# NINE-ELEMENT NONPOINT SOURCE IMPLEMENTATION STRATEGY (NPS-IS)

# **SWAMP CREEK HUC-12**

# (050800020203)

*Swamp Creek near the Village of Verona*

PREPARED FOR THREE VALLEY CONSERVATION TRUST

PREPARED BY ENVIRONMENTAL SOLUTIONS AQ

VERSION 1.0: NOVEMBER 9, 2023

APPROVED: NOVEMBER 9, 2023

## Table of Contents

## List of Figures

## List of Tables

## *ACKNOWLEDGEMENTS*

The Three Valley Conservation Trust would like to acknowledge the collaboration of multiple partners in the preparation of this Nonpoint Source Implementation Strategy for Swamp Creek HUC-12. Thank you to the individuals and organizations that contributed background information, insight into objectives and projects for inclusion in this NPS-IS. We would like to recognize the staff at Darke, Preble and Montgomery soil and water conservation districts, Miami Valley Regional Planning Commission, the Miami Conservancy District and the Darke, Preble, and Montgomery county health departments for their outreach, contributions, and reviews ensuring a comprehensive and accurate plan. Special recognition to the staff at Environmental Solutions AQ, LLC for the extensive work to source and analyze data, leading community meetings and site visits, and drafting the final plan. We also wish to thank the numerous community stakeholders who attended the public meeting, met with us individually to verify data *in situ*, and provided feedback to assist prioritizing future projects. Finally, we would like to express our appreciation to the Ohio Environmental Protection Agency for the funding to develop this plan.

# Chapter 1: Introduction

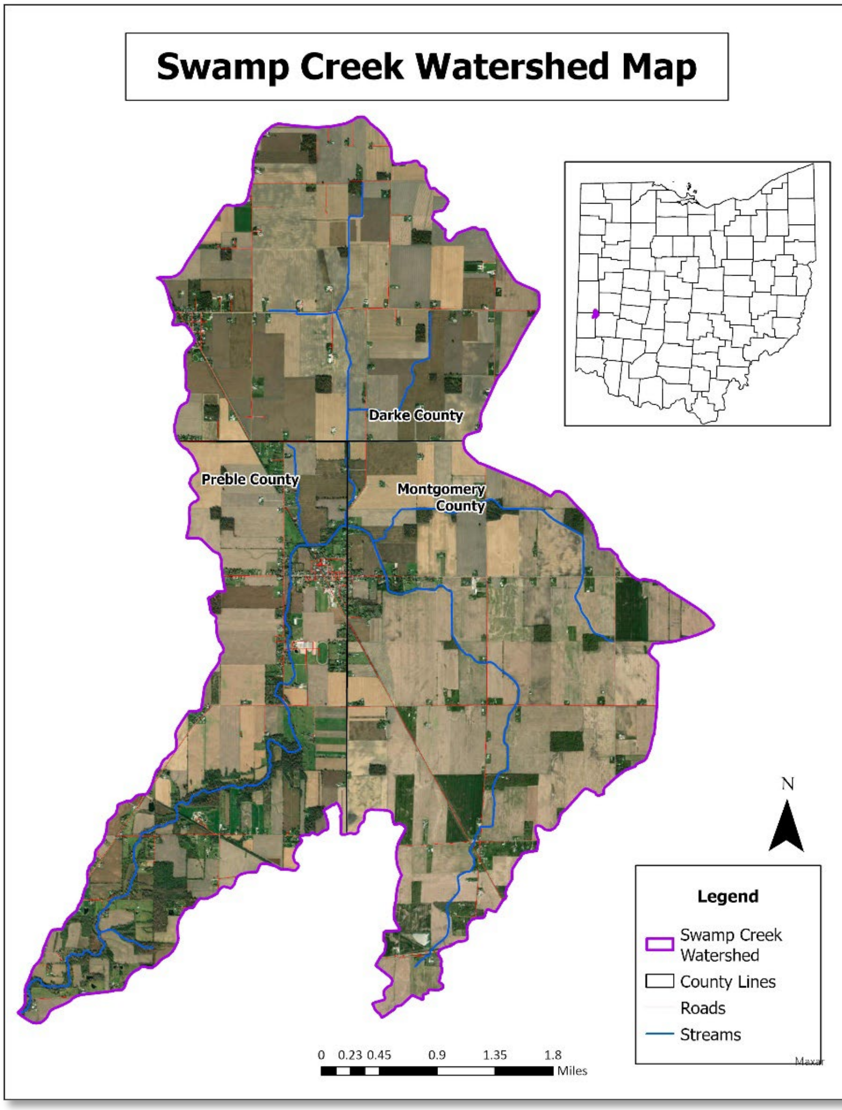



**FIGURE 1-1 SWAMP CREEK HUC-12 WATERSHED MAP**

The Nine-Element Nonpoint Source Implementation Strategies Plan (NPS-IS) is a strategic document that provides assurance to nonpoint source grant programs and institutions (i.e., U.S. EPA) that a proposed water quality improvement project meets the nine essential elements per U.S. EPA §319 Program Guidance (April 2013). The NPS-IS ensures that potentially funded projects are scientifically evaluated, that they are located in areas that will address the worst problems; and that they have the administrative, evaluation, and educational components needed to ensure that the water resources will achieve as much long-term benefit as possible. The NPS-IS is a living strategic planning document that summarizes causes and sources of impairment, establishes critical areas, identifies quantifiable objectives to address causes and sources of impairment, and describes projects designed to meet those objectives.

The Swamp Creek HUC-12 (050800020203) (Figure 1-1) has been identified as one of the priority watersheds where USDA models suggest there is high contribution of nutrient loading from agricultural lands. Swamp Creek is located within the Great Miami River watershed which is a major contributor of nutrients to the Gulf of Mexico (OEPA, 2020a; Goolsby et al., 1999). The Great Miami River basin watershed had the highest soluble reactive phosphorus concentrations and the highest time-weighted average total P concentration amongst 10 streams studied in Ohio (Baker, 2006).

Three Valley Conservation Trust (TVCT) has partnered with Environmental Solutions AQ, a local environmental consultant, for the preparation of this Nine-Element NPS-IS for Swamp Creek HUC-12 watershed.

One important element of Nine-Element NPS-IS is the education and outreach activities that will be conducted while implementing the plan. TVCT is dedicated to engaging the public and informing them of important events and projects as well as educating them about the existing condition of the streams. Key partners, the soil and water conservation districts of Darke, Preble, and Montgomery counties, are also dedicated to educating landowners and agricultural producers about managing nutrient loads by implementing Best Management Practices (BMPs) and about improving and preserving the quality of streams. In addition, partners including Miami Valley Regional Planning Commission, Miami Conservancy District and health departments of Darke, Preble, and Montgomery counties are all willing partners to engage the communities to address drinking water source protection and Home Sewage Treatment Systems (HSTS) in unsewered communities.

**FIGURE 1-2 HEADWATERS OF SWAMP CREEK IS LOCATED IN NORTHWEST MONTGOMERY COUNTY**

## 1.1. Report Background

Ohio has been leading Watershed-Based Planning (WBP) for a long time. It is a process that often results in a document used to guide projects within a geographic area defined by the flow of water. WBP is used to coordinate activities related to water resources including: water quality and/or quantity management, ecological protection and restoration, or the strategic guidance of development, infrastructure improvement, transportation, and recreation among others. WBP is an effective approach to solving difficult water-related problems because it is locally led, collaborative, data driven, and consensus based (OEPA, 2016a).

Ohio EPA developed the Ohio Guide for Development of Watershed Action Plans in 1997 and in 2016, in collaboration with Ohio Department of Agriculture, the Nine-Element NPS-IS template was issued to guide the completion of a state and federal approvable Nine-Element NPS-IS (OEPA, 2016b).

A Nine-Element NPS-IS is a specific type of watershed-based planning that will allow local entities to effectively propose and implement nonpoint source pollution projects utilizing funding made available through the Clean Water Act Section 319 (§319), H2Ohio or the Great Lakes Restoration Initiative. In Ohio, eligibility for these grant programs is strongly preferred or restricted to projects delineated within a critical area of an approved NPS-IS.

**Nine Elements of NPS-IS**
Source: OEPA, 2016a

a) An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan.

b) An estimate of the load reductions expected for the management measures described under paragraph (c) below.

c) A description of the NPS management measures (solutions) that will need to be implemented to achieve the load reductions estimated under paragraph (b) above and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d) An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.

e) An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f) A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

g) A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h) A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS Total Maximum Daily Load (TMDL) has been established, whether the NPS TMDL needs to be revised.

i) A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Swamp Creek Watershed (a subwatershed of Twin Creek) was characterized in the 2010 endorsed Twin Creek Watershed Action Plan (WAP). The Twin Creek WAP concluded that although much of the Twin Creek watershed was very high quality, portions of Twin Creek and its tributaries were not fully meeting aquatic life and recreational use standards (IES, 2010). During OEPA's 2005 study reported in the Biological and Water Quality Study of Twin Creek and Selected Tributaries (OEPA, 2007), Swamp Creek segments were designated as Exceptional Warmwater Habitat (EWH) or Warmwater Habitat (WWH) Aquatic Life Use (ALU), but attainment of that designation was not able to be determined due to low flow at the downstream site. Upstream on the main stem, only partial WWH attainment was achieved. In the 2010 Twin Creek Watershed TMDL report, OEPA concluded that phosphorus and sediment are the pollutants that need to be reduced. The causes of impairment to aquatic life and primary recreation use at Swamp Creek HUC-12 include Low DO, ammonia, phosphorus, and sedimentation/siltation (OEPA, 2007).

Chapters 1 and 2 of the Swamp Creek HUC-12 Nine-Element NPS-IS have been prepared based on knowledge from the Twin Creek WAP, OEPA technical report, TMDL documents, and other published water quality documents. Chapters 3 and 4 were developed via engagement with stakeholders, including partner organizations, agricultural producers, and landowners. The NPS-IS follows the OEPA Nine-Element NPS-IS template (OEPA, 2016b).

## 1.2. Watershed Profile & History

The Swamp Creek HUC-12, located in Preble, Montgomery and Darke counties, Ohio is one of the subwatersheds of the Twin Creek Basin in southwest Ohio (Figure 1-3). The Swamp Creek watershed drains an area of 17.52 mi$^2$ in southwestern Ohio. Twin Creek, 47.03 miles long, has been categorized as an Outstanding State Water in OAC 3745-1-05 (ODA, 2023). Twin Creek originates in Darke County and flows southeast into Preble County and generally south through the eastern portion of the county, then southeast through the southwest corner of Montgomery County, and then into Warren County, Franklin Township, where it meets the Great Miami River. The Twin Creek watershed drains an area of 316 mi$^2$ in southwestern Ohio. The Swamp Creek and Twin Creek watersheds are part of the Lower Great Miami Watershed HUC 05080002 (Figure 1-4).

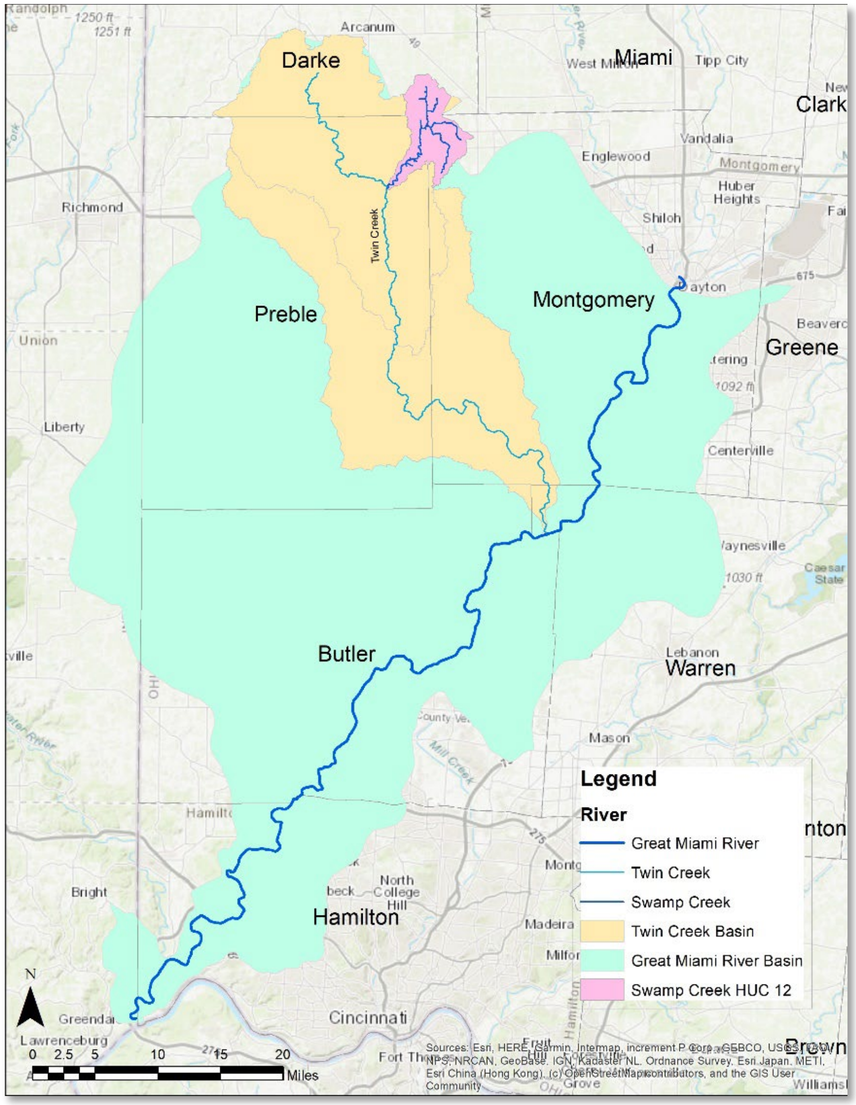



**FIGURE 1-3 SWAMP CREEK HUC-12 IN THE UPPER REACHES OF THE TWIN CREEK WATERSHED (ESRI)**

The main stem of Swamp Creek is 7.3 miles long, almost all of which has been modified through channelization, riparian removal or has been leveed (Twin Creek WAP, 2010). The HUC-12 watershed is 11,213 acres in size. The creek begins around Dodson Road in Montgomery County, curving northwesterly before being joined by tributaries from the north and south, curving around the Village of Verona and crossing into Preble County where it turns to the southwest, flowing into Twin Creek east of the Village of Lewisburg. The Swamp Creek watershed is primarily a rural, agricultural watershed with almost equal proportion of land area in all three counties: 29-percent in Preble County, 30-percent in Darke County and 41-percent in Montgomery County.

Significant tributaries in the Swamp Creek HUC-12 watershed include unnamed tributaries that are channelized. Swamp Ditch drains to Swamp Creek and has been straightened and maintained by Montgomery SWCD. Moyer Ditch in Darke County has several named branches and is maintained by Darke County Ditch Maintenance.

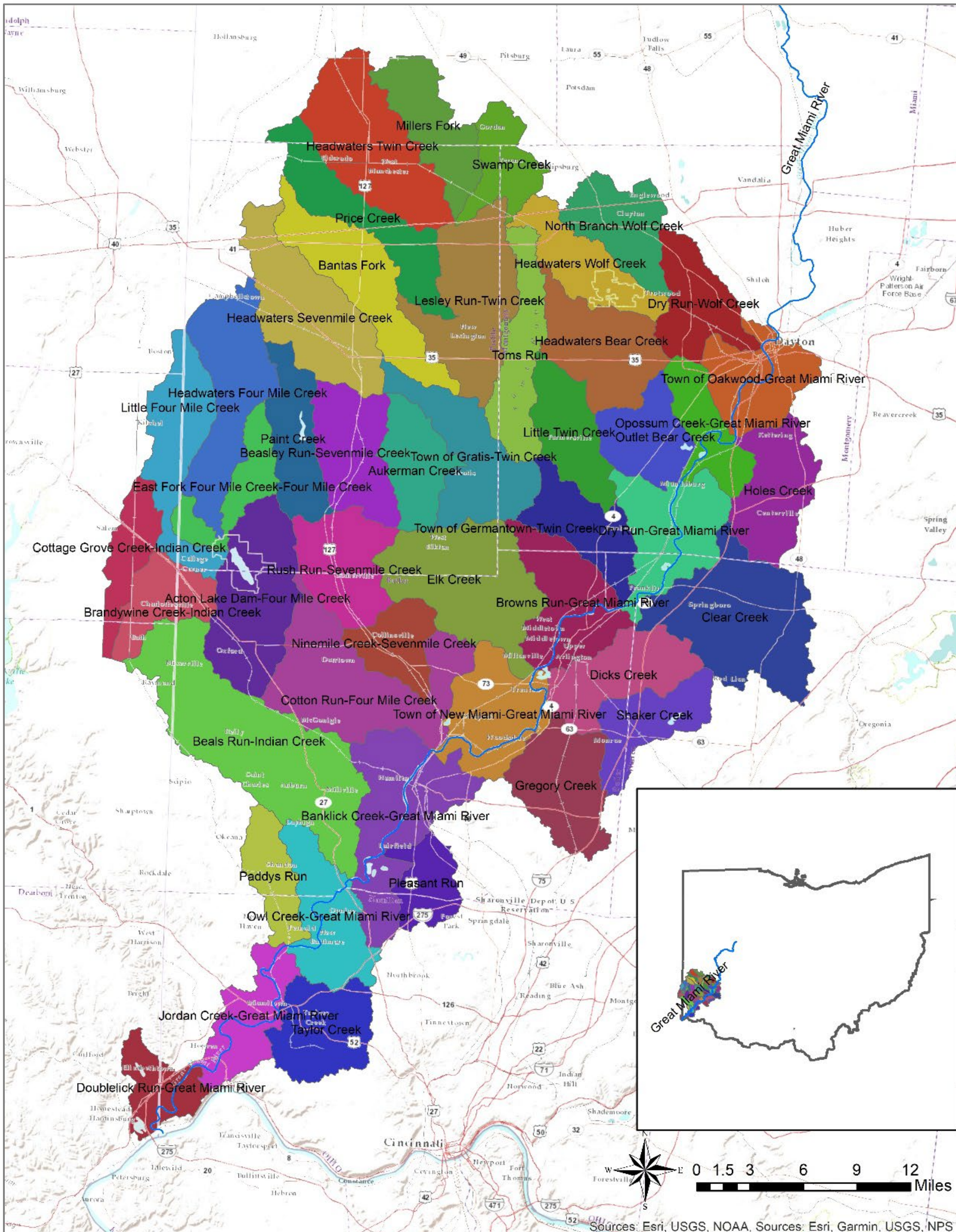



**FIGURE 1-4 LOWER GREAT MIAMI RIVER HUC-8 WITH TWIN CREEK HIGHLIGHTED (ESRI)**

## *Human History*

Shawnee and Miami tribes populated the region during the American colonial period. A path through the watershed taken by indigenous people called the "Wabash Trail" is identified on historic maps (Ohio Historical Society). Landowners report finding arrowheads and other indigenous artifacts in areas along Swamp Creek that were possibly used as travel corridors. Wolves, panther, and dense forests of walnut, oak, ash, elm, and maple impeded travel in this section of the Northwest Territory during the early days of white settlement (Wilson, 1914).

**FIGURE 1-5 WARNCKE BRIDGE OVER SWAMP CREEK IN PREBLE COUNTY**

The National Road (also known as Cumberland Road), authorized by the US Congress in 1806 during the Jefferson Administration, meant white settlers could travel to western Ohio from as far east as Baltimore, Maryland. Completed all the way to Illinois by the 1830s and now known as US Route 40, the road passes through the southern edge of the watershed. It brought business and families to the area early in the 1800s and continued to be a busy interstate route until the parallel Interstate Route 70 was completed during the middle of the 20$^{th}$ century. (Longfellow, 2017).

Today, the Swamp Creek watershed is primarily a rural, agricultural watershed. Most of the land use of the watershed is composed of farmland that is owned by private landowners. Agricultural production is primarily focused on row crops. Swine are raised in a handful of facilities in the Darke County portion of the watershed.

The Village of Verona (population 405, according to the 2020 U.S. Census) is within the Swamp Creek HUC-12. The Village of Gordon (population 245, according to the 2020 U.S. Census) is almost entirely within the watershed. Wengerlawn is a small unincorporated community in Clay Township of Montgomery County. There are no modern housing developments, and only a few industrial, or large-scale commercial facilities within the watershed. Verona Wastewater Treatment Plant, which provides sewage treatment services for the village, is the only permitted National Pollutant Discharge Elimination System (NPDES) facility within the Swamp Creek HUC-12 watershed.

The Wolf Creek Recreation Trail is a paved multi-use trail that runs through the Montgomery County portion of the watershed from southeast to northwest. It is located on a former rail line and passes near the Wengerlawn community. A small trail rest area exists between the trail and Swamp Creek there. The Wolf Creek Recreation Trail's current terminus is in the Village of Verona. The trail is maintained by Five Rivers MetroParks, Montgomery County's park district and is part of southwest Ohio's 350-mile paved trail network.

In 2005, Swamp Creek was partially attaining WWH ALU upstream of the Village of Verona, and no attainment status was determined downstream due to drought conditions. A Swamp Creek tributary upstream of Verona was fully attaining WWH at that time (OEPA, 2007). The stream was channelized sometime in the past to aid drainage through poorly drained Crosby and Brookston soils. This waterway has no riparian buffer and is relatively flat. Nutrient enrichment has occurred, likely caused by adjacent row cropping and likely scattered failing septic systems draining to the ditch.

The Darke County Ditch Maintenance office manages the northern tributary of Swamp Creek known as Moyer Ditch and has done so for decades. The ditch maintenance office noted that many of the ditches existed long before their office was established (Personal interview 8-7-23, Jeff McMiller, Darke County Ditch Maintenance). The Montgomery Soil and Water Conservation District has managed some channelized portions of the mainstem of Swamp Creek since the mid-1990s as a petitioned ditch project.

## 1.3. Public Participation and Involvement

Public participation and involvement are critical to the success of implementing recommendations of any NPS-IS. In 2007, the Twin Creek Advisory Committee was formed, and meetings were held regularly to collaborate in the preparation of the Twin Creek WAP and review of the OEPA prepared Twin Creek TMDL. The Twin Creek watershed projects were operated as a collaborative group of organizations, individuals, and agencies with a goal of protecting and improving water quality in Twin Creek and its tributaries. Various partners engaged in the decision-making process, documentation and plan strategy endorsements, and events including education, public outreach, and stream monitoring. The decision-making process was informal, but consensus driven. The public involvement for the Swamp Creek HUC-12 Nine-Element NPS-IS development is built on this already established working relationship and trust.

In April, 2023, TVCT and its partners, the Montgomery, Preble and Darke soil and water conservation districts (SWCDs) issued the first news release regarding the Swamp Creek HUC-12 NPS-IS development in the local newspaper and sent a postcard to landowners. An invitation postcard or letter was sent to 491 landowners who reside in the Headwaters Twin Creek, Miller's Fork, or Swamp Creek HUC-12 watersheds and who own properties larger than 5 acres. NPS-IS for Miller's Fork and Headwaters Twin Creek HUC-12 watersheds are also currently being prepared. TVCT contacted the owners of easements they hold, to inform them of the project and invite them to the public meeting. TVCT also posted to social media (Figure 1-5). The announcement received immediate positive responses from landowners and producers. TVCT and its partners received emails and phone calls inquiring about the project. The progress of the plan preparation was posted on social media and TVCT's website.

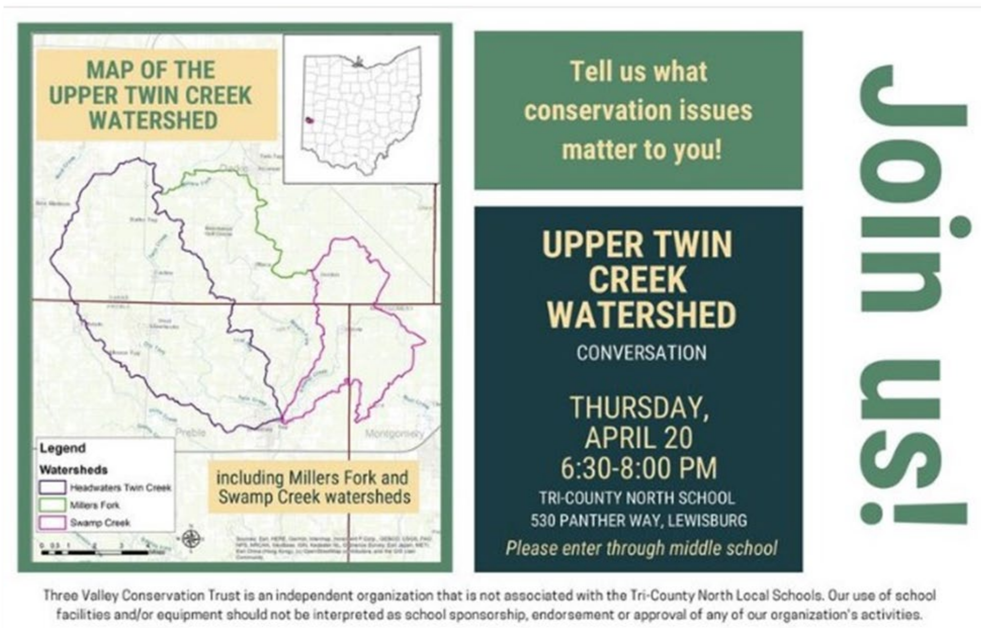



**FIGURE 1-6 DESIGN OF THE POSTCARD SENT TO LANDOWNERS**

## Ohio Nonpoint Source Pollution Control Program

Traditional images of water pollution often consist of a pipe spewing industrial contaminants into a river. The Clean Water Act helped solve many of Ohio's traditional pollution problems. Remaining problems are more challenging and may be traced to two kinds of pollutants: polluted run-off and physical alterations to a stream or river channel. These are referred to as nonpoint sources of pollution since they are the result of a land use and/or man-made changes to a river rather than flowing from a single point of discharge.

