NINE-ELEMENT NONPOINT SOURCE IMPLEMENTATION STRATEGIC PLAN HOWARD CREEK-DRY FORK WHITEWATER RIVER HUC-12 (050800030808)

PREPARED FOR THREE VALLEY CONSERVATION TRUST
PREPARED BY ENVIRONMENTAL SOLUTIONS AQ

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Chapter 1: Introduction

The Howard Creek-Dry Fork Whitewater River Hydrologic Unit (HC-DF WR HUC-12) 050800030808 is primarily an agricultural watershed located on the border of SW Ohio and SE Indiana, and it encompasses a drainage area of approximately 43 mi^2. A majority of the watershed is located in Ohio, in the southwestern corner of Butler County (27 mi^2 or 63%) and the northwestern part of the Hamilton County (6 mi^2 or 14%). Also, approximately 10 mi^2 of the watershed (23% of the total watershed area) extends NW into Franklin County, Indiana (Fig. 1).

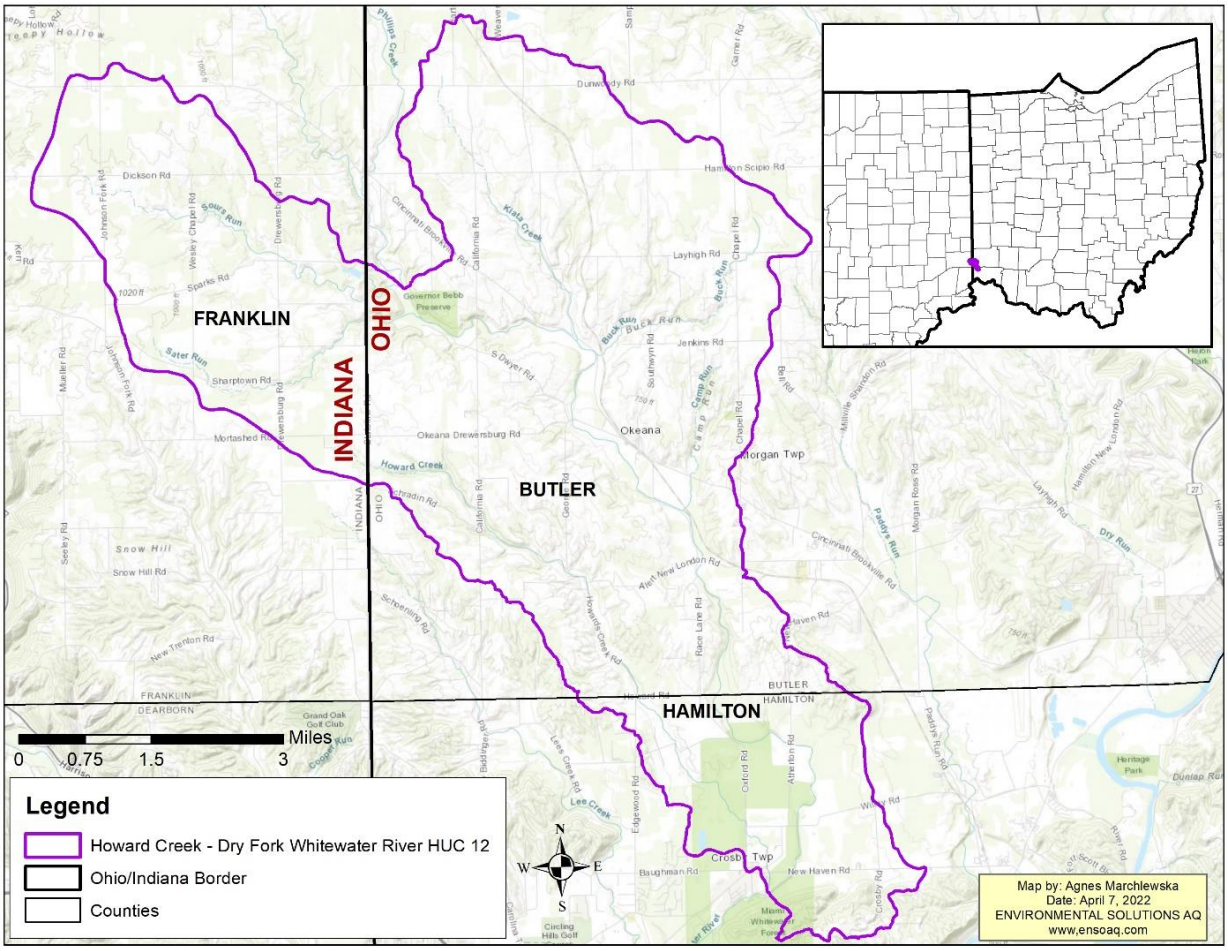

Figure 1 Howard Creek – Dry Fork Whitewater River HUC-12 location

The HC-DF WR HUC-12 is one of the Whitewater River HUC-12s located within the Great Miami River Watershed in the Ohio River Basin. The Great Miami River Watershed has recently been identified as high priority for addressing water quality impairment caused by excessive nutrient loss, especially from agricultural lands.

The Three Valley Conservation Trust (TVCT) has received grant funding from the Ohio Environmental Protection Agency (OEPA) via the Fernald Natural Resource Damages Fund to develop the Nine-Element Nonpoint Source Implementation Strategic Plan (NPS-IS) for the HC-

DF WR HUC-12. The Land Trust partnered on this project with Environmental Solutions AQ (ENSOAQ), a local environmental consultant and with the members of the Upper Dry Fork Collaborative (UDF), a group of stakeholders encompassing local government organizations, park systems, educational institutions and watershed protection organizations.

The developed plan will provide a road map to address the excess nutrient loads, sediments and other nonpoint sources of pollution, which impair water quality in HC-DF WR HUC-12 and contribute to downstream impairment in the Great Miami River, the Ohio River and consequently the Mississippi River and the Gulf of Mexico. Additionally, creating the plan will support the Mississippi River/Gulf of Mexico Hypoxia Task Force (HTF) efforts to reduce nutrients in the Mississippi River Basin by 20% by the year 2025 (EPA 2017). Also, the plan will allow identified projects to meet the eligibility criteria for Clean Water Act Section 319 Grants (319 Grants) and other federal and state resources designated to address nonpoint source impairments in the watershed.

