NINE-ELEMENT NONPOINT SOURCE IMPLEMENTATION STRATEGIC PLAN
COTTON RUN – FMC
HUC 12
(050800020605)

PREPARED FOR THREE VALLEY CONSERVATION TRUST

PREPARED BY ENVIRONMENTAL SOLUTIONS AQ

VERSION 0.1 (NO PROJECTS):

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Acknowledgements

The Three Valley Conservation Trust would like to express our sincere appreciation for the collaboration of multiple partners in developing the Nonpoint Source Implementation Strategy (NPS-IS) for Cotton Run – Four Mile Creek HUC-12.

We extend our gratitude to the individuals and organizations who contributed valuable background information, insights into objectives, and project recommendations for inclusion in this plan. A special thank you to the staff at the Butler County Soil & Water Conservation District for their outreach, contributions, and thorough reviews, which ensured a comprehensive and accurate strategy.

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Chapter 1: **Introduction**

The Cotton Run – FMC Hydrologic Unit (CR-FC HUC 12) 050800020605 is a primary agricultural watershed located in Butler County in SW Ohio, and it encompasses a drainage area of approximately 51 mi^2. This HUC 12 is part of the Great Miami River (GMR) watershed and it is the most downstream sub watershed within the FMC (FMC) HUC10 (Fig 1).

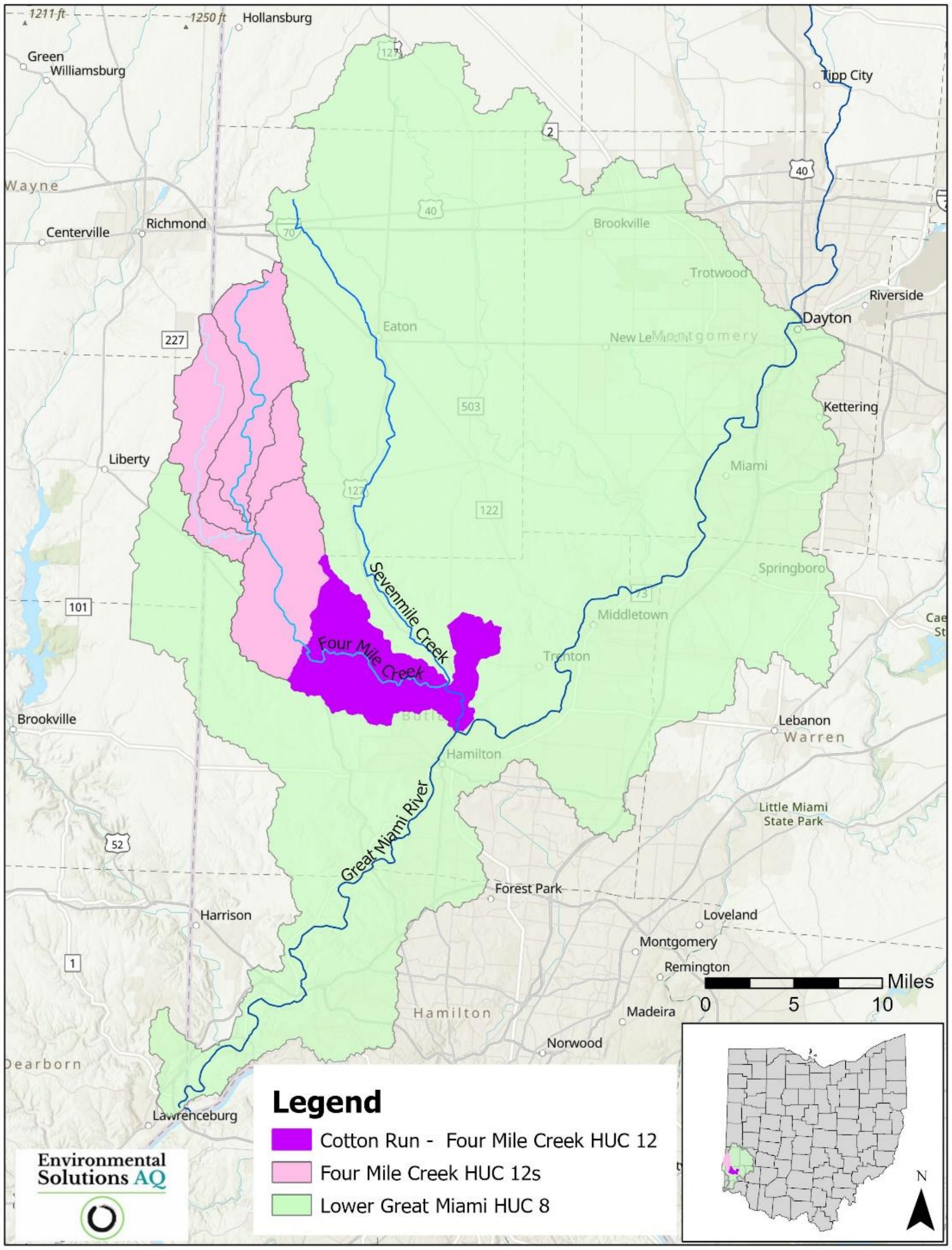

Figure 1 Cotton Run – FMC HUC-12 location

The GMR watershed has been identified as one of the high priority watersheds in the Ohio River Basin to address water quality impairment caused by excessive nutrient loss, especially from agricultural lands.

The plan aims to establish a strategy to tackle excessive nutrient loads, sedimentation, and other nonpoint sources of pollution that degrade water quality within the watershed. These issues contribute to impairments downstream in the Great Miami River, Ohio River, and further affect the Mississippi River and Gulf of Mexico. Additionally, developing this plan aligns with the goals of the Mississippi River/Gulf of Mexico Hypoxia Task Force (HTF) to reduce nutrient levels in the Mississippi River Basin. Furthermore, the plan will help identified projects qualify for Clean Water Act Section 319 Grants (319 Grants) and other federal and state resources aimed at addressing nonpoint source pollution in the watershed.

The CR-FMC HUC 12 NPS-IS initiative is sponsored by Three Valley Conservation Trust (TVCT) and developed in collaboration with Environmental Solutions AQ (ENSOAQ), a local environmental consulting firm.

1.1. Report Background

The GMR watershed, which contains the CR-FMC HUC 12, has been identified as one of high priority watersheds to address impairments caused by nutrient loss to streams and rivers in the Ohio River Basin. The recently published nutrient mass balance report (Ohio EPA, 2022) analyzed three major categories of nutrient sources impacting the GMR watershed; the Nonpoint Pollutant Sources (NPS) defined as nutrients associated with a general land use (developed, agricultural and natural lands), National Pollution Discharge Elimination Systems (NPDES) and Household Sewage Treatment Systems (HSTS). The NPS were identified as the largest contributor of total P and total N to the GMR (66% and 82%, respectively), whereas the HSTS produced the lowest loads of the three categories (5% of total P load and 3% of total N load) (Fig.2)

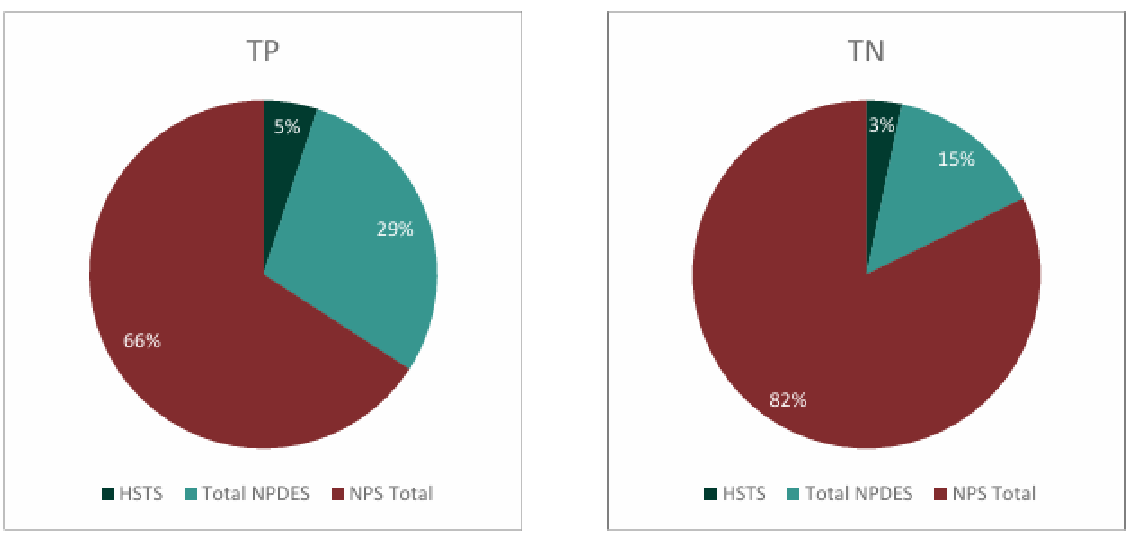

Figure 2 Proportion of total phosphorus and nitrogen load from three major sources: NPS, NPDES and HSTS in the Great Miami River Watershed Average of 5 years (wy 17 - wy 21) (Source: OEPA, 2022, Figure 60)

This NPS-IS will address near-field causes and sources of nonpoint pollutants within the CR-FMC HUC 12 and their far filed impacts on Great Miami, Ohio River and subsequently on Mississippi River and Gulf of Mexico.

The FMC watershed is one of few in Ohio that does not have a Watershed Action Plan. The most recent assessment of the FMC watershed; including the CR-FMC HUC 12 was conducted by the Ohio EPA in 2005. The study evaluated biological and water quality parameters in FMC and its selected tributaries in the Ohio portion of the watershed. The physical description of the watershed, historical context and data from the assessment are referenced in this NPS-IS plan. However, it is essential to acknowledge that environmental conditions and land use practices (such as conservation tillage and nutrient application) may have changed significantly since the last study was conducted.

The Ohio EPA 2024 Integrated Water Quality Monitoring and Assessment Report classified the CR-FMC watershed as “category 5 – impaired, TMDL needed” (Ohio EPA, 2024). The report indicates watershed impairment for aquatic life use and recreation.

1.2. Watershed Profile & History

The CR-FMC watershed is primarily rural and most of its residents live in unincorporated townships: Oxford, Reily, Milford, Hanover, St. Clair, and Wayne. This watershed also includes Darrtown and Williamsdale, both Census Designated Places with populations of 514 and 578, respectively, according to the 2020 census. Small portions of this watershed lie within Seven Mile Village and City of Hamilton (Fig. 3). Additionally, the watershed encompasses most of New Miami Village (population 2,590), which faces economic challenges due to a high poverty rate and projected high flood risk to local properties over the next 30 years. (https://screeningtool.geoplatform.gov/en/about#3/33.47/-97.5).

There are no National Pollutant Discharge Elimination System (NPDES) permitted facilities discharging into streams within the CR-FMC watershed. However, the Oxford WTTP discharges to FMC, a short distance from the watershed’s upstream pour point, located at the confluence of FMC and Lick Run. Additionally, although located in the CR-FMC HUC 12, the New Miami WTP discharges treated effluent directly into the Great Miami River in the New Miami-Great Miami River HUC 12.

Except for Darrtown, Seven Mile Village, New Miami, Williamsdale, and the St. Clair Township area adjacent to New Miami, which utilize centralized water distribution systems, watershed residents rely on private wells for their drinking water. Additionally, public sewer service is available only in a small portion of St. Clair Township west of New Miami, as well as in New Miami and Williamsdale. The majority of watershed residents, including those living in the rural communities of Darrtown and along Elkton Road, rely on household sewage treatment systems (HSTS).

Over the past 250 years, the FMC watershed has undergone significant transitions due to European arrival and subsequent land use changes. Originally inhabited by the Miami Tribe, the area experienced significant changes in the late eighteenth century when Europeans deforested the land, plowed the soils, drained upland wetlands, and constructed dams for mills. Major settlements like Cincinnati, Hamilton, and Richmond were established, with the town of Oxford growing around Miami University, which was chartered in 1809. By 1850, the watershed was largely deforested, a trend that continued with Ohio’s forest cover dropping to 10% by 1920.

Agriculture played a significant role in these changes. In the mid-nineteenth century, the watershed contributed to Cincinnati's meat-packing industry, with major crops including corn, wheat, oats, and hay, much of which was used to feed hogs sold in Cincinnati. Agricultural land use in Ohio peaked in the 1930s-1940s, after which less productive lands began reverting to forest or other uses (Rech et al., 2018).

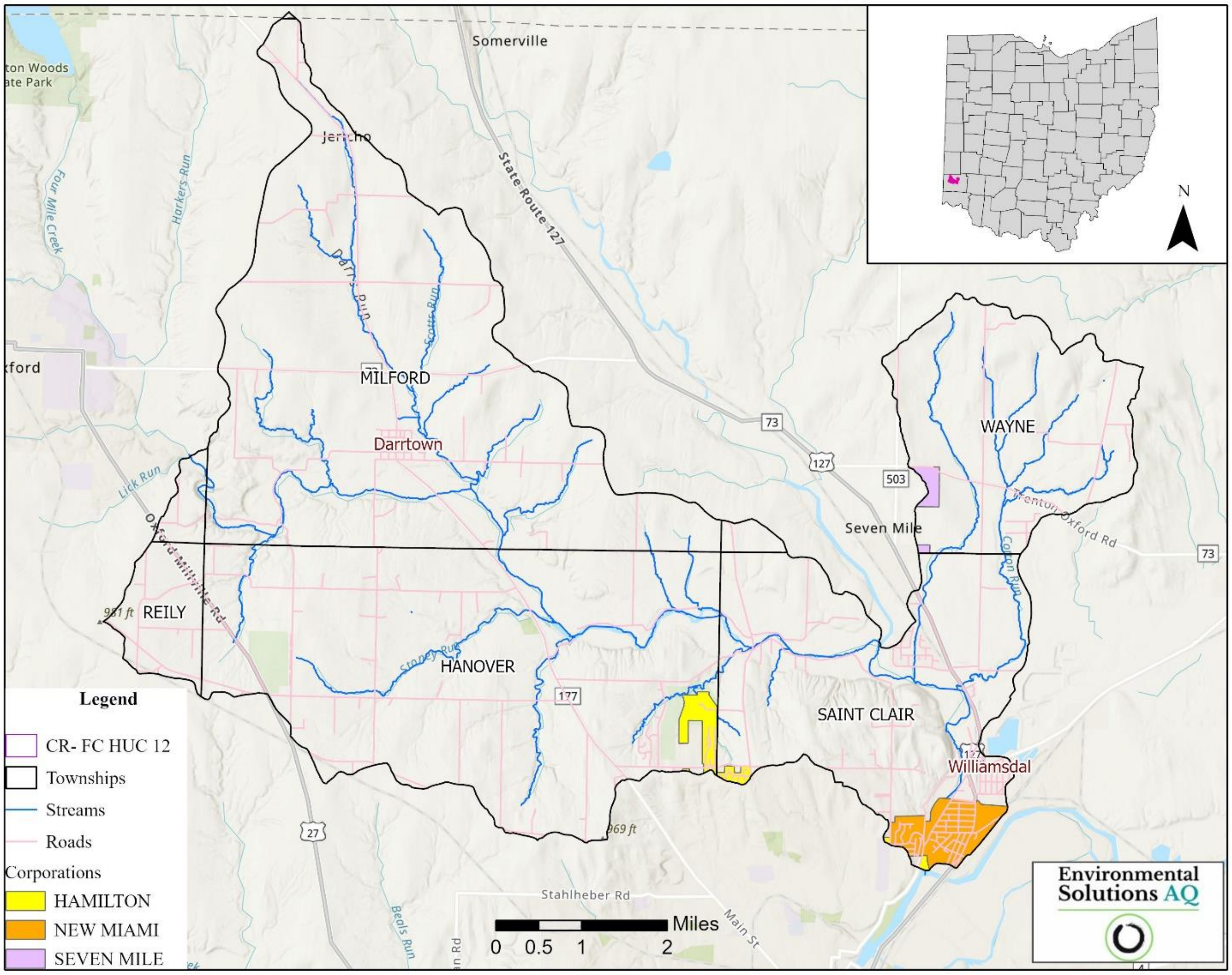

Figure 3 Cotton Run – FMC HUC-12 jurisdictions

1.3. Public Participation and Involvement

To ensure the success of the NPS-IS, the Ohio EPA encourages collaboration with local stakeholders and communities who can help to develop the watershed restoration and protection strategies and later start implementing these strategies.

Three Valley Conservation Trust (TVCT) which sponsored development of the NPS-IS for CR-FMC HUC 12 has been successfully leading conservation efforts in this region for more than 30 years. The organization was established in Oxford, Ohio by Edward Wallace in 1993 and incorporated as an Ohio non-profit in 1994. The land trust's mission is 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. TVCT's service area covers seven regional counties with a special focus on protecting land and natural resources in Butler, Preble and Montgomery counties. The land trust's goals and objectives include:

- Setting standards for land conservation and water quality in our region.
- Protecting and enhancing waterways, woodlands, vistas and farmland in our region with conservation and agricultural easements by partnering with other nonprofit organizations, federal and state government agencies, local parks, community representatives and individual landowners.
- Initiating and promoting community conservation efforts.

Since 1994, TVCT has protected approximately 25,000 acres of important landscapes in southwest Ohio via conservation and/or agricultural easements. Currently TVCT holds easements on 223 properties with individual landowners and organization, including 6 in the CR-FMC HUC 12. The TVCT also sponsored 6 other NPS-IS plans in this region as well as a wetland and stream restoration project funded by H2Ohio.

Stakeholder participation and active engagement are essential for successfully implementing recommendations from any NPS-IS. In July 2024, Three Valley Conservation Trust (TVCT), in collaboration with Butler County Soil and Water Conservation District (SWCD), MetroParks of Butler County, and ENSOAQ staff, conducted site visits across multiple private and public lands within the CR-FMC watershed. The purpose of these visits was to validate the output maps generated by the Agricultural Conservation Planning Framework (ACPF) and assess existing watershed impairments. During these visits, several key issues were identified, including streambank erosion, narrow riparian buffers, and woodlands degraded by invasive species. Notably, a private property along Cotton Run demonstrated strong potential for the installation of a Nutrient Removal Wetland, as identified by the ACPF model. The landowner expressed interest in implementing this practice, contingent on the availability of funding.

In August 2024, the Three Valley Conservation Trust (TVCT) and Butler County Soil and Water Conservation District (SWCD) co-hosted a public meeting for residents of the CR-FMC watershed. The meeting was advertised on the TVCT and Butler SWCD websites. Additionally, landowners, including easement holders, received invitations via postcards, emails, and phone calls from Butler SWCD and TVCT staff. The primary objective of the meeting was to introduce and discuss the scope of the Nonpoint Source-Implementation Strategy (NPS-IS), address water quality concerns in the watershed, and identify critical areas and potential projects. ENSOAQ presented preliminary results from the Agricultural Conservation Planning Framework (ACPF) analysis conducted for the CR-FMC

HUC-12. The ACPF tool integrates high-resolution terrain, drainage, soil, land use, and cropland data to pinpoint potential locations for best management practices (BMPs) at the field scale, facilitating engagement with the farming community in watershed conservation efforts (ARS, 2019). Approximately 20 people attended the meeting, including 10 landowners and 10 representatives from four organizations: Butler County SWCD, MetroParks of Butler County, the Miami Conservancy District (MCD), and the OKI Regional Council of Governments. Local landowners and stakeholders identified agricultural runoff, streambank and field erosion, and more frequent and intensive storm events as the primary causes of water quality impairments in the watershed. During the meeting, attendees discussed these issues, raised questions, and explored potential funding opportunities for conservation and restoration projects. Proposed strategies included erosion mitigation and the implementation of BMPs. Landowners were also invited to complete a 10-item questionnaire, with three completed surveys collected at the event. Key concerns highlighted in the responses were erosion and flooding. If funding were available, landowners expressed interest in streambank restoration, installing filter strips, and planting cover crops to enhance water quality and soil health.

The final draft of the NPS-IS was developed based on input from local stakeholder organizations, including Butler County SWCD, the Natural Resources Conservation Service (NRCS), OKI, MetroParks of Butler County, and MCD.

Chapter 2: **Watershed Characterization and Assessment Summary**

2.1. Summary of Watershed Characterization for Cotton Run – FMC HUC-12

2.1.1. Physical and Natural Features

The CR-FMC 12 is the most downstream sub watershed within the FMC HUC 10. It contains approximately 15-mile section of FMC (total length 45.6 miles) starting at FMC confluence with Lick Run located SE of Oxford in Butler County. The mainstem of FMC flows east and south east across Milford and Hanover Townships, and joins Seven Mile Creek (SMC) south of Seven Mile Village in St. Clair Township. Seven Mile Creek then continues south for approximately 4 miles before emptying into the Great Miami River just outside the New Miami Village. The main tributaries of FMC and SMC in this HUC 12 include: Darrs Run, Scotts Run, Tucky Run, Stoney Run, Mutton Run and Cotton Run.

This watershed is located in ECBP ecoregion defined as a primarily rolling plains with local end moraines, extensively covered by Wisconsinan age glacier deposits. Originally, this ecoregion was dominated by beech forests growing on the Wisconsinan soils. Whereas, less common wetter pre-Wisconsinan soils supported both; the beech forests and elm-ash swamp forests. Today, most of these forests have been cleared to give way to highly productive corn, soybean and livestock farms, which degraded stream habitats and water quality (USEPA, 2013).

The landscape of this region was molded during the glaciations of the Pleistocene Epoch. It features predominantly flat to gently rolling hills with slopes ranging from 0 to 12 degrees. These hills are intersected by deeper stream valleys that exhibit steeper slopes up to 63 degrees. FMC meanders southeastward through the central area of the watershed, where the terrain alternates between broader, flat floodplains and steeper narrows. These steep narrows frequently experience active erosion along the stream banks within the watershed. (Fig. 5)

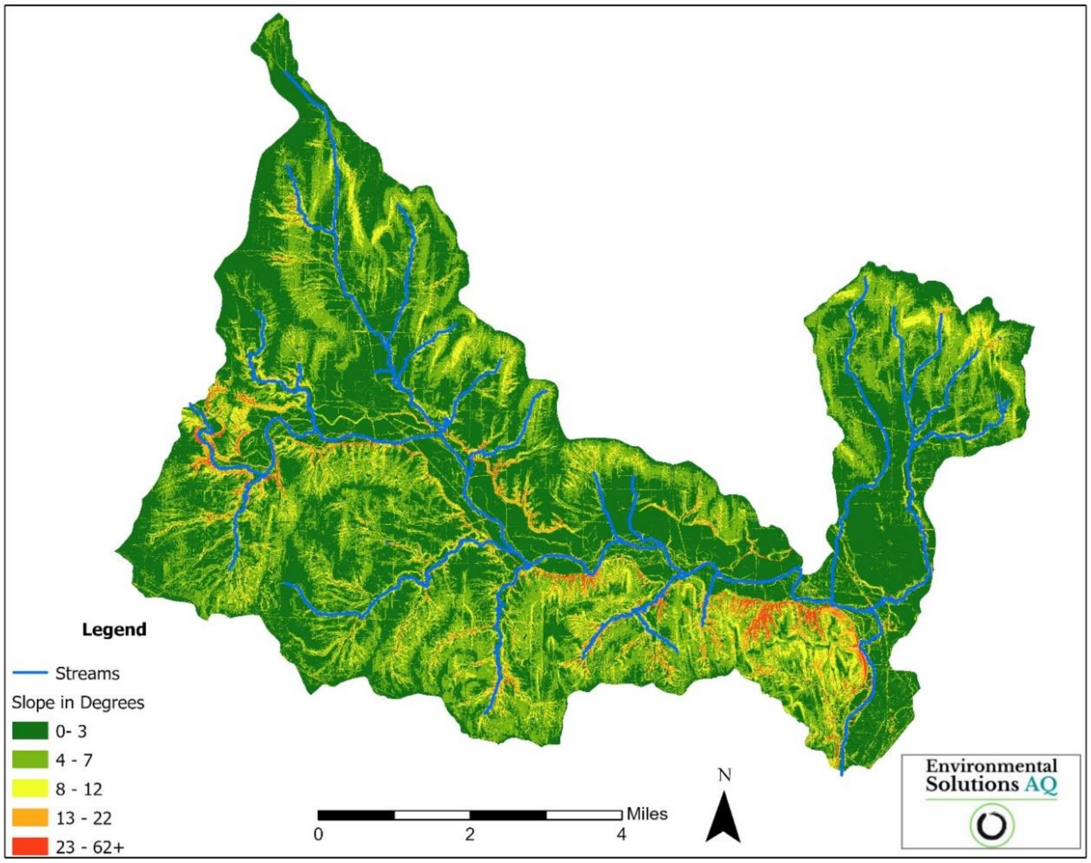

Figure 5 Slope Classification within the Cotton Run – FMC HUC-12

The geologic units within the CR-FMC watershed are Ordovician bedrock, glacial till and outwash primarily associated with the Wisconsinan glaciation, and latest Pleistocene and Holocene alluvium (Ohio Geological Survey, 2005a and 2005 b). Bedrock is comprised of interbedded fossiliferous limestone and shale. The Drakes, Whitewater and Liberty Formations and Waynesville and the Arnheim Formations, both undivided, compromise the majority of upland portion of the watershed (USGS, 2018). Whereas, the Grant Lake and Fairview Formations, Miamitown Shale (undivided) and the Kope Formation are exposed in the FMC valley. The Wisconsinan and Illinoian Epoch ground moraines comprise most of the unconsolidated sediments in the watershed (Ohio Geological Survey, 2005). Loamy, high-lime glacial till, which overlays the Ordovician age bedrock in the upland portions of the watershed is often less than 30 feet thick, and it occasionally contains lenses of gravel and sand. Outwash and alluvial materials, which filled ancient stream and river valleys in the region, are associated with a very productive Great Miami Buried Valley Aquifer (GMBVA) system. The thickness of buried valley aquifer deposits in the CR-FMC watershed vary to a considerable extent (Ohio Geological Survey, 1993).