**Polluted run-off** is rain or snow melt flowing across the land picking up contaminants such as sediment, nutrients or bacteria, carrying these pollutants to small streams that eventually flow into a larger river. **Physical alterations** are changes made to a stream channel or stream banks and include activities such as the conversion of headwater streams into drainage ditches, constructing levees and dams, and straightening a stream to encourage improved drainage. **Physical alterations** also include activities such as removing trees along a river bank or installing rock rip-rap on a river bank to prevent erosion.

The primary causes of nonpoint source impairment in Ohio streams are habitat alteration, hydro-modification to stream channels, sediment and excessive nutrients. Streams in agricultural areas of Ohio appear most frequently to be impaired by physical alterations, such as ditching, and impairments caused from excessive sediment and nutrients. Streams in urban and rapidly developing residential areas of the state are further impaired by nonpoint causes such as lowhead dams and nonpoint source contaminants carried off land surfaces by increased storm water runoff. In the coalfield regions of southeastern Ohio, another cause of impairment is abandoned mine drainage, which has impaired more than 1,300 miles of streams in the region.

Fortunately, management practices to address nonpoint source pollution are becoming more effective. Previous efforts to address these types of problems often consisted of implementing demonstration practices and trying new techniques for managing the ubiquitous nature of nonpoint source pollutants. Years of trial and error are resulting in a much broader understanding of management practices needed to restore impaired waters and improve water quality.

**Physical alterations** may be addressed using restoration practices such as removing lowhead dams, eliminating or modifying levees and restoring floodplains and riparian forest cover. Headwater streams previously converted into drainage ditches are effectively being restored using natural stream channel design techniques. Polluted run-off is being more effectively reduced using pollution prevention practices such as replacing failing home sewage treatment systems, installing riparian filter strips and controlled drainage systems or restoring ditches to 2-stage channels to allow for more natural stream function. Many other practices designed to slow the flow of nutrients from croplands, and sediment from mining sites and construction sites are also available to improve the health of Ohio's rivers and streams.

### Approved 9-Element Nonpoint Source Implementation Strategies in Ohio

The 9-Element NPS-IS is a strategic plan that provides assurance to nonpoint source grant programs and institutions (i.e., U.S. EPA) that, as described, a proposed water quality project meets the 9 Essential Elements per U.S. EPA §319 Program Guidance (April 2013).
For a project to be eligible for Ohio EPA Section 319 Funding, a proposed project must be described in a U.S. EPA-approved 9-Element NPS-IS for the HUC-12 watershed in which the project is located.

The NPS-IS ensures that potentially funded projects are: rooted in the best science available; located in areas that will address the worst problems; and that have the administrative, evaluation, and educational components needed to ensure that the water resource will achieve as much long term benefit as possible.

The NPS-IS is a living strategic planning document that summarizes causes and sources of impairment, established critical areas, identifies quantifiable objectives to address causes and sources of impairment, and describes projects designed to meet those objectives.
Each NPS-IS is unique at the HUC-12 Watershed Assessment Unit (WAU) scale. The NPS-IS is designed to evolve as projects come and go. Likewise, every updated version (containing new projects, new data, and or changes to critical areas, goals and objectives) must be reviewed and approved by Ohio EPA.

### Local Efforts

On April 20th a meeting was held at Tri-County North High school to begin focusing efforts to reduce polluted runoff in the Upper Twin Creek Watershed. Three Valley Conservation Trust (TVCT) is partnering with the soil and water districts of Preble, Darke and Montgomery counties to develop a plan. Additional partnership support involves the Miami Conservancy District, The Nature Conservancy, local park districts and local health departments.

During 2023, TVCT and its contractor Environmental Solutions AQ- along with many local partners will develop Nine-Element Nonpoint Source Implementation Strategy Plans for Headwaters Twin Creek, Millers Fork and Swamp Creek watersheds.
Development of the Nine-Element Plans for Upper Twin Creek will set the stage for future funding to restore wetlands and stream banks to support conservation agriculture. For more information, see www.3vct.org







**FIGURE 1-7 PUBLIC ANNOUNCEMENT IN MONTGOMERY SWCD NEWSLETTER**

**FIGURE 1-8 PUBLIC MEETING ON APRIL 20, 2023 FOR UPPER TWIN CREEK**

On April 20, 2023, a public meeting was held in the lecture room of Tri-County North High School in Lewisburg. About 30 landowners participated in the in-person public meeting. During the meeting, a presentation was given and then the public discussed the scope of the Nine-Element NPS-IS. The meeting presentation and discussion included three HUC-12 watersheds adjacent to one another because the partners are working on these plans simultaneously. Also, many local agricultural producers own or farm land in two or more of these adjacent watersheds. The Miami Conservancy District, as a major stakeholder interested in water conditions, also sent a staff person to the meeting. Representatives from all three county health departments and the Preble County Park District were also present.

At the public meeting, landowners asked questions and discussed the water quality issues at Swamp Creek HUC-12 as well as potential funding opportunities for implementing conservation and restoration projects. In addition, landowners were invited to complete a 10-item questionnaire. Three completed questionnaires and a hand-written note were collected after the meeting from landowners in the Swamp Creek HUC-12. In summary, the landowners were most concerned about logjams, failing septic systems, and flooding. If funding were available, the landowners would participate in installing subsurface drainage control structures, clearing trees, and restoring streambanks.

On May 11, 2023 an interview was held with the Darke County Economic Development Director to discuss water resource needs in the watershed as related to development plans. None of the communities in the Darke County portion of the watershed appear to be seeking new commercial, industrial, or residential development. The Darke County Comprehensive Land Use Plan is under development at the time of publication; Preble and Montgomery counties have published comprehensive land use plans. The Preble County plan calls for additional plans focused on sewer and water infrastructure to attract development (Board of Preble County Commissioners). Montgomery County Planning Commission Comprehensive Land Use Plan and Future Land Use Map (2012) encouraged preservation of farmland through agricultural conservation easements throughout western Clay Township.

On May 25, 2023 a discussion was held with health department environmental staff members from the three counties and Matt Lindsay of the Miami Valley Regional Planning Commission (MVRPC) regarding the problem of failing septic systems and unsewered communities. The Darke County General Health District (DCGHD) staff members provided data about suspected noncompliant Home Sewage Treatment Systems (HSTS) in unsewered communities. An unsewered community is a populated place where small lot size prevents conventional replacement strategies for failing HSTS. The Preble County Public Health (PCPH) and Public Health Dayton-Montgomery County (PHDMC) staff members provided a general overview of complaints, conditions, and possible solutions for failing HSTS in their respective jurisdictions. MVRPC requested assistance from the health departments in contacting leadership of the unsewered communities. MVRPC has offered free planning assistance to these communities to develop customized wastewater treatment options in the form of a General Plan. These plans would look at potential solutions and recommend the most effective option for solving the problem. The plan, which includes preliminary engineering estimates, would lay the groundwork for funding opportunities and will be the first and important step toward possibly building a new or connecting to a nearby wastewater treatment plant.

On June 13, 2023 a smaller group conversation was held with Montgomery County agricultural producers, SWCD personnel, and a board member to consider the Agricultural Conservation Planning Framework (ACPF) recommendations and discuss conservation practices that would likely be attractive to landowners in the area.

The announcement of the NPS-IS project and the April public meeting prompted more landowners' interest and inquiries about implementing conservation practices. Field visits were conducted on June 20, 27, and 30, 2023, to discuss conservation practices within the watershed. During the site visits, the NPS-IS core team met with agricultural producers with large row-crop operations regarding their challenges and successes with various conservation practices, as well as problem areas on their properties. A visit was made to a location on Swamp Creek owned by the Village of Verona and interviews were held with village maintenance staff and a village council member (see Section 2.1.2. for Public Land discussion).

TVCT is committed to continue its mission to conserve natural habitats, waterways and agricultural lands in Southwestern Ohio, for the benefit of present and future generations, through partnerships with people and communities. Preble, Darke, and Montgomery SWCDs are dedicated to continuing to promote conservation practices with public involvement through education and outreach activities. The SWCDs engage with the public in several ways, including publishing newsletters, in-person farm visits and regularly updating social media outlets such as Facebook, as well as updating their websites.

Two regional watershed partners, The Nature Conservancy District and Miami Conservancy District, engaged in the review and discussion of the draft Swamp Creek HUC-12 NPS-IS and also provided funds (in kind and cash) to complete the modeling of the Agricultural Conservation Planning Framework (ACPF) for Swamp Creek HUC-12 (see Section 2.5).

A second press release was issued on October 30, 2023, informing the public that the Draft Nine-Element NPS-IS is complete. The public is encouraged to request a copy of the plan, review it and provide comments. Once comments are received and reviewed, the next version of the Swamp Creek HUC-12 Nine-Element NPS-IS will be updated to incorporate the comments.

# Chapter 2: Watershed Characterization and Assessment Summary

The Swamp Creek HUC-12 watershed includes a few unnamed tributaries and Swamp Creek Ditch (Figure 1-1). In 2005, Ohio EPA conducted the Biological and Water Quality Study of Twin Creek and Selected Tributaries which included Swamp Creek (OEPA, 2007). The report stated that the sampling locations from Swamp Creek met the Warmwater Habitat (WWH) aquatic life use (ALU) designation upstream of Preble County and partially met it at the Preble County line.

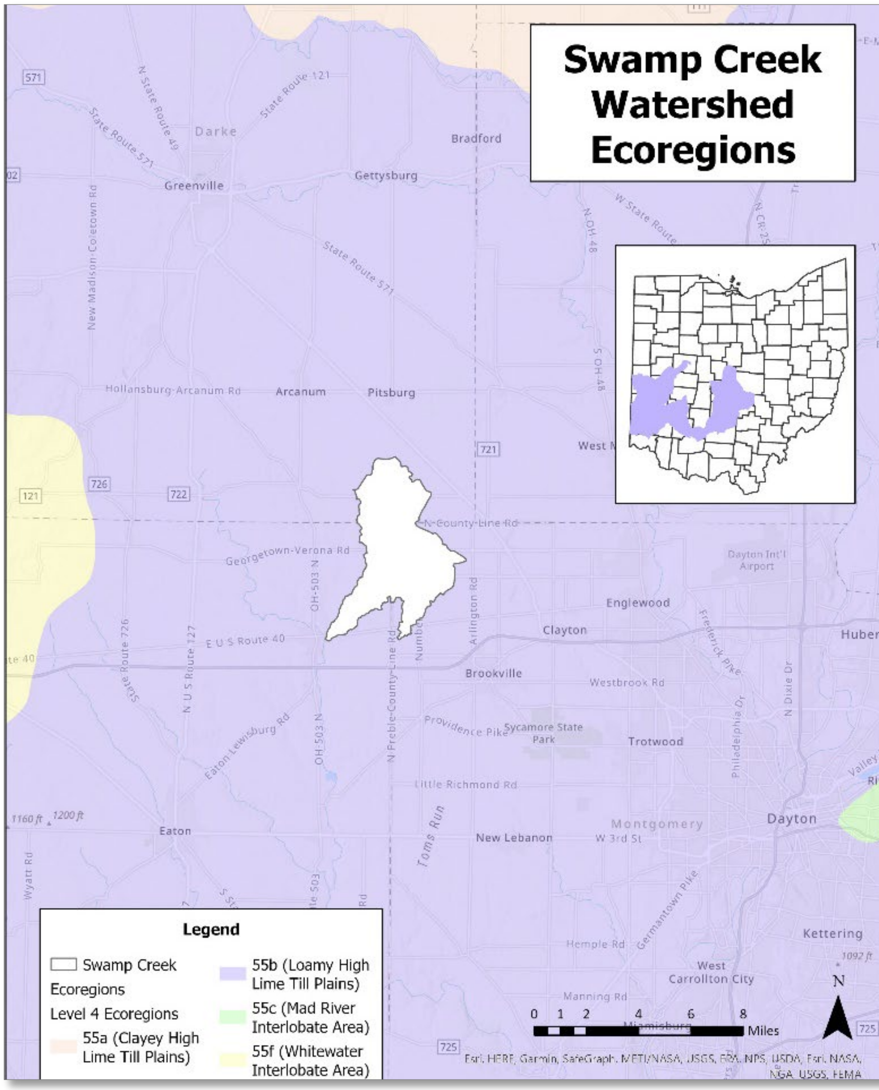



**FIGURE 2-1 SWAMP CREEK ECO-REGION TILL PLAINS (US EPA)**

The Swamp Creek HUC-12 is located within the Eastern Corn Belt Plains (ECBP) ecoregion (Figure 2-2). The ECBP ecoregion is a rich agricultural production area and primarily a rolling till plain with local end moraines that were associated with glacial deposits of Wisconsinian age (7,500 to 11,000 years ago). This region's nutrient-rich soils significantly influence water quality including elevated concentrations of nitrate and phosphorus in many watersheds (USEPA, 2000).

## 2.1. Watershed Characterization Summary for Swamp Creek HUC-12

### 2.1.1. Physical and Natural Features

**FIGURE 2-2 SWAMP CREEK AT DODSON ROAD**

In the Swamp Creek HUC-12 watershed, deposits of loamy, high-lime glacial till composed of cobbles, gravel, sand, silts, and clays overlay sedimentary bedrock of dolomite, limestone and shale formations of marine origin. Glacial till, visible as moraines or depositional ridges of glacial outwash, formed lobate ridges according to glacial advance and retreat. Wisconsinian Era end moraine and ground moraine compose most of the unconsolidated sediments in the watershed (Ohio Geological Survey, 2005). Drift thickness, the amount of glacial deposition that occurs above bedrock, varies from as thin as 20 feet in the watershed's uplands to as thick as 200 feet in the outwash areas and bedrock cut valleys that cover ancient river valleys (Ohio Geological Survey, 2005). Bedrock is commonly visible in the Swamp Creek streambed in the lower portion of the watershed.

Upland soils in the watershed are primarily loamy glacial till that are generally high in fertility and have poor to moderate drainage. Nearly 45-percent of the watershed is poorly drained or very poorly drained (NRCS, 2023). The dominant upland soil association consists of Brookston silty clay loams (Appendix B) which represent soils that have slow and very slow infiltration when thoroughly wet, but are prime farmland when drained. These soils have a very slow rate of water transmission (Figure 2-3).

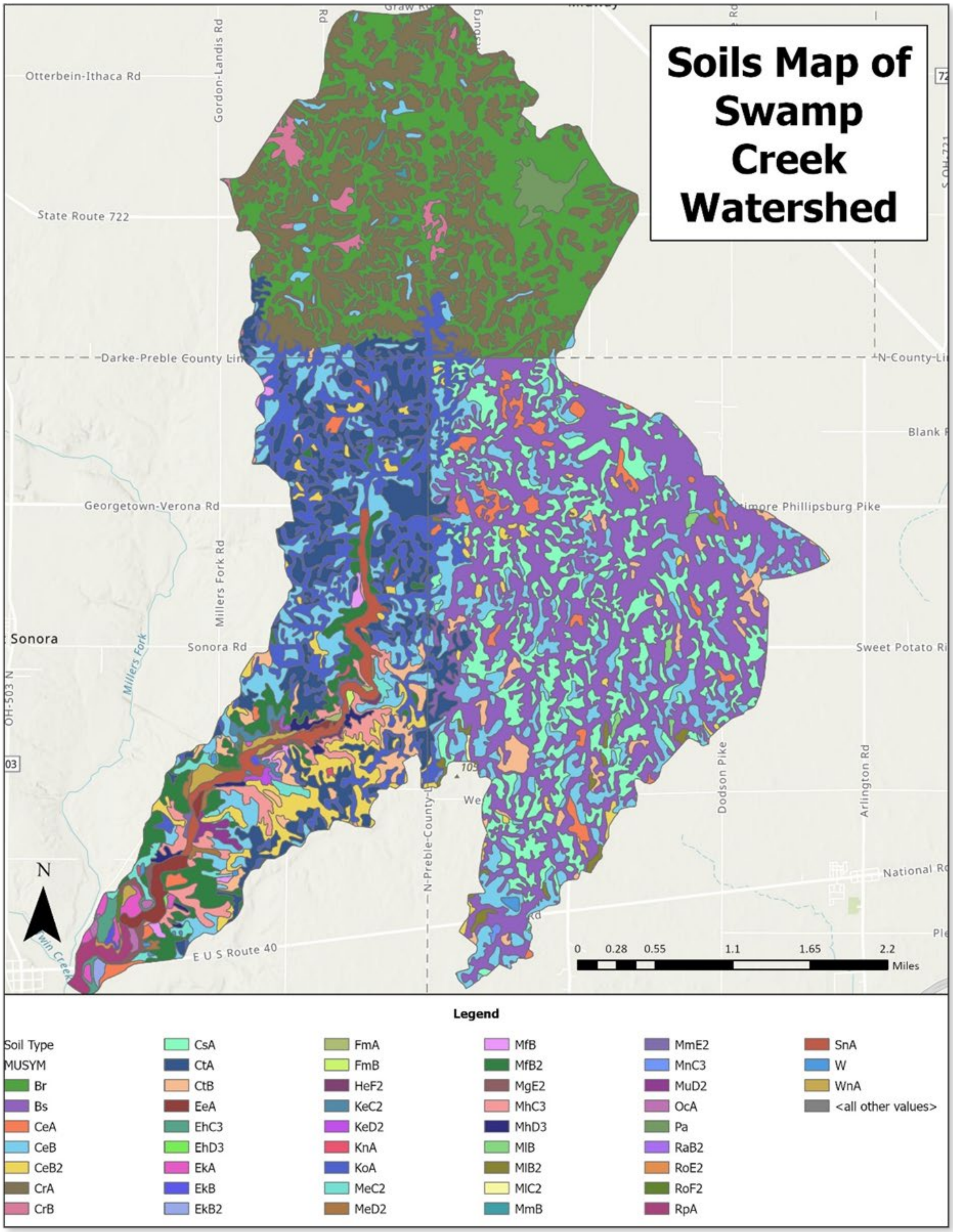



**FIGURE 2-3 SOILS MAP OF SWAMP CREEK HUC-12 (USDA)**

The watershed soils are cultivated in large acreages and are important to farming in this watershed. The control of runoff and soil erosion are the main concern in managing these soils for farming while moderately slow permeability and slope are the dominant limitations to many nonfarm uses (NRCS, 2023). Soils along Swamp Creek primarily are derived from fine to coarse-grained floodplain deposits that overlie older alluvial or outwash sediments. Such floodplain soils tend to be fertile and well-drained (Figure 2-4).

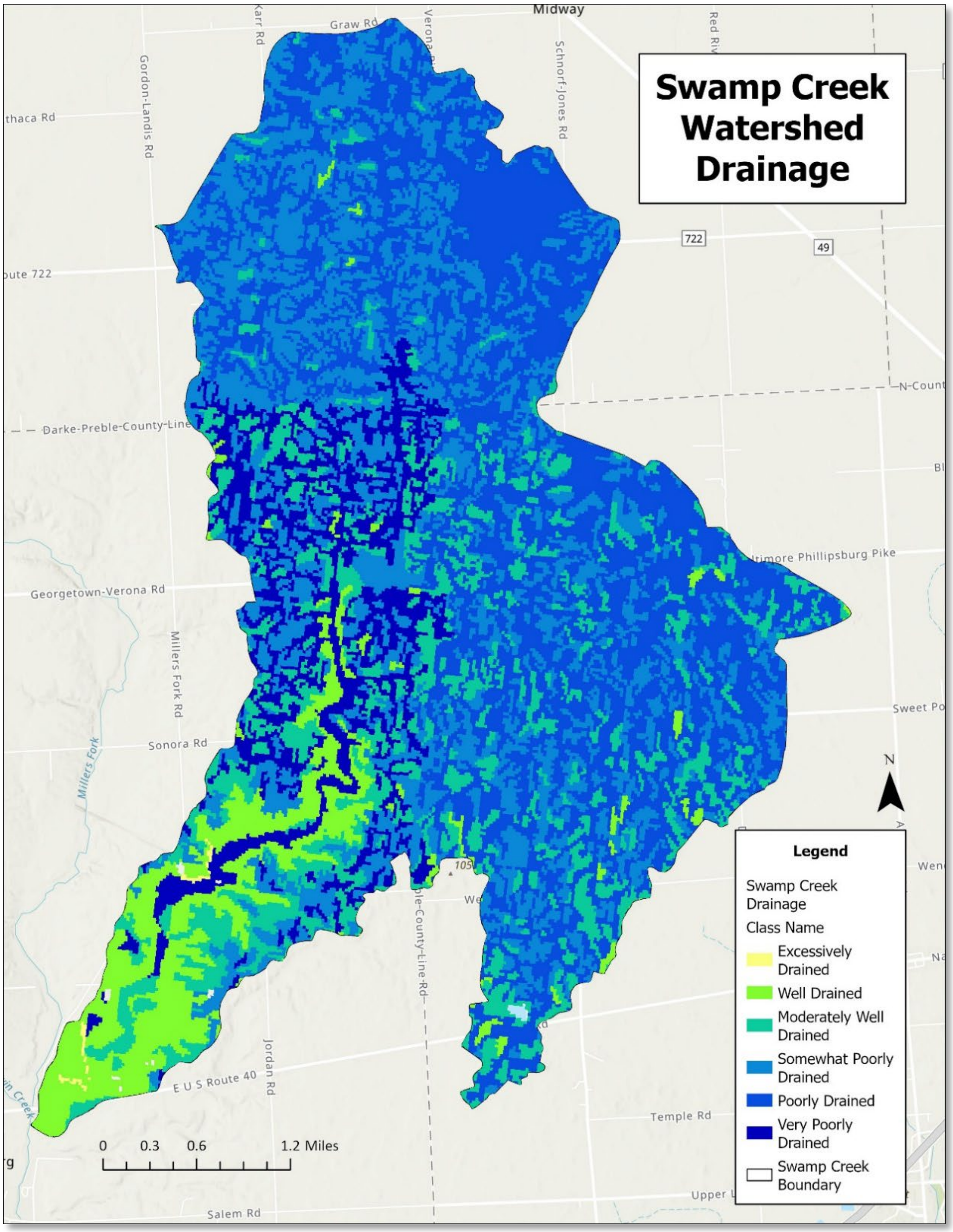



**FIGURE 2-4 DRAINAGE CLASS WITHIN SWAMP CREEK HUC-12 (USDA-NRCS, ESRI)**

It appears that there is not currently an abundance of wetlands in the Swamp Creek HUC-12 (Figure 2-5). Most natural wetlands in the Headwaters Twin Creek HUC-12 watershed were likely lost with the installation of field drainage systems that began as long ago as the early to mid-19th century.

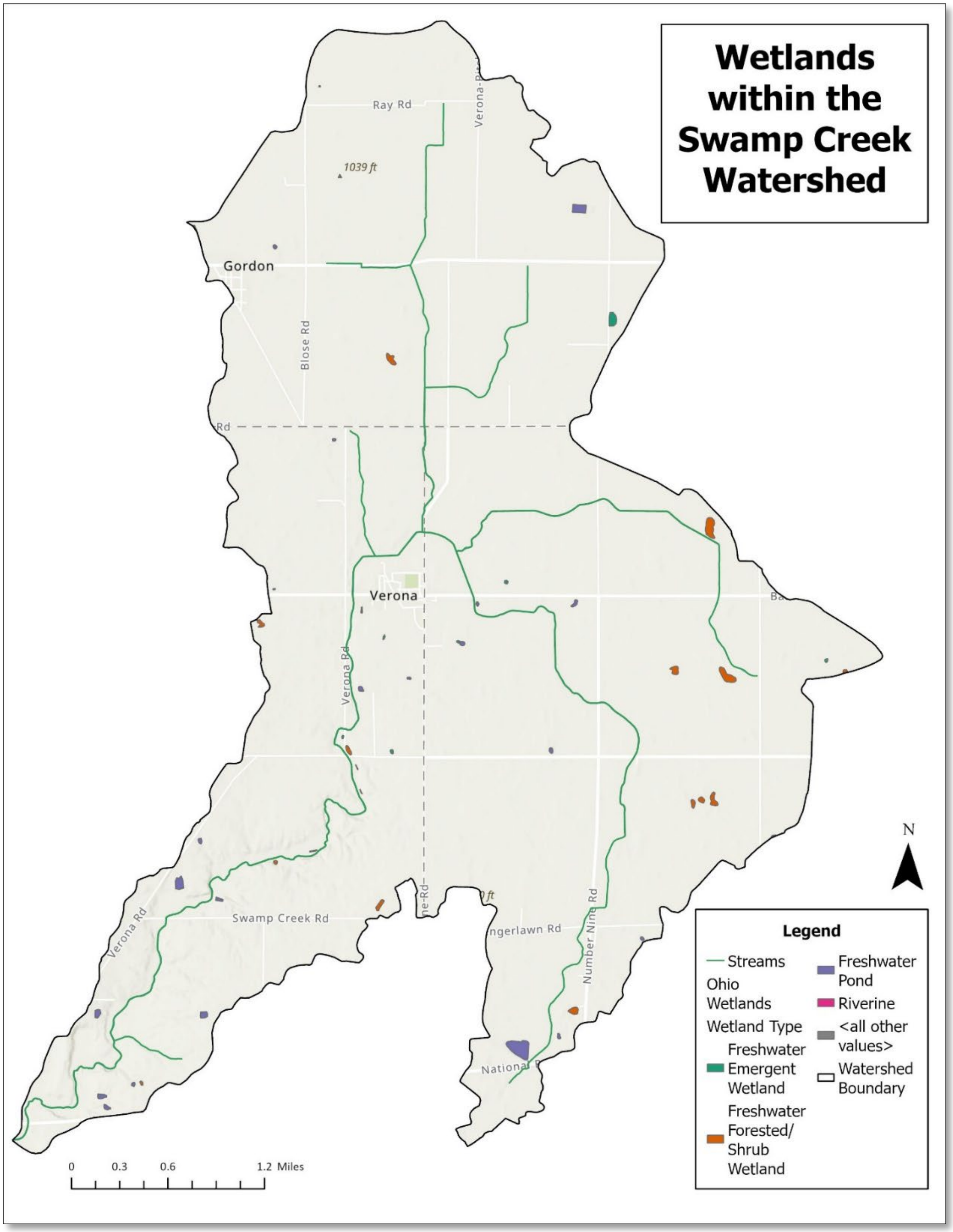



**FIGURE 2-5 WETLANDS WITHIN SWAMP CREEK HUC-12 (USFWS)**

The slope appears to be gentle in the northern portion of the Swamp Creek HUC-12 but there is higher relief in the downstream portion of the watershed. Some of the streambanks have as high as 8-degree slopes which may be the cause of some of the severe streambank erosion observed in the watershed (Figure 2-6). Swamp Creek and nearly all of its tributaries were natural streams flowing through poorly drained Crosby, Kokomo, and Brookston soils, but they have been channelized in the past and have no riparian buffer. Darke County Ditch Maintenance Department and Montgomery SWCD manage these channels in their respective counties. Though there is little erosion due to the low gradient and maintenance regime, there is apparent nutrient enrichment due to adjacent row cropping and scattered HSTS that are not functioning well.

