing, especially for people who do not often deal with such requirements. It was mentioned at several stakeholder meetings that often landowners do not seek the appropriate permits when they are working in and around their streams, because they do not realize that permits are needed, or they view the permitting process as too complicated for compliance. To help rectify this issue, the Huntington District would like to facilitate educational sessions between Corps permitting staff and interested county or local officials. This extra step may help local and regional officials to better explain the permitting process and result in greater permit compliance in the future.

8.5 OTHER PROGRAMS

8.5.1 Ohio EPA Voluntary Action Clean Up

Ohio's Voluntary Action Program was created in September of 1994, with the passage of Senate Bill 221. The program was created to give companies a way to investigate possible environmental contamination, clean it up if necessary, and receive a legal certification from the State of Ohio that no more cleanup is needed. More information on this program can be found in Appendix F of this report.

8.5.2 USDA Farm Service Agency's Emergency Conservation Program

The USDA Farm Service Agency's Emergency Conservation Program provides emergency funding and technical assistance for farmers and ranchers, to rehabilitate farmland damaged by natural disasters and to carry out emergency water conservation measures in periods of severe drought.

8.5.3 USDA Farm Service Agency's Farmable Wetlands Program

The USDA Farm Service Agency's Farmable Wetlands Program is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers by improving the land's hydrology and vegetation. The program is designed to prevent degradation of wetland areas, increase sediment trapping efficiencies, improve water quality, prevent soil erosion, and provide habitat for waterfowl and other wildlife. Eligible producers in all states can enroll land in the program through the Conservation Reserve Program (a separate program, under which producers plant long-term, resource-conserving covers to improve the quality of water, control soil erosion, and enhance wildlife habitat). In return, Farm Service Agency provides participants with rental payments and cost-sharing assistance, under contracts lasting 10 to 15 years.

8.5.4 NRCS' Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers through contracts (lasting as long as 10 years) that provide financial assistance for planning and implementing conservation practices. Goals of the program include:

- address natural resource concerns;
- improve soil, water, plant, animal, air, and related resources on agricultural land and non-industrial private forestland; and
- help producers meet Federal, state, tribal, and local environmental regulations.

8.5.5 NRCS's Agricultural Water Enhancement Program

The Agricultural Water Enhancement Program is a voluntary conservation initiative that provides financial and technical assistance to agricultural producers to implement agricultural water enhancement activities on agricultural land, to conserve surface water and groundwater and to improve water quality.

8.5.6 NRCS's Emergency Watershed Protection Program

The Emergency Watershed Protection Program is an emergency recovery program designed to conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, wind storms, and other natural occurrences. All projects undertaken (with the exception of the purchase of floodplain easements) must have a project sponsor.

8.5.7 NRCS's Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The NRCS provides technical and financial support to help landowners with their wetland restoration efforts, to establish long-term conservation and wildlife practices and protection. NRCS's strives to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program.

8.5.8 Clean Ohio Fund's Green Space Conservation Program

The Green Space Conservation Program helps fund preservation of open spaces, sensitive ecological areas, and stream corridors. Special emphasis was given to projects that:

- protect habitat for rare, threatened, or endangered species;
- preserve high quality wetlands and other scarce natural resources;
- preserve streamside forests, natural stream channels, functioning floodplains, and other natural features of Ohio's waterways;
- support comprehensive open-space planning;
- secure easements to protect stream corridors, which may be planted with trees or vegetation to help reduce erosion and fertilizer/pesticide runoff;
- enhance eco-tourism and economic development related to outdoor recreation in economically challenged areas;
- provide pedestrian or bicycle passageways between natural areas and preserves;
- reduce or eliminate non-native, invasive plant and animal species; and
- provide safe areas for fishing, hunting, and trapping in a manner that ensures a balanced eco-system.

8.5.9 Ohio Water Development Authority Community Assistance Program

This Community Assistance Program provides reduced-rate loans for construction of drinking water and wastewater infrastructure projects, so that communities can maintain affordable water and sewer rates.

9. NON-FEDERAL INTEREST AND POTENTIAL SPONSORS

To date, no letters of intent have been received on behalf of potential interested local sponsors. The Huntington District is engaged in ongoing discussions gauging the level of interest of local governments in participating in further study.