1.1. Report Background

The USEPA for many years has encouraged development of watershed plans to help protect and improve water resources in the United States. The earliest Watershed Action Plan (WAP) guidelines were released in 2001 and the first plans were endorsed in 2004. Initially the WAPs focused on larger size watersheds equivalent to HUC 8 or HUC10 hydrologic units. Over time, the planning efforts shifted to the smaller HUC 12s and focused on defining critical areas and individual projects in more detail. Each plan has to include "nine essential elements" for projects to be eligible for 319 Grants. In 2013 OEPA released a new guide to address the watershed impairments caused by nonpoint source pollution and the first Nine-Element NPS-IS were approved in 2017. Over time the NPS-IS role has expanded to address not only local watershed impairments (near field) but also to help protect and improve waters downstream (far field).

In 2016, the Dearborn County Soil and Water Conservation District (SWCD) in Indiana sponsored a Watershed Management Plan for the Whitewater River Watershed HUC-10. The study conducted biological, chemical and habitat analyses at 21 sampling locations, including 4 in Ohio. The HC-DF WR HUC-12 was listed as one of the highest concern sub watersheds in the Whitewater River Watershed for addressing impairments caused by excessive nutrients, *E. coli* and sediment pollution.

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

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

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

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

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

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

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

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

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

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

The OEPA 2022 Integrated Water Quality Monitoring and Assessment Report classified the HC-DF WR watershed as "category 5 – impaired, TMDL needed" (OEPA, 2022). The report indicates watershed impairment for the aquatic life and recreation due to degraded habitat and high concentrations of *E. coli* in the local waterbodies.