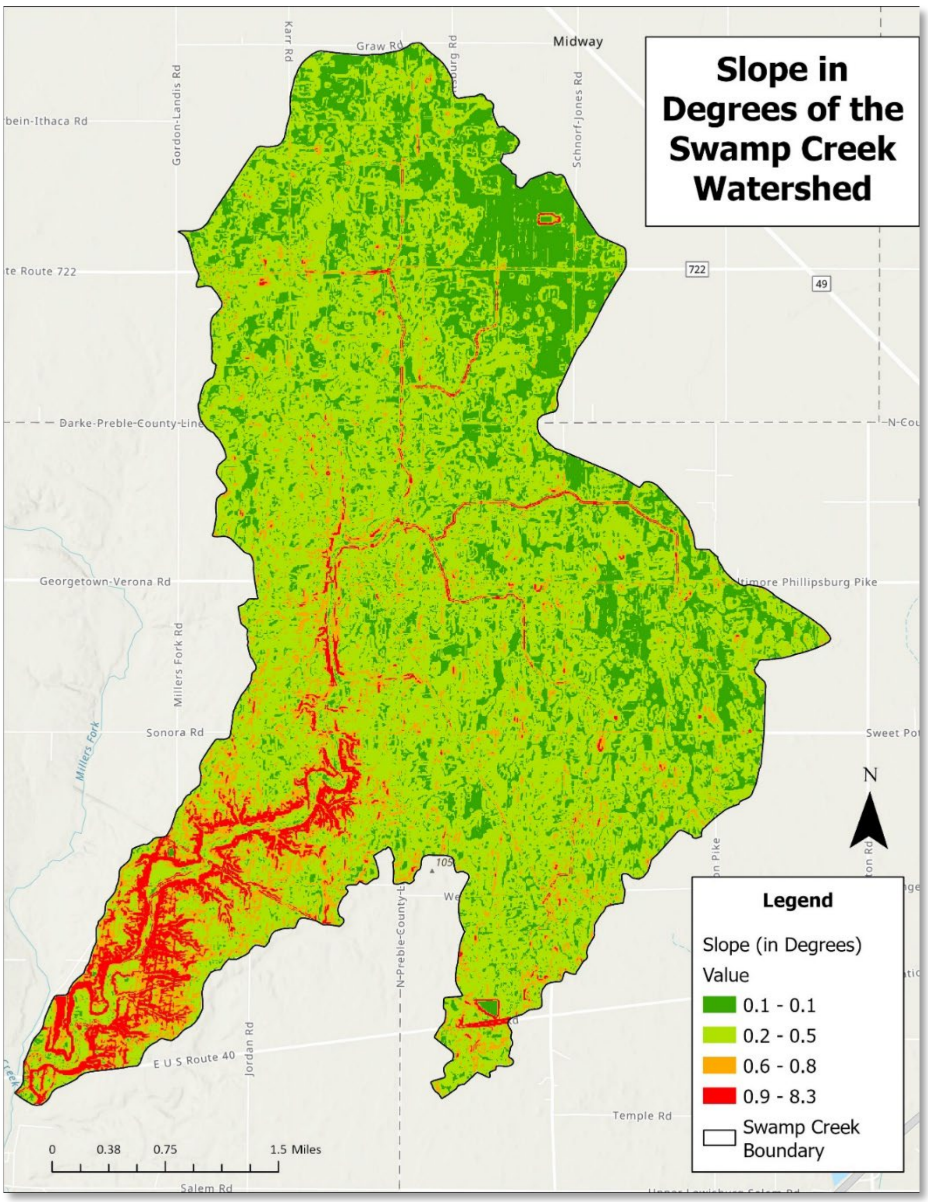



**FIGURE 2-6 SLOPES IN DEGREES OF THE SWAMP CREEK HUC-12 (USGS)**

## 2.1.2. Agricultural Land Use and Conservation Practices

Agriculture is the predominant land use in the Swamp Creek HUC-12 watershed and will continue to be for the foreseeable future (Figure 2-7).

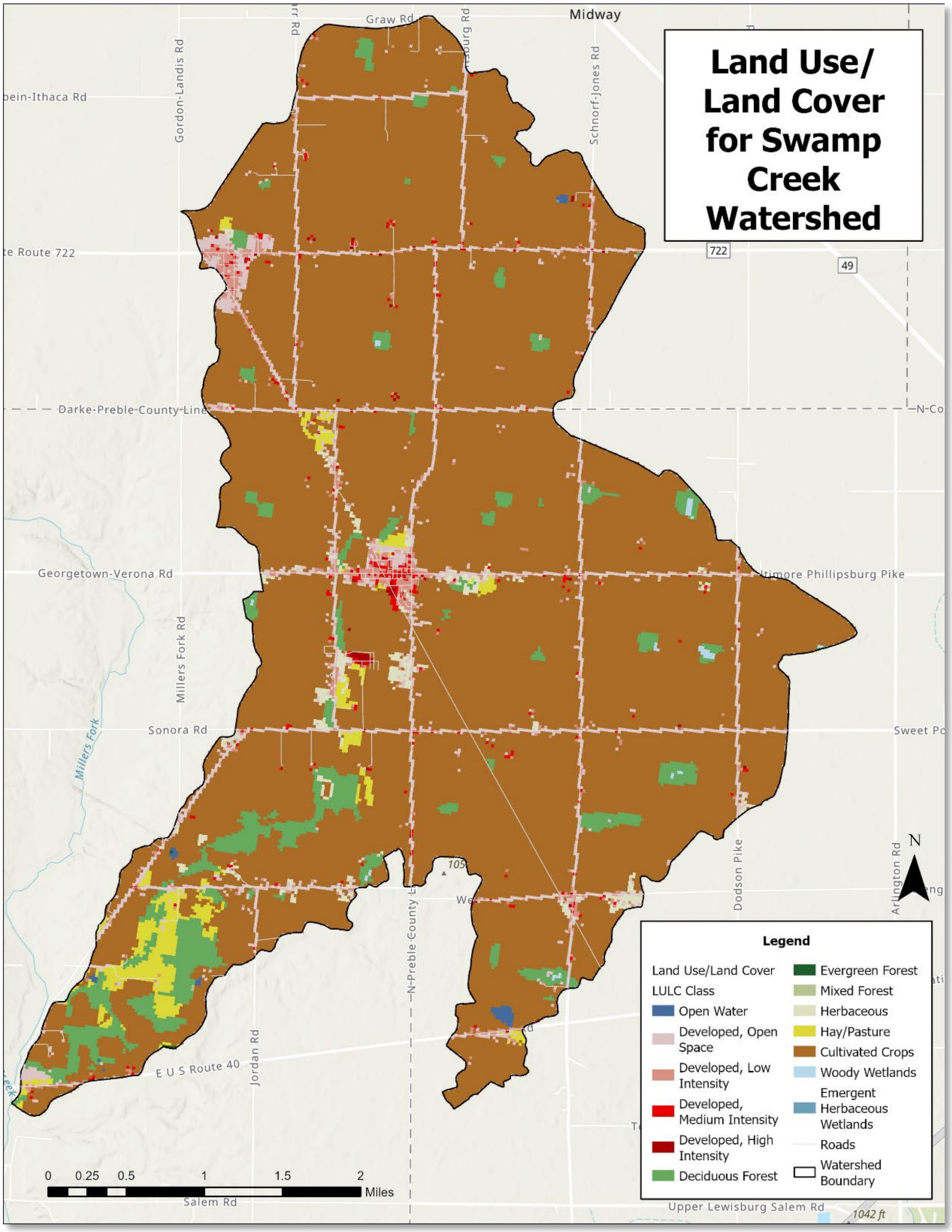



**FIGURE 2-7 LAND USE MAP OF SWAMP CREEK HUC-12 (USGS, 2021)**

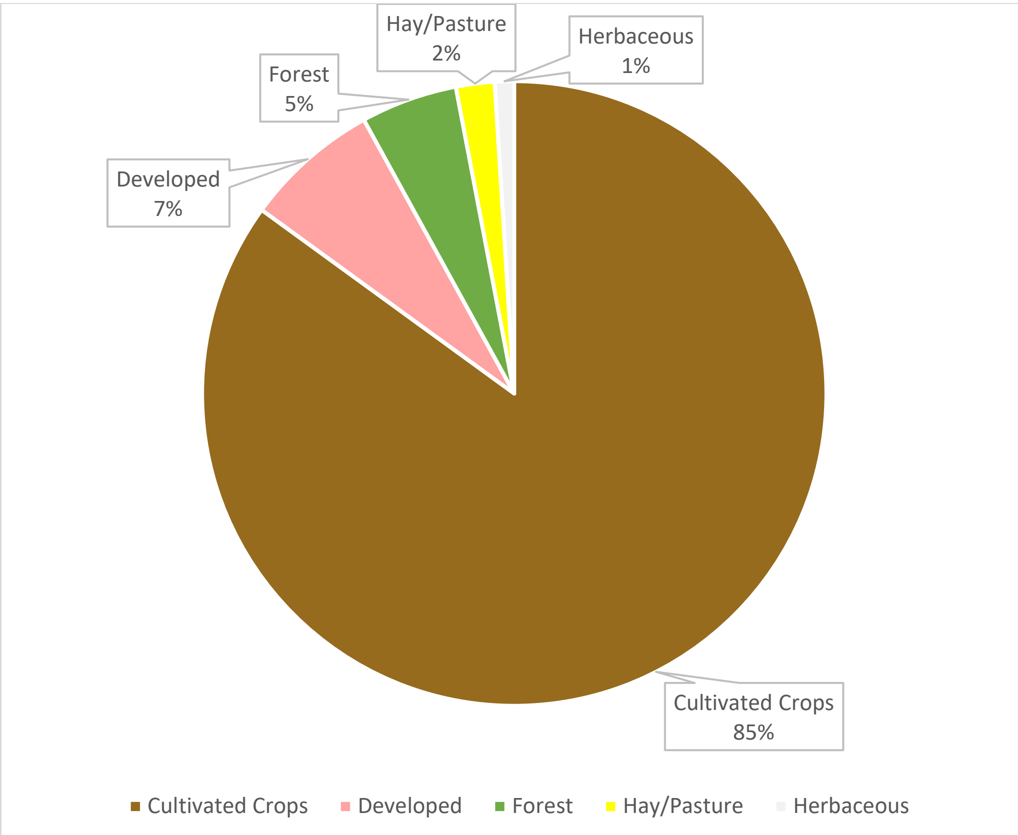



**FIGURE 2-8 LAND USE IN SWAMP CREEK HUC-12 BY PERCENTAGE (USGS, 2021)**

Figure 2-8 indicates 85% of the watershed land use is in row crop production, 2% in hay and pasture, 5% is forested and approximately 7% is developed (NLCD, 2021). The majority of the farmland is classified as prime farmland or prime farmland if drained. (ODA, 2023)

The deciduous forests in the Swamp Creek HUC-12 only occupy about 5% of the watershed and are primarily located in the riparian zone of lower Swamp Creek. The riparian area is also where the steeper slopes are within the southwest section of this watershed (Figure 2-6). Forested areas positively impact water quality by slowing down precipitation, filtering nutrients and other pollutants flowing across the land's surface, decreasing streambank erosion, and cooling adjacent surface water (ODA, 2023) The quality of the riparian zone is moderate with a mixture of high-quality native trees and grasses as well as the dominant invasive such as bush honeysuckle.

According to the 2020 U.S. Census, Verona, a small village on the border of Preble and Montgomery counties, with a population of 403 (2020 U.S. Census), is the only community located fully within in the HUC-12 (Figure 1-1).

Verona holds an NPDES permit to operate a wastewater treatment plant. Two compliance violations were noted in 2021 for excessive discharge of Nitrogen, ammonia total [as N], but they were not considered significant (ECHO, https://echo.epa.gov/detailed-facility-report?fid=110064255540).

The Village of Gordon in Twin Township, Darke County, with a population of 245 (2020 U.S. Census) is partly in Swamp Creek and partly in Millers Fork watersheds. Wengerlawn is an unincorporated community in Clay Township, Montgomery County. Neither Gordon nor Wengerlawn are served by any wastewater treatment plant, so all of the businesses, churches, and homes in Gordon and Wengerlawn -- as well as homes on large acreage outside of these populated areas -- are served by HSTS.

### *Row-Crop Agriculture*

Corn and soybeans are the major crops produced in the Swamp Creek HUC-12. In between 2016 and 2022 there was a combined average of approximately 8,800 acres of corn and soybeans produced in this watershed each year.

**TABLE 2-1 CROPLAND ACREAGE IN THE SWAMP CREEK HUC-12**

| Crop | 2022 | 2020 | 2018 | 2016 |
|---|---|---|---|---|
| **Corn** | 3076 | 3323 | 3853 | 3988 |
| **Soybean** | 5414 | 5617 | 5069 | 4860 |
| **Winter Wheat** | 262 | 90 | 73 | 118 |
| **Winter Wheat/Soybeans (Double Crop)** | 111 | 28 | 14 | 17 |
| **Alfalfa** | 120 | 130 | 41 | 51 |
| **Other Hay** | 25 | 51 | 19 | 7 |
| **Grass/Pasture** | 722 | 585 | 946 | 973 |

Source: USDA NASS CropScape, 2022

### *Livestock Operations*

No concentrated animal feeding facility (CAFF) and no permitted concentrated animal feeding operation (CAFO) are in the Swamp Creek HUC-12. Eleven small-sized livestock operations were identified in June 2023 (Table 2-2), and no medium-sized operations were identified. These estimates were provided by the Montgomery, Darke, and Preble soil and water conservation district staff members in June 2023.

### TABLE 2-2 LIVESTOCK OPERATIONS IN THE SWAMP CREEK HUC-12

| Livestock Species | Operations | Average no. of Animals per Operation |
|---|---|---|
| Horses | 6 | 3 to 100 |
| Dairy Cattle | 0 | 0 |
| Beef Cattle | 3 to 5 | 15 to 50 |
| Poultry | 0 | 0 |
| Hog | 2 | 10 to 4,000 |

Most land within the Swamp Creek HUC-12 is privately owned; therefore, agency knowledge of the individual conservation practices may not be up to date. Some conservation practices can be estimated through program enrollment initiated through the SWCD/NRCS and Farm Service Agency, as well as the annual crop tillage survey performed by Miami University, Oxford OH. Current and recent past (1-5 years) estimates of several practices provided by Montgomery, Darke, and Preble soil and water conservation districts within the Swamp Creek HUC-12 are provided in Table 2-3. As documented by Miami University tillage survey, with 25% (corn fields) and 75% (soybean field) of the Upper Twin watershed currently implementing conservation tillage, this watershed has already made good progress in nutrient management. The Ohio Department of Agriculture published survey results of SWCD personnel, estimating 14% adoption of cover crops and 26% adoption of buffers along relevant waterways in southwest Ohio (ODA, 2023) The total estimate of nitrogen load reduction when combining all of the current and recent past (1-5 years) conservation practices is 9,923 lb/yr using STEPL tool (Table 2-3).

### TABLE 2-3 CURRENT AND RECENT PAST CONSERVATION PRACTICE ESTIMATES USING STEPL

| Practice Type | Estimated Acreage Treated | Estimated Nitrogen Load (lb/yr) | Estimated Phosphorous Load (lb/yr) |
|---|---|---|---|
| Conservation Tillage (no till, reduced till) | 4,924 | 8,066 | 3,302 |
| Cover Crops | 783 | 584 | 60 |
| Buffer - Whole-Field Warm Season Grass, Cool Season Grass Filter Strip, Warm Season Grass Field Border, Grassed Waterways (including grade stabilization structures) | 25 | 37 | 10 |
| Gypsum Application | 440 | N/A | N/A |
| Nutrient Management (Variable Rate Fertilization) | 2,461 | 1,236 | 570 |

**Estimates calculated using Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Version 4.4 (USEPA, 2019).*

## 2.1.3. Protected Land and Endangered Species

### *Conservation Easements*

Two properties, totaling approximately 217 acres, located within the Swamp Creek HUC-12 are currently protected from development through the TVCT easement program (Figure 2-9). One is located partially in the very southern headwater area of a tributary in Montgomery County and one on the mainstem in the downstream section, in Preble County.

Conservation easements held by TVCT require the landowner to follow the Conservation Plan prepared by the local Natural Resources Conservation Service staff and the Woodland Stewardship Plan prepared by the State Forester for wooded properties.

Montgomery SWCD has also worked with several landowners through the USDA Farmland Preservation Program to preserve approximately 175 acres total in the southeast section of the watershed.

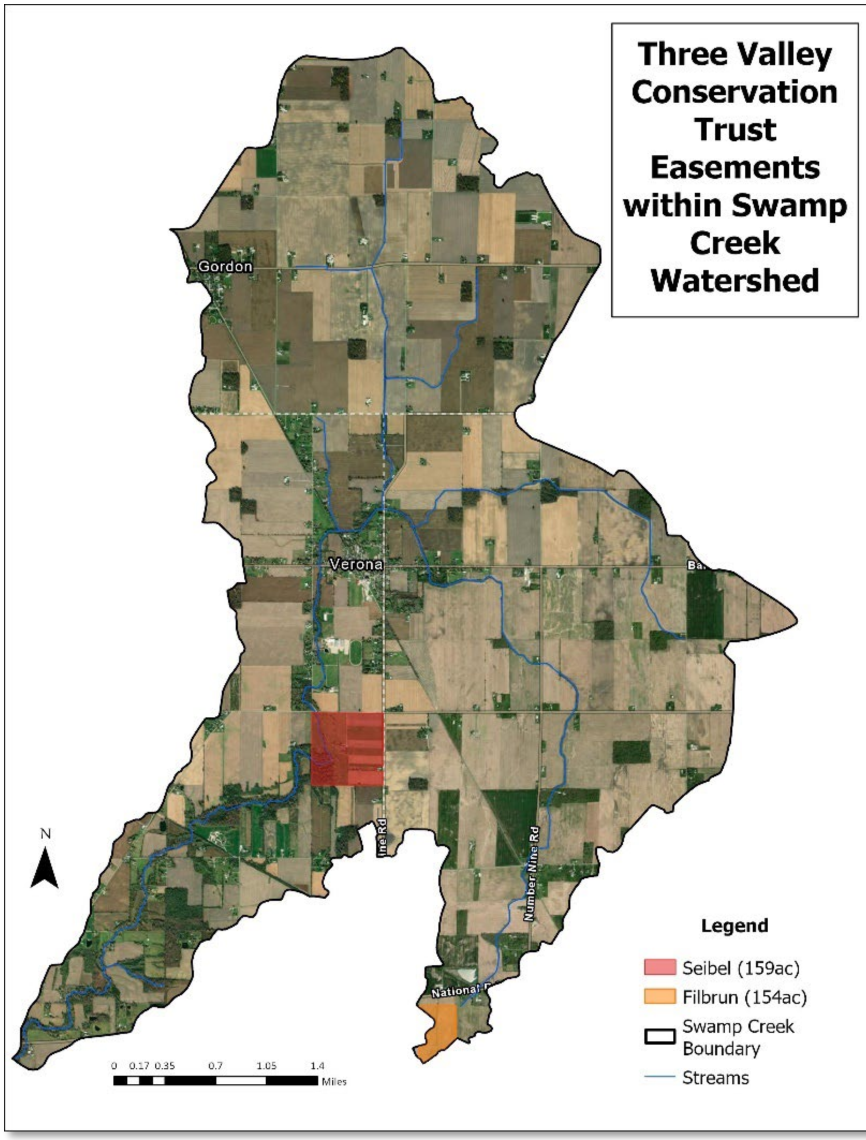



**FIGURE 2-9 EASEMENTS HELD BY THREE VALLEY CONSERVATION TRUST IN SWAMP CREEK WATERSHED (TVCT)**

### *Park Land*

Five Rivers MetroParks holds 14.8 acres in Montgomery County that is part of the Wolf Creek Recreation Trail.

Additionally, the Village of Verona holds a 21-acre parcel on both sides of Swamp Creek along Verona Road. This parcel has a wooded riparian area.

### *Endangered Animal Species*

Several rare, threatened, and endangered plant and animal species are known to live in the Swamp Creek HUC-12 and have some level of state or federal protection or concern (Table 2-4). Loss of riparian and poor water quality conditions can contribute to the degradation of their natural habitats.

**TABLE 2-4 FEDERALLY RARE, THREATENED, AND ENDANGERED ANIMAL SPECIES, BY COUNTY**

| Species | Status | County | Habitat Characteristics |
|---|---|---|---|
| Indiana bat (Myotis sodalis) | Endangered | Montgomery, Preble | Hibernates in caves and mines and forages in small stream corridors with well-developed riparian woods, aswell as upland forests |
| Northern long-eared bat (Myotis septentrionalis) | Threatened | Montgomery, Preble | Hibernates in caves and mines and swarms in surroundingwooded areas in autumn; roosts and forages in upland forests during late spring and summer |
| Snuffbox mollusk (Epioblasma triquetra) | Endangered | Darke | Found in small-to medium-sized creeks, burrowed deep in sand, gravel or cobble substrates; affected by sedimentation, agricultural run-off, and failing septic systems. |
| Clubshell mollusk (Pleurobema clava) | Endangered | Darke | Prefers clean, loose sand and gravel in medium to small rivers and streams; burrowed in the bottom substrate up to four inches; affected by agricultural run-off and industrial waste. |
| Eastern massasauga (Sistrurus catenatus) | Threatened | All | Live in wet areas including wet prairies, marshes and low areas along rivers and lakes. In many areas massasaugas also use adjacent uplands during part of the year. They often hibernate in crayfish burrows but may also be found under logs and tree roots or in small mammal burrows. |

Source: ODNR Division of Wildlife, 2020; US Fish and Wildlife Service, 2017

Numerous invasive plant species occur throughout the Swamp Creek HUC-12. Common invasive species include bush honeysuckle (*Lonicera species*), Japanese honeysuckle (*Lonicera japonica*), multi- flora rose (*Rosa multiflora*), and garlic mustard (*Alliaria petiolata*), These Invasive plants have negative impacts on native vegetation and animals within the watershed. Bush and Japanese honeysuckle out-compete and displace native plants and alter natural habitats by decreasing light availability and depleting soil moisture and nutrient content. Exotic bush honeysuckle competes with native plants for pollinators, resulting in a reduced seed set for native species. Multiflora rose forms dense thickets, excluding most native shrubs and herbs from establishing, and may be detrimental to nesting of native birds. Garlic mustard invades areas disturbed by human activities and displaces many native wildflowers.

### 2.1.4. Home Sewage Treatment Systems

HSTS are small wastewater treatment units that serve individual homes or businesses. The effectiveness of each HSTS depends on its age, maintenance practices, and characteristics of the site -- including lot size, soil drainage, depth to water table, bedrock depth, land slope, and household size. Five-percent of total phosphorus and 3-percent of total nitrogen loading to the Great Miami River were from HSTS between 2017 and 2021 (ODA, 2023). While non-functioning HSTS contribute a small percentage of nutrient pollution, the high bacteria levels they discharge negatively impact stream recreational uses due to potential human health impacts (ODA, 2023). HSTS are considered a major bacteria and organic contributor affecting the water quality of Swamp Creek as indicated in the 2007 OEPA report. The TMDL stated that ammonia, phosphorus, bacteria (recreation use) are among the causes of impairment to Swamp Creek. The NRCS Soil Web Survey for Septic Tank Absorption Fields for Swamp Creek HUC-12 indicated that 99.8% of the watershed is very limited. The evaluation is based on soil properties that affect adsorption of the effluent, construction and maintenance of the system and public health.

The 2020 OKI report on management of onsite systems concluded that better septic system management was recommended for the entire Twin Creek Watershed (OKI, 2020).