According to the USDA NRCS Web Soil Survey (WSS), the most common soil series in the CR – FMC watershed are: Wynn and Xenia silt loams. Approximately 27,819 acres (84.5% of total watershed area) are classified as prime or locally important soils. A total of 292.7 acres (less than 1%) are rated as hydric soils on the NRCS Hydric Soils List. However, according to the

National Land Cover Data (NLCD 2021) approximately 0.15% (49.5 acres) of the total watershed area is currently covered by wetlands. The U.S. Fish & Wildlife Service, National Wetland Inventory database, which also includes historical wetlands data, shows a similar acreage as the NLCD for areas designated as forested or emergent herbaceous wetlands (45.5 acres or 0.14% of total watershed area) (Fig. 6). Most of natural wetlands within the CR-FMC watershed have been drained by tiles commonly installed on the agricultural fields as early as at the beginning of 19th century. The presence of hydric soils shows a potential for wetland restoration opportunities within the watershed. Wetland restoration on declining agricultural land can improve habitat for native species, reduce flooding, and improve water quality.

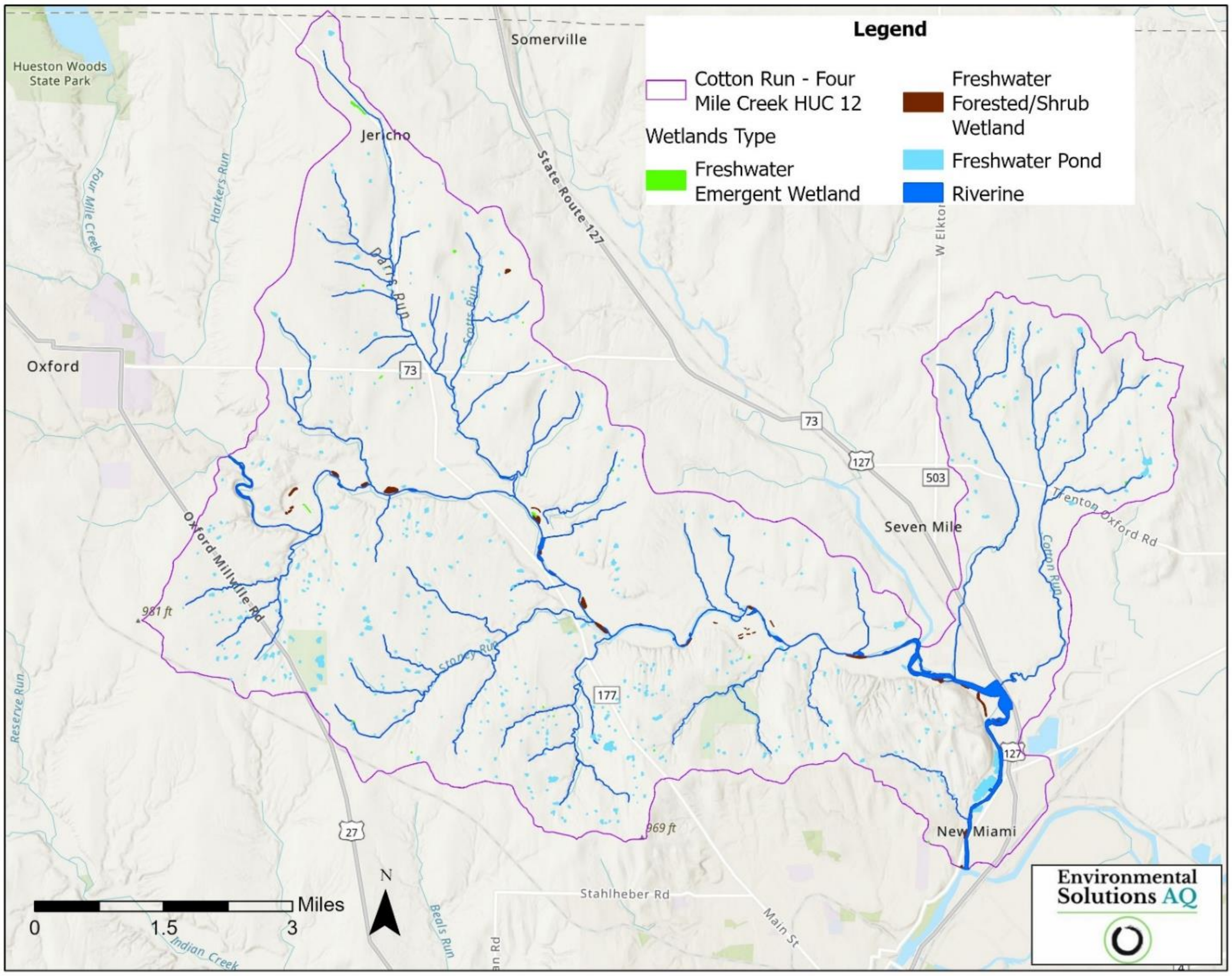

Figure 6 Wetlands within the Cotton Run – FMC HUC-12

Table 1 summarizes soils in the watershed based on their hydrologic characteristics. The categories listed as “unclassified” describe areas covered by water bodies or gravel pits, waste disposal sites or urban lands.

The vast majority of soils within this HUC 12 are classified as well-drained (22,298.1 acres or 67.80% of the watershed area) or moderately well-drained (6,924.8 acres or 20.90% of the watershed area) (Fig. 10). The poorly drained soils (207.2 acres or 0.5% of the watershed area) and somewhat poorly drained soils (2,860 acres or 8.8% of the watershed) are mostly located along northeastern and northwestern watershed boundary. These soils are present in the areas which are usually very flat (0 – 3 degrees of slope) and frequently experience seasonal shallow water table.

Approximately 24,051 acres of soils (73.20% of total watershed area) are classified as C and D or C/D in the hydrologic group classification. These soils, when wet, have slow to very slow infiltration and water transmission rates, therefore, they have higher potential for runoff. The agricultural character of the CR-FMC 12, combined with a high runoff potential of the local soils, might contribute to the watershed impairment caused by the excess nutrients loads. In addition, most of the soils in this watershed have high to moderate erodibility (12,656.3 acres or 38.5% of total watershed area and 17,672 acres or 53.50%, respectively). The high runoff potential of the soils and increased soil erodibility makes this watershed especially susceptible to erosion problems and excessive sedimentation, which can degrade water quality of the local streams.

Table 1 Soil classifications for CR-FMC Watershed

Soil Classification System	**Acres**	**Percent Coverage**
Drainage Class* - Well drained	22,298.1	67.80%
Drainage Class* - Moderately well drained	6,924.8	20.90%
Drainage Class* - Somewhat poorly drained	2,860	8.80%
Drainage Class* - Poorly Drained	207.2	0.50%
Drainage Class* - Not classified	566.10	1.70%
Hydrologic Soil Group** - A	1561.2	4.80%
Hydrologic Soil Group** - B	5,231	15.70%
Hydrologic Soil Group** - B/D	1,280.7	3.80%
Hydrologic Soil Group** - C	18,548.6	56.40%
Hydrologic Soil Group** - C/D	983.5	3.00%
Hydrologic Soil Group** - D	4,519.20	13.80%
Soil Erodibility*** - High	12,656.3	38.5%
Soil Erodibility*** - Moderate	17,672	53.50%
Soil Erodibility*** - Low	1616.70	5.00%
Soil Erodibility*** - Unclassified	732	2.2%

**Drainage classification range from "Well drained" to "Poorly Drained"*

*** Hydrologic Soil Groups classification based on estimates of runoff potential. (Rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms). "A", relatively high infiltration rates; "B", relatively moderate infiltration rate; "C", relatively slow infiltration rates, "D", relatively very slow infiltration rates. "A/D", "B/D", "C/D" - the first letter is for drained areas and the second is for undrained areas.*

*** Soil Erodibility classification based on erosion factor K that indicates the susceptibility of a soil to sheet and rill erosion by water.

"Low", K-factor < 0.23; "Moderate", K-factor ≥ 0.23 and < 0.4; "High", K-factor ≥ 0.4

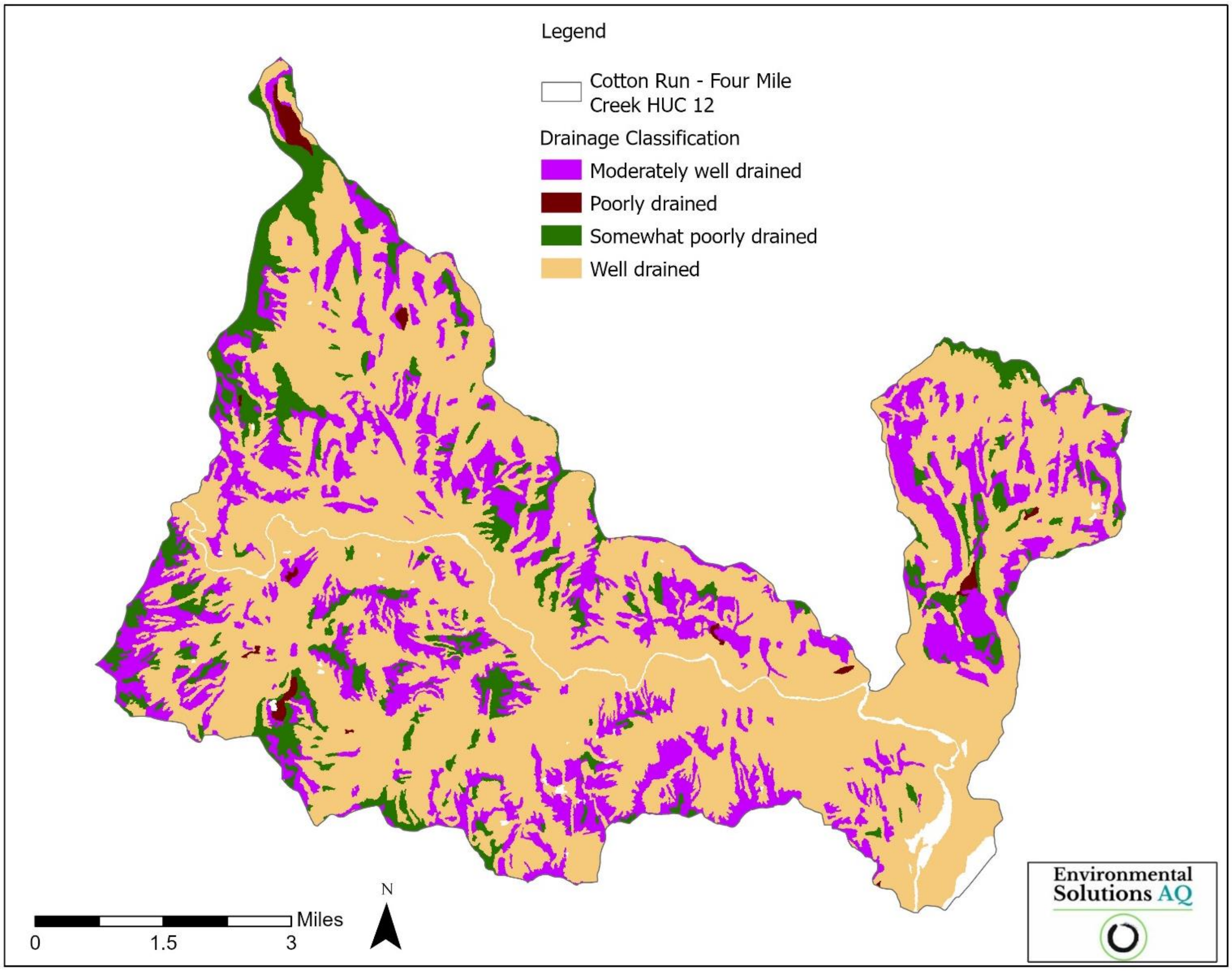

Figure 7 Drainage Classification of the soils within the Cotton Run-FMC HUC-12

Furthermore, the USDA NRCS Web Soil Survey (WSS) classified approximately 18,586.8 acres of soils (56.60% of the watershed area) as “very limited” for sewage treatment systems. This rating considers the soil properties and site features that affect the absorption of the effluent and those that may affect public health. "Very limited" category indicates that “the soil has one or more features that are unfavorable for the specified use (e.g. flooding, ponding, depth to apparent water table, high permeability layer, depth to bedrock or slope). The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.”

According to the “Management of Onsite Wastewater Treatment Systems” document prepared by the OKI Regional Council of Governments (OKI), The Ohio Department of Health recommended “Better septic system management” within the FMC watershed in Butler County portions of the watershed (OKI, 2020). The OEPA designated the CR- FMC watershed as impaired waters for recreation. The non-attainment status is caused by the presence of the *E. coli* bacteria in local waters exceeding water quality standards (OEPA, 2024). The potential sources of this impairment are agricultural runoff, livestock and improperly functioning home sewage treatment systems (HSTS).

In 2018 and 2019, OKI conducted a study across southwest Ohio, including Butler County, to identify areas where failing HSTS (Home Sewage Treatment Systems) most impact water quality (OKI, 2020). The study assessed HSTS based on data related to water resources, water quality, and system density, identifying 500 failing systems in the FMC subwatershed in Butler County. A heat map for the CR-FMC watershed highlighted high and medium-high priority areas, including the Village of New Miami, Darrtown, and the W Elkton Road subdivision. Both Darrtown, located in Milford Township upstream of the Darrs Run and FMC confluence, and the W Elkton Road subdivision, located in St. Clair Township upstream of the Mutton Run and Seven Mile Creek confluence, have the highest concentrations of failing HSTSs in the watershed. These rural communities face significant challenges in maintaining their sewage systems, making immediate action crucial. Addressing these issues is essential for protecting public health, preventing water contamination, and ensuring environmental compliance (Fig. 8).

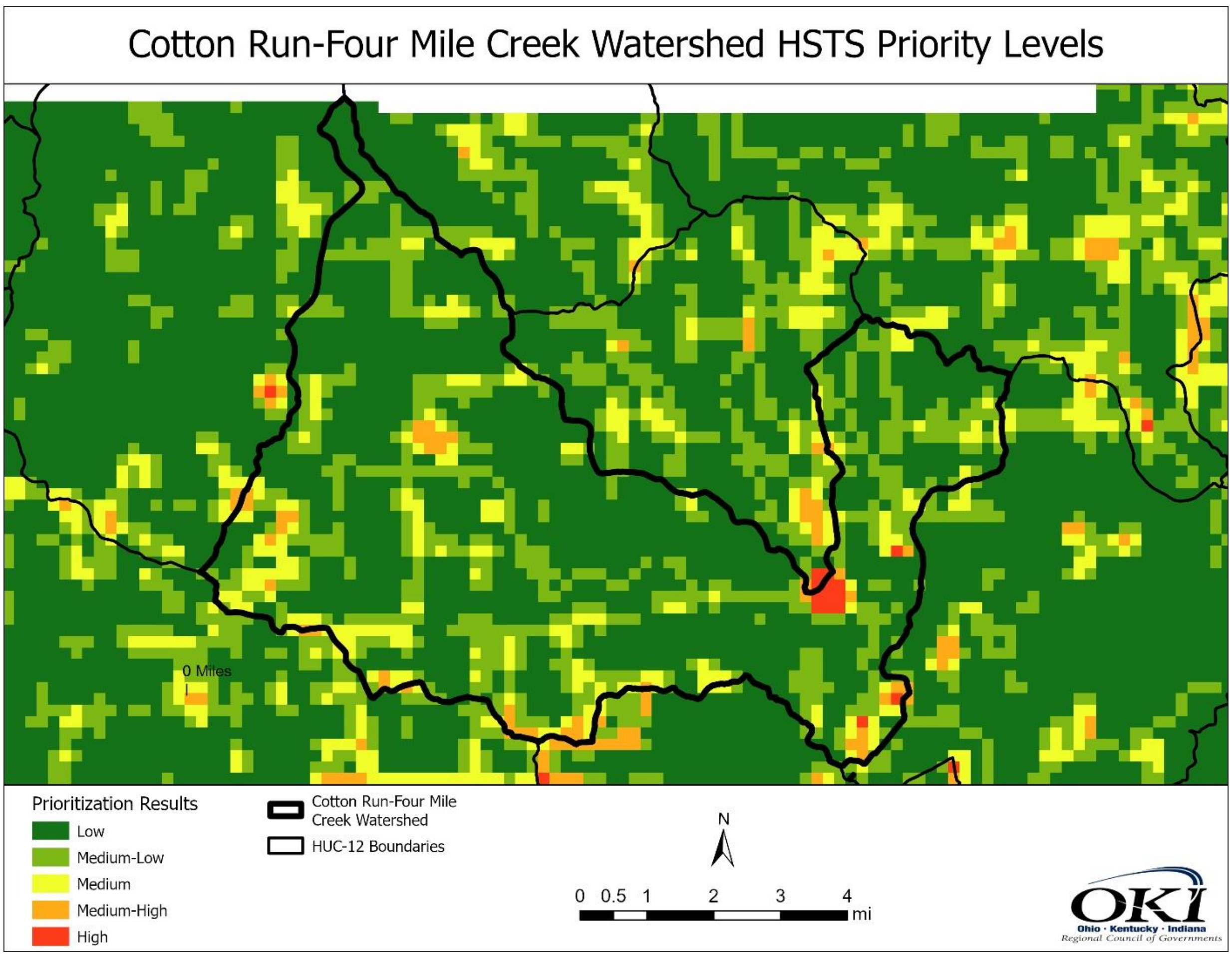

Figure 8 HSTS Priority Analysis for Cotton Run – FMC HUC-12 (Source OKI)

2.1.2. Climate

The CR-FMC watershed experiences a temperate climate with four distinct seasons, marked by warm summers averaging 73°F and cold winters with temperatures around 30°F. The growing season, crucial for agriculture, extends from mid-April to mid-October, providing favorable conditions for crops like corn.

Precipitation plays a significant role in the watershed's climate, with an average annual total of 1.097 meters. Historical data from the Miami Conservancy District's Hamilton Observer Station, spanning over 40 years, reveals trends in precipitation changes. A comparison of precipitation patterns between 1980–2001 and 2002–2023 highlights increase in early spring (March–April) and early summer (June) by 0.87, 0.32, and 0.42 inches, respectively (Fig. 9).

These precipitation trends align with critical periods in the agricultural calendar. Farmers apply fertilizers in March–April during pre-planting preparation and again in May–June to nourish growing crops. The increased precipitation during these months may influence fertilizer application strategies and nutrient runoff, with implications for water quality in the watershed.

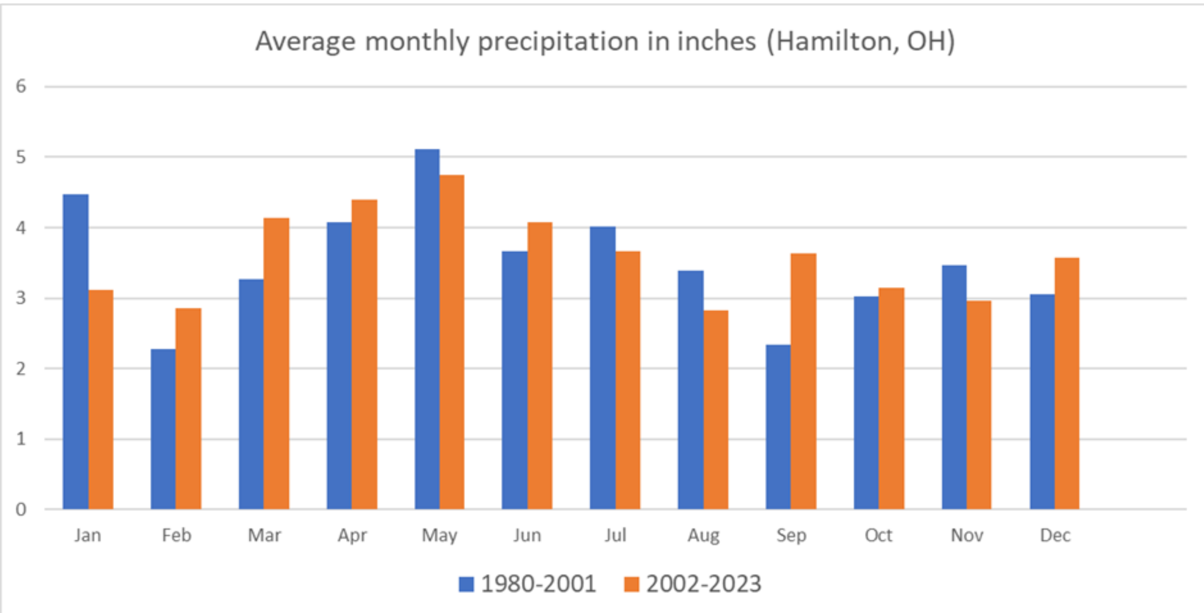

Figure 9 Average Monthly Precipitation at Hamilton, Ohio (Data Source: Mike Ekberg, MCD)

Figure 10 illustrates the annual maximum daily rainfall depth in Hamilton, Ohio, from 1980 to 2023, revealing key trends in precipitation variability. Between 1980 and 2000, the annual maximum daily rainfall depth was generally below 3.5 inches. However, after 2000, rainfall events exceeding 3.5 inches have become more frequent and extreme, with some storms producing 5 inches or more. These extreme rainfall events can lead to increased surface runoff, elevating the risk of nutrient and sediment transport into nearby water bodies. Such events also pose challenges for agriculture. Heavy rainfall can erode topsoil, reducing crop yields and necessitating investments in soil conservation practices like cover crops or no-till farming. Additionally, extreme spring rainfall can result in waterlogged soils, delaying planting schedules and shortening the growing season for crops like corn and soybeans. The variability in maximum rainfall underscores the need for improved water management systems, such as tile drainage, to control water levels in fields and mitigate crop damage. Farmers may also need to adjust fertilizer application rates and timing to reduce nutrient losses during high-rainfall periods. The observed peaks in rainfall highlight the risk of localized flooding, which can disrupt crop production and damage rural infrastructure. Linking these trends to agricultural practices emphasizes the importance of managing fertilizer application, adopting soil conservation strategies, and enhancing drainage systems. These measures are essential not only for improving water quality in the watershed but also for ensuring sustainable farming practices in the region.

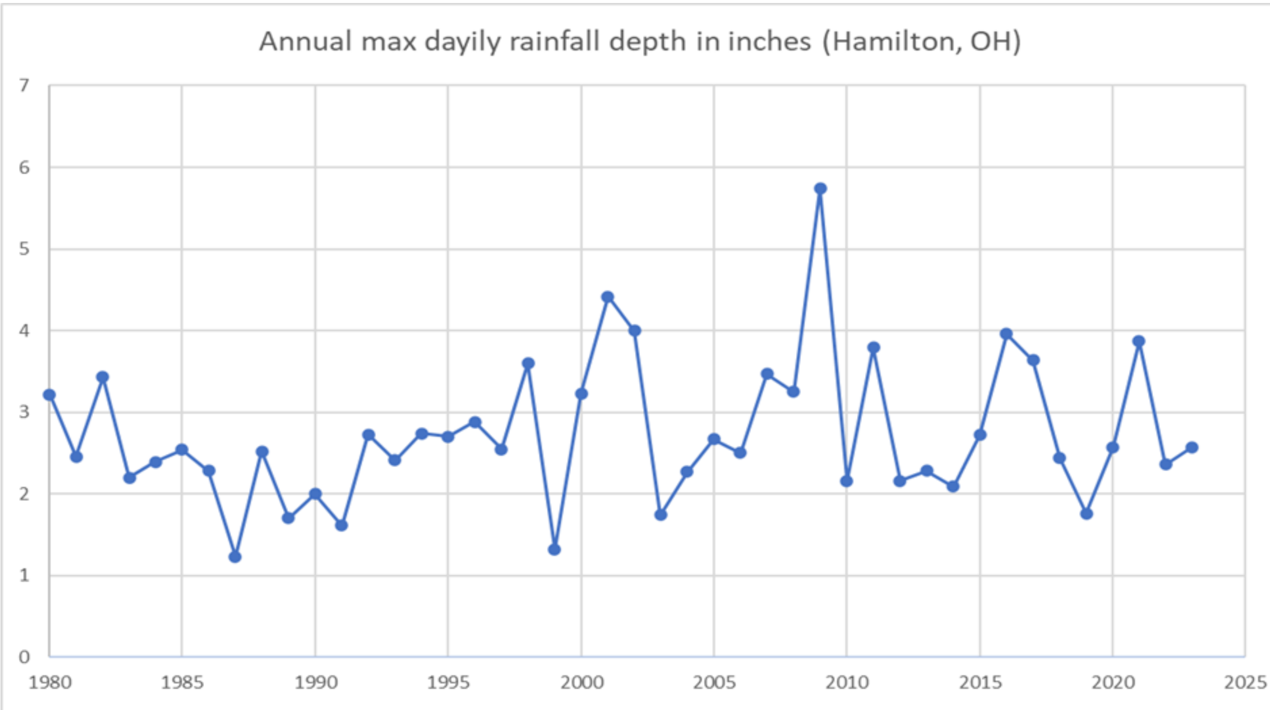

Figure 10 Annual max daily rainfall depth at Hamilton, Ohio (Data Source: Mike Ekberg, MCD)

2.1.3. Flooding Risk

Flooding can have a profound impact on water quality in watersheds by introducing pollutants and sediment into rivers and streams. These pollutants originate from various sources, such as agricultural lands, urban areas, construction sites, roads, and parking lots. Common contaminants include pesticides, fertilizers, nutrients, sediments, bacteria, fuels, animal waste, salts, oil, and grease.