This NPS-IS will be one of the first developed plans for the Whitewater River Watershed in Ohio. The plan will identify causes and sources of nonpoint pollutants within the HC-DF WR HUC-12. It will also determine the watershed critical areas and outline strategic projects, which should be implemented to improve local water quality and help to reduce impairment in the Ohio River Basin and subsequently in the Mississippi River and the Gulf of Mexico. Additionally, identified projects described in the plan will be eligible for federal and state nonpoint source (NPS) funding.

1.2. Watershed Profile & History

The HC-DF WR HUC-12 is located within the GMR watershed on the border of SW Ohio and SE Indiana, and it is the northeastern sub watershed of the Whitewater River HUC-10 (Fig. 3).

The GMR watershed extends across 15 counties and drains approximately 5,367 square miles of land, which includes 3,942 square miles in Ohio and 1,425 square miles in Indiana. The GMR flows approximately 170 miles from its headwaters in SW Hardin County to its confluence with the Ohio River in SW Hamilton County near the border with Indiana. The GMR watershed is broken into three HUC-8 sub watersheds including Upper Great Miami, Lower Great Miami and Whitewater.

The Whitewater River HUC-10 is located in the southeast part of the Whitewater HUC-8 in Dearborn and Franklin counties in Indiana, and Butler and Hamilton counties in Ohio. Its drainage area covers approximately 250 square miles of land, including 74.5 square miles in Ohio. The watershed is a home to approximately 486.9 miles of perennial and intermittent streams. It contains the most downstream section of the Whitewater River starting just south of Brookville, Indiana where the Whitewater River mainstem (West Fork) joins the East Fork of the river, and flows south-east into Ohio to its confluence with the Great Miami River, a tributary of the Ohio River. Some major tributaries of Whitewater River include: Dry Fork Whitewater River, Little Cedar Creek, Big Cedar Creek, Blue Creek, Sand Run, and Wolf Creek. The Whitewater River HUC 10 is further divided into ten smaller hydrologic units: Headwaters Blue Creek HUC-12, Wolf Creek – Blue Creek HUC-12, Big Cedar Creek HUC-12, Little Cedar Creek – Whitewater River HUC-12, Blackburn Creek – Whitewater River HUC-12, Johnson Fork – Whitewater River HUC-12, Upper Dry Fork Whitewater River HUC-12, Lee Creek – Dry Fork Whitewater River HUC-12, Jameson Creek – Whitewater River HUC-12 and Howard Creek – Dry Fork Whitewater River HUC-12, which is the focus area for this Nine-Element NPS-IS.

The HC-DF WR HUC-12 drainage area covers approximately 33 square miles, including 10 square miles in Indiana. The watershed contains 10.7 miles of Dry Fork Whitewater River from the confluence of Sours Run just northwest of the Governor Bebb Preserve in Morgan Township, Butler County, Ohio. This section of Dry Fork Whitewater River flows southeast through the southwest corner of Butler County, then gently turns south and southwest flowing across the northeast corner of Hamilton County to the confluence with Howard Creek by the Miami Whitewater Forest Park in Crosby Township.

There are currently two National Pollutant Discharge Elimination System (NPDES) permitted facilities operating within the HC-DF WR HUC-12, in its Ohio portion. The Morgan Elementary School is in Butler County and the Crosby Elementary School is in Hamilton County. These facilities discharge water treatment effluent into unnamed tributaries of Dry Fork Whitewater River and both are currently in compliance with their NPDES permits (USEPA, 2022).

Table 1 The NPDES permitted facilities discharging into Dry Fork Whitewater River and its tributaries within the Howard Creek – Dry Fork Whitewater River HUC-12

Facility Name	NPDES ID	Lat/Long	Industry	Receiving Stream	Qtrs with NC (of 12)*
MORGAN ELEMENTARY SCHOOL	OH0127558	39.33259 -84.74011	Elementary And Secondary School	Unnamed tributary to Dry Fork Whitewater River	3 *(Failure to Report Discharge Monitoring)*
CROSBY ELEMENTARY SCHOOL	OH0127094	39.27577 -84.71683	Elementary And Secondary School	Unnamed tributary to Dry Fork Whitewater River	3 *(Failure to Report Discharge Monitoring)*