The 2010 Twin Creek TMDL identified Swamp Creek watershed as a key contributor to the recreational use impairment of Twin Creek, specifically pathogens in the form of bacteria were entering the stream and making it unsafe for boating and swimming. Failing HSTS were determined to be the predominant source of bacteria. It was calculated that the establishment of the Verona WWTP (built in 2007) would reduce the bacteria load by 48.2%, and that an additional 215 HSTS need to be replaced with functioning systems or connected to sanitary sewer service to reach recreational use attainment.

HSTS in the watershed are regulated by Darke County General Health District (DCGHD), Public Health Dayton/Montgomery County (PHDMC), and the Preble County Public Health (PCPH) in compliance with the Ohio Administrative Code (OAC) 3701-29-19. Since 2003, DCGHD has made great strides in collecting data about the location and type of HSTS in their jurisdiction, thanks to 319 funding for the project.

According to DCGHD staff, the Village of Gordon has 74 households and 18 of those households have no secondary treatment (e.g. leach field). Those systems are likely discharging waste to a storm sewer or field tile that discharges to a nearby ditch that flows eventually to Swamp Creek. Small lot size limits the ability of many homeowners to install new or replacement leach fields. In 2015, MVRPC contacted the Village of Gordon to offer no-cost wastewater facility planning assistance. The offer was not accepted at that time, but MVRPC may have funds in the near future to make this offer again (April 14, 2023, personal communication with Matt Lindsay).

PCPH has applied for and been awarded approximately $300,000 since 2012 to assist residential sewage system owners in handling the cost of repairing or replacing their sewage treatment systems. PHDMC inspects systems in response to public complaints and had few recorded complaints from the Swamp Creek watershed.

Education is key to reducing the effects of failing HSTS on the stream. Darke SWCD and DCGHD recently have trained 60 contractors in proper HSTS installation procedures. To educate the public about failed HSTS and water quality, a septic system workshop was hosted by Preble SWCD in partnership with the Ohio Farm Bureau in 2021. The workshop was attended by 25 participants and featured talks from a soil scientist who does investigations for septic systems at Ohio State University and Preble SWCD staff.

Because of the poor soil drainage, it is likely that failed HSTS are prevalent and widespread in this watershed. Better resources and coordination from local partners are needed to address the failed HSTS in this rural community and in the region. The geometric mean of five samples tested for *E. coli* in September 2005 exceeded Primary Contact Recreation standards. However, the Village of Verona upstream of the sampling site was still unsewered at the time. See Section 3.3.3. for sampling results.

### 2.1.5. Groundwater Vulnerability and Source Water Protection

There are two basic types of aquifers in the Great Miami River Watershed: the buried valley aquifers – a glacial deposit largely consisting of sand and gravel – and bedrock aquifers where significant amounts of water are stored in the fractures of the rock formation. Some groundwater exists at shallow depths and is unprotected by a confining clay layer. Protecting this shallow groundwater from nutrients and pesticides is a major concern. (ODA, 2023)

The Great Miami River and some of its tributaries including Twin Creek are located along the path of the buried valley aquifers. The Great Miami Buried Valley Aquifer was designated a Sole Source Aquifer in 1988. Ohio Department of Natural Resources (ODNR) published the groundwater pollution potential maps for the State using the DRASTIC system in early 2000. In 2022, a GIS-based, modified DRASTIC model was published by ODNR. DRASTIC parameters include Depth to Water, Net Recharge, Aquifer Media, Soil Media, Topography, Impact of Vadose Zone Media and Hydraulic Conductivity and provide an important tool to evaluate the groundwater vulnerability of an area including communities served by HSTS. Figure 2-10 shows the Groundwater Vulnerability Index (GVI) of the Headwaters Twin Creek HUC-12. The majority of the watershed is at the medium to high GVI.

Rural communities, including villages and unincorporated populated areas, without a public water system -- and the surrounding rural homes -- rely on both HSTS and private wells in close proximity to one another and are thus at risk of contaminating their drinking water resources with nitrate and bacteria (Swann, 2001). The Village of Gordon and the unincorporated community of Wengerlawn are such areas relying on HSTS and private drinking water wells.

In the Swamp Creek HUC-12, the public drinking water supply is entirely from groundwater sources. Many of these sources lie within the floodplain areas of local streams. The villages of Verona and Lewisburg are the public water systems in the Swamp Creek HUC-12 watershed or with supposed source water protection areas in the watershed.

Verona and Lewisburg have drinking water source assessments, developed by the OEPA in and around 2002. The Village of Lewisburg's wellfields are down-gradient from this watershed, but the wellfield's five- and ten-year time-of-travel zones include agricultural areas in the downstream portion of the watershed. The Lewisburg system was identified as having a high susceptibility to contamination due to less than 20 feet depth to groundwater, less than 20 feet thickness of confining layer, and potential significant contamination sources existing within the protection area, including agricultural activities (OEPA 2003). The Verona public wellfields and one- and five-year time of travel zones are located within the Swamp Creek HUC-12. There is no Drinking Water Source Assessment or Source Water Protection Plan for the Village of Verona. Source Water Protection Plans and similar studies would help determine the degree of exchange – if any -- between groundwater and surface water in the local geology. These plans would also determine other risk factors and practices to reduce those risks.

In summary, to address the nonpoint source pollution that is associated with failed septic systems and to protect the water resources in this sparsely populated and rural Swamp Creek watershed is an important and yet challenging task that requires local cooperation, and investment in time and effort. As noted previously, education and outreach are critical and there are resources that can assist the county health departments if the communities are supportive. In this NPS-IS, it is recommended that all public water systems in the Swamp Creek HUC-12 obtain an OEPA-endorsed Source Water Protection Plan. When these plans are complete, protecting drinking source water may become a new critical area of a future version of this NPS-IS Plan.

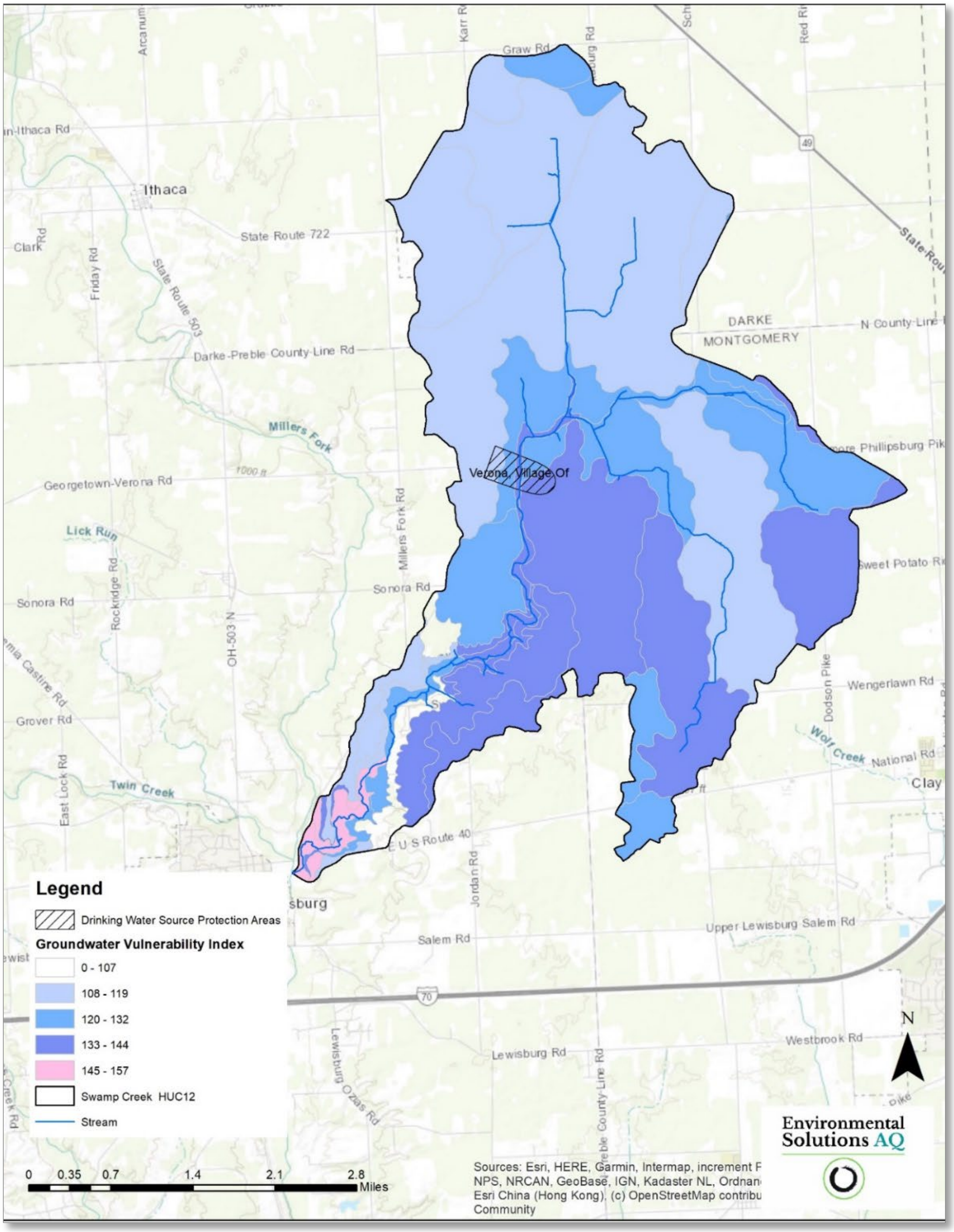



**FIGURE 2-10 GROUNDWATER VULNERABILITY MAP AND DRINKING WATER SOURCE PROTECTION AREAS OF SWAMP CREEK HUC-12 (ODNR, ESRI)**

## 2.2. Summary of Biological Trends for Swamp Creek HUC-12

Ohio EPA Biological and Water Quality Study of the Twin Creek and Selected Tributaries 2007 was the only comprehensive sampling data analysis of Twin Creek and Swamp Creek HUC-12 watershed. Using the data from this report, OEPA prepared the TMDL for the Twin Creek Watershed. This section summarizes the findings of the 2005 OEPA sampling report (OEPA, 2007) and the OEPA TMDL Report (OEPA, 2010).

Three sampling locations were selected in the Swamp Creek HUC-12 during the 2005 OEPA sampling event (Figure 2-11; Table 2-5). Two sampling locations are located along Swamp Creek and one along a tributary that enters the mainstem at RM 6.45. The 2005 ALU designation was WWH at the two upstream sites, but it shifts to EWH at the downstream site after the creek enters Preble County, due to wider riparian corridors and less siltation.

In 1995, both Swamp Creek mainstem sites were designated EWH. At the time, both RM 0.3 and 2.7 met EWH, despite the poorly treated domestic sewage flowing into the creek from the Village of Verona. Since that research, Verona has built a municipal wastewater treatment system which reduced nutrients, ammonia, and bacteria flowing downstream.

No recent samples have been taken and evaluated since 2005 in this watershed.

### TABLE 2-5 2005 OEPA SAMPLING LOCATIONS WITHIN SWAMP CREEK HUC-12

| Stream Mile | Drainage Area ($mi^2$) | Cross Road | Longitude | Latitude |
|---|---|---|---|---|
| 6.3/6.4 | 8.7 | County Line Road, Upstream of Verona | -84.4855 | 39.9090 |
| --/0.2 | 18.0 | US 40 | -84.5303 | 39.8550 |
| **Tributary to Swamp Creek at RM 6.45** | | | | |
| 0.3 | 4.7 | Baltimore-Phillipsburg Rd. | -84.4769 | 39.9034 |

**Conventional water chemistry sampling only*
*Source: OEPA, 2007*

### TABLE 2-6 BIOLOGICAL INDICES SCORES FOR THREE SAMPLING SITES

| Swamp Creek Stream Mile | IBI | MIwb | ICI | QHEI | Aquatic Life Use Designation | Attainment Status |
|---|---|---|---|---|---|---|
| 6.3/6.4 | 44 | N/A | Fair | 34.0 | WWH | Partial |
| --/0.2 | None | None | MG | None | EWH | None provided |
| **Tributary to Swamp Creek at RM 6.45** | | | | | | |
| 0.3 | 38 | N/A | None | 37.5 | Undesignated, WWH recommended | Full if WWH |

Source: OEPA, 2007
*IBI Index of Biotic Integrity*
*The Modified Index of Well Being (MIwb) is not applicable to headwater sites (drainage ≤20 mi2).*
*ICI - Invertebrate Community Index (G=Good; MG=Marginally Good; H Fair =High Fair; F=Fair; L Fair=Low Fair; P=Poor; VP=Very Poor).*
*QHEI - Qualitative Habitat Evaluation Index*
*WWH Warmwater Habitat – ECBP Ecoregion*

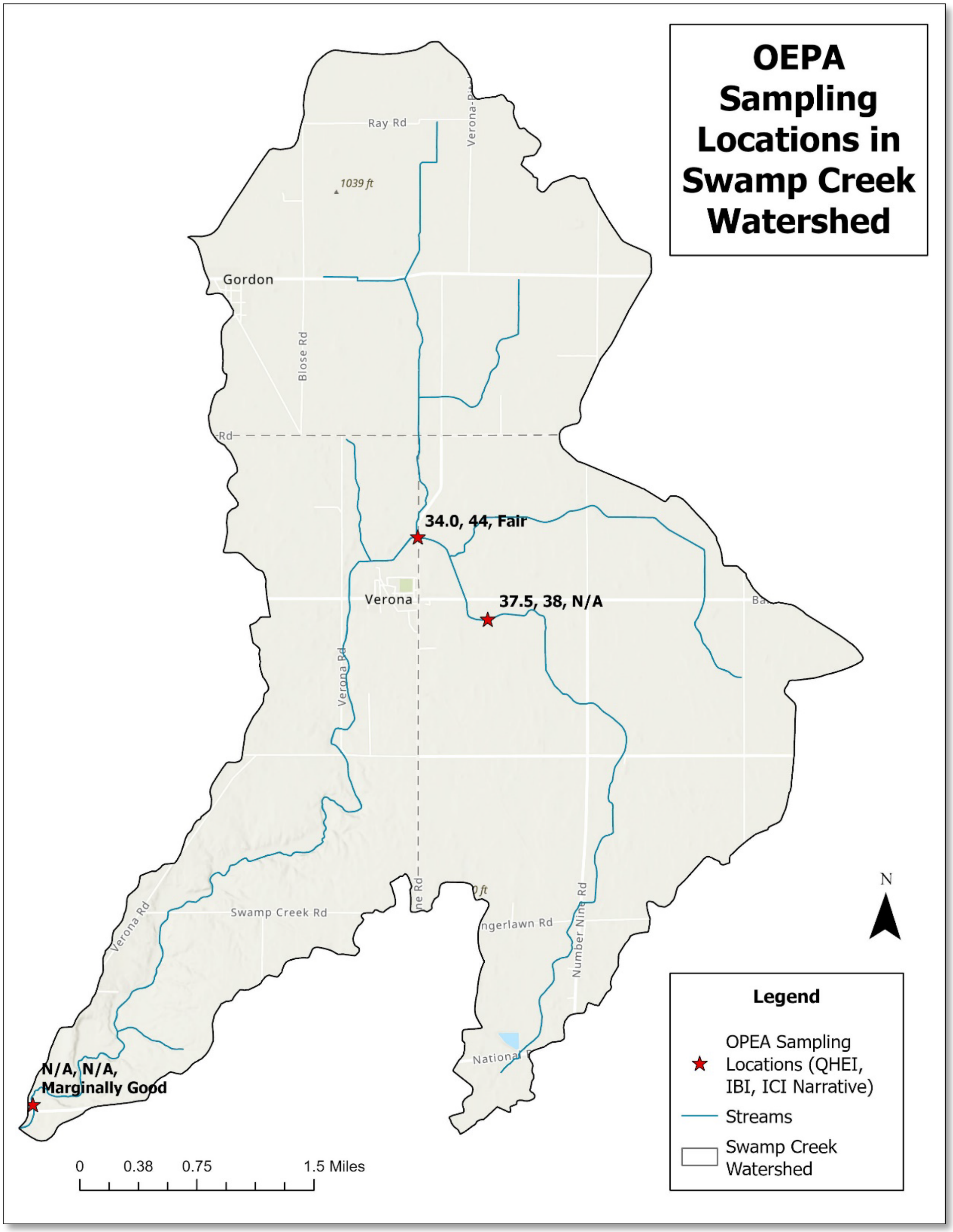



**FIGURE 2-11 2005 OEPA SAMPLING LOCATIONS IN SWAMP CREEK HUC-12 (OEPA, 2007)**

### 2.2.1. Biological Assessment: Fish Assemblages

The fish assemblages of Twin Creek and its tributaries which included Swamp Creek were surveyed and assessed by OEPA in 2005. A total of 35,596 fish comprising 42 species and six hybrids was collected from all Twin Creek tributaries, between July and September 2005. Based on aggregated catch statistics from all tributaries, numerically predominant species included Central stoneroller (30.0%), Northern creek chub (16.1%), white sucker (7.2%), rainbow darter (6.1%), mottled sculpin (5.1%), and striped shiner (3.6%). In terms of relative biomass (kg/0.3km), dominant species were, Central stoneroller (30.2%), Northern creek chub (23.6%), white sucker (14.1%), striped shiner (6.4%), rockbass (3.6%), and mottled sculpin (3.2%). In terms of ranked abundance and biomass measures, these dominant species are typical associates of headwater or brook environments. Community indices and accompanying narrative evaluations from these waters ranged between exceptional (IBI=56/MIwb=9.8) and marginally good (IBI=36/MIwb=8.0). Taken together with the entire Twin Creek tributaries, the fish assemblages were collectively characterized in the narrative as very good. The Twin Creek tributaries including Swamp Creek were found to support fish assemblages fully consistent with the biocriteria applicable to existing designated and recommended Aquatic Life Uses.

**TABLE 2-7 FISH COMMUNITY AND DESCRIPTIVE STATISTICS FOR SWAMP CREEK HUC-12**

| ***Stream* River Mile** | **Mean Number Species** | **Cumu-lative Species** | **Mean Rel. No. (No./km)** | **Mean Rel. Wt. (Wt./km)** | **MeanIBI** | **MeanMIwb** | **QHEI** | **Narrative Evaluation** |
|---|---|---|---|---|---|---|---|---|
| 6.3 | 19.0 | 19 | 1880.00 | 4.20 | 44 | N/A | 34.0 | Good |
| **Swamp Creek Tributary at RM 6.45** | | | | | | | | |
| 0.3 | 17.0 | 17 | 1770.00 | 3.43 | 38 | N/A | 37.5 | Marginally Good |

Source: OEPA 2007

### 2.2.2. Biological Assessment: Macroinvertebrate Community

The macroinvertebrate community in Swamp Creek was evaluated at two sampling locations. Samples collected at RM 6.4 and RM 0.2. The results partially met the current WWH aquatic life use designation at the upstream site. It received fair and marginally good qualitative evaluation. The upstream site had little riparian cover and was directly adjacent to a cash crop field. Algal blooms, a sign of nutrient enrichment existed at the site, in addition to silty waters and embedded substrates. The sensitive to tolerant taxa ratio was among the lowest of all designated WWH sites in the entire Twin Creek watershed. The most downstream site near the confluence with Twin Creek was recovering from droughty conditions during the sampling visit, limiting the species more than expected.

**TABLE 2-8 MACROINVERTEBRATE SAMPLING RESULTS FOR SWAMP CREEK HUC-12**

| Stream RM | Dr. Ar. (Sq. mi.) | Data Codes | Qual. Taxa | EPT Ql/Total | Sensitive Taxa Ql./Total | Density Ql. Qt. | CW Taxa | Predominant Organisms on the Natural Substrates With Tolerance Category(ies) in Parentheses | ICI | Narrative Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|
| 6.4 | 8.7 | - | 36 | 4 | 6 | M-L | 0 | Helicopsyche caddisflies (MI), Elimia snails (MI), Caenis mayflies (F), Beetles (MT,F,MI) | - | Fair |
| 0.2 | 18.0 | - | 34 | 9 | 12 | M-L | 0 | Riffle beetles (MT,F,MI), Sow bugs (F), waterpenny beetles (MI) | - | Marginally Good |

Source: OEPA. 2007
RM: River Mile.
Dr. Ar.: Drainage Area
Data Codes: 8=Non-Detectable Current, 9=Intermittent or Near-Intermittent Conditions, 12=Suspected High Water Influence/Disturbance, 13=Suspected Disturbance by Vandalism, 15=Current >0.0 fps but <0.3 fps, 29=Primary Headwater Habitat Stream.
Ql.: Qualitative sample collected from the natural substrates.
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List as MI (moderately intolerant) or I (intolerant).
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates; density is expressed in organisms per square foot.
Qualitative sample relative density: L=Low, M=Moderate, H=High.

## 2.2.3. Physical Habitat - Qualitative Habitat Evaluation Index QHEI

In 2005, OEPA assessed the habitat characteristics through the Qualitative Habitat Evaluation Index (QHEI), which provides an understanding of the habitat features, existing at the time, important to fish communities and is based upon methodologies established by Rankin's habitat assessments (Rankin 1989, Rankin 1995, OEPA 2006). During this evaluation, several habitat characteristics were assessed on the stream reach, such as type/quality of substrate, amount/quality of in-stream vegetative cover, channel morphology, extent/quality of riparian vegetation, pool/run/riffle quality, etc.

Mean QHEI values from rivers or river segments equal to or greater than 60.0 generally indicate a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms fully consistent with the WWH aquatic life use designation. Average reach values at greater than 75.0 are generally considered adequate to support fully exceptional (EWH) communities (Rankin 1989 and Rankin 1995). Values between 55 and 45 indicate limiting components of physical habitat are present and may exert a negative influence upon ambient biological performance. However, due to the potential for compensatory stream features (e.g., strong ground water influence) or other watershed variables, QHEI scores within this range do not necessarily exclude WWH or even EWH assemblages. Values below 45 indicate a higher probability of habitat derived aquatic life use impairment.

From the 2005 OEPA sampling results, the QHEI scores (34.0 to 37.5) in Swamp Creek and its tributary were determined to partially or fully support the WWH ALU designations and/or recommendation. No QHEI score was provided for the most downstream sampling site due to droughty conditions.

### TABLE 2-9 QHEI MATRIX AND SCORES FOR SWAMP CREEK HUC-12 (OEPA, 2007)

| | | | Swamp Creek | Tributary |
|---|---|---|---|---|
| Key QHEI Elements | | River Mile | 6.3 | 0.3 |
| | | QHEI Score | 34.0 | 37.5 |
| | | Gradient (ft/mi) | 5.38 | 6.76 |
| WWH Attributes | | Not Channelized or Recovered | | |
| | | Boulder/Cobble/Gravel Substrates | • | • |
| | | Silt Free Substrates | | |
| | | Good/Excellent Development | | |
| | | Moderate/High Sinuosity | | |
| | | Extensive/Moderate Cover | | |
| | | Fast Current/Eddies | | |
| | | Low/Normal Embeddedness | | |
| | | Max Depth >40 cm | | |
| | | Low/Normal Riffle Embeddedness | | |
| | | WWH Attributes | 1 | 1 |
| MWH Attributes | Hi Influence | Channelized/No Recovery | • | • |
| | | Silt/Muck Substrates | • | • |
| | | No Sinuosity | • | • |
| | | Sparse/No Cover | • | • |
| | | Max Depth <40 cm | • | • |
| | | Hi-Influence Modified Attributes | 5 | 5 |
| | Moderate Influence | Recovering Channel | • | • |
| | | Heavy/Moderate Silt Cover | • | • |
| | | Sand Substrate (Boat) | | |
| | | Hardpan Substrate Origin | | |
| | | Fair/Poor Development | • | • |
| | | Low Sinuosity | | |
| | | Only 1 or 2 Cover types | | |
| | | Intermittent/Poor Pools | • | • |
| | | No Fast Current | • | • |
| | | High/Moderate Overall Embeddedness | • | • |
| | | High/Moderate Riffle Embeddedness | | |
| | | No Riffle | • | • |
| M.I. MWM Attributes | | | 7 | 7 |
| MWH H.I.+1/WWH+1 Ratio | | | 3.00 | 3.00 |
| MWH M.I.+1/WWH+1 Ratio | | | 6.50 | 6.50 |

Biological performance for Swamp Creek was determined to have good to marginally good communities. The lower reach of Swamp Creek was designated EWH based upon the recommendations of the 1995 Twin Creek survey (Ohio EPA 1997). The upstream sampling location was determined to be WWH. Results from the 2005 sampling survey found similar conditions, including channelization and loss of riparian habitat, confirming the absence of reasonable EWH potential except at the downstream sampling location.

### 2.2.4. Water Quality

In addition to the biological and physical monitoring discussed above, OEPA collected water samples from Twin Creek and selected tributaries and analyzed the water quality to understand existing conditions in 2005. The most downstream OEPA sampling site was at Stream Mile 0.2, which was a sentinel site OEPA monitored throughout the year.

All bacteria samples for Swamp Creek in 2005 were taken downstream from the Village of Verona, which was unsewered at the time. *E. coli* and fecal coliform were detected above Primary Contact Recreation (PCR) Water Quality Standards (WQS). At a tributary to Swamp Creek upstream of Verona, ammonia exceeded the $90^{th}$ percentile on all five sample events. The high ammonia levels were suspected to be connected to failing septic systems and land-applied manure (OEPA 2007).

Most Swamp Creek water column samples were below the 90th percentile background level for total phosphorus (P), NH3-N and NO3-N. The most downstream site was a sentinel site and data there showed the close relationship between high flows and high nitrogen levels. The tributary site had the highest frequency of $90^{th}$ percentile exceedance for P and $NH_3$. The sampling site was downstream of the Village of Verona which was unsewered at the time. An upstream CAFO also land-applied manure which impacted sample results.