Figure 11 shows all structures at risk of flooding within the CR-FMC HUC 12 watershed. Among these, the Village of New Miami, one of the largest communities in the watershed, stands out as particularly vulnerable due to its high flood risk. Currently, 968 properties in New Miami are projected to be at risk of flooding over the next 30 years, accounting for 73.8% of all properties in the community. Flooding poses a significant threat not only to water quality but also to the resilience of communities within the CR-FMC HUC 12 watershed. Data from FEMA underscores the urgent need for targeted mitigation strategies to reduce flood risks, particularly in vulnerable communities like New Miami. Initiatives to enhance flood management, minimize pollutant runoff, and strengthen community preparedness are critical to safeguarding public health, protecting ecosystems, and reducing economic losses.

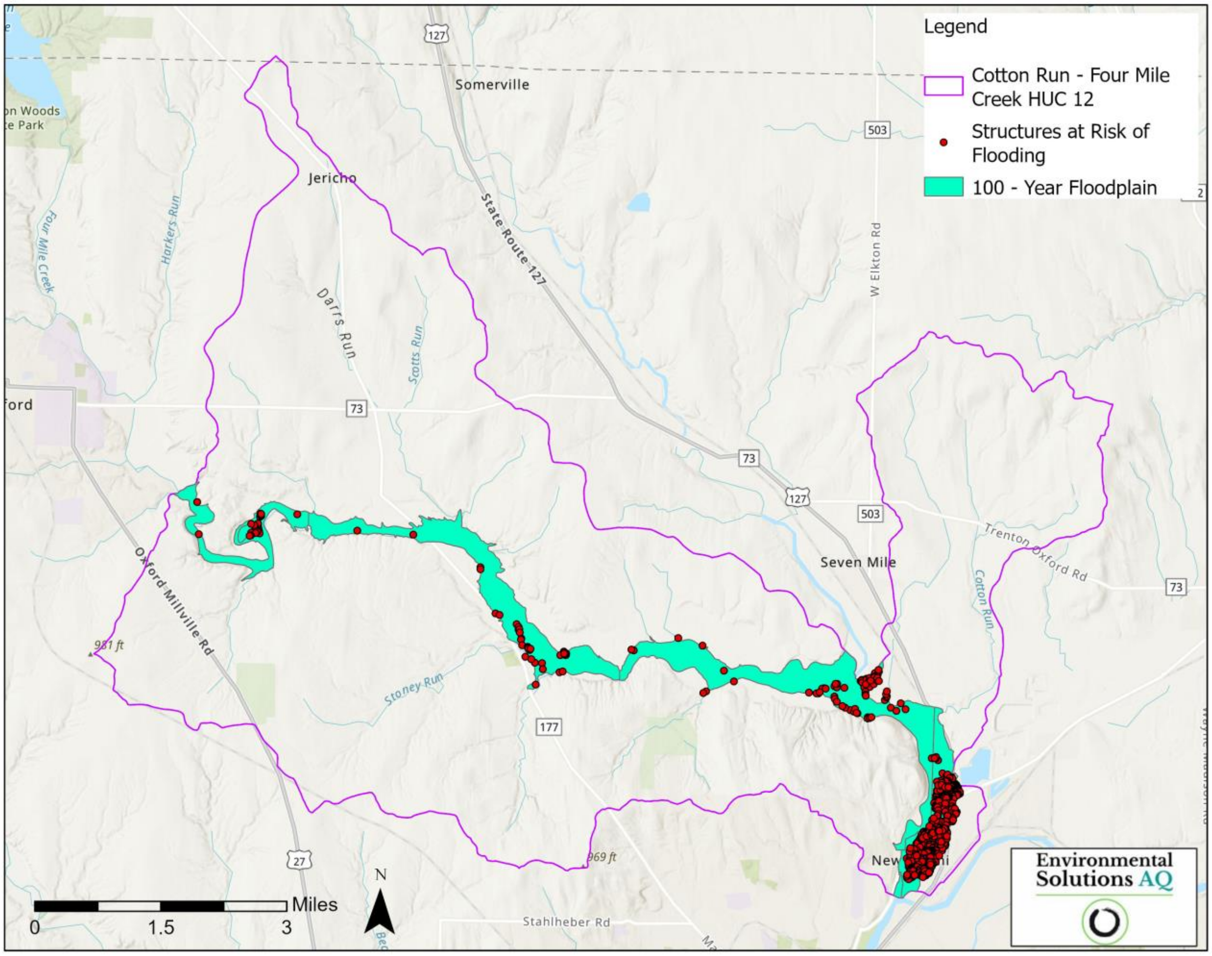

Figure 11 Flooding Risk in the CR-FMC HUC12 (Data Sources: https://www.fema.gov/about/reports-and-data/openfema; https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5)

2.1.4. Land Use and Protection

The CR-FMC 12 is predominantly an agricultural watershed (Fig. 12). Approximately 9817.5 acres (30% of watershed area) are in cultivated crops and 11413.8 acres (34.8% of watershed area) are in hay/pasture (Tab. 2).

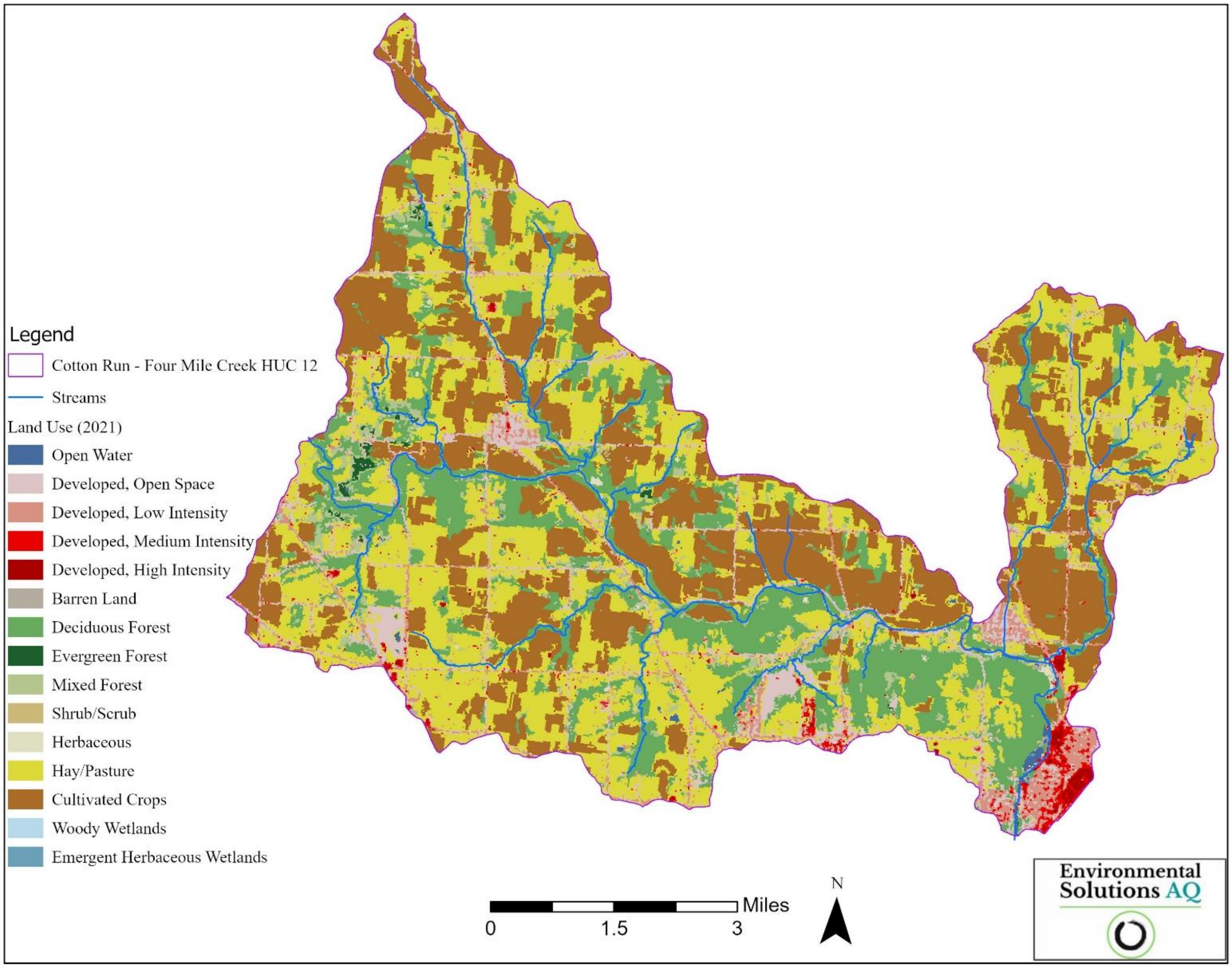

Figure 12 Land Use within the Cotton Run – FMC (Source: NLCD, 2021)

Table 2 Land Use within the CR - FMC HUC12

Type	**Area (Acres)**	**Coverage (%)**
Open Water	121.1	0.4
Developed, Open Space	2006.5	6.1
Developed, Low Intensity	1346.7	4.1
Developed, Medium Intensity	365.7	1.1
Developed, High Intensity	128.5	0.4

Barren Land (Rock/Sand/Clay)	24.7	0.1
Deciduous Forest	6269.1	19.1
Evergreen Forest	81.5	0.2
Mixed Forest	1040.3	3.2
Shrub/Scrub	39.5	0.1
Grassland/Herbaceous	56.8	0.2
Pasture/Hay	11413.8	34.8
Cultivated Crops	9817.5	30.0
Woody Wetlands	9.9	0.0
Emergent Herbaceous Wetlands	39.5	0.1
Total	**32761.2**	**100.0**

Source: NLCD 2021

The main crops growing in this watershed are corn and soybeans (Tab. 3). On average in the last five years 3308.16 acres of land was in corn production and 6,170.72 acres were in soybeans. The crop rotation practice frequently used within the watershed helps to improve and protect local soils and increase crop yields.

Table 3 Cropland Types and Acreage within CR-FMC HUC-12

	2023	**2022**	**2021**	**2020**	**2019**
Corn	3,571.4	3,261.6	3,019.5	3452.5	3235.8
Soybeans	5,561.2	6,279.1	6,642	6315.3	6056
Winter Wheat	386.1	157.5	378.5	182.4	294.9
Alfalfa	437.9	425.4	425.2	558	221.7
Other Hay/NonAlfa	469	482.6	599.4	808	850.2
Grass/Pasture	10,873.8	10494.4	10,225.5	8773.2	9113.7

Source: USDA NASS CropScape, 2024

No concentrated animal feeding facilities (CAFFs) and no permitted concentrated animal feeding operations (CAFOs) are in the CR-FMC HUC 12. According to the Butler County SWCD, there are many small to medium livestock operations (mostly cattle and horse farms) in the watershed (Tab. 4).

Tab. 4 Livestock in CR-FMC HUC 12

Livestock Type	Operation Size	Number of Farms
Cattle/Beef	Small	9
Cattle	Medium	20
Cattle	Large	1
Horse	Small	15
Horse	Medium	1
Hog	Small	1
Alpaca	Small	1
Goat	Small	1
Lama	Small	1

Source: Butler County SWCD. Operation Size: 1-15 Small, 15-30 Medium, 30+ Large.

Deciduous forest covers the next largest portion of the watershed (6267.1 acres or 19.1% watershed area). Its presence is mostly limited to the steeper south and south east portions of the watershed forming the riparian areas of FMC and its tributaries. The forest is represented by a diverse group of moderate to high quality native trees, and it is heavily impacted by the presence of invasive species, including bush honeysuckle (Lonicera species) and Japanese honeysuckle (Lonicera japonica). Other invasives commonly found within the CR-FMC HUC 12 are: multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata*) and Bradford pear (*Pyrus calleryana*).

Approximately 12% (3847.4 acres) of the watershed is developed. The largest communities are: Village of New Miami, Williamsdale, Darrtown and W. Elkton Road subdivision.

Protected lands within the CR-FMC watershed include 6 conservation and agricultural easements on private and public properties held by the TVCT (Fig. 13). These easements protect approximately 465 acres (about 1.4 % of the total watershed area) of prime farmland and natural areas from development in perpetuity. In addition, multiple properties within the watershed are protected by MetroParks of Butler County. These properties are public lands and include Angst Nature Preserve - protected also by the conservation easement - Antenen Nature Preserve, Sycamore Bluffs and Davidson Woods (Fig. 13).

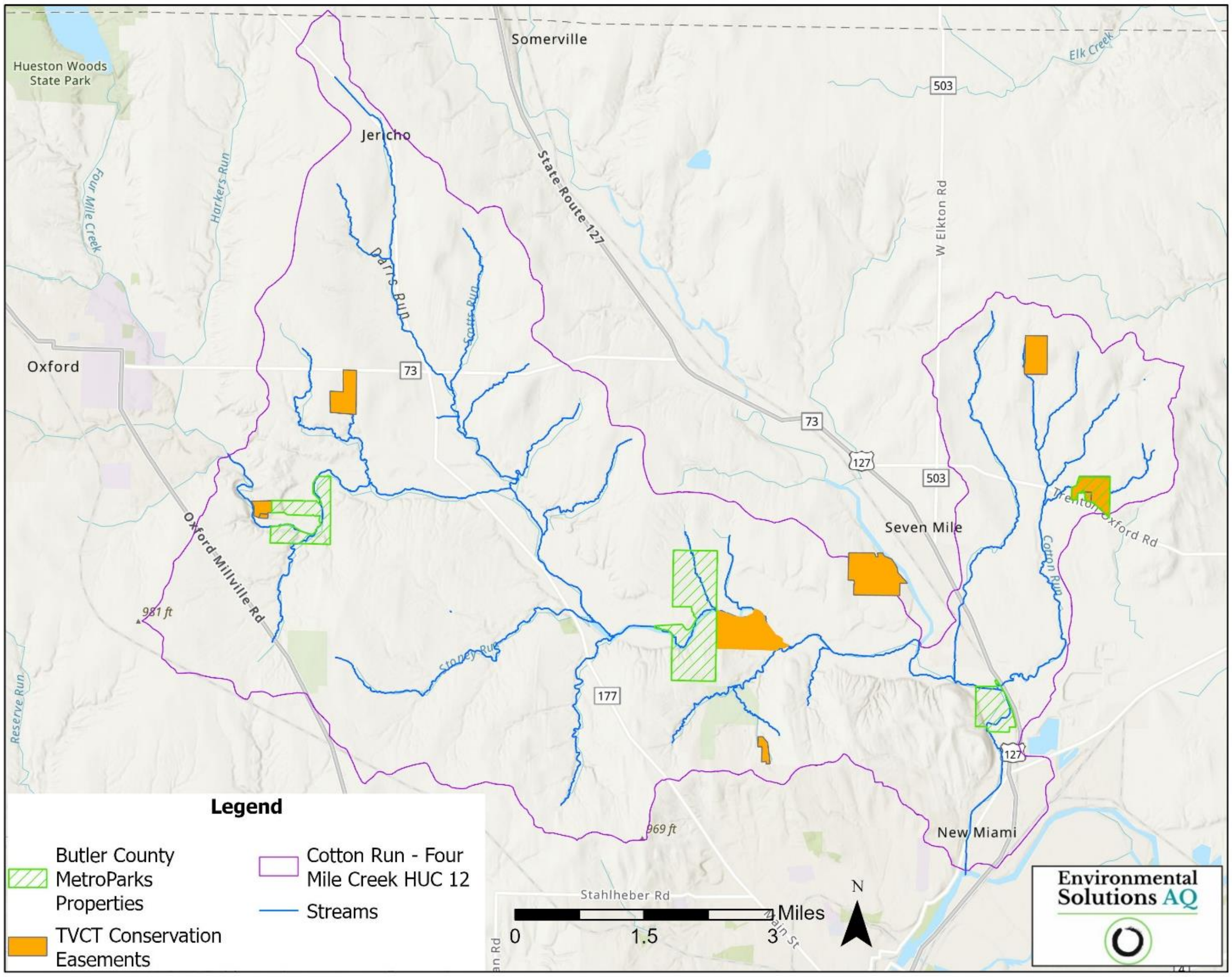

Figure 13 Public and Private Protected Lands in the Cotton Run – FMC HUC 12

Seven threatened or endangered species of wildlife and plants are listed for Butler County by the US Fish and Wildlife Service (USFWS) (Table 5). The deciduous forest growing in the riparian areas of FMC and its tributaries might provide habitat for many of them. Therefore, it is critical to protect it from further habitat degradation caused by invasive species, and agriculture and urban development.

Table 5 Federally Listed Threatened and Endangered Species in Butler County

Species	Status	Habitat
Indiana bat *(Myotis sodalis)*	Endangered	Hibernacula = Caves and mines; Maternity and foraging habitat = small stream corridors with well-developed riparian woods; upland forests
Fanshell Mussel (*Cyprogenia stegaria*)	Endangered	Medium to large streams. Prefer relatively deep water in gravelly substrate with moderate current.

Snuffbox Mussel *(Epioblasma triquetra)*	Endangered	Small to medium sized creeks. Prefer areas with a swift current.
Sheepnose *(Plethobasus cyphyus)*	Endangered	Shallow areas in larger rivers and streams
Rayed bean *(Villosa fabalis)*	Endangered	Smaller, headwater creeks, but they are sometimes found in large rivers
Northern long-eared bat *(Myotis septentrionalis)*	Threatened	Hibernates in caves and mines - swarming in surrounding wooded areas in autumn. During late spring and summer roosts and forages in upland forests
Running buffalo clover *(Trifolium stoloniferum)*	Endangered	Disturbed bottomland meadows; disturbed sites that have shade during part of each day

Source: Federally Listed Endangered and Threatened Wildlife and Plant Species by County, Ohio Department of Natural Resources

Agricultural Conservation Practices

Most of the land in the CR-FMC watershed is privately owned; therefore, knowledge of conservation practices may be limited. Some conservation practices can be estimated through program enrollment initiated through the SWCD/NRCS and the Farm Service Agency. Table 6 provides a summary of the conservation practices installed within the CR-FMC HUC 12 over last 10 years.

Table 6 Estimates of Conservation Practices within the CR-FMC Watershed

Conservation Practice	Estimated Acreage Treated	Sponsoring Program
Conservation Tillage* (no till, reduced till)	3100	N/A
Grassed Waterways[1]	75	Conservation Reserve Program (FSA/NRCS)
Cover Crops[1]	430	Water Quality Trading Program (SWCD)
Nutrient Management (Soil Sampling and Variable Rate)[1]	1550	Water Quality Trading Program (SWCD)

**Estimated by Butler SWCD and NRCS stuff based on the field experience.*
[1] *The practices presented here are between current and the past 5 years.*

Future nutrient reduction projects implemented through this NPS-IS and available state and federal programming will be compiled to track progress made towards nutrient reduction and conservation goals across the CR-FMC HUC 12 and the Great Miami River watershed.

Watershed Development Pressure

Land development has a significant impact on quantity and quality of water resources. As the area urbanizes, it generates more sewage, and increases pollutant and pathogen loading in the watershed. Greater development might increase runoff intensity, stream fluctuation, flashiness, and frequency and severity of flooding. Also, it can increase streambank erosion and sedimentation, degrading water quality of local streams and rivers. Based on the studies conducted by the Center for Watershed Protection (CWP), most streams experience decline in their water quality and habitats when watershed impervious cover (IC) exceeds 10%, with severe degradation expected beyond 25% IC (CWP, 1993).

In 2014, the OKI conducted a study to evaluate the impact of development on the water quality of 82 watersheds in southwest Ohio, including the CR-FMC HUC 12 (OKI, 2014).

The Impervious Cover Model (ICM), a widely accepted watershed management-planning tool, was used to analyze the relationship between impervious surface and slope, soil erodibility, riparian buffers and the underlying aquifer within each watershed. The analyses were conducted using imagery data from 2007 (Personal Communication, OKI). According to the ICM, in 2007 approximately 5.2% of the CR-FMC HUC 12 was covered by impervious surfaces. The IC rating put this watershed in the "sensitive but should have acceptable water quality and habitat" category (OKI, 2014).

A detailed summary of the relationships between impervious cover and environmentally sensitive areas within the CR-FMC watershed are presented in Table 7.

Table 7 Impervious Cover vs. Slope, Soil Erodibility, Riparian Corridors and Aquifer Area in CR-FMC HUC 12

Impervious Acres with 0-10% slopes	Impervious Acres with 11-20% slopes	Impervious Areas with > 20% slopes
1,429.3 (4.4% of the watershed area)	206.6 (0.6% of the watershed area)	85.2 (0.26% of the watershed area)
Impervious Acres on Highly Erodible Soils	**Impervious Acres on Not Highly Erodible Soils**	**Impervious Acres on Potentially Highly Erodible Soils**
114.7 (0.35% of the watershed area)	438.2 (1.3% of the watershed area)	913.1 (2.8% of the watershed area)

Impervious Acres Outside of Riparian Corridors*	Impervious Acres Inside of Riparian Corridors*
1,614.6 (4.9% of the watershed area)	106.7 (0.32% of the watershed area)
Impervious Acres Not Over an Aquifer Area	**Impervious Acres Over an Aquifer Area**
1,120.9 (3.4% of the watershed area)	600.2 (1.83% of the watershed area)

Data Source: OKI
** 200 ft wide riparian corridor*

Currently approximately 12% of the watershed is developed. With the growing population and development pressure, the impervious cover will also increase – negatively affecting the water quality and habitats within the watershed. Therefore, protecting sensitive environments, especially riparian corridors, from further development is critical for keeping the CR-FMC watershed healthy.

2.1.5. Groundwater Vulnerability and Drinking Water Resources Protection

The Great Miami River Watershed features two primary types of aquifers: buried valley aquifers, which are glacial deposits composed primarily of sand and gravel, and bedrock aquifers, where water is stored within fractures in the rock formation. In some areas, groundwater exists at shallow depths without the protection of a confining clay layer, making it particularly susceptible to contamination from nutrients and pesticides (ODA, 2023).

The Great Miami River and several tributaries, such as FMC, lie along the path of the buried valley aquifers. Due to the absence of a protective confining clay layer, these aquifers are highly vulnerable to surface pollution. The interaction between surface water and groundwater, including the migration of nitrates and other contaminants, has been extensively studied in the Dayton region for decades.

The Great Miami Buried Valley Aquifer was designated a Sole Source Aquifer in 1988, emphasizing its importance as a vital drinking water resource. The Ohio Department of Natural Resources (ODNR) developed groundwater pollution potential maps for the state using the DRASTIC system in the early 2000s. In 2022, ODNR published a GIS-based, modified DRASTIC model, which incorporates parameters such as Depth to Water, Net Recharge, Aquifer Media, Soil Media, Topography, Impact of Vadose Zone Media, and Hydraulic Conductivity. This tool plays a critical role in evaluating groundwater vulnerability and assessing how susceptible a specific area's groundwater is to contamination, including pesticides, nutrients, and bacteria from agricultural and urban runoff, livestock operations and faulty septic systems.

Figure 14 displays the Groundwater Vulnerability Index (GVI) for the CR-FMC HUC 12, as determined by the modified DRASTIC model from 2022. The vulnerability index is color-coded as follows: light blue (0-104) represents low vulnerability, blue (105-133) represents moderate vulnerability, dark blue (134-163) indicates high vulnerability, and pink (164-201) represents very high vulnerability.