**Quarters with "No Compliance" status from to 1/1/2019 to 12/31/2021*

The majority of the HC-DF WR watershed is located in the Eastern Corn Belt Plains (ECBP) ecoregion and only a small southern portion of the watershed is classified as the Interior Plateau (IP) ecoregion. This region has a long agricultural history. The first European settlers cleared the deciduous forests and adapted the local lands for crops and pasture beginning in the early 1800s. Currently approximately 71% of the watershed area is in agriculture, 22% is covered by deciduous forest, and 7% is developed (NLCD, 2019). The largest communities in this watershed include Mount Carmel in Indiana, and Okeana and New Haven in Ohio.

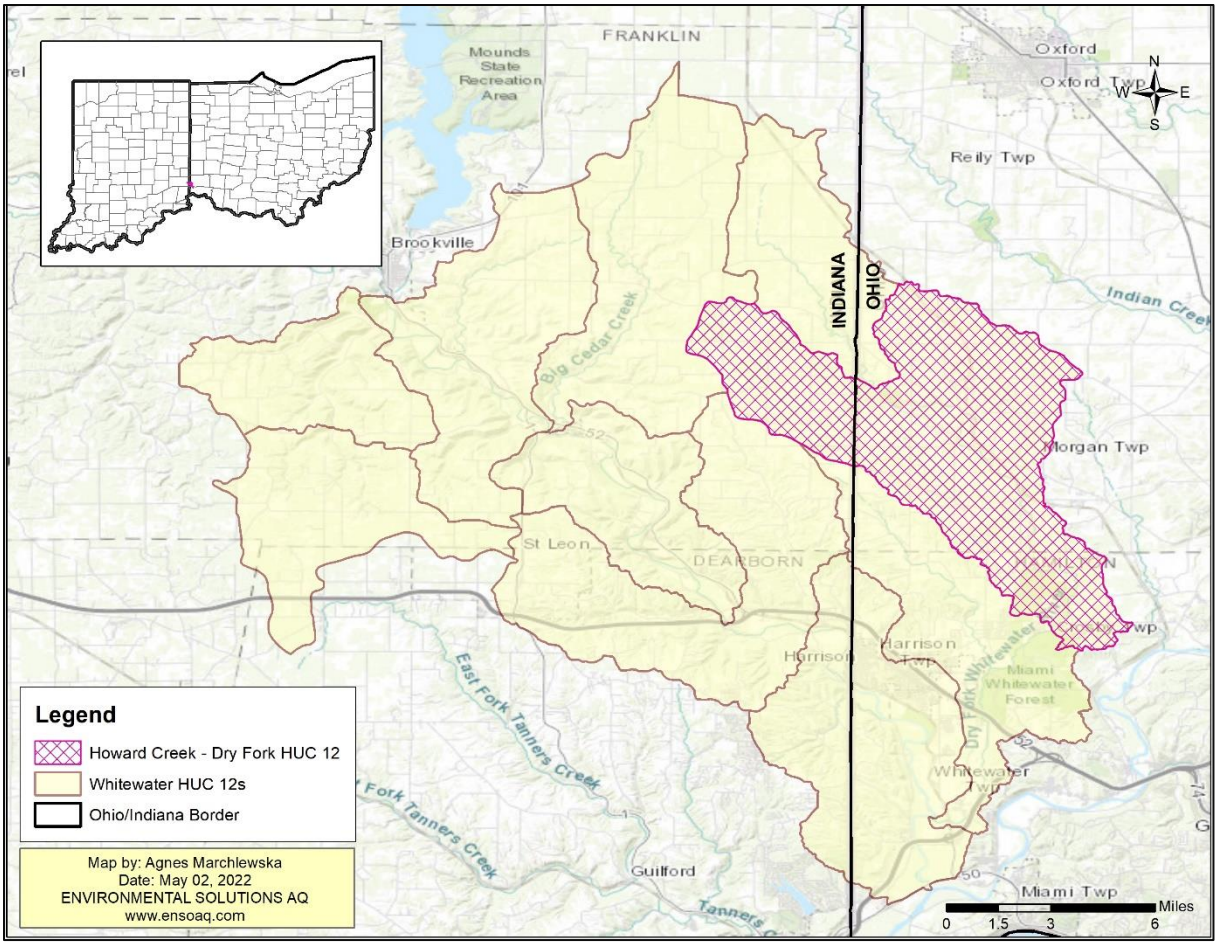

Figure 2 Whitewater HUCs

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 watershed restoration and protection strategies and later start implementing these strategies.

Three Valley Conservation Trust (TVCT) which sponsored development of the NPS-IS for HC-DF WR HUC-12 has been successfully leading conservation efforts in this region for more than 29 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 over 24,500 acres of important landscapes in southwest Ohio via conservation and/or agricultural easements. Currently TVCT holds easements on 218 properties with individual landowners and organization, including 27 in the HC-DF WR HUC-12.

The TVCT is a member of the Upper Dry Fork Collaborative (UDF) established in 2021 by the Hamilton County and Butler SWCDs in partnership with the Ohio Kentucky Indiana Regional Council of Governments (OKI). The collaborative also includes representatives from MetroParks of Butler County, Great Parks of Hamilton County, Ohio Department of Agriculture, Natural Resources Conservation Service (NRCS) in Franklin County, Indiana, Whitewater River Group (WWRG), University of Cincinnati and the Ohio Department of Transportation.

To engage local stakeholders and communities in the process of developing the NPS-IS for HC-DR WR watershed, the UDF hosted two public meetings; first on February 17, 2022 and the second on May 19, 2022.

Figure 3 Second public meeting