**TABLE 2-10 NUTRIENT SAMPLING RESULTS FOR SWAMP CREEK HUC-12**

| Stream (RM) | area $mi^2$ | Frequency of Phosphorus $>90^{th}$ Percentile | Phosphorus Median (mg/l) | Frequency of $NH_3>90^{th}$ Percentile | $NH_3$ Median (mg/l) | Frequency of $NO_3$ $>90^{th}$ Percentile | $NO_3$ Median (mg/l) |
|---|---|---|---|---|---|---|---|
| Swamp Creek (6.3) | 8.7 | 3/5 | 0.211 | 1/5 | 0.197 | 0/5 | 0.16 |
| Swamp Creek (0.2) | 18.0 | 0/5 | 0.091 | 0/5 | 0.062 | 0/5 | 0.16 |
| Trib to Swamp (0.3) | 4.7 | 4/5 | 0.366 | 5/5 | 0.625 | 0/5 | 0.13 |

Source: OEPA 2007

## 2.3. Summary of TMDL

The Twin Creek watershed TMDL was required because portions of the Twin Creek and its tributaries did not attain their water quality goals for aquatic life and recreation (OEPA, 2010). The TMDL stated that ammonia, phosphorus, bacteria (recreation use) and sedimentation/siltation are the causes of impairment. Sources of impairment include natural (low flow) and agricultural (channelization, loss of riparian, subsurface crop drainage), as well as failing HSTS. The TMDL did not find the Verona WWTP as a source of impairment in Swamp Creek. Grazing livestock with stream access was also considered a source of high bacteria in the upper portion of Twin Creek, according to the TMDL. Low flow impairment in the upper portion of Swamp Creek HUC-12 is a natural condition that also contributed to the impairment causing distress in the macroinvertebrate community.

The TMDL paid special attention to failing HSTS. In its Appendix D, it calculated the HSTS replaced by Verona's WWTP (210) and recommended approximately 200 HSTS remaining in the Swamp Creek watershed be eliminated.

In addition to increasing conservation easements and education and outreach, it also recommended the following restoration strategies for Swamp Creek HUC-12 (Table 2-11):

## TABLE 2-11 RESTORATION STRATEGIES FOR SWAMP CREEK HUC-12 FROM 2010 TMDL

| Impairment Sources | Agricultural BMPs | Bank and Riparian Restoration | Stream Restoration | Wetland Restoration | HSTS Planning & Improvement |
|---|---|---|---|---|---|
| Channelization<br><br>Loss of riparian<br><br>Crops- subsurface drainage<br><br>Failing HSTS | Plant cover crops<br><br>Implement conservation tillage practices<br><br>Implement grass/legume rotations<br><br>Install grassed waterways<br><br>Install vegetated buffer areas/strips<br><br>Install conservation buffers<br><br>Conduct soil testing<br><br>Install nitrogen reduction practices<br><br>Develop nutrient management plans<br><br>Implement prescribed & conservation grazing, exclusion fencing<br><br>Install alternative water supplies<br><br>Install erosion & Sediment control structures<br><br>Develop whole farm management plans | Plant native grasses and trees/shrubs<br><br>Restore streambank by contouring and regrading | Install in-stream habitat structures<br><br>Restore floodplain | Reconnect wetland to stream<br><br>Reconstruct & restore wetlands<br><br>Plant wetland species | Develop HSTS plan<br><br>Inspect HSTS<br><br>Repair or replace traditional HSTS<br><br>Repair or replace alternative HSTS |

### 2.3.1. Baseline Load Estimates

Estimated baseline nutrient loads and estimated target load reduction for the Swamp Creek HUC-12 were calculated using a mass balance equation provided by Rick Wilson, OEPA (Table 2-12). The goal loads presented are 20 percent of the total estimated baseline loads for annual contributions in the Swamp Creek watershed.

**TABLE 2-12 ESTIMATED NITROGEN AND PHOSPHORUS LOADINGS FROM CONTRIBUTING NPS SOURCES IN SWAMP CREEK HUC-12**

| | Agricultural Load (lbs Nitrogen/acre) | Agricultural Load (lbs Phosphorus/acre) | Development Load (lbs Nitrogen/acre) | Development Load (lbs Phosphorus/acre) |
|---|---|---|---|---|
| **Current Estimates*** | 187,262 | 11,858 | 7,678 | 486 |
| **Target Reduction Goals (20%)** | 37,452 | 2,372 | 1,536 | 97 |

*Estimates provided by Rick Wilson, OEPA in July 2023

The source of nutrient impairment in this watershed is assumed to be primarily agriculture with 85% of the land use is row crops. HSTS was estimated to contribute to only 5% of total phosphorus and 3% of total nitrogen and NPDES contributed to 29% of total phosphorus and 14% of total nitrogen in the Great Miami River watershed (OEPA, 2020). The number of failing HSTS is unknown, though in the 2010 TMDL, the percentage is assumed to be 50% due to soil limitations, the age of many systems, and the lack of enforcement resources at the three local health departments. Water quality modeling of the Lower Great Miami River Basin was performed by Miami Conservancy District in 2017 and provided insights into the significant nutrient loadings and reduction scenarios and single point sampling limitation in this watershed (MCD, 2017).

## 2.4. Summary of Pollution Causes and Sources

**FIGURE 2-12 SWAMP CREEK NEAR SONORA ROAD**

Swamp HUC-12 and Twin Creek were surveyed in 2005 and the results showed that Swamp Creek had good and marginally good water quality and were able to partially support WWH (Figure 2-12). The biological indicators suggested that water quality improvement through BMPs in the upland and nutrient management are important and required to support any high-quality habitats in Swamp Creek and its tributaries. In the Swamp Creek HUC-12, row crop agriculture is the main source of impairment locally. Nutrients in the form of nitrogen and phosphorus support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish and smaller organisms that live in water but too much nutrients in the water causes algae to grow faster than ecosystems can handle (USEPA, 2022). Nitrogen loss from row-crop agriculture in rural watersheds which drain to the Gulf of Mexico is also the primary source of Gulf Hypoxia -- caused by excess nutrient (Nitrogen) loading, siltation/sedimentation from cropland, and intense runoff delivery via drainage tiles to the waterbodies.

## 2.5. Additional Information for Determining Critical Areas and Developing Implementation Strategies

### 2.5.1. Logjams

Within the Swamp Creek HUC-12, mainly small forested areas exist along stream corridors, along with scattered upland farm woodlots. Forested riparian areas generally have a positive impact on water quality, and the OEPA habitat and biological indicator data demonstrates that ALU attainment is higher in the areas of Swamp Creek HUC-12 with riparian tree cover. Trees in the riparian area absorb pollutants and hold nutrients in the soil, prevent soil erosion, and shade streams to keep water temperatures stable (ODA, 2023).

Unfortunately, trees in the riparian area may fall due to disease, pests, beaver activity, extreme weather, and erosion. When trees fall into the floodplain, they can be carried into the stream during high water. Woody debris in the stream provides cover for fish, improving habitat. Too much woody debris that blocks flow or dams up the stream is called a logjam. Logjams contribute to localized flooding during low to moderate intensity storms. They also impact the path of the stream as flowing water seeks the path of least resistance around fallen trees. When the stream path threatens roadways, bridges, power lines, or other infrastructure, the community may face a costly stream restoration project.

Since much of the Swamp Creek HUC-12 is flat and has poorly drained soils, many local landowners and agricultural producers place a high value on efficient drainage. Efficient drainage benefits agricultural production, especially where the soils have been classified as prime farmland when drained.

The need for efficient drainage has resulted in a decades-old ditch maintenance program within the Darke County government structure and also in the Montgomery SWCD. The ditch maintenance programs are funded through a petition structure that causes benefitting landowners to equitably share the cost of clearing riparian forest and maintaining the improved waterway (Surber). County ditch maintenance typically includes straightening the channel, mowing, and spraying pesticides to prevent the return of woody vegetation. Some private landowners in the watershed choose to clear riparian forests and maintain the streams through their property in similar fashion as a county ditch. If clearing activity is performed without appropriate Best Management Practices, equipment can disturb the soil, increasing erosion, sedimentation, and watershed impairment (ODA, 2023).

Landowners can prevent the need for large stream restoration projects by regularly maintaining the natural stream channels on their properties (ODNR, 2005). Alternate means of providing adequate drainage without impairing streams might include:

- Conducting a snag-and-drag remedy when logjams block local streams.
- Clearing only dead trees from the riparian zone.
- Utilizing BMPs in conjunction with the ODNR Division of Forestry.
- Cutting only riparian trees on one side of the stream so shade benefits continue.

In areas where Swamp Creek and its tributaries are not under routine county maintenance, logjams are reported to be prevalent. One logjam in Preble County, on public property, has become large enough to pool water above the jam, impacting habitat and possibly contributing to upstream flooding in the Village of Verona. Based on conversations held with the public and with local leadership, and on observations about past and current stream maintenance practices, it is feared additional stretches of Swamp Creek will be channelized and riparian cover cleared to promote drainage by reducing the risk of future logjam formation.

### 2.5.2. Climate Resilience

Rising average global temperatures are likely caused by rising greenhouse gases in the atmosphere. The effects of rising average temperatures can include extreme weather events, especially more frequent heavy rain and more severe drought (https://climate.nasa.gov/effects/).

Modifying land management practices has the potential to reduce nutrient runoff into waterways, which is the goal of this planning process. These same practices also mitigate greenhouse gases by sequestering carbon (ODA, 2023), making society more climate resilient (COMET-Planner, https://pln-50-ui-010109-dot-comet-201514.appspot.com/).

The degree of climate benefits of various conservation practices can be quantified. USDA's COMET-Planner estimates greenhouse gas emission reductions. For example, replacing 10 acres of cropland with woody plants -- near a stream in the Headwaters Twin Creek HUC-12 -- would remove 74 tons of carbon dioxide per year from the atmosphere. These additional benefits and potential climate resilience funding sources are important considerations for future projects and incentives.

Cropland management projects that might be considered as promoting climate resilience while also reducing nutrient runoff pollution – listed with their NRCS Conservation Practices code -- include grassed waterway (CPS 412), riparian buffer (CPS 391), contour buffer strips (CPS 332) cover crops (CPS 340), nutrient management (CPS 590), no-till (CPS 329), reduced till (CPS 345), riparian herbaceous cover (CPS 390), and filter strips (CPS 393) (COMET-Planner, http://comet-planner.com/).

### 2.5.3. Biosolids Applications

In the Swamp Creek HUC-12, there are approximately 17 permits for biosolid application on agricultural fields. Issued and regulated by the Ohio EPA's Biosolids Program. Biosolid application can be a sustainable way to manage the product of the treatment process at public wastewater treatment plants. When proper management techniques – including proper rates of application and proper environmental conditions following the NRCS Conservation Practice Standard 590 – are utilized, the potential for the organic nutrients of biosolids to leach into groundwater or runoff into surface water are reduced. Proper application rates and timing are key to reducing water quality problems that result from biosolid application. "Maintenance of buffer zones between application areas and surface water bodies and soil conservation practices will minimize impacts to surface water." (US EPA, 2000) Though biosolid application is a regulated point source, conservation practices that capture and treat runoff from these fields are eligible for nonpoint source funding. Such projects should be prioritized.

### 2.5.4. Agricultural Conservation Planning Framework

The Agricultural Conservation Planning Framework (ACPF) is an agricultural watershed management tool using high-resolution spatial data and ArcGIS to identify opportunities for installing conservation practices within a watershed (Tomer et al., 2013). Developed by the US Department of Agriculture, the ACPF is being used in hundreds of watersheds to inform and engage local communities in agricultural conservation. The program spatially combines high resolution terrain, drainage, soils, land use and crop land data, and identifies and prioritizes potential areas for conservation (ARS, 2019). ACPF can engage stakeholders in the watershed planning process by proposing conservation solutions. The program is not prescriptive but provides various options and scenarios that can be evaluated at watershed and farm levels including in-field, below-field and in the riparian zone (Tomer et al., 2013). The following ACPF conservation practices -- both for in-field and below-field -- and riparian buffers are found applicable in our region:

Grassed Waterway – NRCS Conservation Practice Standard (CPS) code 412
Nutrient Removal Wetlands – NRCS CPS code 658
Water and Sediment Control Basin (WASCOB) – NRCS CPS code 638
Riparian Buffer – NRCS CPS code 391
Streambank Stabilization – NRCS CPS code 580
Buffer Contour Strip – NRCS CPS code 332

Filter Strip – NRCS CPS code 393 - Filter Strips are not specifically identified in the ACPF but it is very applicable in this region. This practice would be situated parallel to a perennial stream and consists of a strip of dense perennial cool-season or warm-season grasses, often with additional broadleaf species mixed in. The thick vegetation removes nutrients and sediment from overland flow and stabilizes floodplains when out-of-bank-flow occurs. Suspended and dissolved solids in overland flow are intercepted and treated by a combination of proper slope placement, minimum 30-foot width, and maintenance -- to include annual plant material removal – are defined by the NRCS Field Office Technical Guide (NRCS, 2017). This has been a very effective nutrient removal and treatment practice in the watershed and will replace the Contour Buffer Strips identified in the ACPF.

As conservation practices are combined or "stacked" in a field, the total nutrient quantity removed increases (Lee, 2022). Therefore, incorporating multiple conservation practices draining to the same ditch or tributary are advantageous to meet the goals of the plan.

One of the important outputs generated by the ACPF is the riparian assessment. The ACPF riparian assessment (riparian buffer and streambank stabilization) utilizes a matrix of two variables: the width of the riparian zone and runoff delivery. This analysis provides better options to improve the effectiveness of riparian conservation planting where field runoff occurs. The output further provides specific riparian design types based on the cross-classification matrix which include critical zone for sensitive sites, multi-species buffer for water uptake, nutrient and sediment trapping, stiff-stemmed grasses for trapping runoff and sediment, deep-rooted vegetation tolerant of saturated soil, and sections emphasize streambank stability because the narrow buffer width. The purpose of this riparian management assessment is to provide the most water quality benefits by identifying segments to install permanent vegetation specifically designed to intercept surface runoff, protect shallow groundwater in low-lying areas and stabilize stream banks. This type of treatment is especially applicable in this watershed since the riparian zone is steep (Figure 2-6) and many bare and exposed banks are the source of stream erosion and siltation/sedimentation.

### 2.5.5. ACPF modeling for Swamp Creek HUC-12

Miami Conservancy District, a major partner of this project, financially supported the ACPF effort of this HUC-12. The Nature Conservancy, also contributed time and effort in preparing and preprocessing of the datasets for running ACPF. The ACPF model was performed for the Swamp Creek HUC-12 using a 2.5 ft LIDAR DEM from Ohio Geographically Referenced Information Program (OGRIP) and a file geodatabase provided by ARS (USDA, 2020).

The ACPF model identified a number of possible in-field conservations practices, below-field practices and also riparian zone designs in the Swamp Creek HUC-12. At the Swamp Creek HUC-12, 23% of the fields are considered high and very high runoff risks and 90% of the watershed is tile-drained agricultural fields as estimated by the ACPF (Table 2-13). Figures 2-13 to 2-16 depict the ACPF model results.

Outputs from the ACPF model were discussed at stakeholder meetings on June 5, 7, and 13, 2023 and at follow up field visits and ground verification at selected locations on June 20, 27, and 30. The ACPF maps provide a visual tool, making field visits and discussions more effective and efficient. It is noted that although the ACPF recommended contoured buffer strips, it is not a practice that is common in the region. Therefore, instead of contoured buffer strips, the in-field practice of riparian filter strips is more appropriate.

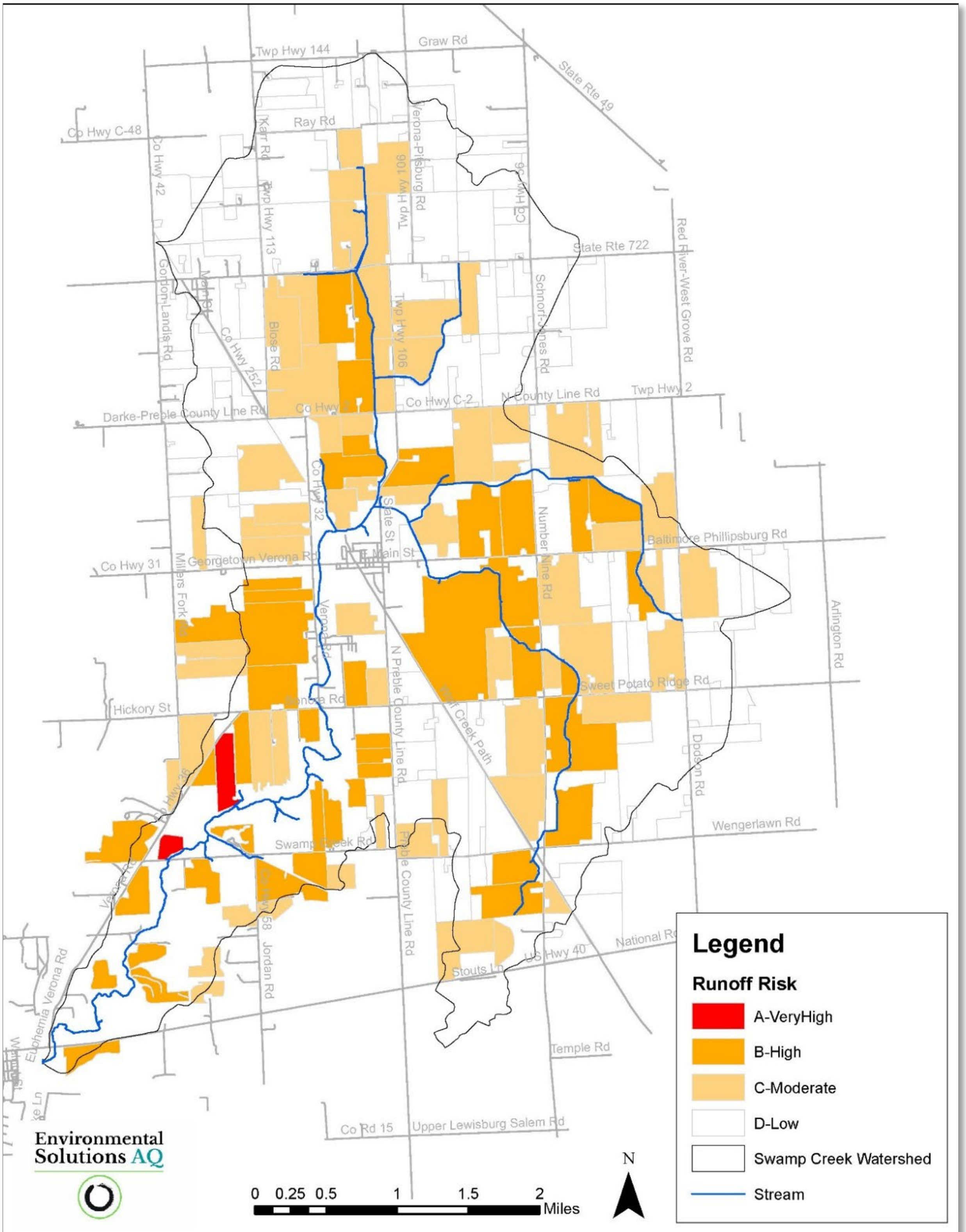
The ACPF output shows an abundant of grassed waterways as a significant way to improve water quality in this watershed. The recommendation was based on the topography and drainage of the watershed. These locations were field verified on June 20, 27, and 30, 2023.

### Table 2-13 Conservation Practices in Swamp Creek HUC-12 Suggested by ACPF (ACPF maps and estimates are only for planning purposes)

| Practice | Unit | Length (miles) | Total Area (Acres) |
|---|---|---|---|
| **In-Field Practices** | | | |
| Grassed Waterways | 1,043 sites | 28.5 | NA |
| Contoured Buffer Strips | 8 sites | 0.4 | NA |
| Tile Drainage Management | 147 sites | NA | 5,684 |
| Depressions (potential wetland restoration sites) | 111 depressions | NA | 942 |
| **Below-Field Practices** | | | |
| Nutrient Removal Wetlands | 0 wetlands | NA | NA |
| WASCOBs | 3 sites | NA | 33 |
| Denitrifying Bioreactors | 78 sites | NA | 19** |
| Farm Ponds | 4 | NA | 68*<br>Pools: 1 |
| **Riparian Zone Practices** | | | |
| High Nutrient Sensitive Buffers | NA | 1.2 | NA |
| Riparian Buffers Filters (various plants) | NA | 32 | NA |
| Stream Bank Stabilization | NA | 10.5 | NA |
| Saturated Buffer | NA | 5.4 | NA |
| Saturated Buffer Requiring Carbon Enhancement | NA | NA | NA |

**Assuming 30 feet wide*
*** Total potentially treated area*
**** Contributing area*
***** Average surface area of potential bioreactor*
*NA – Not applicable*