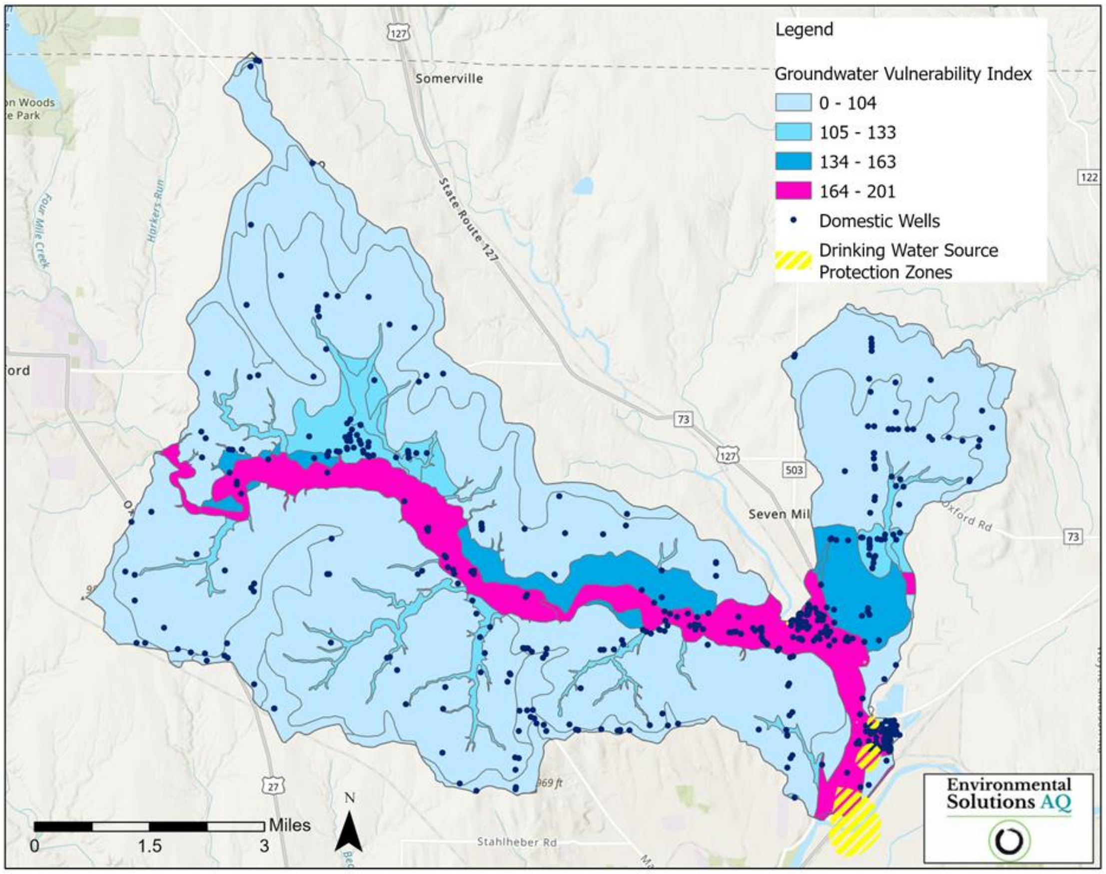

Figure 14 Groundwater Vulnerability Assessment and Source Water Protection in the CR-FMC HUC-12

Data Sources: https://ohiodnr.gov/discover-and-learn/safety-conservation/about-odnr/geologic-survey/groundwater-resources/groundwater-vulnerability-map., https://waterwells.ohiodnr.gov/search, https://geo.epa.ohio.gov/portal/apps/webappviewer/index.html?id=6ff3062a68284ef28951f673ca9cbd10

Areas marked in pink are particularly vulnerable, likely due to thin or absent protective layers (such as clay) and/or high recharge rates, which allow contaminants to easily infiltrate the aquifer. This region overlaps with FMC, which lies within the buried valley aquifer system. This waterway interacts with groundwater, potentially serving as a source or pathway for pollutants from the surface runoff, including fertilizers, pesticides, bacteria, and other contaminants that are carried from urban, agricultural, or industrial areas. Tributaries contribute surface water flow and also play a role in the hydrological connection with the local groundwater system. According to ODNR there are 504 domestic wells in the CR – FMC watershed (small blue dots on Fig 14). The density of these wells indicates human reliance on groundwater for drinking and other domestic uses in this watershed. Clusters of wells in higher vulnerability areas (such as the pink zones) indicate a greater risk of groundwater contamination, potentially affecting human health. Zones marked with yellow diagonal hatching represent critical areas designated to protect water sources for public supply systems in New Miami and Williamsdale. The overlap of these zones with high-vulnerability areas (pink) underscores the importance of implementing stricter protection measures and adopting thoughtful land management practices to prevent contamination of drinking water supplies.

2.2. Summary of Biological Trends for Cotton Run – FMC Creek HUC-12

The 2005 Ohio EPA Biological and Water Quality Study of Fourmile Creek, Indian Creek and selected Tributaries was the only comprehensive sampling data of the CR-FMC HUC 12 watershed. This section summarizes the major findings of the 2005 OEPA sampling report (OEPA, 2008).

Six sampling locations were selected in the CR-FMC HUC12 during the 2005 OEPA sampling event (Fig. 15, Tab. 8). Four of the sampling locations are located along the FMC mainstem and the remaining two were located on Darrs Run and Stoney Run. No samples were ever collected and analyzed from Cotton Run.

Table 8 2005 OEPA Sampling Location Within CR-FMC HUC 12

Stream Mile	Sample Type	Location	Latitude	Longitude
Fourmile Creek				
13.65	C, B, F, M	Lanes Mill Rd.	39.4817	84.6861
11.00	C, S, O, D, Pd, Ch, F, M	SR 177	39.4874	84.6531
5.40	C, B, S, O, F, M	SR.732	39.4631	84.5828
0.35	C, S, O, D, F, M	Seven Mile Ave	39.4308	84.5440
Darrs Run				
2.13	C, B, S, O, D, F, M	SR73	39.5079	84.6623
Stoney Run				
0.30	C, F, M	SR 177	39.4681	84.6319

M - macroinvertebrate quantitative sample, M - macroinvertebrate qualitative sample, F - fish sample (2 passes), F - fish sample (1 pass), C - conventional water chemistry parameters (5 runs), B - bacteria (5 runs), S - sediment sample (conventional and organics), D - datasonde monitor, O-organic water chemistry (2 runs).

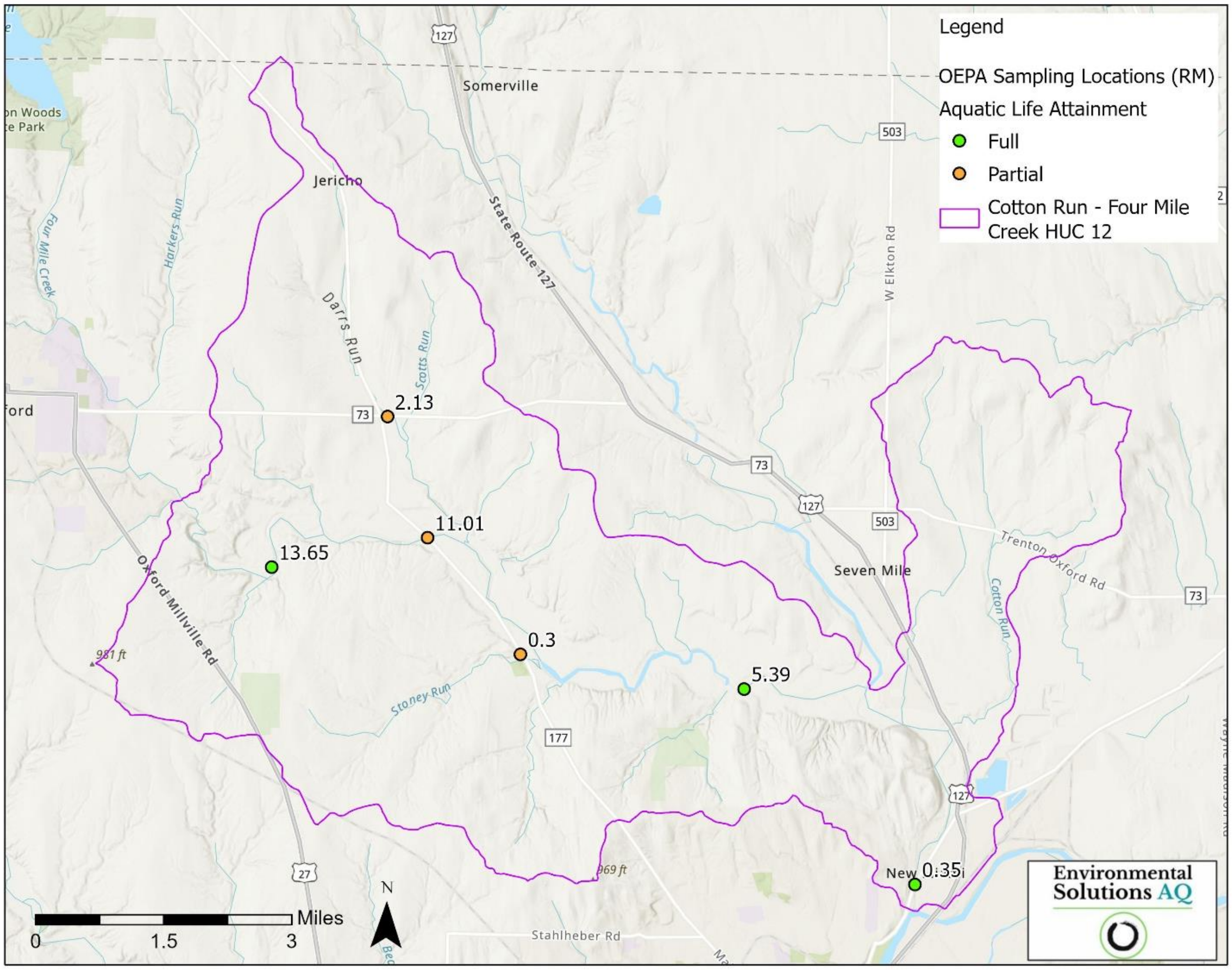

Figure 15 OEPA Sampling Locations in Cotton Run – FMC HUC 12 by Stream Miles

In 2005, four sampling locations along the FMC mainstem and two sampling locations along two FMC tributaries: Darrs Run and Stoney Run, were evaluated for the biological indices indicating the quality of near and in-stream habitats (Table 9). Qualitative Habitat Evaluation Index (QHEI) values for the FMC sampling sites ranged between 74.5 and 92.5 with a mean of 81.5. Mean QHEI values from rivers or river segments equal to or greater than 75 generally indicate a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms consistent with the Exceptional Warmwater Habitat (EWH) aquatic life use designation (OEPA, 2008). The 2008 OEPA report concluded that the quality of near and in-stream macrohabitat throughout the entire length of FMC appeared capable of supporting diverse, functionally organized, and well-structured assemblages of aquatic organisms, consistent with its recommended EWH aquatic life use. The partial attainment status for the FMC site at RM 11 was due to the elevated phosphorus concentrations in the stream, resulting from the discharge of the Oxford WTTP and decline of the macroinvertebrate community performance compared to the 1996 results. The partial status at two FMC tributaries was caused by the low flow conditions during the sampling season (OEPA, 2008).

Table 9 Biological Indices Scores for the Sampling Sites

River Mile	IBI	MIwb[a]	ICI[b]	QHEI	Aquatic Life Use Designation	Attainment Status[c]	Causes
Fourmile Creek							
13.6	54	10.0	G	92.5	WWH Existing	Full	NA
11.0	52	10.2	40*	74	EWH Existing	Partial	Phosphorus
5.4	56	10.4	VG[ns]	83.0	EWH Existing	Full	NA
0.3	42	9.9	42	76.5	EWH Existing	Full	NA
Darrs Run							
2.1	44	NA	F*	54.5	WWH Existing	Partial	Interstitial Stream flow
Stoney Run							
0.3	54	NA	Low F*	52.0	Undesignated /WWH Recommended	Partial	Interstitial Stream flow

Source: OEPA, 2008

a MIwb is not applicable to headwater streams with drainage areas < 20 mi2.

b A narrative evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable due to current velocities less than 0.3 fps flowing over the artificial substrates. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c Attainment status is given for the existing or, if a change is proposed, the recommended use designation.

ns Nonsignificant departure from biocriterion (<4 IBI or ICI units, or <0.5 MIwb units).

** Indicates significant departure from applicable biocriterion (>4 IBI or ICI units, or >0.5 MIwb units).*

Underlined scores are in the Poor or Very Poor range.

QHEI - Qualitative Habitat Evaluation Index

WWH Warmwater Habitat – ECBP Ecoregion

2.2.1. Biological Assessment: Fish Assemblages

The fish assemblages of FMC and its tributaries were surveyed and assessed by OEPA in 2005. The fish sampling effort within the CR- FMC HUC 12 included four stations, evaluating approximately 13 miles of the mainstem between RM 13.65 and RM 0.3 (Tab. 10). Based on aggregated catch statistics, numerically predominant species (No./0.3km) included central stoneroller (17.7.1%), bluntnose minnow (15.8%), northern hog sucker (10.5%), sand shiner (9/0%), striped shiner (6.6%), and spotfin shiner(6.6%). In terms of relative biomass (kg/0.3km), dominant species were common carp (30.5%), northern hog sucker (13.5%), black redhorse (8.8%), smallmouth bass (7.4%), and central stoneroller (6.1%). Nearly 20% of the numerically dominant species and 30% of fish biomass were composed of environmentally sensitive species. No fish species classified as rare, threatened, endangered, or otherwise recognized for special conservation status by the Ohio Department of Natural Resources (ODNR) were observed. However, highly intolerant, declining or otherwise ecologically significant species included mimic shiner, rosyface shiner, silver shiner, southern redbelly dace, banded darter, slenderhead darter, and black redhorse. Community indices and accompanying narrative evaluations for FMC ranged between exceptional (IBI=56/MIwb=10.4) and good/exceptional (IBI=42/MIwb=9.9). Overall, the fish assemblage of FMC was characterized as very good/exceptional. As measured by the IBI and MIwb (where applicable), community performance was consistent with the recommended EWH and WWH biocriteria.

The fish assemblages of two direct tributaries of FMC were also surveyed and assessed at two sampling stations in 2005. Similar to the FMC mainstem, no fish species classified as rare, threatened, endangered, or otherwise recognized for special conservation status by ODNR were observed. However, highly intolerant, declining or otherwise ecologically significant species included southern redbelly dace and rosyface shiner were found at Darrs Run. Community indices and accompanying narrative evaluations from these waters ranged between exceptional (IBI=54) and good (IBI=44).

Both tributaries, Darrs Run and Stoney Run supported fish assemblages consistent with the WWH biocriteria.

Table 10 Fish Community and Descriptive Statistics

Stream River Mile	Mean Number Species	Cumulative Species	Mean Rel. No. (No./km)[a]	Mean Rel. Wt. (Wt./km)[a]	Mean IBI	Mean MIwb	QHEI	Narrative Evaluation[b] (Recommended/ Existing)
Fourmile Creek								
13.65	30	30	1795.7	22	54	10.0	92.5	Exceptional
11.0	27	27	1692.0	35.2	52	10.2	74.0	Exceptional
5.4	29	29	2392.5	55.8	56	10.4	83	Exceptional
0.3	29	29	964	62.1	42	9.9	76.5	Good/Excpt.
Darrs Run								
2.1[H]	16	16	7623	21	44	NA	54.5	Good
Stoney Run								
0.3[H]	22	22	2767.5	7.9	54	NA	52.0	Exceptional

Source: OEPA 2008
a- Relative abundance and relative weight estimate normalized to 0.3km.
b - Narrative biological performance.
H - Headwaters: sites draining areas < 20 $miles^2$.
ns- Nonsignificant departure from the biocriteria (<4 IBI units or <0.5 MIwb units).

2.2.2. Biological Assessment: Macroinvertebrate Community

Macroinvertebrate communities were assessed at six stations along FMC and its tributaries meeting WWH expectations (Tab. 11). The community performance in FMC ranged from Exceptional (ICI = 42) to Good (ICI = 40). Two stations, located at Darrs Run and Stoney Run, exhibited macroinvertebrate community performance classified as Fair and Low Fair, respectively. These streams were apparently limited by low to interstitial flows. Sensitive taxa including Maccaffertium medinopunctatum and the midges Polypedilum (C.) ontario were found in FMC at RM 0.3 and RM 11, respectively.

Table 4 Macroinvertebrate Sampling Results

Stream RM	Dr. Area (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[a]	Narrative Evaluation
Fourmile Creek										
13.6	132	-	52	15	17	M	0	Chimarra Caddisflies (MI), midges (MI,F), hydropsychid caddisflies (MI, F)	-	Good
11.0	137	4	41	16/17	20/24	M-H/ 1354	0	Rheotanytarsus midges (MI)	40	
5.4	163	-	42	19	18	M	0	Baetied mayflies (F), hydropsychid caddisflies (F,MI), Chimarra caddisflies (MI)	-	Very good
0.3	315	-	39	12/20	12/24	L-M/ 1310	0	Midges (F,M)	42	
Darrs Run										
2.1	5.1	9	33	9	8	L-M	0	Hydropsychid caddisflies (F), baetid mayflies (F)	-	Fair
Stoney Run										
0.3	4.8	9	13	4	4	M	0	Heptageniid mayflies (F), Helicopsyche caddisflies (MI)	-	Low Fair

Source: OEPA. 2008
RM: River Mile.
Dr. Ar.: Drainage Area
Data Codes: 5=3 HD Only, 9=Intermittent or Near-Intermittent Conditions, 15=Current >0.0 fps but <0.3 fps.
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.
CW: Coolwater/Coldwater.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant

ICI values in parentheses are invalidated due to insufficient current speed over the artificial substrates. The station evaluation is based on the qualitative sample narrative evaluation.

2.2.1. Physical Habitat - Qualitative Habitat Evaluation Index QHEI

OEPA assessed the habitat characteristics through the Qualitative Habitat Evaluation Index (QHEI), which provides an understanding of existing habitat features 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.

The 2008 OEPA report shows the QHEI scores in FMC ranging from 74.0 to 92.5 and fully supporting the WWH communities (Tab.12). Key attributes for WWH include characteristics such as Boulder/Cobble/Gravel Substrates, Moderate Sinuosity, and Fast Currents, with no significant channelization. The MWH attributes for these segments, particularly at 0.3 RM, show some channel recovery and embeddedness issues.

Darrs Run at RM 2.1 had a QHEI score of 54.5. The habitat was marked by low sinuosity, poorly developed pools, significant riffle embeddedness, and the absence of fast currents. The site also showed signs of channelization, limited cover, and advanced stages of channel recovery. However, channel development, sinuosity, and substrate composition were still influenced or controlled by the artificial and entrenched nature of Darrs Run's active channel. Although recovery was incomplete, the persistent surface flow seemed sufficient to support WWH communities, despite lower habitat score.

Stoney Run was found in a natural, unmodified state typical of small limestone bedrock streams. The stream was over-wide, shallow, and prone to dewatering during droughts, with only residual pools remaining in September 2005. This led to a fair QHEI score of 52.0, due to the lack of key habitat features like riffles. However, the habitat appeared more suitable for warm water habitat (WWH) communities than the QHEI score suggests.

Table 5 QHEI Matrix and Scores

Key QHEI Components			WWH Attributes											MWH Attributes																				
River Mile	QHEI	Gradient (ft/mi)	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrate	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**	Channelized/No Recovery	Silt/Muck Substrate	No Sinuosity	Sparse/No Cover	Max Depth > 40 cm	**High-Influence Modified Attributes**	Recovering Channel	Heavy/Moderate Substrate	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 Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Mod. Influence Modified Attributes**	MWH HI. + 1/ WWH +1 Ratio	MWH M.I./WWH Ratio
FMC																																		
13.7	**92.5**	10.99	x	x		x	x	x	x	x	x	x	9						0		x											1	0.10	1.20
11.0	**74.0**	15.63	x			X	x	x	x	x	x	x	8						0		x											1	0.11	0.22
5.4	**83.0**	10.53	x	x		x	x	x	x	x	x	x	9						0		x								x			2	0.10	0.30
0.3	**76.5**	7.1	x	x		x	x	x		x	x	x	8						0	x								x	x			3	0.11	0.44
Darrs Run																																		
2.1	**54.5**	37.04		x							x		2			x	x		2	x	x			x				x	x	x		6	1.00	3.00
Stoney Run																																		
0.3	**52.0**	45.45	x	x		x	x			x			5				x	x	2					x				x			x	3	0.5	1.50

Source: OEPA, 2008

2.2.2. Water Quality

In 2005, inorganic chemistry grab samples and field measurements were taken at six sites along FMC and its tributaries (Tab. 13). Four sites were also sampled for organic compounds, and bacteria samples (fecal coliform and E. coli) were collected at three sites. Datasonde® continuous monitors were deployed at two mainstem sites on FMC and one site on Darrs Run. Key results from these analyses are summarized in this section.

Water chemistry results exceeding Ohio Water Quality Standards (WQS) criteria were primarily attributed to organic compounds, particularly legacy organochlorine pesticides (dieldrin, heptachlor epoxide, and aldrin), along with low dissolved oxygen (D.O.) and elevated bacteria levels. Fecal coliform and E. coli concentrations were highest in the FMC mainstem at RM 13.65 (E. Coli 430CFU/100 ml), located downstream from the Oxford WTTP.

Two sampling sites located at Darrs Run and Stoney Run, respectively had the D.O readings below WSQ minimums for the WWH and the temperature exceed the WSQ standards at the Soney Run. Field notes indicated that the water column at the Darrs Run site was murky and greenish throughout the survey and that flows became interstitial on at least one occasion.

Both, nitrate-nitrite - N and phosphorus concentrations in FMC mainstem were generally low with respective overall medians of 2.5 mg/l and 0.06mg/l for all samples collected in FMC. However, the phosphorus concentrations surged downstream from the Oxford WWTP at RM 13.7 (median 0.70 mg/l) and remained elevated, well above ECBP reference values, until being assimilated near the mouth at RM 0.3 (median 0.04 mg/l).

Total suspended soils (TSS) concentrations at FMC mainstem RM 11.00 and RM 5.40 were consistently elevated with TSS medians of 52 mg/l and 41 mg/l, respectively.

Table 6 2005 Water Quality Exceedances

Stream River Mile (use designation[3])	**Parameter (value)**
FMC (EWH, EWH, AWS, IWS, PCR)	
13.65	Fecal coliform (1700" JL) E. coli (430"")
11.00	Dieldrin (0.0035#) Heptachlor epoxide (0.0026#)
5.4	Dieldrin (0.0027#, 0.0040#)
0.35	Dieldrin (0.0027#, 0.0040#)
Darrs Run (WWH, PCR, AWS, IWS)	
2.13	Dissolved Oxygen (4.9‡) Aldrin (0.0034#) Dieldrin (0.0028#) Heptachlor epoxide (0.0032#, 0.0029#)
Stoney Run (undesignated)	
0.3	Dissolved Oxygen (3.47‡‡, 4.6‡, 4.1‡) Temperature (28.2*)

Source: OEPA 2008
Aquatic Life Habitat - EWH - Exceptional warmwater habitat; WWH - Warmwater habitat; (WWH criteria apply to "undesignated" surface waters)
Water Supply - IWS - industrial water supply; AWS - agricultural water supply
Recreation PCR – primary contact recreation.
‡ value is below the below the EWH minimum 24-hour average D.O. criterion (6.0 mg/l) or value is below the WWH minimum 24-hour average D.O. criterion (5.0 mg/l) or value is below the MWH minimum 24-hour average D.O. criterion (4.0 mg/l) as applicable.
‡‡ value is below the EWH minimum at any time D.O. criterion (6.0 mg/l) or value is below the EWH minimum at any time D.O. criterion (5.0 mg/l) or value is below the WWH minimum at any time D.O. criterion (4.0 mg/l) or value is below the MWH minimum at any time D.O. criterion (3.0 mg/l) as applicable.
" value is above the average PCR criteria (fecal coliform 1000/100ml; E. coli 126/100ml)
"" value is above the maximum PCR criteria (fecal coliform 2000/100ml; E. coli 298/100ml

2.3. Summary of Pollution Causes and Sources

As outlined in the *Biological and Water Quality Study of Fourmile Creek, Indian Creek, and Select Tributaries, 2005* (OEPA, 2008), all stream sampling locations within the CR-FMC watershed were found to support an aquatic organism assemblage consistent with Exceptional Warmwater Habitat (EWH) and Warmwater Habitat (WWH) standards. Partial attainments were observed at two sampled tributaries: Stoney Run and Darrs Run. The OEPA attributed these biological impairments to natural conditions, particularly low stream flow during the dry summer season when the biological assessments were conducted. Additionally, one sampling location along FMC at RM 11.01 was categorized as having partial attainment for the Aquatic Life Use (ALU) due to elevated phosphorus levels.