However, it is important to note that during the stakeholder meeting there was significant interest by local officials in participating in future studies that might result from this IWA. The MWCD has communicated an interest in participating as a non-Federal cost share sponsor for a basinwide FWA. The town of Shelby has indicated interest in pursuing a flood risk management study to assess the flooding issues taking place in their area. The towns of Copley, Barberton, Norton, New Franklin, and Green (the principal towns in the Headwaters of the Tuscarawas River sub-watershed) are interested in pursuing a detailed watershed assessment to identify flooding sources and correct water quality issues.

10. SCOPE AND OBJECTIVE OF FINAL WATERSHED ASSESSMENTS (SECTION 729 ASSESSMENTS)

10.1 WATERSHED ASSESSMENTS FOR THE MUSKINGUM RIVER BASIN AND NIMISHILLEN CREEK, HEADWATERS TUSCARAWAS RIVER AND CHIPPEWA CREEK SUB-WATERSHEDS

As previously mentioned in Sections 8.1.1 and 8.1.2, the Huntington District recommends moving ahead with the second phase of this study, to develop an FWA for the entire Muskingum River basin as well as for the Headwaters Tuscarawas River sub-watershed.

USACE may be involved with partners in watershed planning as either a participating agency or as a lead agency. As a participating agency, USACE could assist local efforts by providing technical expertise, skills, tools, and data; funding for such endeavors is available under Section 22, Planning Assistance to States. A comprehensive USACE-led watershed study, to address basinwide needs, most appropriately would be pursued under a USACE-led Section 729 watershed study and is therefore the recommendation of this IWA. Upon completion, the watershed plans produced from the FWAs will be handed off to local stakeholders for implementation. If USACE projects are identified, such Federal projects would require specific congressional authorization for further study prior to implementation and construction. It is unknown at this time whether the watershed studies would likely generate specific proposals for major Federal actions that could adversely affect the human environment. If they did, National Environmental Policy Act

(NEPA) documentation would be required. If they did not, the Final Watershed Plans would be classified as categorical exclusions according to ER-200-2-2 9.c., which includes "planning and technical studies which do not contain recommendations for authorization or funding for construction, but may recommend further study."

Water quality and flooding are key problems in the Muskingum River basin and Nimishillen Creek, Headwaters Tuscarawas River and Chippewa Creek sub-watersheds. These issues can be highly detrimental to water resources. Water quality issues in the basin and watershed stem from a number of sources, including stream-bank erosion, loss of riparian corridor, and urban development (see Table 7). Flooding — a common problem throughout the basin and watershed — results in property damage as well as emergency-management and cleanup costs.

Watershed planning — one of the most effective solutions to water-quality and flooding problems — integrates water resources, natural resources, economic considerations, and social desires to meet private and public needs and to provide a joint vision of a desired end state. A USACE-led watershed approach can identify desired future conditions, improve natural-resources management, minimize conflicts, and address problems and opportunities; such an approach considers the interdependency of water uses, competing demands, and the desires of a wide range of stakeholders.

The full scope and objective of the FWAs will be fully developed and negotiated with non-Federal cost-share partners through a WAMP. Numerous, prevalent problems in the basin and watershed could form the basis for the scope and objective of the WAMP. The most encompassing problems found through research and stakeholder outreach are water quality and flooding; both have direct connections to flood risk management measures and ecosystem restoration opportunities, as well as water quality and land-use planning. The scope and objectives of the proposed FWA should address, at a minimum, ways to combat or minimize the issues identified by this IWA.

In addition to studying water quality and flooding problems, future watershed planning may consider:

- protecting historical, scenic, and natural beauty areas;
- protecting wetlands and stream corridors;
- educating landowners on best land-use management practices, providing for open spaces and parks;
- developing attractive residential, institutional, and industrial areas that adequately manage storm runoff; and
- maintaining floodplains for flood storage, groundwater recharge, water supply protection, critical habitat preservation, recreation buffer zones, and conservation education uses.

11. FINAL RECOMMENDATIONS

Based on this Initial Watershed Assessment and strong sponsor and stakeholder support, I recommend that the following Watershed Assessment Management Plans (WAMPs) be developed and negotiated with a non-Federal sponsor:

- The Muskingum River Basin
- The Nimishillen Creek, Headwaters Tuscarawas River and Chippewa Creek Sub-Watersheds

Further, I recommend that if the WAMPs and associated cost-sharing agreement are successfully negotiated for these projects, that the US Army Corps of Engineers, Huntington District, participate in a comprehensive Watershed Assessment of the previously mentioned watersheds and tributary streams as discussed in this report.

_____ _____

Robert D. Peterson
Colonel, Corps of Engineers
District Engineer

Date