**FIGURE 2-13 ACPF RUN-OFF RISK FOR SWAMP CREEK HUC-12**



### FIGURE 2-14 TILE DRAINAGE CONTROL AND IN-FIELD PRACTICES SUGGESTED BY ACPF FOR SWAMP CREEK HUC-12 WATERSHED

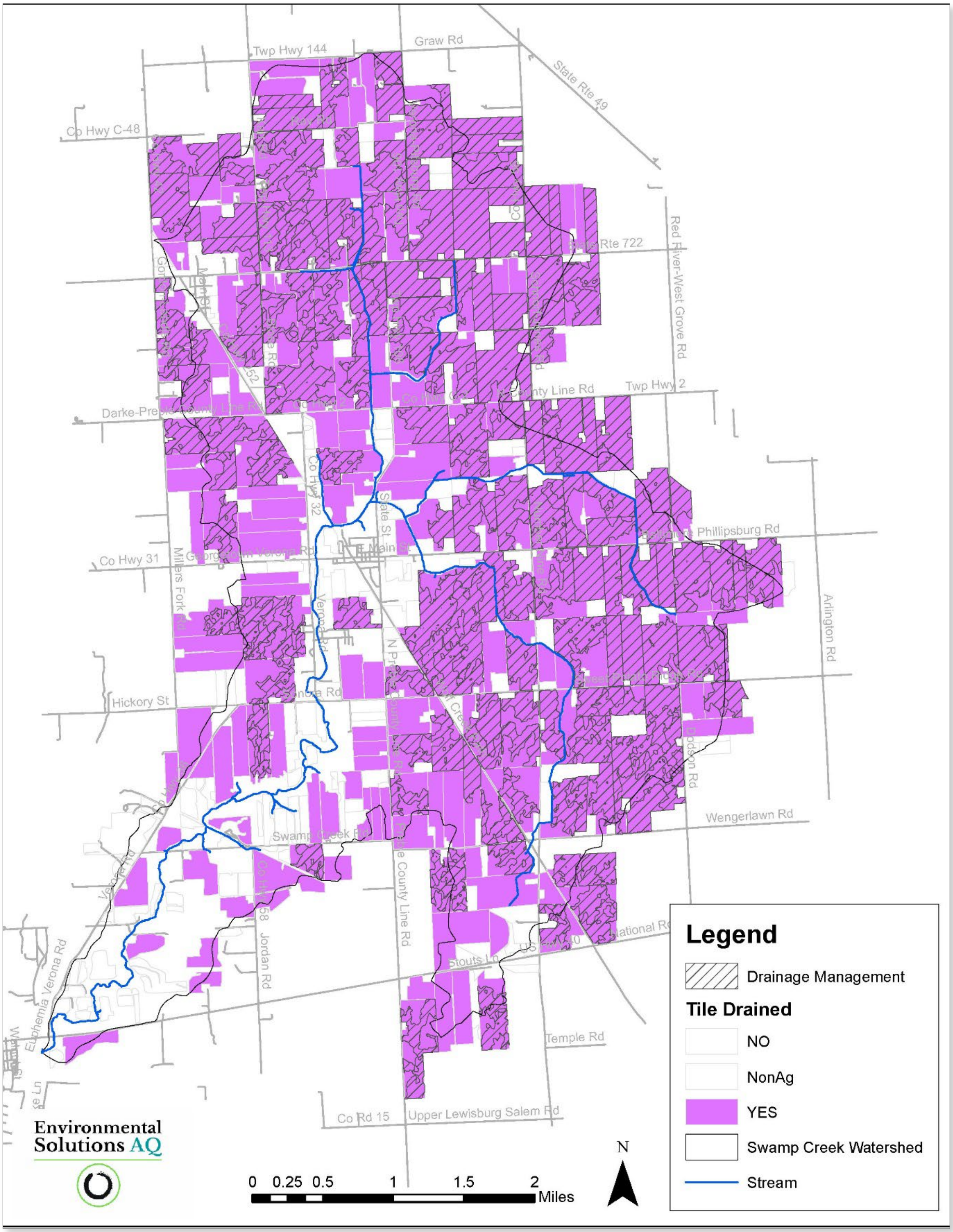
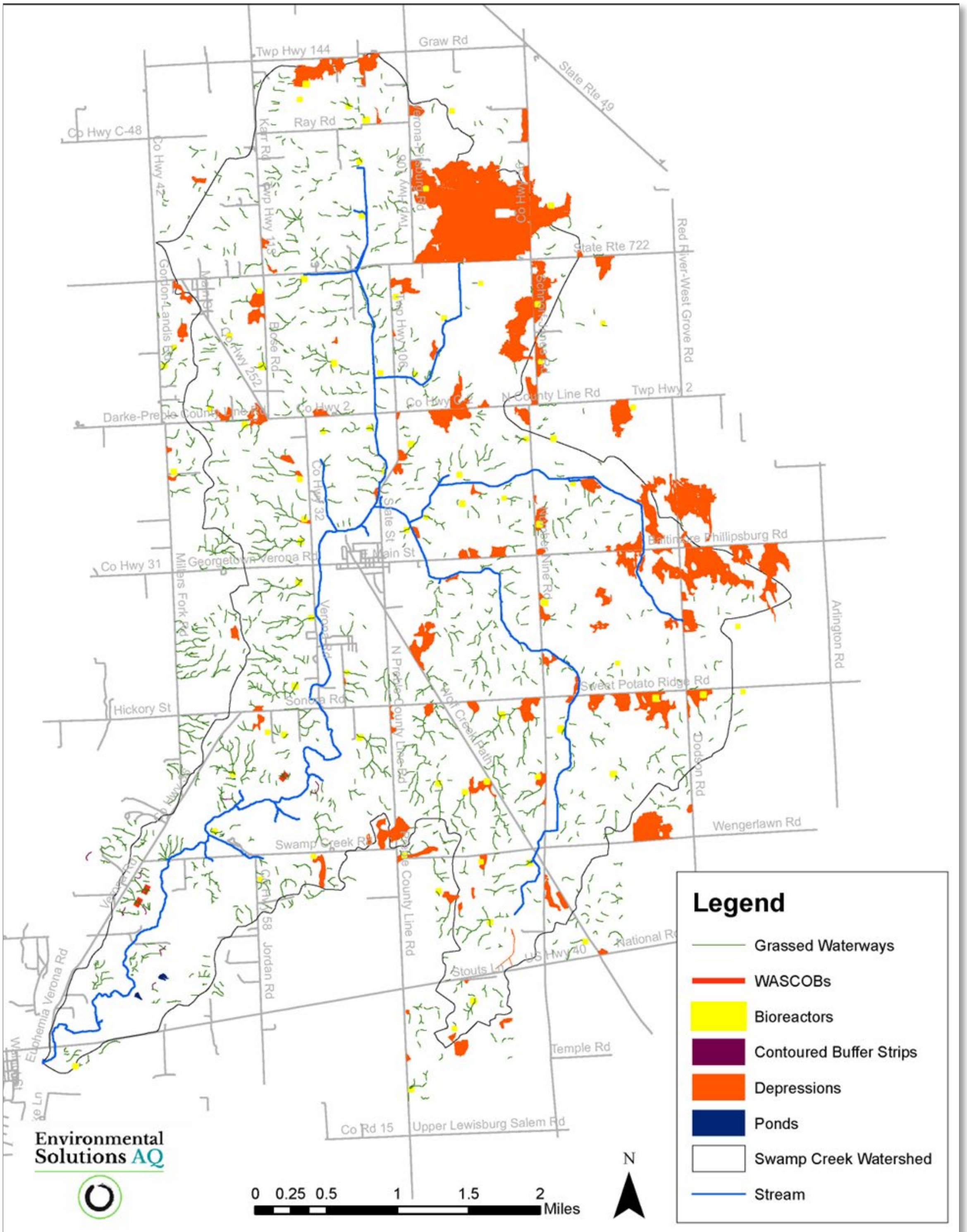
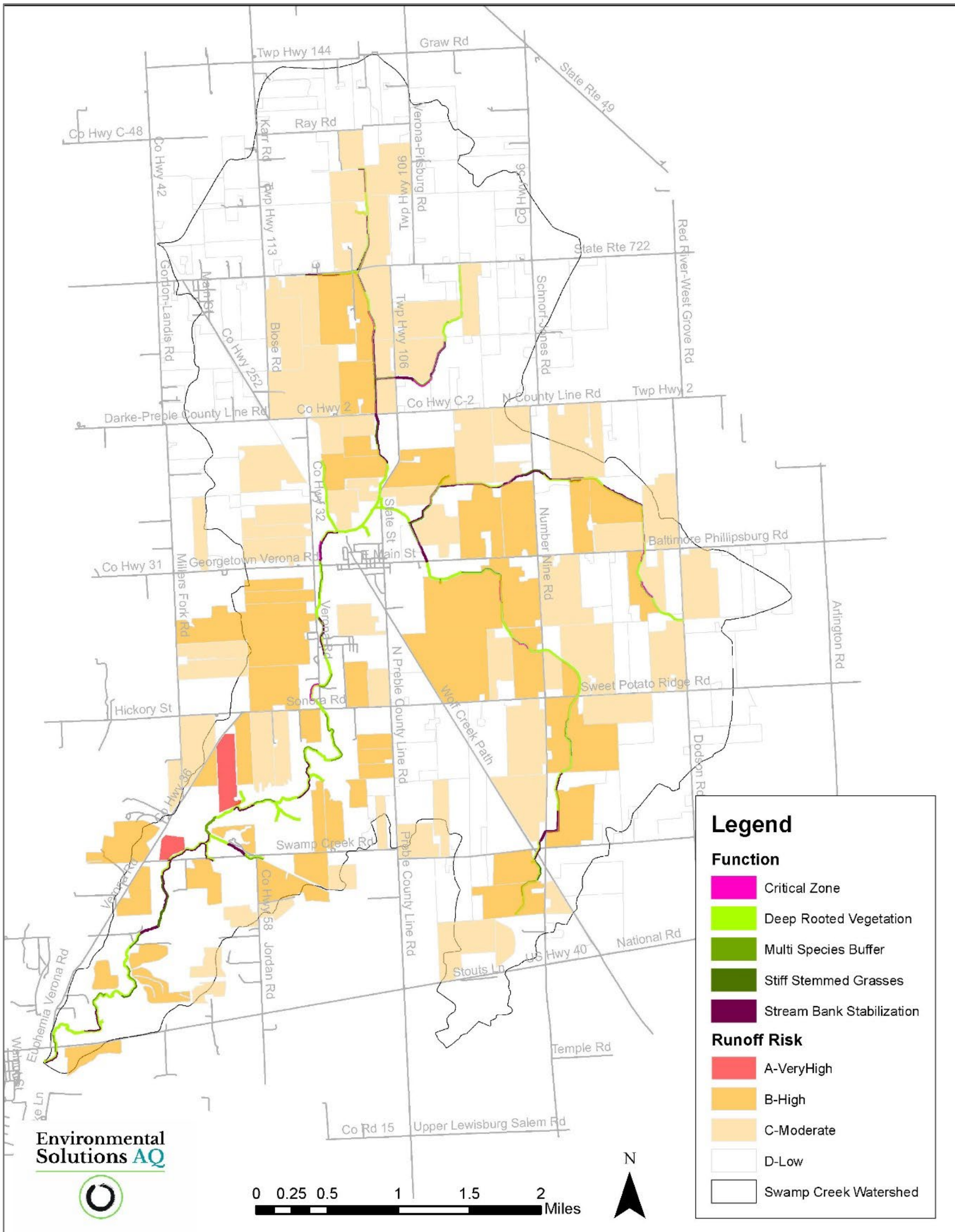


**FIGURE 2-15 BELOW-FIELD PRACTICES SUGGESTED BY ACPF FOR SWAMP CREEK HUC-12**



## FIGURE 2-16 RIPARIAN FUNCTIONS SUGGESTED BY ACPF FOR SWAMP CREEK HUC-12



# Chapter 3: Conditions & Restoration Strategies for Swamp Creek HUC-12 Critical Areas

## 3.1. Overview of Critical Areas

Swamp Creek and an unnamed tributary were assessed during Ohio EPA's Biological and Water Quality Study of Twin Creek and Selected Tributaries, 2005 (OEPA, 2007). Of the three samples taken in the Swamp Creek HUC-12, one was in full attainment of its designated ALU (WWH), one -- at the confluence of the northern tributary -- was in partial attainment of WWH ALU, and the furthest downstream one was not assessed due to low flow.

The 2010 TMDL provided impairment causes and restoration strategies. Meeting the goal of nutrient reductions requires targeted programs that expand existing partnerships and build new partnerships while supporting education and outreach to promote on-the-ground implementation (USEPA, 2014). Implementation of effective actions and progress must be verified with improved tracking mechanisms and watershed monitoring, and modeling tools (USEPA, 2014).

Swamp Creek HUC-12 is dominated by tile-drained agricultural fields and landowners voiced their concerns about flooding, severe erosion, and streams contaminated by raw sewage during the public meeting and through other forms of communication. This HUC-12 is not large (11,213 acres with 85% row crop) and with over 90% of tile-drained fields (determined by ACPF).

Three critical areas have been identified within the Swamp Creek HUC-12 in this NPS-IS. The critical areas were identified to address the in-field and below-field nutrient management (Table 3-1).

Critical Area 1 is tile-drained row-crop agricultural fields. Conservation practices reduce nutrient loading that impacts the far-field (Gulf of Mexico) and near-field (local waterways).

Critical Area 2 is the riparian zone. This critical area targets improving the 44 miles of the riparian zone and restoring stream functions, as well as improving and protecting sensitive riparian habitats.

Critical Area 3 is failing HSTS, especially in the unsewered community of Gordon. This critical area addresses bacteria and nutrient reduction from the systems that directly discharge human waste to Swamp Creek and its tributaries.

### Table 3-1 Critical Areas of Swamp Creek HUC-12

| Critical Area | Area Description | Impairment Being Addressed | Size |
| --- | --- | --- | --- |
| 1 | Tile-drained row crop agricultural fields as determined by ACPF | Near-field and Far-field impairment – Gulf of Mexico hypoxia with N and P reduction) - Nutrient management in prioritized agricultural lands using BMPs | 10,034 Acres |
| 2 | Swamp Creek riparian corridor with insufficient riparian zones and loss of functioning floodplain | Near-field and Far-field impairment – Gulf of Mexico hypoxia - Improve habitat scores of QHEI and stream health by reducing nutrients and associated sedimentation. | 44 miles (both sides of Swamp Creek and its tributaries) determined by ACPF. |
| 3 | Failing HSTS, especially in the unsewered community of Gordon and near Swamp Creek | Near Field - Reduce ammonia, bacteria, N and P discharging directly to local streams or to tiles that lead to steams from an unsewered community. | 35 failing HSTS: The unsewered community (Gordon) – population = 245 with 15 failing HSTS, plus 20 failing HSTS outside of the village and near Swamp Creek. |

## 3.2. Critical Area 1: Conditions, Goals, & Objectives for Nutrient Reduction and Management in Swamp Creek HUC-12 tiled agricultural fields.

### 3.2.1. Detailed Characterization

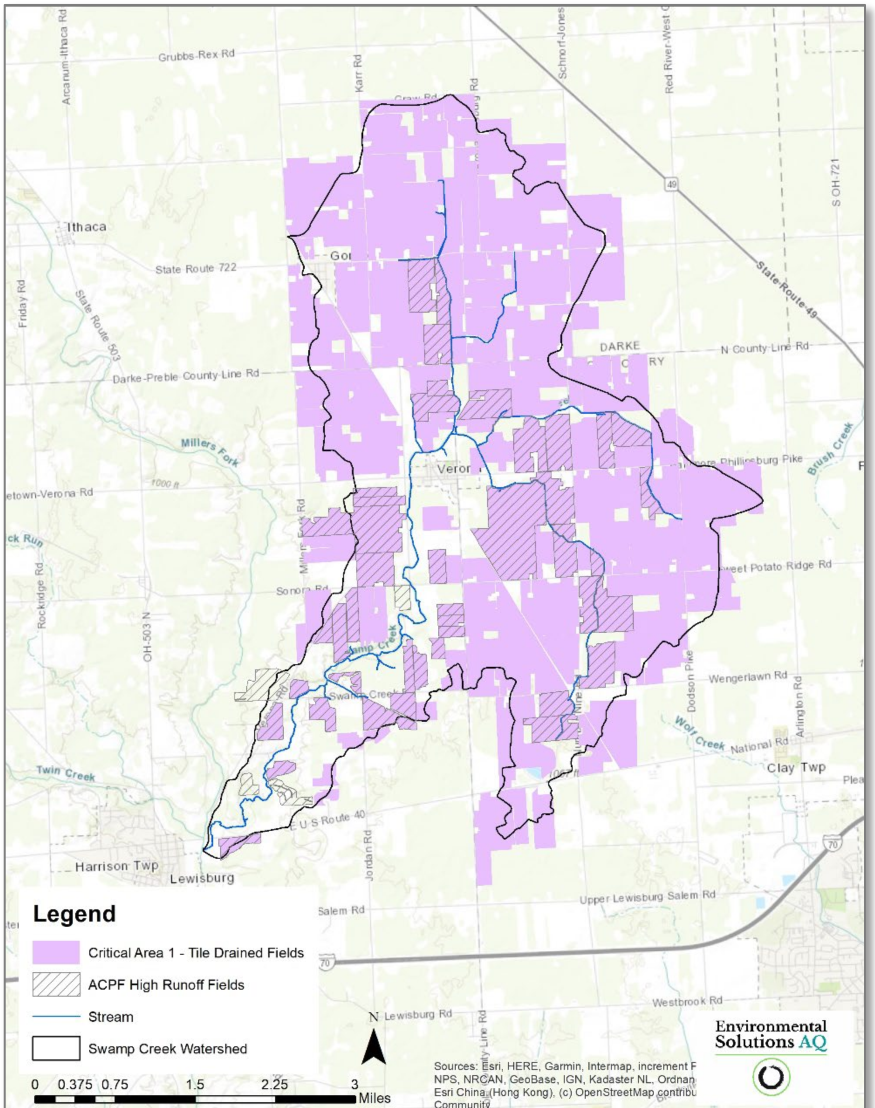



**FIGURE 3-1 CRITICAL AREA 1: TILE-DRAINED FIELDS**

Given the dominance of agricultural land use in the Swamp Creek HUC-12, agricultural nutrient management with the use of BMPs implemented in high runoff, tile-drained fields is the best way to reduce nutrients to nearby waterways. Although BMPs are encouraged on all agricultural lands, certain lands are more susceptible to nutrient loss and erosion than others are; and therefore, they need to be prioritized for BMP implementation. Critical Area 1 is comprised of all tile-drained agricultural fields as determined by the ACPF model (Figure 3-1). ACPF also determined the specific high runoff fields based on slope steepness and the fields' close proximity to the stream. The ACPF model was used to identify very high and high runoff fields covering 2,247acres of the agricultural land (23%) within the Swamp Creek watershed.

Based on stakeholders' input and the watershed characteristics, the prioritized areas and potential projects should meet at least one of the following criteria:

- Lands identified as high and very high runoff fields by ACPF;
- Lands directly adjacent to Swamp Creek or its tributaries;
- Lands currently under conventional tillage regimes and/or underutilizing cover crops;

- Lands without current nutrient management plan

### 3.2.2. Detailed Biological Conditions

The 2005 sampling conducted by OEPA at two fish sampling points in this HUC-12 indicates that conditions were at least partially suitable for supporting WWH. Table 3-2 illustrates the attributes of the fish sampled in 2005 at both monitoring locations, resulting in IBI scores of 44 at the upstream site and 38 at the nearby tributary site. Table 3-2 also includes the habitat assessment scores, represented by QHEI values.

**TABLE 3-2 FISH COMMUNITY AND HABITAT DATA FOR SWAMP CREEK CRITICAL AREA 1**

| Stream River Mile | Mean Number Species | Cumu-lative Species | Drainage Area ($mi^2$) | Predominant species (% of catch)* | IBI | QHEI | Narrative Evaluation |
|---|---|---|---|---|---|---|---|
| 6.3 | 19.0 | 19 | 8.7 | Central Stoneroller (30%), Northern Creek chub (16.1%), white sucker (7.2%), rainbow darter (6.1%), mottled sculpin (5.1%) and Striped shiner (3.6%) | 44 | 34.0 | Good |
| **Swamp Creek Tributary at RM 6.45** | | | | | | | |
| 0.3 | 17.0 | 17 | 18 | “ | 38 | 37.5 | Marginally Good |

*only aggregate sampling results from the tributaries were reported (OEPA, 2007)
Source: OEPA, 2007

From the 2005 OEPA sampling results, the QHEI scores (34 and 37.5) aligned with the biological performance for Swamp Creek, which was good to marginally good. OEPA recommended the designation for Swamp Creek to be WWH. Regarding macroinvertebrate populations, the OEPA report concluded that the Swamp Creek sampling site upstream of the Village of Verona at river mile 6.4 was likely impacted by nonpoint sources of pollution. The agency observed evidence of nutrient enrichment in the forms of algal blooms, silty waters, and embedded substrates. All of these conditions limited the benthic macroinvertebrate community. “The sensitive to tolerant taxa ratio at this site (6/14; 0.43) was among the lowest in the entire watershed for a WWH stream.” (p. 91, OEPA 2007)

**TABLE 3-3 MACROINVERTEBRATE DATA FOR SWAMP CREEK CRITICAL AREA 1**

| Stream RM | Dr. Area (Sq. mi.) | Density Ql. Qt. | Predominant Organisms on the Natural Substrates; With Tolerance Category(ies) in Parentheses | ICI | Narrative Evaluation |
|---|---|---|---|---|---|
| 6.4 | 8.7 | M-L | *Helicopsyche* caddisflies (MI), *Elimia* snails (MI), *Caenis* mayflies (F), Beetles (MT,F,MI) | - | Fair |
| 0.2 | 18.0 | M-L | Riffle beetles (MT,F,MI), Sow bugs (F), waterpenny beetles (MI) | - | Marg. Good |

Source: OEPA, 2007
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant.

### 3.2.3. Detailed Causes and Associated Sources

The 2005 OEPA survey demonstrated that the streams in this HUC-12 were of marginally good/fair quality, therefore, nutrient management is necessary to improve and maintain stream health. One partial attainment status was assigned for the most upstream sampling site due to sedimentation/siltation and excel algal growth caused by channelization, loss of riparian habitat, and crop production with subsurface drainage (OEPA, 2007). Cropland activities in the Great Miami River basin can contribute to excessive nutrient loadings to local streams and small tributaries and ultimately contributing to in Gulf Hypoxia. Practical and property-specific BMPs can help reduce the amount and concentration of nutrient-laden surface runoff. These BMPs can also address the loss of sediment /topsoil from agricultural lands and retain and maximize the nutrients in the fields. The implementation of BMPs on tiled agricultural lands can address the causes of topsoil and nutrient loss in the fields and reduce the sources of this excess nutrient and sediment into the waterways.

### 3.2.4. Outline Goals and Objectives for the Critical Area

The goal of the NPS-IS is to improve water quality, meet nutrient reduction goals, and improve impairment status. In Critical Area 1, the samples collected in 2005 showed that Swamp Creek was in full attainment in the tributary, partial attainment at the upper watershed sampling location and unknown attainment at the lower watershed sampling location. However, over 90% of the Critical Area 1 is tile-drained agricultural fields. Drain tiles can act as conduits and directly transport nutrients to waterways. They must be well-managed to reduce risk of nutrient loss and to maximize fertilizer use efficiency. This plan and future funding will provide opportunities to promote BMPs that are appropriate and cost effective in this region. To achieve the nutrient loading goals, the following goal and objectives have been established:

**Goal 1** – Reduce nitrogen loading contributions in Critical Area 1 by 20% from 187,262 lb. N to 149,810 lb. N, a reduction of 37,452 lb.

NOT ACHIEVED: Current total nitrogen load is estimated to be 187,262 lb.

**Goal 2** – Reduce phosphorus loading contributions in Critical Area 1 by 20% from 11,858 lb. P to 9,486 lb. P, a reduction of 2,372 lb.

NOT ACHIEVED: Current total phosphorus load is estimated to be 11,858 lb.

**Goal 3** – Achieve a QHEI score at or above 60 throughout the watershed.

NOT ACHIEVED: QHEI score was 34 at the mainstem and 37.5 in the tributary.

### *Objectives*

In order to reach the load reduction goal of 20% within the Swamp Creek HUC-12 and improve aquatic life use attainment, effort will include implementing a variety of appropriate BMPs within Critical Area 1. However, the effort must also balance resources and willing landowners. With the ACPF output, a number of in-field and below-field practices are identified that are applicable in this region (Table 3-4).

**Objective 1:** Implement an additional 246 acres of conservation tillage annually to the current 4,924 acres estimated under continuous conservation tillage, until nearly 100% of all row-crop agricultural fields utilizing conservation tillage.

**Objective 2:** Plant an additional 500 acres of cover crops annually over the 783 acres that are already planted per year.

Darke, Montgomery and Preble SWCDs believe cover crops is a practice that has the potential to increase in the watershed with appropriate resources and incentives. They each have a list of interested agricultural producers who would implement the practice with some support. Ducks Unlimited and Farmers for Soil Health are among the funding sources for the practice, in addition to the traditional federal programs.

An outreach initiative could promote cover crops to producers. Such an initiative might include a field day at the farm of a local producer utilizing cover crops, researchers explaining how cover crop implementation improves yields, and an overview of various incentive opportunities.

**Objective 3:** Reduce nutrient loss through the installation of in-field BMPs such as grassed waterways, filter strips (NRCS code 393, see Section 2.5.4 for description), treating at least 540 acres per year. Project locations are suggested by the ACPF model. Grassed waterways are deemed most effective in removing and treating nutrient runoff in this region because:

- They reduce soil movement and thus the phosphorus chemically bound to the soil.
- Producers easily adopt the practice as a means to manage in-field gully erosion.

**Objective 4:** Reduce nutrient loss from subsurface tile drainage or below-field practices through the installation of drainage water management structures at locations suggested by the ACPF model, treating 180 acres per year.

#### TABLE 3-4 ESTIMATED NUTRIENT LOADING REDUCTIONS FOR CRITICAL AREA 1 OBJECTIVES

| Objective Number | Best Management Practice | Acreage Treated per year | Estimated Nitrogen (N)/Phosphorus (P) Load Reduction (lbs/yr)* |
|---|---|---|---|
| 1 | **Conservation Tillage** | 246 | 404 lbs (N)/165 lbs (P) |
| 2 | **Cover Crops** | 500 | 376 lbs (N)/39 lbs (P) |
| 3 | **In-field BMPs: Grassed Waterway** | 360 | 599 lbs (N)/159 lbs (P) |

| | | | |
|---|---|---|---|
| **3** | **In-field BMP: Filter Strips** | 180 | 299 lbs (N)/80 lbs (P) |
| **4** | **Below-field BMPs: Controlled drainage BMP such as nutrient removal wetlands or WASCOBs** | 180 | 227 lbs (N)/32 lbs (P) |
| | **TOTAL** | 1,039 | 1,904 lbs (N)/474 lbs (P) |

**Estimates calculated using Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Version 4.4 (USEPA, 2019)*

These objectives will be directed towards implementation on prioritized tile-drained agricultural lands using the stakeholders/landowners agreed criteria. The implementation of BMPs included in these objectives, as well as BMPs implemented through federal and state programs and other voluntary efforts will be recorded to track progress towards nutrient reduction goals within Swamp Creek HUC-12.

There are significant demands for grassed waterway installation in this HUC-12 especially in the downstream portion of the watershed. The SWCD staff has limited resources to keep up with the grassed waterway installation requests. There is an opportunity to promote additional practices associated with grassed waterways, such as cascading waterways and edge of field retention features that will filter additional nutrients from field runoff.

The practices of nutrient removal wetlands and WASCOBs are uncommon in this region due to the soils and drainage conditions and the lack of examples in the area. Nutrient management programs are being implemented by some producers, and there is room for growth in this area. Extra outreach effort will be required in the coming years to promote these water management practices.

Conservation easements have been successfully used in the region to protect local water resources and prime farmland from degradation caused by overdevelopment and unsuitable land management. This legal tool limits the impervious surface cover permitted on agricultural lands, encourages implementation of BMPs and permanently protects sensitive areas including prairies, forested stream buffers and wetlands filtering agricultural runoff. The TVCT the three SWCDs will continue to promote conservation easements to help farmers permanently protect their land and improve overall health of Swamp Creek watershed.

Currently there is no routine monitoring or sampling in the Swamp Creek HUC-12. But the future project-specific monitoring efforts will verify progress towards meeting the goals identified in the plan. The objectives, projects and implementation strategies presented herein will be reevaluated and modified if determined necessary, as several versions of this NPS-IS are expected.

This Swamp Creek NPS-IS presents an adaptive and living watershed planning approach and is anticipated to be dynamic as critical areas are identified and objectives are implemented, and other objectives recognized. The objectives listed above will be reevaluated, fine-tuned and modified as necessary when more information becomes available or conditions change. Additional objectives may also be included to make progress towards further reduction goals, as new and additional BMPs can improve nutrient reduction.

The OEPA Nonpoint Source Management Plan Update, which includes a full list of nonpoint source management strategies, will be utilized. Strategies, as presented in the overview tables of Chapter 4, include the following:

- Urban Sediment and Nutrient Strategies;
- Altered Stream and Habitat Restoration Strategies;
- Agricultural Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies

## 3.3. Critical Area 2: Conditions, Goals, & Objectives for Nutrient Reduction and Management in Swamp Creek and Tributaries' Riparian Zones

### 3.3.1. Detailed Characterization

**FIGURE 3-2 CHANNELIZED SWAMP CREEK**

In 2005, three samples were collected from the stream and sampled for biological indices and water quality. The samples from the upper watershed showed that the locations were in partial or full attainment of WWH ALU. The biological indicators showed the stream was marginally good/good conditions.

Because of the extensive tile-drained agricultural fields, nutrients from upland are transported directly into the streams and at high speed and volume during and after storms – which appear to be more intense in recent years. The channelization and very narrow riparian buffer provide no means for these nutrients to be assimilated or for sinuous habitat important to aquatic species. Headwater areas of Swamp Creek and its tributaries are typically channelized and with very narrow or no riparian buffer. The lack of riparian buffer affects the water quality and habitat.