The water quality data collected in 2005 revealed several sampling locations within the CR-FMC watershed where various parameters exceeded Ohio Water Quality Standards (WQS) (see Table 13). These parameters included dissolved oxygen, bacteria, and legacy organochlorine pesticides. The OEPA identified bacteria (specifically E. coli) as a primary cause of recreational impairment (OEPA, 2008). Potential sources of these impairments include the Oxford Wastewater Treatment Plant (WTTP) located upstream of the CR-FMC watershed, agricultural and urban runoff, livestock access to the streams, streambank erosion and sedimentation, habitat alterations, flooding and failing household sewage treatment systems (HSTS).

Row crop agriculture has been identified as a significant contributor to excessive nutrient loads and sedimentation/siltation in rural watersheds, as well as a major source of nutrient pollution, particularly nitrogen, which contributes to hypoxia in the Gulf of Mexico. The OEPA has provided baseline estimates and reduction goals for nutrient loads from agricultural activities and urban development within the CR-FMC watershed (see Table 14). This version of the Nonpoint Source Implementation Strategy (NPS-IS) for the CR-FMC HUC 12 will focus on reducing agricultural nutrient loads by 20%.

Table 7 Estimated Nutrient Loadings from Contributing NPS Sources in CR-FMC HUC 12

	Agricultural Load (lbs/yr)		**Developed/Urban Load (lbs/yr)**	
	Total Nitrogen	**Total Phosphorus**	**Total Nitrogen**	**Total Phosphorus**
Current Estimates*	409,535	25,933	17,000	2,350
Target Estimates*	81,908	5,187	3,400	470

**Estimate provided by Rick Wilson, OEPA in 2024*

2.4. Additional Information for Determining Critical Areas and Developing Implementation Strategies

2.4.1. ACPF modeling for Cotton Run – FMC HUC 12

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 fields, below fields and in riparian zones (Tomer et al., 2013). The following ACPF conservation practices -- both for in fields and below fields -- and riparian buffers are found applicable in our region:

Grassed Waterway – NRCS Practice code 412
Buffer Contour Strip – NRCS Practice code 332

Nutrient Removal Wetlands – NRCS Practice code 658
Water and Sediment Control Basin (WASCOB) – NRCS Practice code 638
Riparian Buffer – NRCS Practice code 391
Streambank Stabilization – NRCS Practice code 580

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.

The ACPF riparian assessment (focusing on riparian buffer and streambank stabilization) uses a matrix based on two key variables: riparian zone width and runoff delivery. The output provides tailored riparian management recommendations derived from this cross-classification matrix. These include critical zones for sensitive sites, multi-species buffers for water uptake and nutrient trapping, stiff-stemmed grasses for capturing runoff and sediment, deep-rooted vegetation adapted to saturated soils, and sections prioritizing streambank stability due to narrow buffer widths.

The purpose of this assessment is to maximize water quality benefits by identifying segments for installing permanent vegetation specifically designed to intercept surface runoff, protect shallow groundwater in low-lying areas, and stabilize streambanks.

The ACPF model was performed for the Cotton Run – FMC HUC-12 using a 2.5 ft LIDAR DEM from Ohio Geographically Referenced Information Program (OGRIP) and a file geodatabase provided by ARS (USDA, 2024). Modeled was performed using ACPF Version 5.0

The ACPF model identified a number of possible in-field conservations practices, below-field practices and also riparian zone designs in the Cotton Run – FMC HUC-12. In this HUC-12, 5,7% of the fields are considered high and 1.3% very high runoff risks and 23% of the watershed is tile-drained agricultural fields as estimated by the ACPF. Figures 16-18 depict the ACPF model results.

Outputs from the ACPF model were validated through field visits at multiple locations in the watershed on June 27, 2024, and further discussed during a stakeholder meeting in August. The ACPF maps serve as a valuable visual tool, enhancing the effectiveness and efficiency of both field assessments and discussions. Notably, while the ACPF recommended contoured buffer strips, this practice is not commonly used in the region. As a more suitable alternative, riparian filter strips have been identified as the preferred in-field practice

Table 8 Conservation Practices at CR - FMC 12 Suggested by the ACPF

The ACPF Maps end estimates are only for planning purposes

Practice	Unit	Length (miles)	Total Area (Acres)
In-Field & Below-Field Practices			
Grassed Waterways	1470 sites	149	NA
Contoured Buffer Strips	287 sites	65	NA
Tile Drainage Management	4 sites	NA	89
Depressions (potential wetland restoration sites)	2 depressions	NA	0.1
Nutrient Removal Wetlands	42 wetlands	NA	8930* Pools:56.4 Buffers: 68.6
WASCOBs	127 sites	NA	959*
Denitrifying Bioreactors	49 sites	NA	12**
Riparian Zone Practices			
High Nutrient Sensitive Buffers	NA	0.2	NA
Riparian Buffers Filters (various plants)	NA	59	NA
Stream Bank Stabilization	NA	86	NA
Saturated Buffer	NA	7.5	NA
Saturated Buffer Requiring Carbon Enhancement	NA	3	NA

**Contributing area*
*** Average surface area of potential bioreactor*
NA- Not applicable

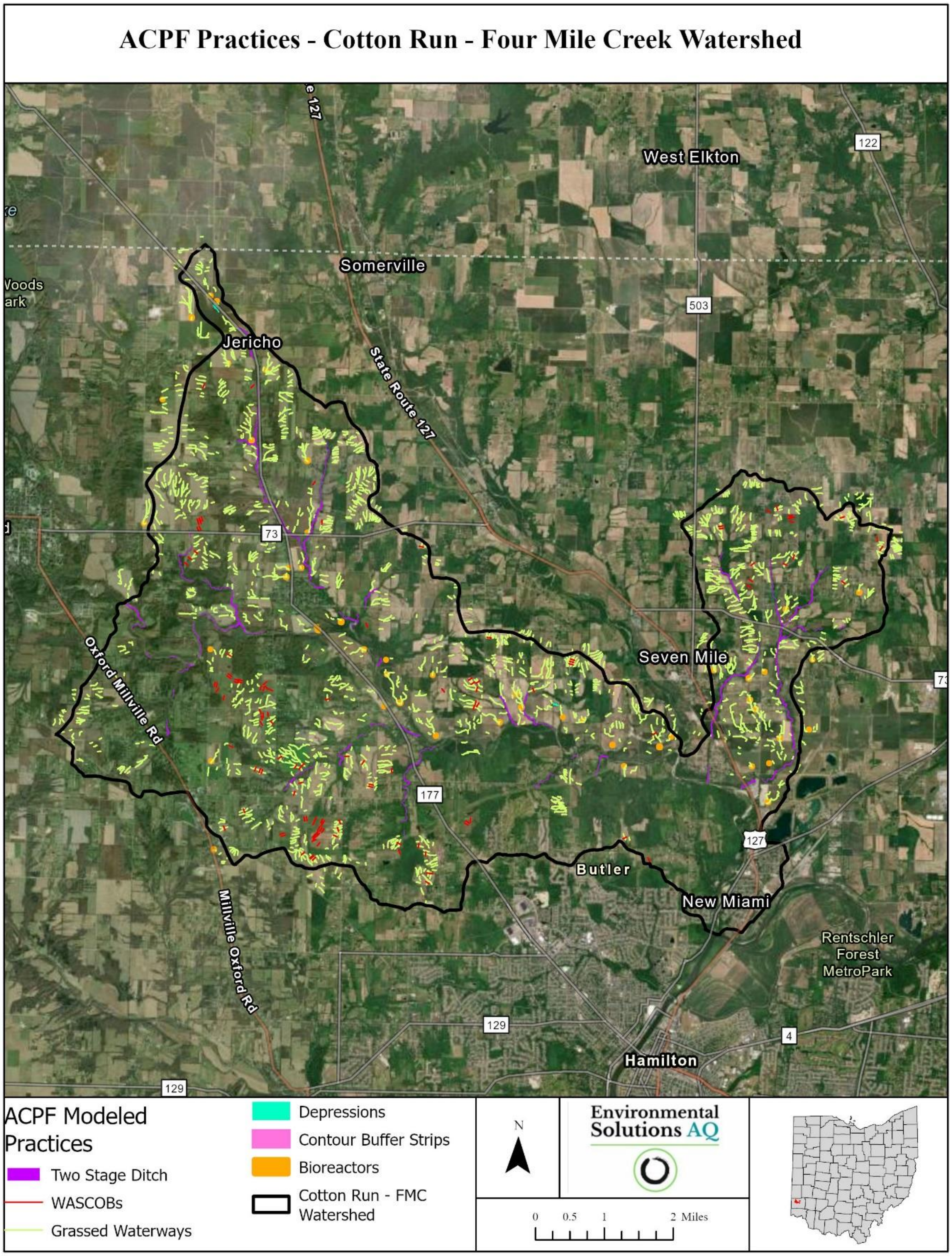

Figure 16 ACPF In-Field Agricultural Conservation Practice Opportunities in CR-FMC HUC 12

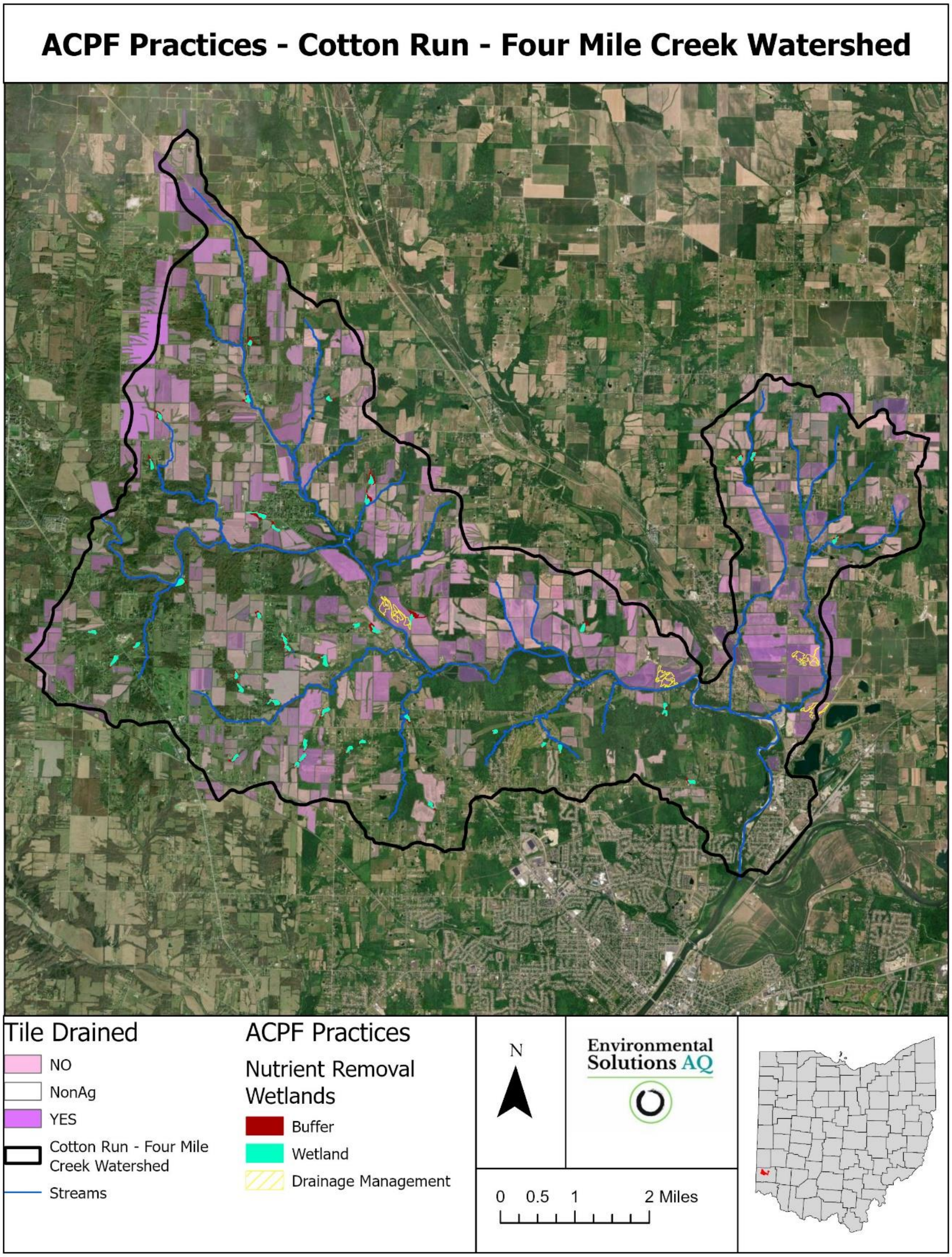

Figure 17 ACPF Below-Field Agricultural Conservation Practice Opportunities in CR-FMC HUC 12

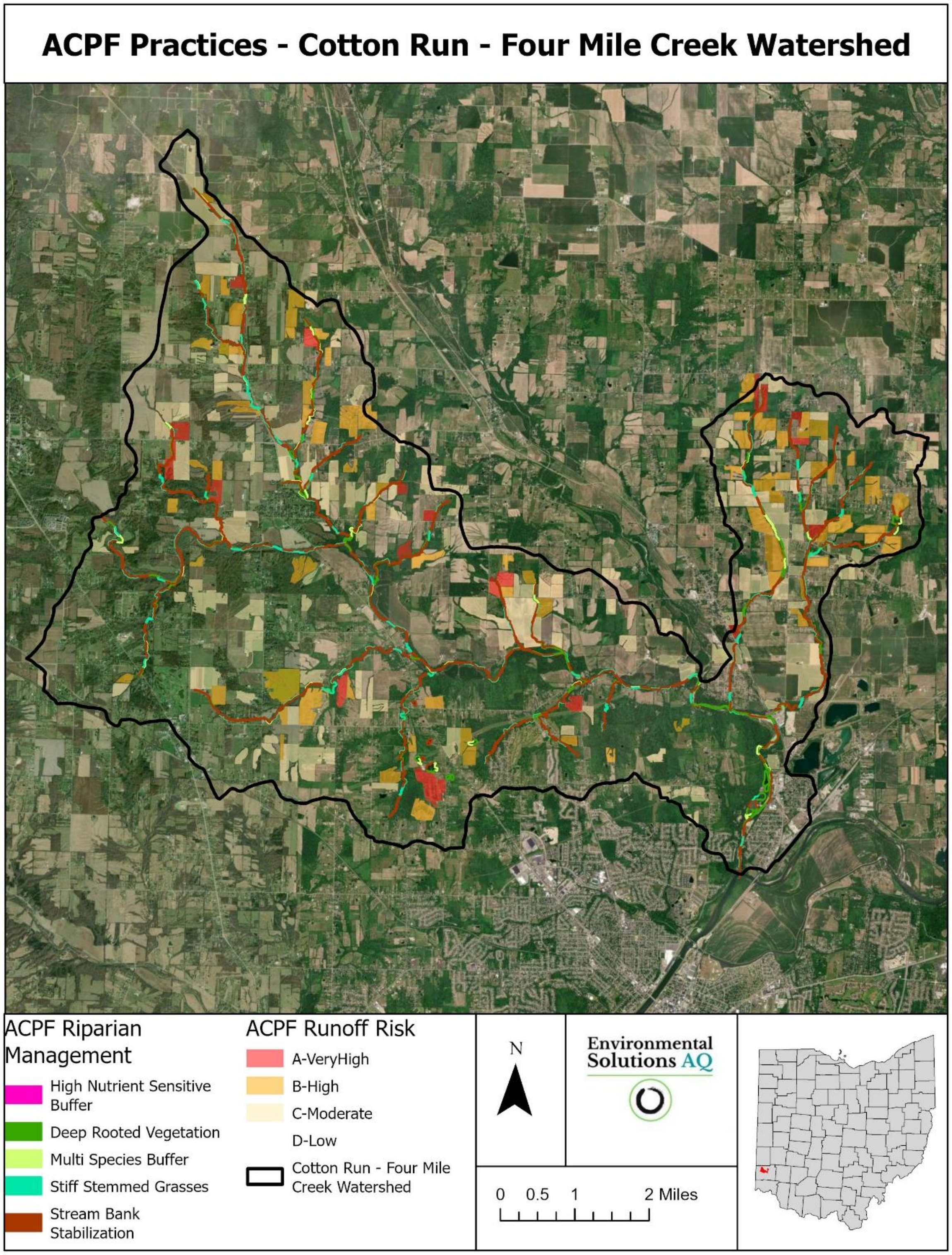

Figure 4 Riparian Function Management Suggested by ACPF IN CR-FMC HUC 12

2.4.2. Citizen Science

The Butler County Stream Team is a citizen science initiative comprised of dedicated volunteers from Butler County. Led by the Institute for the Environment and Sustainability at Miami University, the program operates in partnership with the Butler County Storm Water District and the Butler County SWCD. Its primary focus is the collection, analysis, and reporting of water quality data from local streams, holding EPA Level 2 credible data status. The team monitors key water quality indicators, including nitrates, total phosphorus, bacteria, conductivity, total dissolved solids, pH, and turbidity. All collected data is publicly accessible (Butler County Stream Team, 2024).

Seven sampling sites are located within the CR-FMC watershed. Six of these sites coincide with the Ohio EPA's 2005 sampling locations along FMC, Darrs Run, and Stoney Run. Additionally, Cotton Run has also been sampled (Fig 19).

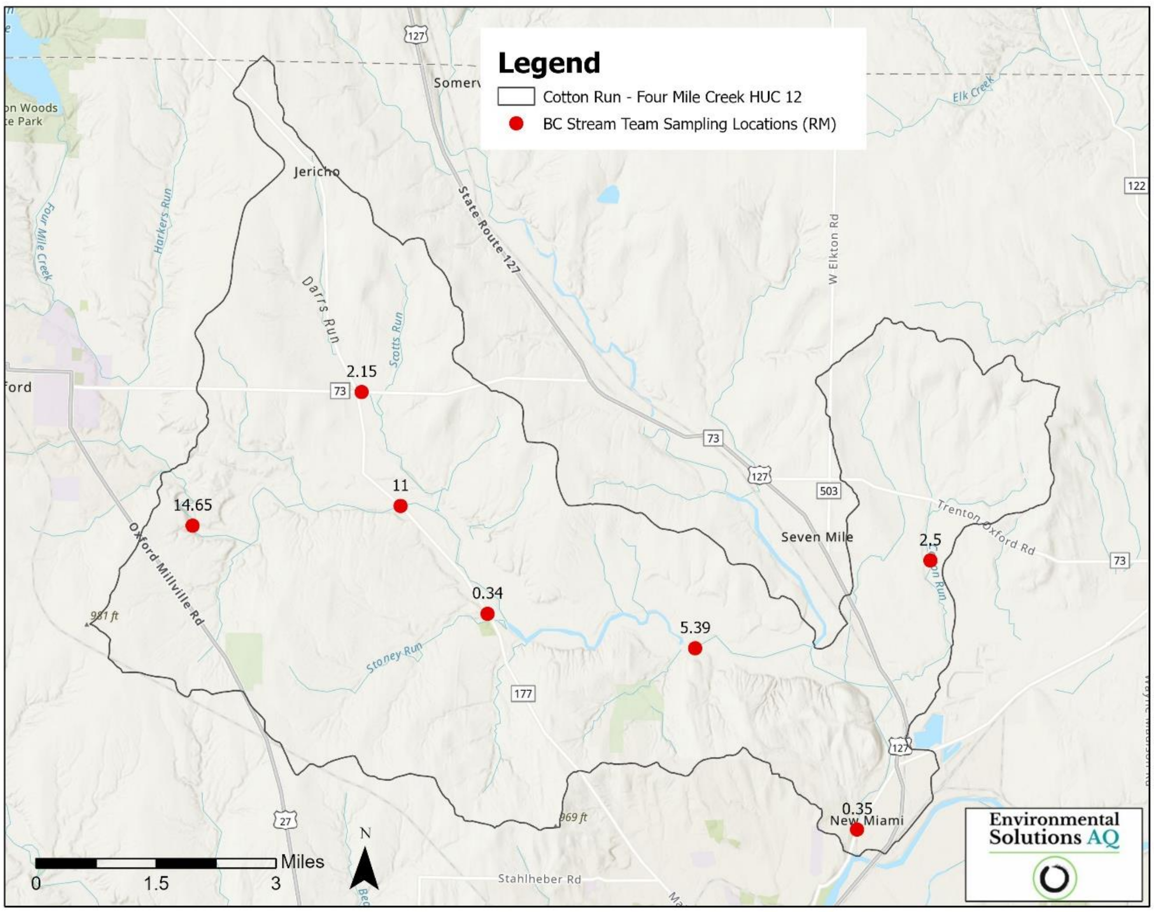

Figure 5 Butler County Stream Team Sampling Locations in CR-FMC HUC-12

Samples collected monthly from March to November 2022 were analyzed and averaged according to seasonal periods: spring (March, April, May), summer (June, July, August), and fall (September, October, November) (see Table 16). Sampling is paused during winter months (December, January, February).

Table 9 2022 average season water quality values for Stream Team sampling sites.

Site Location (RM)	Total Phosphorus (mg/L)			Nitrate (mg/L)		
	Spring (n=2)	*Summer (n=3)*	*Fall (n=3)*	*Spring (n=2)*	*Summer (n=3)*	*Fall (n=3)*
Cotton Run at RM 2.5	0.032	0.08	0.098	0.9	0.78	0.42
FMC at RM 0.35	0.038	0.031	0.033	2.51	2.1	1.95
FMC at RM 5.39	0.104	0.127	0.36	3.3	2.39	4.11
Stoney Run at RM 0.34	0.029	0.072	0.103	0.195	0.518	0.209
FMC at RM 11.0	0.173	0.243	2.6	3.75	2.88	8.66
Darrs Run at RM 2.15	0.007	0.032	0.043	0.846	0.585	0.112
FMC at RM 14.65	0.146	0.483	3.77	3.77	4.85	15.28
Site Id	**Conductivity (µs/cm)**			**TDS (mg/L)**		
	Spring (n=2)	*Summer (n=3)*	*Fall (n=3)*	*Spring (n=2)*	*Summer (n=3)*	*Fall (n=3)*
Cotton Run at RM 2.5	589.25	619.17	719	281.75	297	344.25
FMC at RM 0.35	578.5	606.67	676	276	290.83	323.33
FMC at RM 5.39	571.5	617.67	960.33	271	296	464
Stoney Run at RM 0.34	593.5	570	663	283.5	274.17	317.67
FMC at RM 11.0	553	661.67	1193	263	317.67	578.33
Darrs Run at RM 2.15	588.25	598.17	739	280.25	287.67	354.67
FMC at RM 14.65	536.5	709	1488.17	255	339.17	724.83
Site Id	**Turbidity (NTU)**			**pH**		
	Spring (n=2)	*Summer (n=3)*	*Fall (n=3)*	*Spring (n=2)*	*Summer (n=3)*	*Fall (n=3)*
Cotton Run at RM 2.5	2.78	4.03	2.95	8.01	8.17	7.87
FMC at RM 0.35	2.57	3.57	1.57	8.08	7.94	7.77
FMC at RM 5.39	2.79	12.33	3.54	8.21	8.02	7.95
Stoney Run at RM 0.34	5.34	5.84	1.87	8.16	8.07	7.95
FMC at RM 11.0	3.48	12.32	4.11	8.18	8.09	8.19
Darrs Run at RM 2.15	2.183	1.855	2.243	8.11	7.98	7.71
FMC at RM 14.65	3.075	5.125	2.512	8.02	7.96	7.88
Site Id	**Total Coliform (CFU/100 ml)**			**E. Coli (CFU/100 ml)**		
	Spring (n=2)	*Summer (n=3)*	*Fall (n=3)*	*Spring (n=2)*	*Summer (n=3)*	*Fall (n=3)*
Cotton Run at RM 2.5	6203.25	21607.33	8951.17	1148.5	2149.17	623.67
FMC at RM 0.35	7247.5	10834.83	4961.5	122.5	176	80.33
FMC at RM 5.39	10425.5	18553.67	8211.67	121	486.33	141.33
Stoney Run at RM 0.34	11402	10944	5264	217.5	365.33	173.3
FMC at RM 11.0	13065.5	17553	6591.5	99	313	63.33
Darrs Run at RM 2.15	4885.75	16568	3953.67	247.25	1990	147.67
FMC at RM 14.65	12578	18997.17	9219.67	86.5	323.33	597.33

The Ohio EPA has established specific parameter limits for three key water quality indicators: nitrate in drinking water, total dissolved solids (TDS) for warmwater habitat (WWH) aquatic life use, and *E. coli* in primary contact surface waters. These limits are designed to protect public health, preserve ecological integrity, and ensure safe conditions for recreational activities.

Total phosphorus discharge limits in Ohio are determined on a case-by-case basis, taking into account the unique characteristics of each waterbody and its watershed. Currently, the Ohio EPA is developing a Total Maximum Daily Load (TMDL) report for FMC to guide nutrient management and improve water quality.