The high-quality riparian habitats including riparian buffers, wetlands and floodplains connected to the streams are critical for mitigating the negative impacts of nutrients, siltation/sedimentation, and excessive runoff volume from the surrounding agricultural lands. These habitats also support a wide range of wildlife, including some threatened or endangered species identified in the watershed. Therefore, it is critical to protect these areas from further habitat degradation caused by invasive species and agriculture activities.

In Critical Area 2, the ACPF offers riparian design using the two variables of runoff delivery and width of the shallow water table zone. By applying these strategies, the riparian zone will have better function in nutrient removal, water quality improvement, and restore natural stream functions.

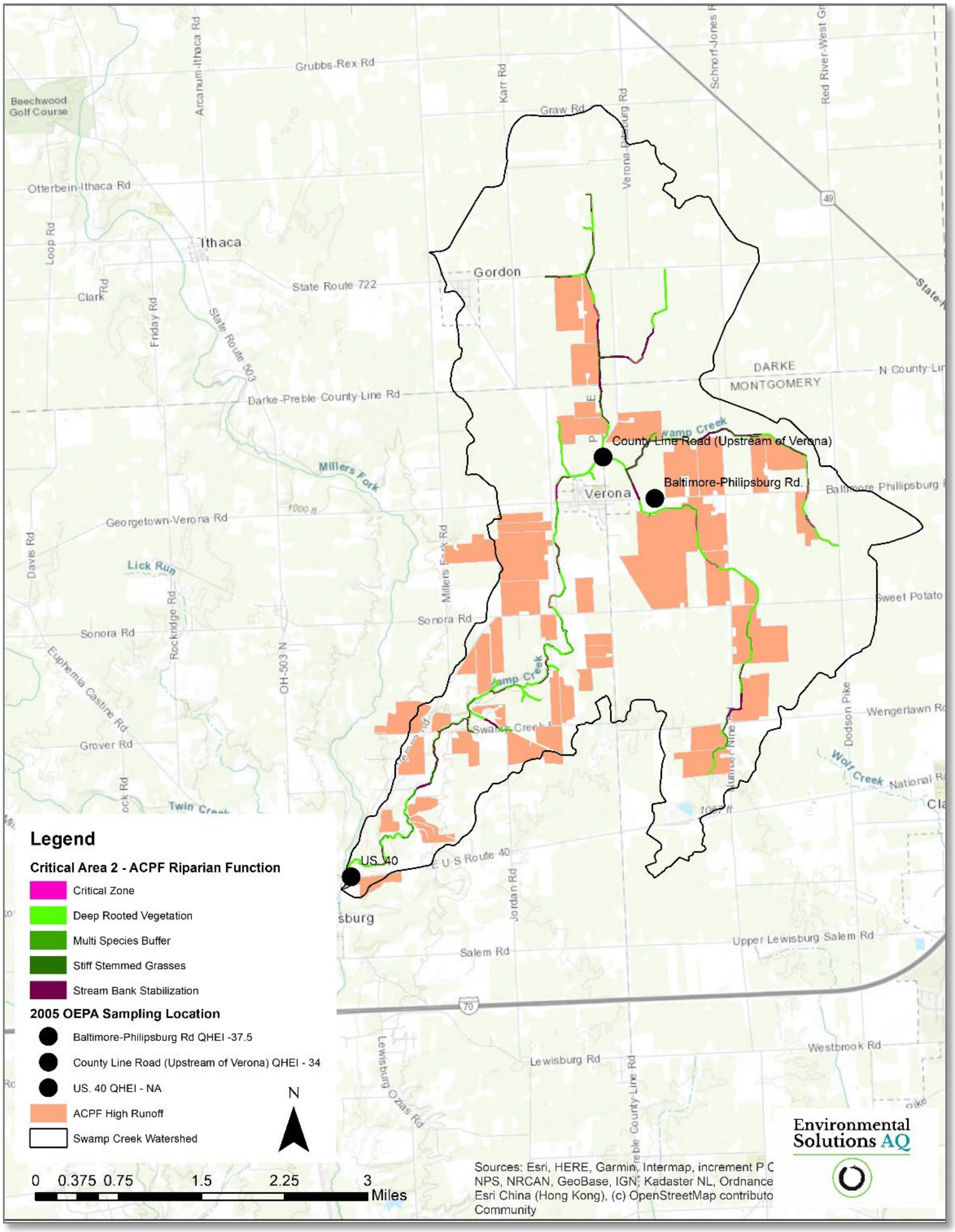



**FIGURE 3-3 CRITICAL AREA 2: SWAMP CREEK HUC-12 RIPARIAN ZONE**

Based on inputs from landowners and stakeholders, the prioritized areas and potential projects in Critical Area 2 may meet the following criteria:

- Riparian area of Swamp Creek and tributaries at the upper reach upstream of the OEPA sampling stations that did not receive full attainment (Table 2-8)
- Riparian areas of Swamp Creek and tributaries near the high runoff fields
- Riparian areas with narrow, lack of vegetation or with little or no riparian buffer
- Riparian areas suitable for floodplain/wetland enhancement and/or restoration

### 3.3.2. Detailed Biological Conditions

As previously shown in Section 2, the 2005 sampling conducted by OEPA at three sampling points in this HUC-12 indicates that conditions were suitable for supporting warmwater aquatic habitat with the QHEI scores of 34 at the upstream site and 37.5 at the tributary sampling site. The further downstream site was designated as Exceptional, though no attainment status was provided due to droughty conditions. The low scores upstream reflected the low quality of Swamp Creek because of channelization, narrow or no riparian buffer and moderate stream erosion. The biological and chemical indicators in 2005 demonstrated that the water quality and habitats were only marginally good/good.

### 3.3.3. Detailed Causes and Associated Sources

The biological indices, habitat and water quality data collected in 2005 showed Swamp Creek marginally good/good quality. The majority of Swamp Creek in the upper section of the watershed has been channelized and with narrow or no riparian buffer (OEPA, 2007). Crops are planted very close to the stream and excess nutrients are directly flows into the creek. The implementation of planting of riparian buffers and stream restoration can slow the runoff from the fields and reduce the amount of nutrients washing directly into the streams.

For the high-quality riparian corridors in the lower portion of the watershed, it is important to maintain the quality level by ensuring the riparian area is protected, wetlands and floodplains are restored or enhanced, and buffers are vegetated with the appropriate plant species. For areas with severe streambank erosion, large amounts of sediments are washed down from the banks during and after intense storms. Many of the eroding banks are bare, steeply cut and not protected. The implementation of streambank stabilization and planting of riparian buffers can reduce erosion and siltation/sedimentation in the streams.

### 3.3.4. Outline Goals and Objectives for the Critical Area

The goal of the NPS-IS is to improve water quality and meet nutrient reduction goals and improve impairment status. Narrow stream buffers and severe stream erosion and siltation/sedimentation, which are common in the Headwaters Twin Creek watershed, might cause water quality degradation and contribute to Gulf of Mexico hypoxia. The Critical Area # 2 focuses on protection and management of riparian corridors and improving water quality and aquatic life in both near-field and far-field waterways.

Currently riparian BMPs are underutilized in this watershed. The floodplain and wetland restoration, stabilization of severely eroding banks and riparian buffer planting will provide great benefits to maintain and improve stream health and aquatic life attainment. No stream restoration projects have been implemented in this HUC-12.

**Goal 1** – Achieve an IBI score at or above 40.

NOT ACHIEVED: IBI was 44 at Swamp Creek and 38 in its tributary

**Goal 2** – Achieve an ICI score at or above 46, which can be described as "good."

NOT ACHIEVED: ICI score was described as Fair and Marginally Good at the two sites

**Goal 3** – Achieve a QHEI score at or above 60 throughout the watershed.

NOT ACHIEVED: QHEI score was 34 at the mainstem and 37.5 in the tributary.

### *Objectives*

The upper section of Swamp Creek is in partial attainment with low QHEI and IBI scores and improvement is needed. The lower section of the creek is in full attainment and needs to be protected from degradation.

**Objective 1:** Improve the biological habitats in Swamp Creek and its tributaries by restoring the natural stream channel, or implementing a conservation or two-stage ditch along at least 3 miles in Montgomery and Darke counties, reconnecting the stream with the floodplain and reducing sediment at Critical area 2.

**Objective 2:** Improve the natural habitats in the upper portion of the Swamp Creek by restoring the riparian buffer for at least 3 miles at Critical area 2.

**Objective 3:** Protect with conservation easements or via land acquisitions 10 acres or at least 1 mile of Swamp Creek and its main tributaries.

**TABLE 3-5 ESTIMATED NUTRIENT REDUCTIONS FOR CRITICAL AREA 2 OBJECTIVES**

| Objective Number | Best Management Practice | Total Length/Acreage Treated | Estimated Load Reduction using STEPL* |
|---|---|---|---|
| 1 | Stream and floodplain restoration using ACPF modeling | 3 miles/ 18 acres (avg 50 feet wide) | 72 lbs (N)/16 lbs (P) |
| 2 | Riparian Buffer as designed using ACPF modeling based on the width of the riparian zone and runoff delivery (see Section 2.5.1). | 3 miles/ 18 acres (avg 50 feet wide) | 37 lbs (N)/10 lbs (P) |
| 3 | Protecting riparian areas and wetland with conservation easements and retire 10 acres. | 10 acres | 44 lbs (N)/9 lbs (P) |
| TOTAL | | 46 acres | 153 lbs (N)/35 lbs (P) |

*Estimated using Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Version 4.4 (USEPA, 2019)
N-Nitrogen; P-Phosphate

Conservation easements have been successfully used in the region to protect local water resources and prime farmland from degradation caused by overdevelopment and unsuitable land management. This legal tool limits the impervious surface cover permitted on agricultural lands, encourages implementation of BMPs and permanently protects sensitive areas including prairies, forested stream buffers and wetlands filtering agricultural runoff. The TVCT and

SWCDs will continue to promote conservation easements to help farmers permanently protect their land and improve overall health of Swamp Creek watershed.

Currently there is no routine monitoring or sampling in the Swamp Creek HUC-12. But the future project-specific monitoring efforts will verify progress towards meeting the goals identified in the plan. The objectives, projects and implementation strategies presented herein will be reevaluated and modified if determined necessary, as several versions of this NPS-IS are expected.

This NPS-IS will employ an adaptive management process. As objectives and implementation projects are reevaluated, objectives listed above will be reevaluated, fine-tuned and modified as necessary when more information become available or conditions change. Additional objectives may also be included to make progress towards further reduction goals or water quality improvement goals, as new and additional BMPs can improve nutrient reduction and sedimentation in streams.

The OEPA Nonpoint Source Management Plan Update, which includes a full list of nonpoint source management strategies, will be utilized. Strategies, as presented in the overview tables of Chapter 4, include the following:

- Urban Sediment and Nutrient Strategies;
- Altered Stream and Habitat Restoration Strategies;
- Agricultural Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies

## 3.4. Critical Area 3: Conditions, Goals, & Objectives for Nutrient Reduction and Management from the Unsewered Community of Gordon in Swamp Creek HUC-12

### 3.4.1. Detailed Characterization

According to the 2020 U.S. Census, Gordon, a small Darke County village with a population of 245 and Verona, a small village on the line of Montgomery and Preble counties with a population of 405 are the only villages in the HUC-12. Verona holds an NPDES permit to operate a wastewater treatment plant. Gordon is not served by any wastewater treatment plants, so all of the businesses, churches, and homes in Gordon -- as well as homes, typically on larger lots outside villages -- are served by HSTS. The Clean Watershed Needs Survey conducted the Household Sewage Treatment System Failures in Ohio by the Ohio Department of Health in 2012 indicated the failure rate of HSTS in southwest Ohio was 18% (ODH, 2013). However, the Darke County General Health Department (DCGHD) stated the failure rate for the Village of Gordon is estimated to be significantly higher. OEPA's 2010 TMDL estimated 50% of 226 HSTS in the Swamp Creek HUC-12 were failing, or 113 HSTS without proper treatment.

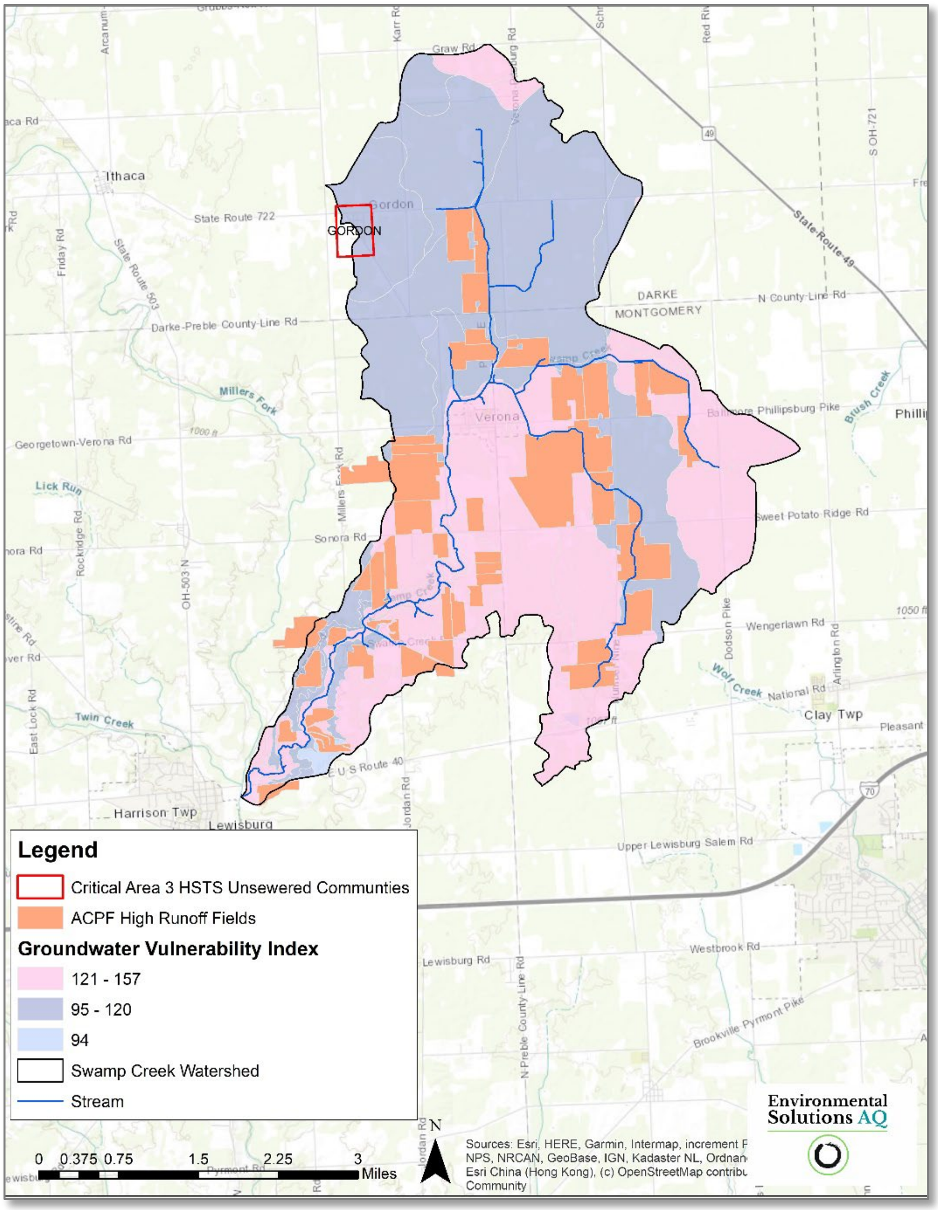



**FIGURE 3-4 CRITICAL AREA 3: UNSEWERED COMMUNITY OF GORDON IN SWAMP CREEK HUC-12**

Gordon has 109 acres and is located in the headwaters of Swamp Creek HUC-12. Gordon is not served by any wastewater treatment plant. So, all of the businesses, churches, and homes in Gordon -- as well as homes, typically on larger lots outside villages -- rely on HSTS to treat sewage. The Clean Watershed Needs Survey conducted the Household Sewage Treatment System Failures in Ohio by the Ohio Department of Health in 2012 indicated the failure rate of HSTS in southwest Ohio was 18% (ODH, 2013). Rural homes throughout the watershed are also served by HSTS.

Ohio's Nutrient Mass Balance Study for Ohio's Major Rivers 2020 (OEPA, 2020) estimated the HSTS community in the Great Miami River Basin contributed 5% of the total P load and 3% of the total N load. HSTS are considered a major bacteria contributor affecting the water quality of Swamp Creek as indicated in the 2007 OEPA report. The NRCS Soil Web Survey for Septic Tank Absorption Fields for Headwaters Twin Creek HUC-12 indicated that 99.8% of the watershed is very limited. Because of the poor soil drainage and shallow depth to bedrock, it is likely that failed HSTS are prevalent and widespread in this watershed.

### 3.4.2. Detailed Biological Conditions

As previously shown in Section 2, the 2005 sampling conducted by OEPA found Swamp Creek and its primary tributary to be in partial or full attainment of WWH. The two sites had relatively low QHEI scores of 34 and 37.5 respectively. Macroinvertebrate and fish assemblages were perhaps more diverse than expected with the low canopy cover, but OEPA attributed the diversity to the cooling influence of groundwater.

The Village of Gordon is more than two miles upstream of the nearest OEPA sampling site which scored a Fair ICI in 2005. Wengerlawn is nearly three miles upstream of the nearest OEPA sampling site (tributary site) and had no ICI score, but did score a 38 IBI.

### 3.4.3. Detailed Causes and Associated Sources

As of September 2005, Swamp Creek was not attaining primary contact for recreational use (PCR) due to elevated bacteria levels. In the 30-day period of OEPA *E. coli* testing, results had a geometric mean of 416 colonies/100 ml., exceeding the 126 colonies/100 ml for PCR. The sampling was done before the Village of Verona's WWTP was constructed and the site was downstream of Verona's known failing HSTS.

OEPA's 2010 TMDL report recognized the positive impact of the new Verona WWTP, but quantified remaining failing HSTS in the Swamp Creek watershed at 113 systems. It is unknown if the 74 systems in the Village of Gordon were the majority of the TMDL's 113 failing systems and have since been replaced with upgraded systems. No data exists about the unincorporated and unsewered community of Wengerlawn in Clay Township, Montgomery County. However, since a major tributary of Swamp Creek flows through the community, it is likely to receive untreated or poorly treated wastewater from failing HSTS in Wengerlawn.

According to DCGHD staff, the Village of Gordon has approximately 74 HSTS serving homes, businesses, churches, etc. Of those 74 HSTS, 59 have permits to operate from DCGHD and 15 do not have permits. DCGHD staff estimate 20% of all existing HSTS are failing, or 15 HSTS. The systems either have no secondary treatment (e.g. leach field) or the leach field is more than fifty years old. Failing systems are likely discharging waste to field tiles or ditches that discharge directly to Swamp Creek. OEPA's 2007 report demonstrated the agency's concern about failing septic systems in the watershed, especially in unsewered communities like the Village of Verona, though a WWTP was being built for the village at the time of the report.

Lot sizes smaller than one half acre severely limit the ability of homeowners to install new or replacement leach fields. Groundwater is also likely being impacted – a particular risk of nitrate contamination, especially in shallower wells (Swann, 2001).

This plan's objectives focus on the Village of Gordon and the potential for municipal wastewater treatment because small lot size makes conventional system replacement impossible, and funding unconventional systems such as sand filters or mound systems financially impractical.

To determine the annual nutrient load from HSTS to Swamp Creek from Gordon, an estimate of the concentration of Total N and Total P in septic tank effluent is needed. Since there are no nutrient concentrations determined in Gordon, four studies with similar septic tank effluent concentrations were located from literature search (Swann, 2001). Table 3-6 provides an average of those studies' findings, plus the conversion to pounds per million gallons of water.

### TABLE 3-6 ESTIMATED CONCENTRATIONS OF NUTRIENTS IN SEPTIC TANK EFFLUENT

| | **Average mg/L in septic tank effluent from four similar studies** | **Ave.lbs./million gallons in septic tank effluent** |
|---|---|---|
| Total N | 42.4 | 353.8 |
| Total P | 16 | 134 |

*Source: Swann 2001*

DCGHD estimated the number of septic systems they believe to be failing. 2020 Census data and USGS estimates of average water use per day are also included in Table 3-7.

### TABLE 3-7 GORDON POPULATION, HSTS AND ESTIMATED WATER USE

| **Gordon, Ohio** | | | | | |
|---|---|---|---|---|---|
| **Population (2020 US Census)** | **Number of HSTS (DCGHD)** | **People per HSTS, based on US Census** | **Number of failing HSTS (DCGHD)** | **Total number of humans whose waste is discharging failed system** | **Gallons of water used per day at 82 gal per person (USGS)/M Gallion per year** |
| **245** | **74** | **3.3** | **15** | **49.5** | **4,059/1.48** |

*Source: US Census, DCGHD*

This data provides the opportunity to estimate pounds per year of both total nitrogen and total phosphorus (Table 3-8).

### TABLE 3-8 ESTIMATED ANNUAL NUTRIENT LOADS TO TWIN CREEK FROM FAILING SEPTIC SYSTEMS IN GORDON, OHIO

| | **Million gallons effluent per year flowing from failing HSTS in Gordon, Ohio** | **Average concentrations of nutrients in mg/L (Swann)** | **Average concentrations of nutrients in lbs./million gallons*** | **Estimated pounds per year of nutrients discharging HSTS from Gordon to Swamp Creek**** |
|---|---|---|---|---|
| **Total N** | 1.48 | 42.4 | 353.8 | 523.6 |
| **Total P** | | 16 | 134 | 198.3 |

**https://www.unitconverters.net/concentration-solution/milligram-liter-to-pound-million-gallon-us.htm*

***Pounds per year = AVE mg/L N or P -> Ave lbs./ M gal N or P * (number of humans on failing septic systems * 82 gallons per day use * 365 days in a year)*

### 3.4.4. Outline and Objectives for the Critical Area

The goal of NPS-IS is to improve water quality and meet nutrient reduction goals. Reduction of HSTS nutrient contributions will lead to the reduction of bacteria and nutrients releasing to the environment and local waterways. The Swamp Creek HUC-12 is a rural watershed (11,213 acres) and most of the watershed is unsewered.

Based on the watershed characteristics, the prioritized areas in Critical Area 3 and potential projects should meet at least one of the following criteria:

- Lands where the villages or other densely populated areas are unsewered (Gordon);
- Lands directly adjacent to Swamp Creek or its tributaries;
- Lands within the high Groundwater Vulnerability Index;
- Lands within the source water protection areas.

Baseline development loads for nitrogen is 7,678 lb and phosphorous is 486 lb (Table 2-13). In order to meet the 20% overall nutrient reduction goals, reductions in nutrient contributions from failing HSTS at Gordon should be considered.

**Goal 1** Reduce phosphorus loading contributions in *Critical area 3* to a level at or below 97lbs/year (20% reduction).

NOT ACHIEVED: Currently 15 of 74 HSTS are failing in the Village of Gordon. Phosphorus load contribution is estimated to be 198.3 lbs/year.

**Goal 2** Reduce nitrogen loading contributions in Critical area 3 to a level at or below 1,536 lbs/year (20% reduction).

NOT ACHIEVED: Currently 15 of 74 HSTS are failing in the Village of Gordon. Nitrogen load contribution is estimated to be 418 lbs/year.

**Goal 3** Attain and maintain PCR use in Swamp Creek.

NOT ACHIEVED: At US Route 40 in September2005, the bacterial geometric mean documented *E. coli* at 416 colonies/100ml, an exceedance of the PCR WQS of 126 colonies/100 ml. 40% of *E. coli* sampling results at that site exceeded 298 colonies/100 ml, and the Water Quality Standard is not more than 10% shall do so in a 30-day period (OEPA 2007). This finding reveals a higher *E. coli* contamination than biological testing throughout the upper Twin watershed -- where 39% of samples exceeded the *E. coli* standard.

If all failing/discharging HSTS were replaced in Gordon, it is estimated that 523.6 pounds of nitrogen and 198.3 pounds of phosphorus would be prevented from entering Swamp Creek annually. Significant *E. coli* and fecal coliform bacteria and other pathogens would no longer discharge to the headwaters of Swamp Creek, protecting the health of families in the Swamp Creek HUC-12 (OEPA 2010).

#### *Objectives*

In order to make substantive progress toward the achievement of the phosphorous load reduction goal of198 lbs for the HSTS contribution, effort must commence on more widespread implementation, according to the following objectives as first steps to address the failing HSTS within *Critical area 3.*

**Objective 1:** Replace 15 failing HSTS in the Village of Gordon or connect them to sanitary sewer infrastructure.

**Objective 2:** Enroll all HSTS in the HUC-12 in county health department permitting programs, including operation and maintenance systems.

**Objective 3:** Replace 20 failing HSTS outside of the Village of Gordon, and within 500 feet of Swamp Creek and/or known to have no secondary treatment and to be discharging directly to surface water.

To achieve these objectives, Darke, Preble and Montgomery county health departments could pursue funding assistance from Ohio EPA Division of Financial Assistance (DEFA) to provide cost-share for income-eligible homeowners. Additional staff resources are needed to achieve universal compliance.

It is recommended that the Village of Gordon complete an engineering study of customized wastewater treatment options in small communities where HSTS are no longer providing adequate wastewater treatment.

Currently there is no routine stream monitoring or sampling in the Swamp Creek HUC-12. But the future project-specific monitoring efforts will verify progress towards meeting the goals identified in the plan. The objectives, projects and implementation strategies presented herein will be reevaluated and modified if determined necessary, as several versions of this NPS-IS are expected. Complete an engineering study of customized wastewater treatment options in small communities where HSTS are no longer providing adequate wastewater treatment.

This NPS-IS will employ an adaptive management process. As objectives and implementation projects are reevaluated, objectives listed above will be reevaluated, fine-tuned and modified as necessary when more information become available or conditions change. Additional objectives may also be included to make progress towards further reduction goals or water quality improvement goals, as new and additional BMPs can improve nutrient reduction and sedimentation in streams.

The OEPA Nonpoint Source Management Plan Update, which includes a full list of nonpoint source management strategies, will be utilized. Strategies, as presented in the overview tables of Chapter 4, include the following:

- Urban Sediment and Nutrient Strategies;
- Altered Stream and Habitat Restoration Strategies;
- Agricultural Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies

# Chapter 4: Projects and Implementation Strategy

The Great Miami River Basin is one of the major nutrient contributors to Ohio River and Gulf Hypoxia (OEPA, 2020). It is important and beneficial for the NPS-IS initiatives to be implemented in this region as soon as possible. Swamp Creek HUC-12 is an agricultural watershed and implementation of proposed conservation practices is targeted to reduce nutrient load reduction by 20%. Based on the 2005 OEPA sampling, the Swamp Creek HUC-12 was a marginally good/good quality stream and therefore, the goal is to improve and protect its stream and habitat health.

The Project and Implementation Strategy of the Swamp Creek HUC-12 NPS-IS includes an action plan based on the cause and source of NPS pollution which are described in the previous Chapter. Chapter 3 presented the two Critical Areas and their goals, objectives, and potential projects. These critical areas will be reevaluated through time to monitor progress towards meeting their NPS goals and objectives. Some of the positive impacts may be slow and take years to show progress towards recovery.

## 4.1. Overview Tables and Project Sheets for Critical Areas

The critical areas provide a general concept and will be further evaluated as partners and landowners provide additional feedback on projects the team proposed. The estimated project costs and the time frame are both dependent upon funding opportunities and coordination with landowners and project partners. At such a time as a project becomes viable, the team will submit an updated NPS-IS with additional project summary sheets.

At such a time, the project summary sheets will outline how the nine minimum elements of watershed planning are being met by each opportunity, as shown in the first column of each table. Moreover, this NPS-IS will be updated periodically to address stakeholder input and additional project opportunities may be added at that time. If a future critical area is identified (e.g., HSTS nutrient loading) within the Swamp Creek HUC-12, supplemental information will be provided.

## 4.2. Project Tables

The Project Overview Table for each Critical Area presents a summary of each strategy identified for each critical area. BMP strategies are divided into several categories, including urban storm water runoff management, altered stream and habitat restoration strategies, and other nonpoint source causes and associated sources of impairment.

### TABLE 4-1 CRITICAL AREA 1 PROJECT OVERVIEW TABLE FOR SWAMP CREEK HUC-12

| For Swamp Creek HUC-12 (050800020203) Critical Area 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Goal** | **Objective** | **Project** | **Project Title (EPA Criteria g)** | **Lead Organization (EPA Criteria f)** | **Time Frame (EPA Criteria f)** | **Estimated Cost (EPA Criteria d)** | **Funding/Actual Sources (EPA Criteria d)** |
| Urban Sediment and Nutrient Reduction Strategies | | | | | | | |
| | | | | | | | |
| Altered Stream and Habitat Restoration Strategies | | | | | | | |
| | | | | | | | |
| Agricultural Nonpoint Source Reduction Strategies | | | | | | | |
| 1, 2 | 2 | 1 | Agricultural BMP – 500 Acres Cover Crops | Preble, Montgomery, Darke SWCD | Short to Medium (1-7 years) | $20,000 | EQIP-CIC, CSP, Ducks Unlimited, Farmers for Soil Health |
| High Quality Waters Protection Strategies | | | | | | | |
| | | | | | | | |
| Other NPS Causes and Associated Sources of Impairment | | | | | | | |
| | | | | | | | |

## TABLE 4-2 CRITICAL AREA 1 - PROJECT 1 TABLE: COVER CROPS

| Project #1– Headwaters Twin Creek HUC-12 Critical Area 1 | | |
|---|---|---|
| **Nine Element Criteria** | **Information needed** | **Explanation** |
| n/a | Title | Agricultural BMPs – Cover Crops |
| criteria d | Project Lead Organization & Partners | Darke Soil and Water Conservation District<br>Montgomery Soil and Water Conservation District<br>Preble Soil and Water Conservation District |
| criteria c | HUC-12 and Critical Area | Swamp Creek HUC-12 (050800020203) Critical Area 1 |
| criteria c | Location of Project | Private landowners – exact location not disclosed |
| n/a | Which strategy is being addressed by this project? | Agricultural Nonpoint Source Reduction |
| criteria f | Time Frame | Short to Medium (1-7 years) |
| criteria g | Short Description | Administer cost-share program for cover crop installation |
| criteria g | Project Narrative | Darke, Montgomery, and Preble SWCDs will administer a cost-share program to local landowners in prioritized agricultural lands to install about 500 acres of cover crops. |
| criteria d | Estimated Total cost | $20,000 |
| criteria d | Possible Funding Source | EQIP-CIC, CSP, Ducks Unlimited, Farmers for Soil Health |
| criteria a | Identified Causes and Sources | Cause: Nutrient loadings<br><br>Source: Agricultural land use activities |
| criteria b & h | Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area? | **Objective 2:** Plant an additional 500 acres of cover crops annually in addition to the 700 acres that are already planted per year.<br><br>The overall goal in Critical area 1 is to reduce estimated total nitrogen load for agricultural lands by 20% (37,452 lb). In order to meet the Gulf of Mexico hypoxia reduction goals, the total nitrogen loadings must be reduced by additional 37,452 lb/year and the phosphorous load reduction needed is 2,372 lb./year. |
| | Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project? | Goal: This project is expected to achieve 1% of the total nitrogen reduction goal and 1.6% of the total phosphorous reduction goal. |
| | Part 3: Load Reduced? | Estimate of 376 lbs/yr (N)/39 lbs/yr (P) load reduction based on STEPL 4.4b Spreadsheet Model for 10 Watersheds. |

### TABLE 4-3 CRITICAL AREA 2 PROJECT OVERVIEW TABLE FOR SWAMP CREEK HUC-12

| For Swamp Creek HUC-12 (050800020203) Critical Area 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Goal** | **Objective** | **Project** | **Project Title (EPA Criteria g)** | **Lead Organization (EPA Criteria f)** | **Time Frame (EPA Criteria f)** | **Estimated Cost (EPA Criteria d)** | **Funding/Actual Sources (EPA Criteria d)** |
| Urban Sediment and Nutrient Reduction Strategies | | | | | | | |
| | | | | | | | |
| Altered Stream and Habitat Restoration Strategies | | | | | | | |
| | | | | | | | |
| Agricultural Nonpoint Source Reduction Strategies | | | | | | | |
| | | | | | | | |
| Other NPS Causes and Associated Sources of Impairment | | | | | | | |
| | | | | | | | |

## TABLE 4-4 CRITICAL AREA 3 PROJECT OVERVIEW TABLE FOR SWAMP CREEK HUC-12

| For Swamp Creek HUC-12 (050800020203) Critical Area 3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Goal** | **Objective** | **Project** | **Project Title (EPA Criteria g)** | **Lead Organization (EPA Criteria f)** | **Time Frame (EPA Criteria f)** | **Estimated Cost (EPA Criteria d)** | **Funding/Actual Sources (EPA Criteria d)** |
| Urban Sediment and Nutrient Reduction Strategies | | | | | | | |
| | | | | | | | |
| Altered Stream and Habitat Restoration Strategies | | | | | | | |
| | | | | | | | |
| Agricultural Nonpoint Source Reduction Strategies | | | | | | | |
| | | | | | | | |
| High Quality Waters Protection Strategies | | | | | | | |
| | | | | | | | |
| Other NPS Causes and Associated Sources of Impairment | | | | | | | |
| | | | | | | | |

# Chapter 5: Appendix

## *APPENDIX A – References*

Agricultural Research Service. 2019. Using Watershed Information to Power Conservation. U.S. Department of Agriculture, Agricultural Research Service, National Laboratory for Agriculture and the Environment. Ames, Iowa. April 2019. http://acpf4watershets.org. Accessed May 2023.

Agricultural Research Service. 2023. ACPF formatted geodatabase for Swamp Creek HUC-12.

Baker, D.B., R.P. Richards, and J.W. Kramer. 2006. “Point source-nonpoint source trading: applicability to stream TMDLs in Ohio.” Proceedings – Innovations in Reducing Nonpoint Source Pollution. (November 28 – November 30, 2006), 328-327.

“COMET-Planner” USDA Natural Resources Conservation Service. Colorado State University, September 2022, https://pln-50-ui-010109-dot-comet-201514.appspot.com/

“Conservation Practice Standards” USDA Natural Resources Conservation Service. October 2022, https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-standards

Coppess, Jared. Darke Soil and Water Conservation District. Personal correspondence, March-August, 2023.

“Enforcement and Compliance History Online: Detailed Facility Report” United States Environmental Protection Agency, September 21, 2022. https://echo.epa.gov/detailed-facility-report?fid=110064255540

Everman, Ed. Montgomery Soil and Water Conservation District. Personal correspondence, March-August, 2023.

Farver, Elizabeth. Darke Soil and Water Conservation District. Personal correspondence, June 29, 2023.

Goolsby, D.A., W.A Battaglin, G.B. Lawrence, R.S. Artz, B.T. Aulenback, R.P. Hooper, D.R. Keeney, and

G.J. Stensland. 1999. “Flux and sources of nutrients in the Mississippi-Atchafalaya River Basin: Topic 3 report for the integrated assessment on hypoxia in the Gulf of Mexico.” NOAA Coastal Ocean Program Decision Analysis Series No. 17.

Institute for Environment and Sustainability (IES) Miami University, 2010. Updated Twin Creek Watershed Action Plan, April 2010.

Lindsay, Matthew. Miami Valley Regional Planning Commission. Personal correspondence, April 19, 2023.

Longfellow, Rickie. “Back in Time: The National Road.” Federal Highway Administration, June 2017, https://www.fhwa.dot.gov/infrastructure/back0103.cfm

Miami Conservancy District, 2017. Lower Great Miami River Nutrient Management Project, February, 2017.

Miami Valley Areawide Water Quality Management Plan: Final 208 Plan, Miami Valley Regional Planning Commission. May 2011

National Academies, Global warming is making some extreme weather events worse. August 12, 2021. https://www.nationalacademies.org/based-on-science/climate-change-global-warming-is-contributing-to-extreme-weather-events. Accessed June 2023.

National Land Cover Database, 2021 (NLCD 2021). Multi-Resolution Land Characteristics Consortium (MRLC). https://www.mrlc.gov/data.

Ohio Department of Agriculture – Division of Soil and Water Conservation, Regional Watershed Program, Watershed Plan, Region 3, First Edition, 2023.

Ohio Department of Natural Resources – Division of Soil and Water Resources. 2005. Ohio Stream Management Guide: Stream Debris and Obstruction Removal.

Ohio Department of Natural Resources – Division of Water Resources, Ohio Dam Safety Program Ohio Dam Locator https://gis.ohiodnr.gov/mapviewer/?config=ohiodams. Accessed February 2023

Ohio Division of Geological Survey, 2005. Bedrock geologic map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map BG-1, generalized page-size version with text, 2 p., scale 1:2,000,000.

Ohio Environmental Protection Agency (OEPA), 2002. Drinking Water Source Assessment for the Village of West Manchester PWS ID # 6801412.

Ohio Environmental Protection Agency (OEPA), 2003. Drinking Water Source Protection Report for the City of Lewisburg Public Water System.

Ohio Environmental Protection Agency (OEPA), 2007. Biological and water quality study of Twin Creek and select tributaries 2005. Darke, Preble,

Montgomery, and Warren Counties, Ohio. Ecological Assessment Section, Division of Surface Water, Columbus, OH.

Ohio Environmental Protection Agency (OEPA) 2010. Total Maximum Daily Loads for the Twin Creek Watershed, Final Report January, 2010.

Ohio Environmental Protection Agency (OEPA), 2016a. Guide to Developing Nine-Element Nonpoint Source Implementation Strategic Plans in Ohio, August 2016.

Ohio Environmental Protection Agency (OEPA), 2016b. Template with Descriptions for Ohio's Nonpoint Source Pollution Implementation Strategies. Final. July 2016.

Ohio Environmental Protection Agency (OEPA), 2020a. Nutrient Mass Balance Study for Ohio's Major Rivers 2020, December, 2020, OEPA Division of Surface Water.

Ohio Environmental Protection Agency (OEPA), 2020b. Ohio 2020 Integrated Water Quality Monitoring and Assessment Report, Final Report, May 2020.

Ohio Environmental Protection Agency (OEPA) 2020c. Nonpoint Source Management Plan Update. Ohio EPA, Division of Surface Water, Nonpoint Source Program.

Ohio Historical Society, Anthony Wayne Campaign Map, retrieved 02/22/2023 from https://ohiomemory.org/digital/collection/p267401coll32/id/17207

Ohio Historical Society, Indians in Ohio History, retrieved 02/22/2023 from https://ohiomemory.org/digital/collection/p267401coll32/id/16227

Pape, D., J. Lewandrowski, R. Steele, D. Man, M. Riley-Gilbert, K. Moffroid, and S. Kolansky, 2016. Managing Agricultural Land for Greenhouse Gas Mitigation within the United States. Report prepared by ICF International under USDA Contract No. AG-3144-D-14-0292. July 2016.

"Preble County Public Health Sewage Treatment System Program FAQ," Public Health Preble County. Revised Aug. 2018, https://www.preblecountyhealth.org/_files/ugd/cd8f33_12349e805bf3432ca9effea52b20eca1.pdf

Price, B.J., Preble Soil and Water Conservation District. Personal correspondence, June 2023.

Board of Preble County Commissioners. Preble County Comprehensive Economic Development Strategy and Land Use Plan, Adopted approximately 2016.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI), rationale, methods, and application. Ohio Environmental Protection Agency, Division of Water Quality Planning and Assessment, Ecological Assessment Section, Columbus, OH.

Rankin, E. T. 1995. Habitat indices in water resource quality assessments, pp. 181- 208 in Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Davis, W.S. and Simon, T.P. (eds.), Lewis Publishers, Boca Raton, FL.

Rosgen, D.L. 2001. A Practical Method of Computing Streambank Erosion Rate.

Proceedings of the Seventh Federal Interagency Sedimentation Conference, Vol. 2, pp. II - 9-15, March 25-29, 2001, Reno, NV. Available on the Wildland Hydrology website: http://www.wildlandhydrology.com/html/references_.html

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed June 12, 2023.

Surber, James P, Darke County Engineer. Date unknown. Responsibility and Procedures for Improvement and Maintenance of Ditches, Drains and Watercourses.

Swann, C. 2001. The Influence of Septic Systems at the Watershed Level: Watershed Protection Techniques Special Issue on Urban Lake Management. Center for Watershed Protection, Ellicott City, MD. Pages 821-834

Tomer, M.D., S.A. Porter, D.E. James, K.M.B. Boomer, J.A. Kostel, and E. McLellan. 2013. Combining precision conservation technologies into a flexible framework to facilitate agricultural watershed planning.

Journal of Soil and Water Conservation 68 (5): 113A-120A.

United States Department of Agriculture (USDA) National Agricultural Statistics Service Cropland Data Layer 2016-2022. Published crop-specific data layer. Available at http://nassgeodata.gmu.edu/CropScape/ USDA-NASS, Washington, DC. (accessed June 2023). USDA-NASS, Washington, DC.

United States Department of Agriculture (USDA) Natural Resources Conservation Service. COMET-Planner Carbon and Greenhouse Gas Evaluation for NRCS Conservation Practice Planning, A companion report to www.comet-planner.com. (Version 3 DRAFT). September 2022.

United States Department of Agriculture (USDA) Natural Resources Conservation Service Web Soil Survey. 2020. Preble County OH, June 2020. Accessed April 2023.

United States Department of Agriculture (USDA) Natural Resources Conservation Service Web Soil Survey. 2020. Darke County OH, June 2020. Accessed April 2023.

United States Department of Agriculture (USDA) Natural Resources Conservation Service Web Soil Survey. 2020. Montgomery County OH, June 2020. Accessed April 2023.

US Fish and Wildlife Service, 2017. Ohio County Distribution of Federally-Listed Endangered, Threatened, and Proposed Species. Accessed February 2021.

United States Environmental Protection Agency (USEPA), 2000. Biosolids Technology Fact Sheets: Land Application of Biosolids, EPA 832-F-00-064.

United States Environmental Protection Agency (USEPA), 2012. Ecoregion Download Files by State - Region 5. https://www.epa.gov/ecoresearch/ecoregion-download-files-state-region-5. Accessed June 2023

United States Environmental Protection Agency (USEPA), 2013. Nonpoint Source Program and Grants Guidelines for States and Territories, §319 Program Guidance (April 2013).

United States Environmental Protection Agency (USEPA), 2014, Mississippi River Gulf of Mexico Watershed Nutrient Task Force New Goal Framework, December 3, 2014.

United States Environmental Protection Agency (USEPA). 2019. Spreadsheet Tool for Estimating Pollutant Load (STEPL), Version 4.4. http://it.tetratechffx.com/steplweb/. Accessed April 2021

Water Quality Portal. Washington (DC): National Water Quality Monitoring Council, United States Geological Survey (USGS), Environmental Protection Agency (EPA); 2021. https://doi.org/10.5Wilson, Frazer E., History of Darke County Ohio, The Hobart Publishing Company, Milford, Ohio, 1914. courtesy of HathiTrust. https://babel.hathitrust.org/cgi/pt?id=nyp.33433081845418&view=1up&seq=13). Accessed May 1, 2023.

“World of Change: Global Temperatures.” *Earth Observatory,* National Aeronautics and Space Administration`, https://earthobservatory.nasa.gov/world-of-change/global-temperatures

## *APPENDIX B – Common Soils of the Swamp Creek Watershed*

| **Summary by Map Unit — Darke County, Ohio (OH037)** | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| Br | Brookston silty clay loam, fine texture, 0 to 2 percent slopes | Poorly drained | 1,586.10 | 14.10% |
| CeB | Celina silt loam, 2 to 6 percent slopes | Moderately well drained | 81.9 | 0.70% |
| CrA | Crosby silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes | Somewhat poorly drained | 1,361.40 | 12.10% |
| CrB | Crosby silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes | Somewhat poorly drained | 79.5 | 0.70% |
| CtA | Crosby-Celina silt loams, 0 to 2 percent slopes | Somewhat poorly drained | 59 | 0.50% |
| CtB | Crosby-Celina silt loams, 2 to 4 percent slopes, eroded | Somewhat poorly drained | 1.3 | 0.00% |
| KoA | Kokomo silty clay loam, 0 to 1 percent slopes | Very poorly drained | 81.4 | 0.70% |
| MmB | Miamian silt loam, 2 to 6 percent slopes | Well drained | 7.5 | 0.10% |
| Pa | Patton silty clay loam, 0 to 2 percent slopes | Poorly drained | 72.4 | 0.60% |
| **Subtotals for Soil Survey Area** | | | **3,330.60** | **29.70%** |

| **Summary by Map Unit — Montgomery County, Ohio (OH113)** | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| Bs | Brookston silty clay loam, fine texture, 0 to 2 percent slopes | Poorly drained | 2,365.20 | 21.10% |
| CeA | Celina silt loam, 0 to 2 percent slopes | Moderately well drained | 127 | 1.10% |
| CeB | Celina silt loam, 2 to 6 percent slopes | Moderately well drained | 713.7 | 6.40% |
| CeB2 | Celina silt loam, 2 to 6 percent slopes, eroded | Moderately well drained | 48.9 | 0.40% |
| CsA | Crosby silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes | Somewhat poorly drained | 970.9 | 8.70% |
| CtA | Crosby-Celina silt loams, 0 to 2 percent slopes | Somewhat poorly drained | 71.8 | 0.60% |
| CtB | Crosby-Celina silt loams, 2 to 4 percent slopes, eroded | Somewhat poorly drained | 113.8 | 1.00% |
| KoA | Kokomo silty clay loam, 0 to 1 percent slopes | Very poorly drained | 123.9 | 1.10% |
| MlB | Miamian silt loam, 2 to 6 percent slopes | Well drained | 16 | 0.10% |
| MlB2 | Miamian silt loam, 2 to 6 percent slopes, eroded | Well drained | 39.1 | 0.30% |
| MlC2 | Miamian silt loam, 6 to 12 percent slopes, eroded | Well drained | 3.6 | 0.00% |
| MnC3 | Miamian clay loam, 6 to 12 percent slopes, severely eroded | Well drained | 5.7 | 0.10% |
| W | Water | | 5.8 | 0.10% |
| **Subtotals for Soil Survey Area** | | | **4,605.40** | **41.10%** |

| **Summary by Map Unit — Preble County, Ohio (OH135)** | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| CeA | Celina silt loam, 0 to 2 percent slopes | Moderately well drained | 36 | 0.30% |
| CeB | Celina silt loam, 2 to 6 percent slopes | Moderately well drained | 423.9 | 3.80% |
| CeB2 | Celina silt loam, 2 to 6 percent slopes, eroded | Moderately well drained | 237.8 | 2.10% |
| CtA | Crosby-Celina silt loams, 0 to 2 percent slopes | Somewhat poorly drained | 613.4 | 5.50% |
| CtB | Crosby-Celina silt loams, 2 to 4 percent slopes, eroded | Somewhat poorly drained | 115.7 | 1.00% |
| EeA | Eel silt loam, gravelly substratum, 0 to 1 percent slopes, occasionally flooded | Moderately well drained | 53.5 | 0.50% |
| EhC3 | Eldean gravelly clay loam, 6 to 12 percent slopes, severely eroded | Well drained | 27.2 | 0.20% |
| EhD3 | Eldean gravelly clay loam, 12 to 18 percent slopes, severely eroded | Well drained | 1.4 | 0.00% |
| EkA | Eldean loam, 0 to 2 percent slopes | Well drained | 31.5 | 0.30% |
| EkB | Eldean loam, 2 to 6 percent slopes | Well drained | 7.1 | 0.10% |
| EkB2 | Eldean loam, 2 to 6 percent slopes, eroded | Well drained | 7.6 | 0.10% |
| FmA | Fox silt loam, till substratum, 0 to 2 percent slopes | Well drained | 4.9 | 0.00% |
| FmB | Fox silt loam, till substratum, 2 to 6 percent slopes | Well drained | 3.2 | 0.00% |
| HeF2 | Hennepin-Miamian silt loams, 25 to 50 percent slopes, eroded | Well drained | 6.7 | 0.10% |

| | | | | |
|---|---|---|---|---|
| KeC2 | Kendallville-Eldean silt loams, 6 to 12 percent slopes, eroded | Well drained | 23.7 | 0.20% |
| KeD2 | Kendallville-Eldean silt loams, 12 to 18 percent slopes, eroded | Well drained | 9.7 | 0.10% |
| KnA | Kokomo silt loam, 0 to 1 percent slopes | Very poorly drained | 4.6 | 0.00% |
| KoA | Kokomo silty clay loam, 0 to 1 percent slopes | Very poorly drained | 757.4 | 6.80% |
| MeC2 | Miamian silt loam, 6 to 12 percent slopes, eroded | Well drained | 65.5 | 0.60% |
| MeD2 | Miamian silt loam, 12 to 18 percent slopes, eroded | Well drained | 19 | 0.20% |
| MfB | Miamian-Celina silt loams, 2 to 6 percent slopes | Well drained | 26.3 | 0.20% |
| MfB2 | Miamian-Celina silt loams, 2 to 6 percent slopes, eroded | Well drained | 297.3 | 2.70% |
| MgE2 | Miamian-Kendallville silt loams, 18 to 25 percent slopes, eroded | Well drained | 31 | 0.30% |
| MhC3 | Miamian-Losantville clay loams, 6 to 12 percent slopes, severely eroded | Well drained | 160.3 | 1.40% |
| MhD3 | Miamian-Losantville clay loams, 12 to 18 percent slopes, severely eroded | Well drained | 33.2 | 0.30% |
| MmE2 | Miamian-Hennepin silt loams, 18 to 25 percent slopes, eroded | Well drained | 8.6 | 0.10% |
| MuD2 | Milton silt loam, 12 to 18 percent slopes, eroded | Well drained | 19.9 | 0.20% |
| OcA | Ockley silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes | Well drained | 11.9 | 0.10% |
| RaB2 | Rainsville silt loam, 2 to 6 percent slopes, eroded | Moderately well drained | 2 | 0.00% |

| | | | | |
|---|---|---|---|---|
| RoE2 | Rodman-Kendallville complex, 18 to 25 percent slopes, eroded | Excessively drained | 5.1 | 0.00% |
| RoF2 | Rodman-Kendallville complex, 25 to 50 percent slopes, eroded | Excessively drained | 10.1 | 0.10% |
| RpA | Rossburg silt loam, moderately wet, sandy substratum, 0 to 1 percent slopes, occasionally flooded | Well drained | 41.6 | 0.40% |
| SnA | Sloan silt loam, sandy substratum, 0 to 2 percent slopes, frequently flooded | Very poorly drained | 138.3 | 1.20% |
| W | Water | | 7 | 0.10% |
| WnA | Westland silt loam, 0 to 2 percent slopes | Very poorly drained | 34.3 | 0.30% |
| **Subtotals for Soil Survey Area** | | | **3,276.90** | **29.20%** |
| **Totals for Area of Interest** | | | **11,212.90** | **100.00%** |

*Source: USDA 2023*