In 2000, the U.S. EPA published the *Ambient Water Quality Criteria Recommendations for Rivers and Streams in Nutrient Ecoregion VI* to support state and tribal development of nutrient criteria. This document provides reference conditions that reflect pristine or minimally impacted waters as a basis for developing nutrient criteria in the Eastern Corn Belt Plains (ECBP) ecoregion (U.S. EPA, 2000). The reference conditions for total phosphorus in rivers and streams within the ECBP ecoregion range from 0.063 to 0.12 mg/L. This threshold is intended to prevent excessive nutrient enrichment, which can trigger eutrophication, harmful algal blooms, and oxygen depletion - factors that degrade water quality and disrupt aquatic ecosystems.

In the CR-FMC watershed, seasonal total phosphorus concentrations varied significantly across different sites and seasons. Water samples collected along FMC generally exceeded the recommended phosphorus concentration range during spring, summer, and fall. The highest recorded seasonal average of total phosphorus reached 3.77 mg/L at a site downstream from the Oxford Wastewater Treatment Plant (WWTP), suggesting that the WWTP, along with agricultural runoff, has a substantial impact on local water quality and exceeds the upper reference limit of 0.12 mg/L for total phosphorus set by the EPA. In contrast, total phosphorus concentrations in the tributaries above the WWTP remained below or within the reference condition range during all three seasons.

Ohio's water quality standard for nitrate is set at a maximum contaminant level (MCL) of 10 mg/L, in accordance with the Federal Safe Drinking Water Act, to protect public health, particularly vulnerable populations such as infants.

In 2022, seasonal average nitrate levels remained below the MCL at most sites, except for one location (FMC at RM 14.65) along FMC, where the fall average nitrate concentration reached 15.28 mg/L. Additionally, elevated nitrate levels (8.66 mg/L average in fall) were observed at FMC at RM 11.0 site location along FMC, though they did not exceed the MCL. Both FMC at RM 14.65 and FMC at RM 11.0 are located downstream of the Oxford WWTP, indicating that the treatment plant may contribute to elevated nitrate concentrations in this section of the creek.

The EPA recommends reference conditions for turbidity levels in the range of 4.33–9.21 FTU for pristine or minimally impacted rivers and streams in the ECBP ecoregion (U.S. EPA, 2000). Turbidity affects light penetration and can be detrimental to aquatic life. Elevated turbidity is often caused by stormwater runoff, agricultural activities, and soil erosion, which introduce sediment-bound nutrients into water systems. This increases nutrient availability and can contribute to water quality degradation.

In the CR-FMC watershed, average seasonal turbidity levels measured in 2022 in spring and fall remained below or within the EPA reference conditions for pristine or minimally impacted waters. However, two sampling sites: FMC at RM 5.39 and FMC at RM 11.00 exhibited average summer turbidity levels exceeding the reference range (12.33 NTU and 12.32 NTU, respectively), suggesting increased sediment loads, likely due to runoff and erosion, which may negatively impact water clarity and aquatic habitats.

The seasonal average Total Dissolved Solids (TDS) results for all sampling locations met water quality standards, with TDS levels remaining below 1500 mg/L.

In Ohio, the EPA has established specific numeric criteria for E. coli concentrations in surface waters to protect public health and recreational activities. The E. coli standard for Primary Contact Recreation (PCR) is a 90-day geometric mean of 126 CFU/100 mL (Ohio EPA, 2018).

During the summer, the average E. coli concentrations at all sampling sites exceeded the PCR standard. The observed values ranged from 176 CFU/100 mL at the FMC RM 0.35 to 2149.14 CFU/100 mL at the Cotton Run RM 2.5. The elevated E. coli levels during summer can be attributed to several factors, including higher temperatures, which can enhance bacterial survival and growth, increased recreational activities, and stormwater runoff from summer storms, which can wash bacteria from surrounding land into the waterways. Additionally, lower stream flows during dry periods reduce dilution, leading to higher bacterial concentrations.

In the spring, the average E. coli concentration was above the PCR standard at all sampled tributaries, including sampling sites at Cotton Run RM 2.5, Stoney Run RM 0.34, and Darrs Run RM 2.15, with seasonal averages of 1148.5 CFU/100 mL, 217.15 CFU/100 mL, and 247.25 CFU/100 mL, respectively. The elevated E. coli levels in spring are likely due to increased precipitation and surface runoff, which transport bacteria from agricultural fields, wildlife habitats, and urban areas into streams. Additionally, soil disturbances from springtime agricultural activities and thawing ground may contribute to bacterial mobilization.

In the fall, in addition to high E. coli concentrations at tributary sampling sites, FMC also exceeded the Primary Contact Recreation standard at sites RM 5.39 and RM14.65. The likely contributors to these elevated levels include fall rainfall events, which flush accumulated bacteria from the landscape into waterways, as well as increased livestock and wildlife activity near streams during periods of high temperatures and low flows, when they seek water for drinking and cooling. Additionally, organic matter from fallen leaves can provide nutrients that support bacterial persistence in stream environments.

In summary, seasonal water quality monitoring from March to November 2022 in the CR-FMC watershed revealed significant variations in nutrient levels, turbidity, and contamination sources. Phosphorus concentrations frequently exceeded recommended levels downstream of the Oxford WWTP, with a peak seasonal average of 3.77 mg/L, indicating substantial impacts from wastewater discharge and agricultural runoff. Nitrate levels remained mostly within safe limits, except at FMC at RM 14.65 in fall (15.28 mg/L), suggesting wastewater influence. Turbidity levels generally stayed within EPA reference conditions, though exceedances in summer at FMC at RM 5.39 and RM 11.00 pointed to increased sediment loads from runoff and erosion. E. coli concentrations surpassed the Primary Contact Recreation standard at all sites during summer, with the highest levels recorded at Cotton Run (2149.14 CFU/100 mL), emphasizing its vulnerability to contamination. Notably, Cotton Run was not sampled during the 2005 EPA survey, underscoring the importance of continued monitoring. These findings highlight the need for targeted nutrient management and watershed protection efforts.

Chapter 3: Conditions & Restoration Strategies for Cotton Run – FMC HUC-12 Critical Areas

3.1. Overview of Critical Areas

In 2005, FMC and its main tributaries were included in a biological and water quality assessment conducted by the Ohio EPA (OEPA, 2008). Six sampling sites within the CR-FMC HUC 12 were evaluated for biological indicators and analyzed for water quality. All sampling locations within the CR-FMC watershed supported Exceptional Warmwater Habitat (EWH) or the Warmwater Habitat (WWH) aquatic communities. Each sampling site along the FMC mainstream fully met Aquatic Life Use (ALU) standards, except for the site at RM 11.01, which was classified as partial attainment due to elevated phosphorus concentrations. Two tributaries of FMC, Darrs Run and Stoney Run, also showed partial attainment for ALU, attributed to natural causes.

Additionally, all sampling locations exhibited elevated concentrations or exceeded Ohio Water Quality Standards (WQS) for dissolved oxygen, bacteria, and legacy pesticides. Currently, the CR-FMC HUC 12 is listed as impaired for recreational use due to E. coli and for ALU. Potential sources of these impairments include row crop agriculture, manure runoff, cattle access to streams, streambank and topsoil erosion, and urban runoff from unsewered areas. Increasing development pressure, along with the resulting impervious surface cover, poses a further threat to high-quality habitats in the watershed, including riparian areas and wetlands.

To protect and enhance water quality and habitat integrity, it is essential to implement and maximize conservation and land management practices within this watershed. These efforts will help preserve sensitive habitats, improve the health of both near-field and far-field waterways, and protect vulnerable groundwater supplies used for drinking water.

Three critical areas have been identified within the CR-FMC watershed (Fig. 20):

Critical Area 1 will address the effects of nutrient enrichment, siltation, and sedimentation from agricultural activities on both the local waterways and the far-field (Gulf of Mexico).

Critical Area 2 will focus on restoring riparian corridors focusing on the FMC's 100-year floodplain while protecting ecologically sensitive habitats along FMC and its tributaries. This area is vital because it supports diverse wildlife, helps filter pollutants before they reach the waterways, mitigates flooding by absorbing excess water, and stabilizes streambanks to prevent erosion. Protecting and restoring this landscape is crucial for maintaining water quality, ecosystem health, and long-term watershed resilience. Critical Area 2 will focus on restoring riparian corridors specifically the FMC's 100-year floodplain while protecting ecologically sensitive habitats along FMC and its tributaries. This area is vital because it supports diverse wildlife, helps filter pollutants before they reach the waterways, mitigates flooding by absorbing excess water, and stabilizes streambanks to prevent erosion. Protecting and restoring this landscape is crucial for maintaining water quality, ecosystem health, and long-term watershed resilience.

In addition, Critical Area 2 follows Ohio's recommended stream setback widths, as established by the Ohio EPA and ODNR (Ohio EPA Rainwater and Land Development Manual; ODNR Stream Management Guides). General guidelines recommend determining stream setbacks based on the drainage area size:

- **Small Streams** (Drainage Area < 0.5 sq. mile): 25–50 feet from the top of the bank
- **Medium Streams** (Drainage Area 0.5–20 sq. miles): 75–100 feet
- **Large Streams & Rivers** (Drainage Area > 300 sq. miles): 120–300 feet

These setbacks help protect water quality, reduce erosion, and maintain healthy riparian ecosystems.

Critical Area 3 will focus on addressing failing HSTS systems in two rural communities: Darrtown and the W Elkton Road subdivision. This is essential because failing home sewage treatment systems can release harmful bacteria, nutrients, and other pollutants into groundwater and nearby streams, posing risks to public health and the environment. Given that the W Elkton Road community relies solely on well water for drinking, improving wastewater treatment is crucial for preventing contamination, protecting water quality, and ensuring long-term sustainability for residents.

These critical areas may be revised, or additional areas may be identified, in future updates of this Nonpoint Source Implementation Strategy (NPS-IS).

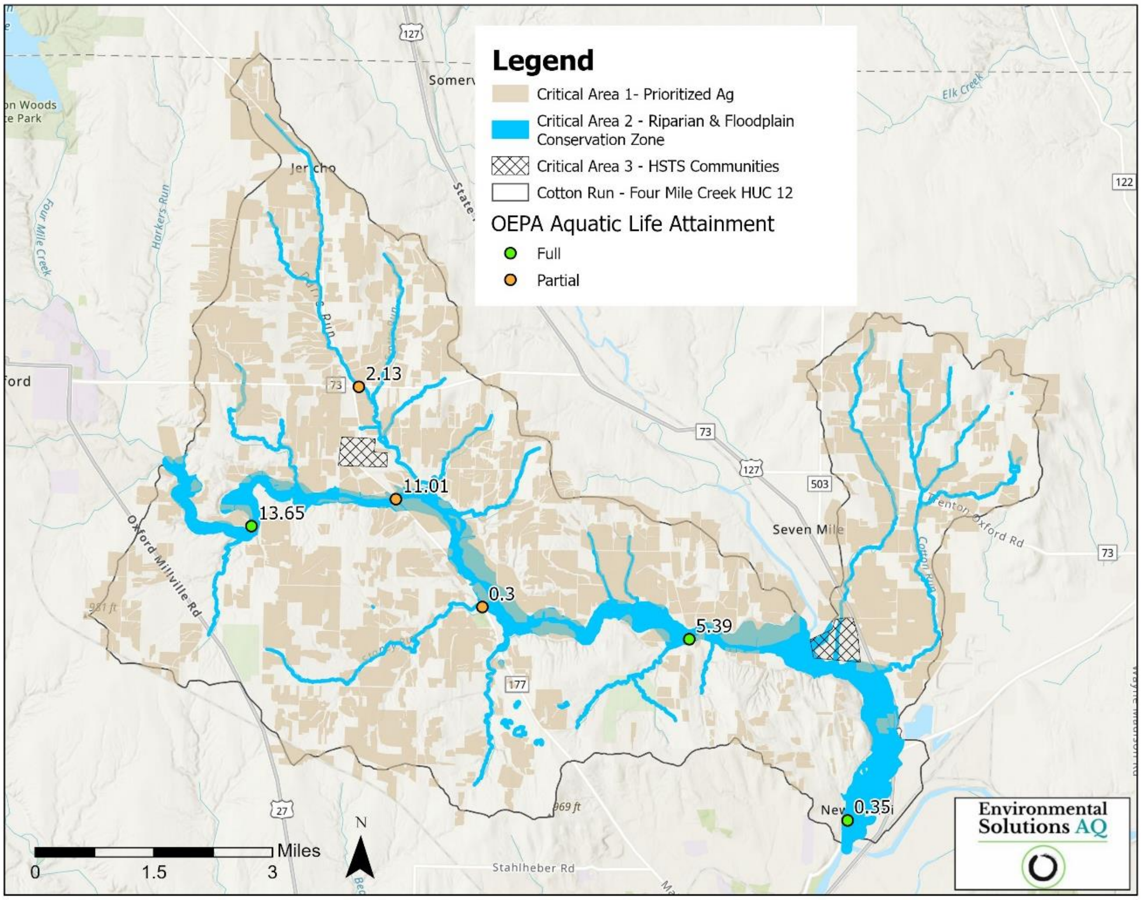

Figure 20 CR - FMC HUC 12 Critical Areas Overview

Table 10 Critical Areas of CR-FMC HUC 12

Critical Area	Critical Area Description	Addressed Impairments	Area (Acres)
1	Prioritized Agricultural Lands as determined by ACPF	Nutrient Management in Prioritized Agricultural Lands *(Near-Field and Far-Field Impairment – Gulf of Mexico hypoxia – N and P Reduction))*	15,838
2	Riparian and Floodplain Conservation Zone (300 ft width on each site of FMC mainstem and 75 ft width on each site of tributaries)	Maintain or improve high quality habitats scores in IBI, ICI, QHEI and stream health by reducing nutrients and siltation/sedimentation *(Near-Field and Far-Field Impairment – Gulf of Mexico Hypoxia*)	3,155

3	Home Sewage Treatment Systems in Darrtown and W Elkton Road Communities	Near-Field recreational impairment and Far-Field impairment (Gulf of Mexico hypoxia)	279

3.2. Critical Area 1: Conditions, Goals, & Objectives for Nutrient Reduction and Management in Cotton Run – FMC HUC-12 for Prioritized Agricultural Lands

3.2.1. Detailed Characterization

Given the dominance of agricultural land use throughout the CR-FMC watershed, the use of best management practices (BMPs) targeting nutrient loss from local farm fields and agricultural activities is recommended. Additionally, implementing BMPs may help reduce siltation and sedimentation in local streams.

Although BMPs are encouraged on all agricultural lands, certain areas are more susceptible to nutrient loss and erosion than others and should be prioritized for BMP implementation. Furthermore, local stakeholders are concerned about the negative impact of nutrients, bacteria, and pesticides from the agricultural activities leaching into the shallow aquifer, which serves as a primary source of drinking water for the local communities. Therefore, implementing BMPs on agricultural lands that overlap the high groundwater vulnerability areas is also a priority.

Critical Area #1 includes all agricultural lands throughout the CR-FMC HUC-12 and is prioritized based on criteria established by local stakeholders (Fig. 21). The ACPF model identified 98 high-runoff fields covering approximately 2,313 acres of agricultural land (14% of the CR-FMC watershed). Additionally, the ACPF identified 48 suitable locations for the creation of Nutrient Removal Wetlands, which, collectively, can filter agricultural runoff from approximately 8,930 acres.

Based on stakeholders' input and/or determined by the ACPF analyses, the prioritized areas and potential projects should meet at least one of the following criteria:

- Lands identified as high runoff fields;
- Lands overlapping the high groundwater vulnerability areas as determined by the DRASTIC model published in 2022 by the ODNR;
- Lands suitable for creating the Nutrient Removal Wetlands as determined by the ACPF
- Lands currently under conventional tillage regimes and/or underutilizing cover crops;
- Lands without current nutrient management plan or current soil test results (< 3 years).

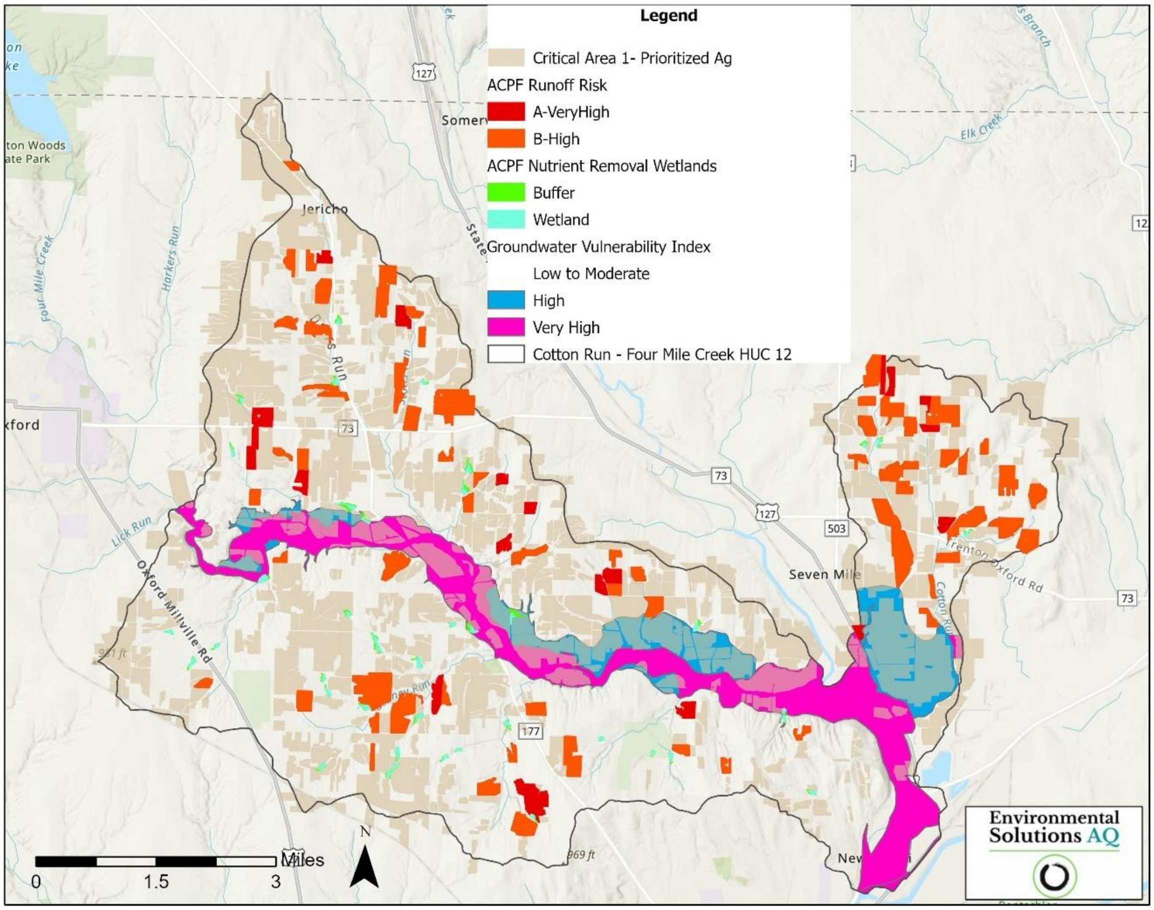

Figure 21 CR-FMC HUC 12 Critical Area #1

3.2.2. Detailed Biological Conditions

Fish community assessment conducted by Ohio EPA in 2005 at multiple sampling locations within the FMC watershed is summarized in Tab. 17. Both the FMC mainstem and its tributaries supported fish assemblages consistent with the Warmwater Habitat (WWH) standards. The biological indicators for four sampling locations along the mainstem of FMC ranged from exceptional (IBI = 54/MIwb = 10.0) to good/exceptional (IBI = 42/MIwb = 9.9). At these locations, the fish community met the WWH WQS for IBI and MIwb, with IBI scores above the minimum threshold of 40, demonstrating overall good to exceptional ecological conditions. The most upstream site at RM 13.65W exhibited the highest biological integrity, with a diverse and abundant community dominated by species such as the central stoneroller, bluntnose minnow, and northern hog sucker, reflecting a robust and healthy fish population.

Two tributary sampling locations, Darrs Run (RM 2.1H) and Stoney Run (RM 0.3H), showed favorable biological indicators, with IBI scores ranging from exceptional (IBI = 54) to good (IBI = 44). Both tributary locations met the WWH WQS for IBI, confirming that these streams support fish communities with minimal impairment. While Darrs Run had a slightly lower IBI score, it still reflected good conditions, consistent with a diverse fish assemblage.

In 2005, the Ohio EPA evaluated the physical stream features and riparian conditions within the FMC watershed (Tab. 18). The QHEI values for FMC mainstem ranged between 74.0 and 92.5, with a mean score of 81.5. The tributaries, Darrs Run and Stoney Run, had QHEI values of 54.5 and 52.0, respectively. FMC mainstem sampling sites (RM 13.7, RM 5.4, RM 0.3) consistently scored above 74, indicating excellent habitat quality capable of supporting aquatic communities consistent with WWH standards. The tributary sampling stations at Darrs Run (RM 2.1) and Stoney Run (RM 0.3) showed lower QHEI scores, with Darrs Run indicating moderate habitat quality, while Stoney Run also demonstrated less than optimal, though still supporting moderate aquatic life. The most common habitat deficiencies in the watershed were related to substrate composition and cover availability, but these were not significant enough to preclude attainment of WWH standards at most sites.

Table 11 Fish Community and Habitat Data

RM	QHEI	Drainage Area (mi²)	Mean # of Species	Predominant species (% of catch)*	Mean MIwb	IBI	Narratives
FMC							
13.65[W]	92.5	132	30	Central stoneroller (17.7.1%), bluntnose minnow (15.8%), northern hog sucker (10.5%), sand shiner (9/0%), striped shiner (6.6%), and spotfin shiner(6.6%).	10.0	54	Exceptional
11.0[W]	74.0	137	27		10.2	52	Exceptional
5.4[W]	83.0	163	29		10.4	56	Exceptional
0.3[W]	76.5	315	29		9.9	42	Good/ Exceptional
Darrs Run							
2.1[H]	54.5	5.6	16		NA	44	Good
Stoney Run							
0.3[H]	52.0	4.8	22		NA	54	Exceptional

**Only aggregate sampling results from the Indian Creek mainstream were reported (OEPA, 2008)*
QHEI Qualitative Habitat Evaluation Index
MIwb Modified Index of Well Being
IBI Index of Biotic Integrity
H Headwater sample (Drainage Area ≤ 20 mi²)
W Wading sample (Drainage Area > 20 mi² ≤ 500 mi²)
ns not significant departure from the biocriteria (<4 IBI units)
N/A Not applicable (MIwb only applies to drainage areas > 20mile²)

Macroinvertebrate community performance within the FMC and its tributaries was assessed by the Ohio EPA in 2005 (Tab. 19). The survey included several sampling sites along FMC mainstem and two of its tributaries, Darrs Run and Stoney Run. The conditions of macroinvertebrates in FMC mainstem ranged from very good to good, with the mainstem sites meeting the Aquatic Life Use (ALU) standard. The dominant taxa at the most upstream site at RM 13.6 were Chimarra caddisflies and midges, while the site at RM 5.4 was dominated by Baetid mayflies and hydropsychid caddisflies, reflecting a very good community condition. However, the site at RM 11.0 showed an impairment due to elevated phosphorus levels, likely from the upstream Oxford Wastewater Treatment Plant (WTTP) and surrounding residential and agricultural runoff.

Macroinvertebrate communities in FMC tributaries, specifically Darrs Run (RM 2.1) and Stoney Run (RM 0.3), were classified as fair to low fair. The Darrs Run site had underperforming macroinvertebrate communities due to the lack of surface flow, while Stoney Run's condition was similarly limited. Both tributary sites showed the presence of hydropsychid caddisflies and mayflies, indicating a moderately impaired community structure.

These findings highlight the varying health of the macroinvertebrate communities across the watershed, with nutrient enrichment and flow conditions influencing the biological integrity of both mainstem and tributary sites. Nutrient management and flow restoration efforts are essential to improve these conditions and protect aquatic biodiversity.

Table 19 Macroinvertebrate Community

RM	Dr. Area (Sq. mi.)	Density Ql./Qt.	Predominant Organisms on the Natural Substrates with Tolerance Category(ies) in Parentheses	ICI	Narrative Evaluation
FMC					
13.6^{W}	132	Moderate	Chimarra caddisflies (MI), midges (MI,F), hydropsychid caddisflies (MI, F)	-	Good
11.0^{W}	137	Moderate - High	Rheotanytarsus midges (MI)	40	
5.4^{W}	163	Moderate	Baetied mayflies (F), hydropsychid caddisflies (F,MI), Chimarra caddisflies (MI)	42	Very Good
0.3^{W}	315	Low-Moderate	Midges (F, M)	42	
Darrs Run					
2.1^{H}	5.6	Low-Moderate	Hydropsychid caddisflies (F), baetid mayflies (F)	-	Fair
Stoney Run					

0.3H	4.8	Moderate	Heptageniid mayflies (F), Helicopsyche caddisflies (MI)	-	Low Fair

Source: OEPA, 2005
RM - River Mile
W - Wading Sample (Drainage Area > 20 mi^2 ≤ 500 mi^2)
H - Headwater Sample (Drainage Area ≤ 20 mi^2)
Ql.: Qualitative sample collected from the natural substrates.
Qt.: Quantitative sample collected on Hester-Dendy artificial substrates, density is expressed in organisms per square foot.
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant.
ICI - Invertebrate Community Index
No data available

Ohio EPA data from 2005 indicated that while nitrate-nitrite-N and phosphorus concentrations in FMC mainstem were generally low, phosphorus levels increased downstream from the Oxford WWTP at RM 13.7 and remained elevated until assimilated near the mouth at RM 0.3. The Butler Stream Team data collected in 2022 revealed that seasonal nutrient concentrations in FMC showed total phosphorus levels often exceeding the EPA's reference range for the Eastern Corn Belt Plains ecoregion, particularly downstream of the Oxford WWTP, where the highest seasonal average concentration reached 3.77 mg/L. In contrast, tributaries, maintained phosphorus concentrations within the reference range. Nitrate levels generally remained below the Ohio MCL of 10 mg/L at most sites, except for elevated concentrations at FMC RM 14.65 (15.28 mg/L) and FMC RM 11.0 (8.66 mg/L), suggesting potential contributions from the WTTP and surrounding agricultural runoff, as well as failing HSTSs in the area. These elevated nutrient levels could have significant impacts on water quality, including eutrophication and harmful algal blooms, which threaten aquatic ecosystems and public health, and impair the watershed for recreation.

3.2.3. Detailed Causes and Associated Sources

The 2005 Ohio EPA survey revealed that the mainstem of FMC was fully attaining the Aquatic Life Use (ALU) standard, with the exception of the section at RM 11.0. Elevated levels of total phosphorus in this area, likely originating from the upstream Oxford WTTP and exacerbated by urban and agricultural runoff from surrounding areas, were identified as the primary contributors to this impairment. Additionally, two tributaries of FMC, Darrs Run (RM 2.1) and Stoney Run (RM 0.3), were found to be in partial attainment. The impairment status of these tributaries was attributed to underperforming macroinvertebrate communities, which were negatively impacted by the degraded habitat and lack of surface flow during the sampling period.

Agricultural activities within the CR-FMC watershed, coupled with discharges from wastewater treatment systems and urban runoff, are major contributors to nutrient enrichment in local streams and rivers. These excessive nutrient loads also have downstream consequences, ultimately contributing to the hypoxic zone in the Gulf of Mexico. Targeted, property-specific BMPs can play a significant role in reducing the volume and concentration of nutrient-rich runoff. In addition, these practices can address the erosion of sediment and topsoil from agricultural lands, helping to retain and optimize nutrients in the fields. By addressing the underlying causes of nutrient and sediment loss, the implementation of BMPs can effectively reduce the amount of excess nutrients and sediment entering local waterways, leading to healthier aquatic systems and better water quality for the communities they support. Protecting and maintaining the health of the streams in this watershed is essential for sustaining and enhancing the region's aquatic biodiversity. As such, effective nutrient management is critical. Moreover, FMC is directly linked to the underlying buried aquifer that serves as a source of drinking water for local communities. Implementing best management practices (BMPs) will help safeguard these water supplies by preventing or reducing the infiltration of contaminants from the surface to the aquifer.

The CR-FMC HUC 12 watershed supports a variety of livestock operations, with cattle farms being the most common. There are 30 cattle farms in total, including 9 small, 20 medium, and 1 large operation (see Tab 4 in Chapter 2 for more details). Other livestock operations are primarily small-scale, including 15 horse farms, along with smaller numbers of hogs, alpacas, goats, and llamas. Only one medium-sized horse farm is reported. Livestock operations can impact water quality through nutrient runoff, bacterial contamination, sedimentation, and streambank degradation. Manure contributes nitrogen and phosphorus, leading to algal blooms and water pollution, while bacteria like E. coli pose health risks. Overgrazing and direct livestock access to streams cause erosion and habitat loss, increasing sediment in waterways. Best management practices such as riparian buffers, exclusion fencing, rotational grazing, and updating manure storage facilities can help reduce these impacts by preventing runoff and improving nutrient management, ultimately protecting water resources.

To determine the annual nutrient load from the manure facilities for medium size livestock operations (15 to 30 heads of cattle) to FMC and its tributaries an estimate of the concentration of total nitrogen and total phosphorus produced by cattle in a year is needed.

The annual nitrogen and phosphorus excretion by cattle vary based on factors such as diet composition, animal size, and management practices. On average, cattle excrete approximately 170.7 grams of nitrogen and 99.5 grams of phosphorus per day per animal (Bougoiuin et al., 2022).

Tab. 20 Typical Daily and Annual Nitrogen and Phosphorus Excretion by Cattle

	1 Head of Cattle g/day*	**1 Head of Cattle lb/year**	**30 Heads of Cattle lb/year**
Total N	170.7	137.5	4125
Total P	99.5	80.12	2403.6

**Source: Bougoiuin et al., 2022*

The percentage of total nitrogen and total phosphorus that can leach and runoff from a manure facility is influenced by various factors, including the type of manure management system, environmental conditions, and the presence of protective measures such as buffers or cover crops. Agricultural research and environmental management studies commonly estimate that 15-50% of nitrogen and 20-45% of phosphorus can be lost through runoff and leaching (Livestock Nutrient Management Research: (Research and Reports on Nutrient Pollution | US EPA, Nutrient Management | Natural Resources Conservation Service). However, the actual percentage of nutrient loss depends heavily on site-specific factors such as manure management practices, rainfall, and soil characteristics.

For the purposes of this plan, we have assumed a 50% loss of total nitrogen and 45% loss of total phosphorus due to runoff and leaching from a manure storage facility at a medium-sized beef cattle operation (30 heads) located in the CR-FMC HUC 12. Based on this assumption, the annual loss of total nitrogen for 30 heads of cattle is estimated to be 2,107.5 lb/year (4125 lb/year * 50%), while the annual loss of total phosphorus is estimated at 1,081.62 lb/year.

3.2.4. Outline Goals and Objectives for the Critical Area

The primary purpose of NPS-IS is to improve water quality, meet nutrient reduction goals and remove impairment status for the waterbodies. Cropland activities in Critical Area #1 contribute to far-field impairment through excessive nutrient loss to local waterways that flow to the Great Miami River and ultimately add to Gulf of Mexico hypoxia. To address this impairment, the nutrient reduction goal for the agricultural watersheds within the Great Miami River basin, including the CR-FMC HUC 12 is set at levels 20% of the current estimated agricultural loadings (Rick Wilson, OEPA, personal communication). To achieve the nutrient loading goals at the CR-FMC HUC 12, the following goal and objectives have been established:

Goal 1 – Reduce total nitrogen loading contributions in Critical Area 1 by 20%.

NOT ACHIEVED: Current total nitrogen load is estimated to be 409,535 lb and the reduction goal is 81,908 lb

Goal 2 – Reduce total phosphorus loading contributions in Critical area 1 by 20%

NOT ACHIEVED: Current total nitrogen load is estimated to be 25,933 lb and the reduction goal is 5,187 lb

Goal 3 – To maintain or achieve the IBI score at or above 50 at all 2005 Ohio EPA sampling locations, which aligns with EWH ALU;

NOT ACHIEVED – The IBI at the Four Mile RM 0.3 has a score of 42 and 44 Darrs Run RM 2.1

Goal 4 – To maintain or achieve the MIwb score at or above 9.7 at all 2005 Ohio EPA sampling locations with Drainage Area > 20 mi^2

ACHIEVED

Goal 5 – To maintain or achieve the ICI score above at or above 40 or narrative “very good”

NOT ACHIEVED – The ICI narrative at the FMC mainstem RM 13.6 is “good”, at the Darrs Run RM 2.1 is “fair” and at Stoney Run RM 0.3 “low fair”.

Goal 6 – To maintain or achieve the QHEI score at or above 70 at all sampling sites.

NOT ACHIEVED – The QHEI scores yield 54.5 at the Darrs Run RM 2.1, and 52.0 at the Stoney Run RM 0.3.

Goal 7 – Attain and maintain Primary Contract Recreation Class B standard of 126 colonies/100 ml E.coli in FMC mainstem and the tributaries

NOT ACHIEVED In 2008, the Ohio EPA reported a seasonal geometric mean E. coli concentration of 430 CFU/100 mL in the FMC mainstem at RM 13.65. Additionally, sampling conducted by the Butler County Stream Team in 2022 during the spring, summer, and fall seasons revealed that the average seasonal E. coli concentrations in the FMC mainstem and its tributaries consistently exceeded the Class B standard of 126 CFU/100 mL. These average seasonal concentrations ranged from 176 CFU/100 mL at the FMC site (RM 0.35) to 2,149.14 CFU/100 mL at Cotton Run (RM 2.5).

OBJECTIVES

In order to reach the load reduction goal of 20% within the CR-FMC HUC 12, 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 (Tab. 21).

Objective 1: Implement and additional 1000 acres of conservation tillage yearly to add to the current 3,100 acres estimated under continuous conservation tillage, until nearly 100% of all row-crop agricultural fields utilize conservation tillage.

Objective 2: Plant 2000 acres of cover crops in addition to the 430 acres that have already been planted.

Objective 3: Increase and additional 1550 acres of nutrient management practices to double the current existing practices.

Objective 4: Reduce erosion and nutrient loss through the installation of grassed waterways and filter strips on at least 100 acres at locations suggested by the ACPF model in addition to 75 acres of already existing grassed waterways.

Objective 5: Reduce nutrient loss from subsurface tile drainage or below-field practices through the installation of drainage water management structures such as nutrient removal wetlands or WASCOBs on at least 15 acres at locations suggested by the ACPF model.

Objective 6: Install minimum 1500 ft of fence to restrict livestock access to the streams.

Objective 7. Upgrade at least two manure storage facilities to prevent leaching or runoff into nearby streams and ponds in the watershed. The farms located in the Great Lakes Region (Ohio and neighboring states) have seen up to a 30% reduction in nitrogen and phosphorus runoff following upgrades to manure storage facilities, such as concrete pads and more efficient storage design to minimize leakage.

Objective 8: Protect at least 1500 acres of farmland; including flooded cropland, farmed wetland, riparian areas, and pastures with permanent conservation easements, in addition to 465 acres already protected by TVCT; and enroll at least 5% of these lands in the Conservation Reserve Program (CRP) or other suitable program to retire crop production.

Table 12 Estimated Nutrient Loading Reductions from Each Objective

Objective Number	Best Management Practice	Total Acreage Treated	Estimated Nitrogen (N)/Phosphorus (P) Load Reduction (lbs/yr)*
1	Conservation Tillage	1000	5,360 lb/yr (N)/ 1,227 lb/yr (P)
1	Cover Crops	2000	11,354 lb/yr(N)/277 lb/yr (P)
3	Nutrient Management (Soil Sampling and variable rate)	1550	9,279 lb/yr (N)/ 837 lb/yr (P)
4	In-field BMPs: Grassed Waterway and Filter Strips	100	1028 lb/yr (N)/ 79 lb/yr (P)
5	Below-field BMPs: Nutrient removal wetlands and WASCOBs	15**	15,825 lb/yr(N)/ 503 lb/yr (P)

6	Livestock exclusion	1.72***	10.63 lb/yr(N)/ 0.66 lb/yr (P)
7	Upgrade two Manure Storage Facilities	N/A	1261 lb/yr(N)/ 649 lb/yr (P)
8	Conservation Easements and CRP	1500/75*****	2094 lb/yr(N)/ 114 lb/yr (P)
	TOTAL	6166.72	46,203.63 lb/yr (N)/ 3686.7 lb/yr (P)

** Estimates calculated using Pollutant Load Estimation Tool 2.0 (USEPA, 2024)*
*** 1500 acres of catchment area determined by the ACPF is used for this estimate*
**** assumes 1500 feet length and 50 feet width*
*** Estimated calculated based on method detailed above and based on 30% nutrient runoff reduction as reported by farmers in Great Lakes region.*
******75 acres of land retirement is used for this estimate*

These objectives will be directed towards implementation on prioritized agricultural lands using the stakeholder/landowner-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 CR-FMC HUC 12.

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 the sensitive areas including prairies, forested stream buffers and wetlands filtering the agricultural runoff. The TVCT will continue to promote conservation easements to help farmers permanently protect their land and improve overall health of CR-FMC watershed.

The future project-specific monitoring efforts will be conducted by Ohio EPA, MCD or other qualified organization, and 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 CR-FMC 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 Ohio EPA 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 the Riparian and Floodplain Conservation Zone

3.3.1. Detailed Characterization

Critical Area #2 encompasses approximately 3,155 acres of riparian corridors, including 2,185 acres within the 100-year floodplain of FMC and 71 miles of FMC and its tributaries (Fig. 22). In 2005, six sampling locations along the FMC mainstem and its two tributaries were assessed for biological water quality indices (previously presented). All mainstem sites were in full attainment, except for the sampling location at RM 11.0, which showed partial attainment due to elevated total phosphorus concentrations. The tributary sites—Darrs Run and Stoney Run—also had partial attainment status, primarily due to interstitial stream flow conditions. However, the QHEI scores generally supported Warmwater Habitat (WWH) and Exceptional Warmwater Habitat (EWH) communities.

Maintaining and protecting the high-quality riparian habitats, including wetlands and riparian buffers, within the CR-FMC watershed is essential for mitigating the adverse effects of excessive nutrients and sediment from surrounding landscapes. These habitats play a critical role in controlling flooding and erosion while safeguarding water quality in both local waterways and the underlying aquifer.

To address these concerns, it is vital to protect, enhance, and restore floodplains, ensuring they remain connected to streams. Additionally, wetland and riparian buffer restoration efforts should be prioritized, particularly in areas where agricultural and residential development encroach upon natural buffers and in locations severely impacted by streambank erosion.

The ACPF model identified 86 miles of eroding streambanks within the watershed, of which 59 miles are suitable for riparian buffer restoration or enhancement along FMC and its tributaries.

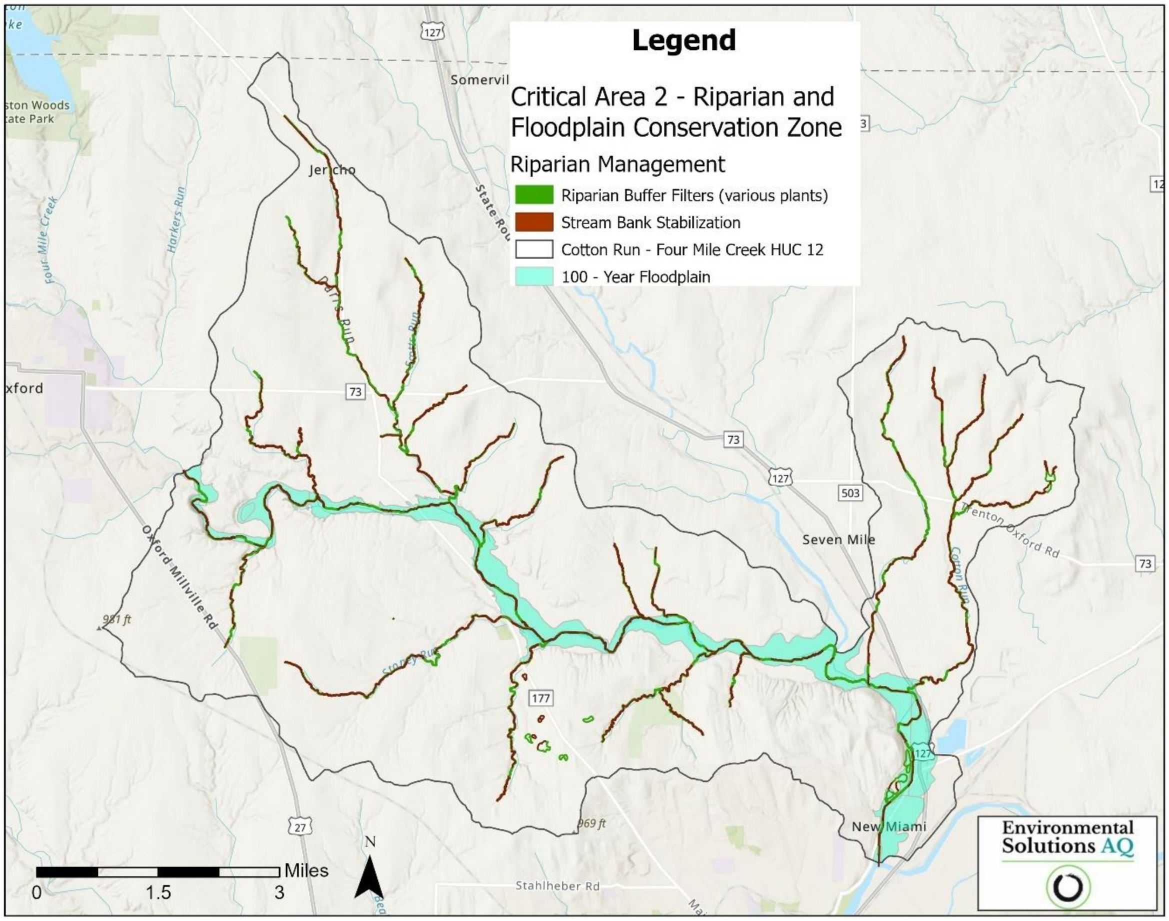

Figure 22 CR-FMC 12 Critical Area #2

3.3.2 Detailed Biological Conditions

As presented in Tables 18 and 19, the 2005 Ohio EPA biological assessment of six sampling sites supported the CR-FMC HUC 12's Warmwater Habitat (WWH) and Exceptional Warmwater Habitat (EWH) status designation. Fish community indices in this watershed ranged from exceptional (IBI = 56/MIwb = 10.4) to good/exceptional (IBI = 42/MIwb = 9.9) for the FMC mainstem and from exceptional (IBI = 54) to good (IBI = 44) for its tributaries, Darrs Run and Stoney Run.

Nearly 20% of the numerically dominant fish species collected in the FMC mainstem consisted of environmentally sensitive species, including mimic shiner, rosyface shiner, silver shiner, southern redbelly dace, banded darter, slenderhead darter, and black redhorse. These species are highly sensitive to environmental disturbances, and their presence indicates some of the highest-quality riverine habitats in Ohio (OEPA, 2008).

Macroinvertebrate community performance in the FMC mainstem ranged from exceptional (ICI = 42) to good (ICI = 40). However, macroinvertebrate performance in the tributaries varied from fair to low fair, primarily due to intermittent surface flow conditions.

Habitat quality in the FMC mainstem (RM 13.7 to RM 0.3) was generally rated as exceptional to good, with QHEI scores ranging from 92.5 to 74.0. The stream exhibited strong WWH attributes, including diverse substrates, ample cover, and a fast current. However, minor signs of modification at the lower reaches (RM 0.3) and a slightly lower QHEI score at RM 11.0 suggest opportunities for habitat improvement.

In contrast, Darrs Run and Stoney Run exhibited more modified conditions, particularly in terms of substrate composition and current velocity, with QHEI scores ranging from 54.5 to 52. While these tributaries retain some WWH characteristics, their moderate to low habitat quality ratings highlight the need for restoration efforts to enhance habitat structure and improve flow conditions.

3.3.3 Detailed Causes and Associated Sources

The primary causes of impairment in Critical Area #2 include intermittent surface flow in tributaries, habitat modifications, and localized declines in habitat quality, particularly in the lower reaches of FMC. Stream and hydrologic alterations have disrupted substrate stability and flow conditions, increasing erosion and sedimentation risks. Encroachment into riparian zones from agriculture and urban development further degrades water quality and reduces flood storage capacity. Agricultural activities contribute excess nutrients, pesticides, and sediments, leading to eutrophication, algal blooms, and habitat degradation. Urbanization, with its impervious surfaces, accelerates runoff, erosion, and stormwater pollution while diminishing groundwater recharge. The loss of riparian vegetation weakens natural filtration and floodwater absorption, heightening flood risks and watershed instability. To mitigate these impacts, preserving and restoring vegetated buffers, wetlands, and eroding streambanks is essential. These measures improve flood control, enhance riparian buffers' filtering capacity, and reduce agricultural and urban runoff pollution. Without intervention, excessive sedimentation from unstable banks will continue to degrade water quality and aquatic habitats, while increased runoff and reduced floodplain connectivity will exacerbate flood risks and watershed destabilization.

3.3.4 Outline Goals and Objectives for the Critical Area

Critical Area #2 includes riparian corridors and a 100-year floodplain, encompassing streams that receive runoff from agricultural and urbanized areas. This area prioritizes restoring stream functions, enhancing riparian zones, and protecting ecologically sensitive habitats affected by land use changes. Mitigating the impacts of degraded or absent riparian buffers can be achieved through streambank stabilization, floodplain and wetland restoration, and the establishment of forested riparian buffers, which help improve water quality, reduce erosion, and enhance flood resilience. Recognizing the need for targeted restoration, stakeholders have established specific criteria to prioritize areas and guide restoration efforts in Critical Area #2.

- Wide, intact, or restorable areas that enhance water filtration and increase the floodplain's capacity to absorb excess water.
- Existing or restorable wetlands in the riparian area and floodplain that can filter pollutants and provide temporary floodwater storage
- Areas near livestock farms, manure storage, septic systems, stormwater outfalls, or wastewater discharge points, where intervention will have the greatest impact on water quality.

- Degraded or narrow riparian zones that, when restored, can improve both water filtration and flood absorption.
- Riparian areas experiencing severely eroding banks that contribute to sediment-bound phosphorus and bacterial contamination while increasing flood risks.
- Riparian areas with the fragmented floodplain connectivity due to agricultural or urban activities

Though reductions in nutrient contributions are not a goal of this critical area, they will be achieved as an additional benefit of practices to improve aquatic life use.

Goal 1 – To maintain or achieve the IBI score at or above 50 at all 2005 Ohio EPA sampling locations, which aligns with EWH ALU;

Not Achieved – The IBI at the Four Mile RM 0.3 has a score of 42 and 44 Darrs Run RM 2.1

Goal 2 – To maintain or achieve the MIwb score at or above 9.7 at all 2005 Ohio EPA sampling locations with Drainage Area > 20 mi^2

Achieved

Goal 3 – To maintain or achieve the ICI score above at or above 40 or narrative “very good”

Not Achieved: The ICI narrative at the FMC mainstem RM 13.6 is “good”, at the Darrs Run RM 2.1 is “fair” and at Stoney Run RM 0.3 “low fair”.

Goal 4 – To maintain or achieve the QHEI score at or above 70 at all sampling sites.

Not Achieved: The QHEI scores yield 54.5 at the Darrs Run RM 2.1, and 52.0 at the Stoney Run RM 0.3.

Objectives

The implementation of these objectives, coupled with implementation in Critical Area #1 will help ameliorate negative impacts from excessive nutrients and sediments and improve aquatic life in the near-field and far-field waterways.

Objective 1: Stabilize at least 1000 feet of the severe streambank erosion at FMC and its tributaries. [1]

Objective 2: Create, enhance and/or restore floodplain/riparian wetlands for habitat restoration and/or sediment attenuation on at least 50 acres.

Objective 3: Create, enhance and/or restore floodplain/ riparian buffer along impacted or barren stretches of FMC and its main tributaries within *Critical Area #2* (at least 100 feet on each side

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[1] *Stakeholders recognize a need for restorative actions in strategic places; however, objectives are set low to realistically reflect the anticipated amount of land available for restoration.*

of FMC mainstem and 75 feet on each site of the tributaries) by establishing and enhancing at least 100 acres of riparian habitats. [1]

Objective 4: Protect with conservation easements or via land acquisitions at least 2 miles of FMC and its main tributaries. Retire at least 40 acres of riparian corridor from farming.

Table 21 Nutrient Reductions from Each Objective

Objectiv e Number	Best Management Practice	Total Length/Acreage Treated	Estimated Load Reduction using PLET*
1	Streambank stabilization/restoration	1000 feet/ 1.15 Acres (avg 50 feet wide)	408 lb/yr (N)/126 Ib/yr (P) and sediment of 240 tons/yr
2	Floodplain/Wetland enhancement/restoration	50 acres**	7,288 lb/yr (N)/ 232 Ib/yr (P)
3	Riparian Buffer as designed using ACPF modeling based on the width of the riparian zone and runoff delivery	8.25 miles/100 Acres (avg 100 feet wide)	1444 lb/yr (N)/ 86.31 Ib/yr (P)
4	Protecting at least 2 miles of riparian corridor with conservation easements and retire 40 acres from farming.	40 Acres (riparian corridor width: 100 feet at each side of the stream)	1047 lb/yr (N)/57 Ib/yr (P)
Total		191.15	10,187 lb/yr (N)/501.31 Ib/yr (P)

*****Estimates calculated using Pollutant Load Estimation Tool (USEPA, 2025)***
***** Assuming 700 acres capture area***

The future project-specific monitoring efforts will be conducted by Ohio EPA, MCD or other qualified organization and 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 becomes 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 Ohio EPA 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:

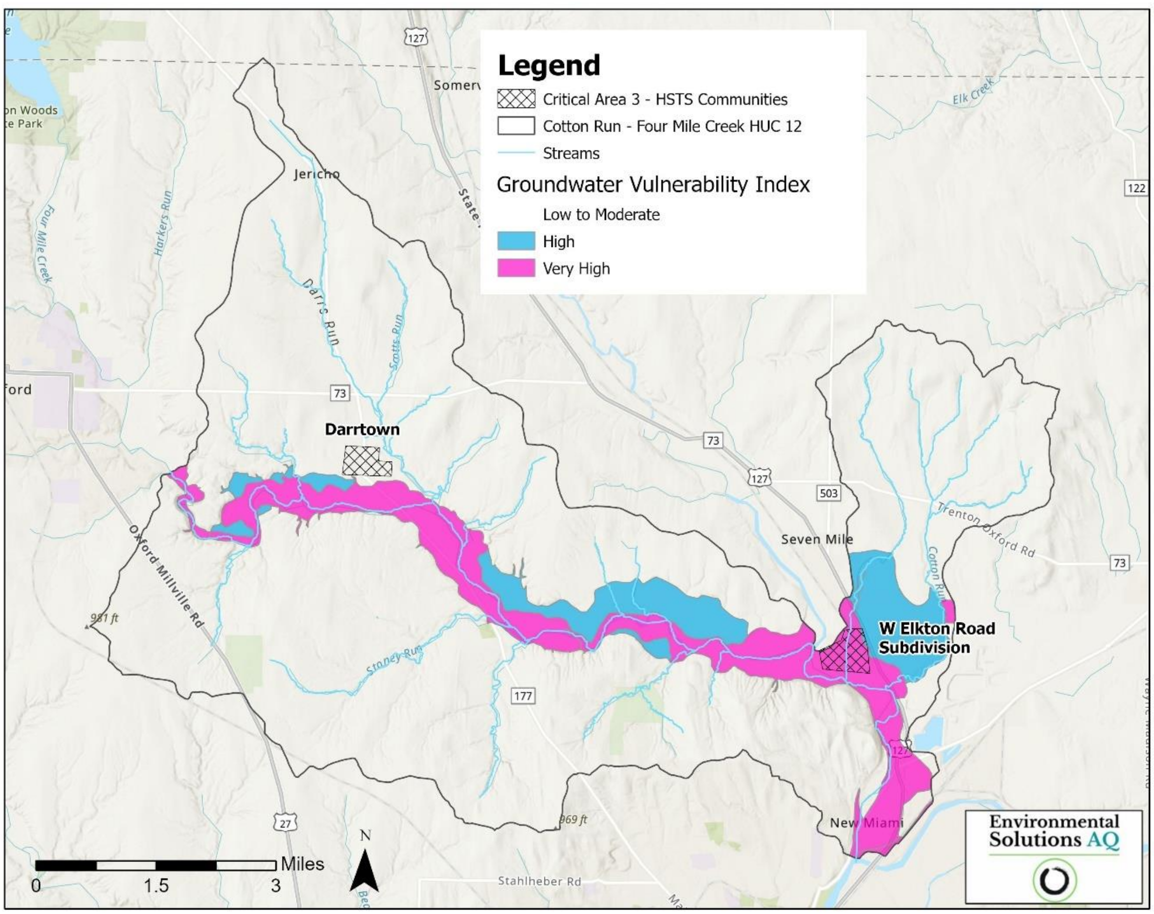
- Urban Sediment and Nutrient Strategies;
- Altered Stream and Habitat Restoration Strategies;

- Agricultural Nonpoint Source Reduction Strategies; and
- High Quality Waters Protection Strategies

3.4. Critical Area 3:Conditions, Goals, & Objectives for Home Sewer Treatment Systems in Darrtown and West Elkton Road Communities

3.4.1. Detailed Characterization

Critical Area #3 includes two rural communities: Darrtown and Elkton Road subdivision, which were identified as high-priority locations due to failing HSTS that contribute to the bacterial pollution affecting local waterways. The 2018-2019 OKI Regional Council of Governments study emphasized these communities as critical for intervention, as malfunctioning HSTS are a key source of the impairment. Correcting these issues is necessary to restore the watershed's ability to meet Ohio EPA's recreational standards for water quality. In addition, the W Elkton Road community is located in the groundwater high variability zone, which makes it prone to groundwater contamination and can put in danger the local water supplies as this community relays on domestic wells for drinking purposes.



3.4.2 Detailed Biological Conditions

Darrtown is located in the upper portion of the CR-FMC watershed in Milford Township, just west of Darrs Run and north of the FMC mainstem. Downstream, the W. Elkton Road subdivision lies in St. Clair Township, near the confluence of FMC and Mutton Run.

As noted in Chapter 2, 2005 Ohio EPA sampling found the CR-FMC watershed in full attainment for Aquatic Life Use (ALU) at all sites except FMC mainstem (RM 11.1), Darrs Run (RM 2.1), and Stoney Run (RM 0.3). The partial attainment at these locations was attributed to elevated total phosphorus levels at FMC RM 11.1 and natural causes at Darrs Run and Stoney Run.

Table 18 in Chapter 3 provides detailed fish community and habitat data for FMC, Darrs Run, and Stoney Run at sites upstream and downstream of the Darrtown and Elkton Road communities. FMC exhibited exceptional habitat conditions and fish community ratings, with species diversity ranging from 27 to 30. Dominant species included central stoneroller and bluntnose minnow. Although Darrs Run and Stoney Run had lower habitat scores, they still supported good to exceptional fish community integrity.

The macroinvertebrate assessment (Table 19 in Chapter 3) found that FMC had moderate to high organism densities, with dominant taxa including Chimarra caddisflies, midges, and hydropsychid caddisflies. Invertebrate Community Index (ICI) scores ranged from 40 to 42, reflecting good to very good conditions. In contrast, Darrs Run and Stoney Run had lower organism densities, with communities dominated by mayflies and caddisflies. Their evaluations ranged from fair to low fair, indicating reduced habitat quality.

3.4.3 Detailed Causes and Associated Sources

The biological indices, habitat, and water quality data collected in 2005 indicated that FMC generally has very good water quality. However, partial attainment was noted at RM 11.1 due to high total phosphorus levels, likely originating from the upstream wastewater treatment plant (WTTP) in the Acton Lake-FMC HUC 12. Agricultural activities and failing HSTS may also contribute to this impairment. Partial attainment was also observed in two tributaries, where low flow and degraded habitats were identified. Elevated E. coli levels have led the Ohio EPA to designate the CR-FMC watershed as impaired for recreation, particularly in the FMC mainstem and Darrs Run. The primary sources of this contamination are failing septic systems, agricultural runoff, and livestock waste. Public sewer service is limited to small parts of St. Clair Township, leaving most of the watershed reliant on aging, high-risk septic systems. Rural communities without public water systems depend on HSTS and private wells situated on small lots, increasing the risk of contamination from nitrate and bacteria (Swann, 2001).

A 2018–2019 study by OKI identified approximately 500 malfunctioning systems in the FMC subwatershed, with Darrtown and the W. Elkton Road subdivision highlighted as high-priority areas. Over 56% of the watershed is classified as "very limited" for sewage treatment by the USDA NRCS Web Soil Survey due to unfavorable soil conditions like flooding, high water tables, and poor drainage. These factors heighten the risk of septic system failure, which exacerbates water quality issues. Failing systems discharge untreated or partially treated wastewater, contaminating both surface and groundwater, and increasing the risk of nitrate contamination, especially in shallow wells.

Critical Area #3 faces significant water quality challenges driven primarily by failing or inadequately functioning HSTS in Darrtown and W. Elkton Road. With limited access to centralized wastewater treatment, residents rely on outdated or improperly maintained septic systems located in areas unsuitable for wastewater absorption. The W. Elkton Road subdivision, characterized by small lots (less than 0.5 acre), has limited space for the proper installation and functioning of HSTS, further exacerbating the potential for contamination. Expanding the public sewer system to this area would alleviate these challenges by replacing inadequate systems with a more reliable and sustainable wastewater management solution. Additionally, the W. Elkton Road subdivision is situated in a very high groundwater vulnerability index zone, making the aquifer particularly vulnerable to contamination from failing HSTS. Moreover, this area relies solely on private well water for drinking, further increasing the risk of groundwater contamination. Without intervention, untreated wastewater will continue to degrade water quality, raising bacteria and nutrient levels, leading to eutrophication, habitat degradation, and further public health risks.

To address these issues, repairing, replacing, or upgrading failing septic systems, particularly in high-priority areas like Darrtown and the W. Elkton Road subdivision, is essential. Expanding the public sewer system to the W. Elkton Road subdivision, where small lot sizes limit the use of HSTS, alongside improved septic system management as recommended by the Ohio Department of Health, will help alleviate the strain from failing systems. Strengthening monitoring and enforcement will also be crucial to prevent further contamination. Addressing these challenges will significantly improve water quality in FMC and its tributaries, reducing bacterial contamination and restoring aquatic habitats.

To estimate the annual nutrient load from HSTS to FMC and its tributaries in Darrtown and W. Elkton Road subdivision, an estimate of Total N and Total P concentrations in septic tank effluent is needed. Since no specific nutrient concentrations are available for these communities, four studies with similar septic effluent concentrations were reviewed (Swann, 2001). The table below presents an average of these studies' findings, including the conversion to pounds per million gallons of water.

Table 22 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

The authors of the plan have estimated the population and number of HSTS in both Darrtown and W. Elkton Road subdivision based on the 2020 census data and Google Earth images. These estimates as well as USGS estimates of average water use per day are included in the following table. These data are estimates and will be updated in the future, once more accurate information is available from Butler County Health Department.

Table 23 Darrtown and W Elkton Rd Communities Populations, HSTS and Water Use

Estimated population	Estimated number of HSTS	Estimated people per HSTS	Total number of humans whose waste is discharging from failing HSTS	Gallons of water used per day at 82 gal/person (USGS)/M Gallon per year
Darrtown, Milford Township, Butler County, Ohio				
514	198	2.6	514	42,148/15.4 M
W. Elkton Road Subdivison, St. Clair Township, Butler County, Ohio				
770	296	2.6	770	63,140/23.1 M

The following formula is used to estimate pounds per year of both total nitrogen and total phosphorus loads from failing HSTS in Darrtown and W. Elkton Road communities:

****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)**

Table 24 Estimated Annual Nutrient Loads to FMC and its Tributaries from Failing Septic Systems in Darrtown and W Elkton Rd Communities.

	Million gallons effluent per year flowing from failing HSTS	Average concentrations of nutrients in mg/L (Swann)	Average concentrations of nutrients in lbs/million gallons*	Estimated lbs/year of nutrients discharging from HSTS
Darrtown, Milford Township, Butler County, Ohio				
Total N	15.4	42.4	353.8	5,448.5
Total P		16	134	2,063.6
W Elkton Road Subdivision, St. Clair Township, Butler County, Ohio				
Total N	23.1	42.4	353.8	8172.8
Total P		16	134	3095.4

3.4.4 Outline Goals and Objectives for the Critical Area

The goal of the NPS-IS is to improve water quality and achieve nutrient reduction targets. Critical Area 3 includes two high-priority communities within the CR-FMC watershed where failing HSTS pose a significant risk. These malfunctioning systems contribute to nutrient and bacterial contamination in local waterways, threatening the underlying aquifer, the primary drinking water source for residents. Additionally, failing HSTS degrade aquatic habitats by increasing nutrient loads that fuel algal blooms, depleting oxygen levels, and harming fish and macroinvertebrates. Organic matter and sediment accumulation further disrupt aquatic ecosystems, while bacterial contamination poses health risks to wildlife. Addressing these failures is essential to safeguarding both surface and groundwater quality and restoring healthy stream habitats. The following goals and objectives have been set for this critical area:

Goal 1 – To maintain or achieve the IBI score at or above 50 at all 2005 Ohio EPA sampling locations, which aligns with EWH ALU;

NOT ACHIEVED – The IBI at the Four Mile RM 0.3 has a score of 42 and 44 Darrs Run RM 2.1

Goal 2 – To maintain or achieve the MIwb score at or above 9.7 at all 2005 Ohio EPA sampling locations with Drainage Area > 20 mi^2

ACHIEVED

Goal 3 – To maintain or achieve the ICI score above at or above 40 or narrative "very good"

NOT ACHIEVED – The ICI narrative at the FMC mainstem RM 13.6 is "good", at the Darrs Run RM 2.1 is "fair" and at Stoney Run RM 0.3 "low fair".

Goal 4 – To maintain or achieve the QHEI score at or above 70 at all sampling sites.

NOT ACHIEVED – The QHEI scores yield 54.5 at the Darrs Run RM 2.1, and 52.0 at the Stoney Run RM 0.3.

Goal 5 – Reduce bacterial loading to streams. Attain and maintain Primary Contact Recreation Class B standard of 126 CFU/100 ml. E. coli in FMC mainstem and its tributaries.

NOT ACHIEVED – In 2008, the Ohio EPA reported a seasonal geometric mean E. coli concentration of 430 CFU/100 mL in the FMC mainstem at RM 13.65. Additionally, sampling conducted by the Butler County Stream Team in 2022 during the spring, summer, and fall seasons revealed that the average seasonal E. coli concentrations in the FMC mainstem and its tributaries consistently exceeded the Class B standard of 126 CFU/100 mL. These average seasonal concentrations ranged from 176 CFU/100 mL at the FMC site (RM 0.35) to 2,149.14 CFU/100 mL at Cotton Run (RM 2.5).

Objectives

The implementation of these objectives, coupled with implementation in Critical Area 1 and 2 will help ameliorate negative impacts from excessive nutrients and sediments and improve aquatic life in the near-field and far-field waterways.

Objective 1: Extent sanitary sewer service from New Miami to W Elkton Road subdivision to reduce N, P, and E. Coli contamination of surface and groundwater.

Objective 2: Repair, upgrade, or replace failing HSTS in Darrtown to ensure full compliance with regulatory standards and protect water quality.

Table 24 Critical Area 3 Estimated Nutrient Reductions from Each Objective

Objective Number	Best Management Practice	Estimated Total Nitrogen lb/year	Estimated Total Phosphorus lb/year
1	HSTS replacement with the public sewer system at W Elkton Road subdivision	8172.8	3095.4
2	Failing HSTS, repairs, upgrades or replacement in Darrtown	5,448.5	2,063.6
Total		13,621.3	5,159

To achieve compliance in the under-resourced rural communities of Darrtown and West Elkton Road, the Butler County Health Department could seek funding assistance from the Ohio EPA to offer cost-share options for income-eligible homeowners. Furthermore, connecting the West Elkton Road area to the New Miami public sanitary system would enhance access to safe, reliable wastewater treatment, addressing critical infrastructure needs in the region.

Water quality monitoring is an integral part of the project implementation process. Both project-specific and routinely scheduled monitoring will be conducted to determine progress towards meeting the goals (i.e., water quality standards). Through an adaptive management process, the aforementioned objectives will be reevaluated and modified as necessary. Objectives may be added to make further progress towards attainment goals, or altered, as a systems approach of multiple best management practices (BMPs) can accelerate the improvement of water quality conditions.

The Ohio EPA 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, 2022). It is important and beneficial for the NPS-IS initiatives to be implemented in this region as soon as possible. CR - FMC HUC 12 is an agricultural watershed and implementation of proposed conservation practices will help to meet the nutrient reduction goals. The Project and Implementation Strategy of the CR-FMC HUC 12 NPS-IS includes an action plan addressing the causes and sources of NPS pollution, as outlined in the previous chapter. Chapter 3 identified three critical areas, along with their respective goals and objectives. These critical areas will be periodically reassessed to monitor progress in achieving the NPS goals and objectives. While some positive impacts may take years to become evident, the ongoing efforts will foster long-term recovery. The potential projects are currently in the early stages of development and will be incorporated into the plan in the near future.

4.1 Overview Tables and Project Sheets for Critical Areas

An overview table and associated project summary sheets for each of the critical areas (Prioritized Agricultural Fields, Riparian and Floodplain Conservation Zone and Home Sewage Treatment Systems in Darrtown and W Elkton Road Communities) are presented in this chapter. At the time, projects for the three critical areas are not included in this NPS-IS plan. However, projects will be included in future versions of the NPS-IS plan as more information is gathered and opportunities are presented.

Table 13 Projects and Implementation Strategy Overview - Critical Area 1

For CR-FMC HUC 12 (050800020605) 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							
High Quality Waters Protection Strategies							
Other NPS Causes and Associated Sources of Impairment							

4.2 Project Summary Sheets

Nine Element Criteria	Information needed	Explanation
n/a	**Title**	*Provide a title for the project. Preferably 75 characters or less.*
criteria d	**Project Lead Organization & Partners**	*Provide the primary organization responsible for the project and any significant partnering organizations.*

criteria c	**HUC-12 and Critical Area**	*Provide the HUC 12 code and name, as well as the identifying name/number of the Critical Area where your project is located.*
criteria c	**Location of Project**	*Provide your project's physical address or as much as possible. If there isn't an actual address, please use a mapping program (i.e. Google Maps) to get the closest address or provide the latitude/longitude of your project's location.*
n/a	**Which strategy is being addressed by this project?**	*Provide the NPS reduction, restoration or protection strategy from* Ohio's Nonpoint Source Management Plan (Update) *that will be addressed by this project.*
criteria f	**Time Frame**	*Provide the expected date and/or term for implementation of this project (i.e. Short-Term (Priority) (1-3 yr); Medium Term (3-7 yrs); Long Term (7+ yrs); Ongoing (annual events)). Any Short-Term project should have a completed Project Summary Sheet*
criteria g	**Short Description**	*Provide a concise synopsis. Include pertinent details like a location description, issues addressed, and/or restoration activities. Preferably 250 characters or less.*
criteria g	**Project Narrative**	*Provide a more detailed synopsis explaining the project to partners, funders and the public. Include information like <u>who</u> is involved, <u>what</u> are the detailed goals and methods, <u>where</u> is will be done and <u>how</u> it will result in progress toward restoration of the impairment. Use numeric or measureable values when possible (i.e. 1500' of bank stabilization, 20% reduction of phosphorus loading). Similar to US EPA outputs. Preferably 2,500 characters or less.*
criteria d	**Estimated Total cost**	*Provide a total of all expected expenses necessary to conduct your project. If possible, provide a breakdown by Personnel/Fringe, Travel, Equipment/Supplies, and Sub-contractual. List any sources of cash or in-kind match and the amount, if they have been identified and/or committed. Also, where applicable, include an estimated cost per unit for BMPs.*
criteria d	**Possible Funding Source**	*Provide a list of possible funding sources for your project.*
criteria a	**Identified Causes and Sources**	*Provide a list of the identified Cause(s) and associated Source(s) that your project will address. The causes/source should be those listed for the critical area you are working in.*
criteria b & h	**Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?**	*This should be based on Water Quality Standards such as those in the Goals and Objectives of Chapter 3 subsection 3.2.4. (i.e., biological targets: IBI scores need to be improved by 5 points to meet WQS; load reductions: phosphorus loading needs to be reduced by 6%)*
	Part 2: How much of the needed improvement for the whole Critical Area is *estimated* to be accomplished by this project?	*Provide the amount of measured improvement expected for each of the biological and/or chemical impairments. Similar to US EPA outcomes.*

	Part 3: Load Reduced?	*Estimate of reduction in pollutants (e.g., Tons sediment/yr., #P/yr., #N/yr.)*
criteria i	**How will the effectiveness of this project in addressing the NPS impairment be measured?**	*Provide an explanation of how you or your partners intend to measure the improvement. (i.e. Ohio EPA 319 staff will conduct biological criteria sampling, ABC University will measure changes in flow)*
criteria e	**Information and Education**	*Provide a brief description of how information about this project will be shared. Be measurable when possible (i.e. hold 2 workshops)*

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 January 2021.

Agricultural Research Service. 2024. ACPF formatted geodatabase for Cotton Run-FMC 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.

Bougouin A, Hristov A, Dijkstra J, Aguerre MJ, Ahvenjärvi S, Arndt C, Bannink A, Bayat AR, Benchaar C, Boland T, Brown WE, Crompton LA, Dehareng F, Dufrasne I, Eugène M, Froidmont E, van Gastelen S, Garnsworthy PC, Halmemies-Beauchet-Filleau A, Herremans S, Huhtanen P, Johansen M, Kidane A, Kreuzer M, Kuhla B, Lessire F, Lund P, Minnée EMK, Muñoz C, Niu M, Nozière P, Pacheco D, Prestløkken E, Reynolds CK, Schwarm A, Spek JW, Terranova M, Vanhatalo A, Wattiaux MA, Weisbjerg MR, Yáñez-Ruiz DR, Yu Z, Kebreab E. Prediction of nitrogen excretion from data on dairy cows fed a wide range of diets compiled in an intercontinental database: A meta-analysis. J Dairy Sci. 2022 Sep;105(9):7462-7481. doi: 10.3168/jds.2021-20885. Epub 2022 Aug 2. PMID: 35931475.

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

Lee, Larry (2022, December 15). Researcher Sees the Benefits of Stacking Conservation Practices. Brownfield. https://brownfieldagnews.com/news/researcher-sees-the-benefits-of-stacking-conservation-practices/

MetroParks of Butler County, Ohio. 2024. MetroParks description available at https://www.yourmetroparks.net/parks/indian-creek-metropark. Accessed January 2024.

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

National Land Cover Database, 2021 (NLCD 2021). Multi-Resolution Land Characteristics Consortium (MRLC). https://www.mrlc.gov/data Accessed May 2024.

Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey (WSS). http://websoilsurvey.sc.egov.usda.gov/. Accessed October 2024.

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, Ohio Stream Management Guide, https://ohiodnr.gov/discover-and-learn/safety-conservation/about-ODNR/water-resources/water-inventory-planning/stream-management-guides, Accessed in January 2025

Ohio Department of Natural Resources, Division of Geological Survey, Water Well Database, https://waterwells.ohiodnr.gov/search, Accessed in July 2024.

Ohio Department of Natural Resources, Division of Geological Survey. 1993. Groundwater Resources of Butler County by James J. Schmidt. Division of Geological Survey Map, scale 1:62,500.

Ohio Department of Natural Resources, Division of Geological Survey 1998. Physiographic regions of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map with text, 2 p., scale1:2,100,00.

Ohio Department of Natural Resources, Division of Geological Survey, 2005a. 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 Department of Natural Resources, Groundwater Vulnerability Map of Ohio, https://ohiodnr.gov/discover-and-learn/safety-conservation/about-odnr/geologic-survey/groundwater-resources/groundwater-vulnerability-map, Accessed in July 2024

Ohio Division of Geological Survey 2005b, Glacial map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map with text, 2 p., scale 1:2,000,000.

Ohio Environmental Protection Agency (OEPA), 2008. Biological and Water Quality Study of Fourmile Creek, Indian Creek, and Select Tributaries, 2005

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

Ohio Environmental Protection Agency (OEPA), 2022. Nutrient Mass Balance Study for Ohio's Major Rivers 2022, December 2022, OEPA Division of Surface Water.

Ohio Environmental Protection agency (OEPA), Rainwater and Land Development, https://epa.ohio.gov/divisions-and-offices/surface-water/guides-manuals/rainwater-and-land-development?utm_source=chatgpt.com, accessed in December 2024.

Ohio Kentucky Indiana Regional Council of Governments (OKI), 2020. Amendment #45, Water quality Management Plan for Butler, Clermont, Hamilton and Warren Counties. September 2020.

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.

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 2019-2023. Published crop-specific data layer. Available at https://nassgeodata.gmu.edu/CropScape/. Accessed October 2022.

United States Department of Agriculture (USDA) 2020 – Cotton Run-FMC HUC 12 geodatabase.

United States Department of Agriculture (USDA) Natural Resources Conservation Service. Field Office Technical Guide – Ohio FOTG v5.7.0.90.

United States Environmental Protection Agency (USEPA). 2000.Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tibial Nutrient Criteria For Rivers and Streams in Nutrient Ecoregion VI.

United States Environmental Protection Agency (USEPA). 2013. Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States. https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states. Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States. https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states. Accessed October 2024.

United States Environmental Protection Agency (USEPA), 2017. Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. 2017 Report to Congress.

United States Environmental Protection Agency (USEPA), 2021. Enforcement and Compliance History Online (ECHO). https://echo.epa.gov/. (Accessed December 2024)

United States Fish and Wildlife Service (USFWS). 2018. Ohio – County Distribution of Federally-Listed Endangered, Threatened and Proposed Species. https://www.fws.gov/midwest/endangered/lists/ohio-cty.html. Accessed August, 2024.

United States Geological Survey (USGS). 2018. The State Geologic Map Compilation (SGMC) Geodatabase of the Conterminous United States. https://www.sciencebase.gov/catalog/item/5888bf4fe4b05ccb964bab9d#:~:text=The%20SGMC%20is%20a%20compilation,have%20been%20%5B...%5D Accessed April 202