The purpose of the first meeting was to learn about the collaborative process for the Dry Fork Watershed, which include both Upper Dry Fork HUC-12 and the Howard Creek – Dry Fork Whitewater River HUC-12. Also, the attendees were provided with the information about existing programs and funding opportunities, and the TVCT introduced the NPS-IS development project for the HC-DF WR HUC-12. The meeting was advertised on the UDF members websites and social media. The announcements were made in the Journal-News and multiple posters prepared by the OKI were distributed at key public locations within the Dry Fork Watershed. Furthermore, the SWCDs drafted and sent letters directly to all farmers whose properties are located within the watershed in their districts, inviting them to the meeting. The TVCT published an article about the development of the NPS-IS for the HC-DF WR HUC-12 in their quarterly newsletter and invited all members of the Trust, including the conservation easement owners, to the meeting. Approximately 29 people attended the first meeting, including 14 landowners and 15 representatives of the UDF. The landowners voiced their concerns about severe erosion, flooding and nutrients/fertilizer runoff degrading water quality in local streams and asked about potential solutions and available funding to mitigate these problems.

Similarly, to the first meeting, the second public meeting was advertised on the UDF members websites, social media, local newspapers and in the newsletters. Also, new posters prepared by the OKI were distributed in various public places in the watershed. The SWCDs again sent out the invitations to all landowners in their districts' who own the land in the Dry Fork watershed. The letter included a short questionnaire to gather more information about landowners concerns and priorities for the conservation work within the HC-DF WR watershed. The questionnaire was also posted online on the Hamilton County SWCDs website and advertised on social media. The second meeting focused on reviewing the questionnaires, further discuss landowners' concerns, identify potential critical areas and projects. Six landowners and 10 representatives of

the local organizations, including Butler and Hamilton County SWCDs, OKI, TVCT and Metroparks of Butler County participated in this meeting.

ENSOAQ presented results of the Agricultural Conservation Planning Framework (ACPF) analyses conducted for HC-DF WR HUC-12. The ACPF tool spatially combines high-resolution terrain, drainage, soils, land use and cropland data to determine potential locations for best management practices (BMPs) at the field scale and helps to engage farming communities in watershed conservation efforts (ARS, 2019).

Again, the landowner expressed their concerns about severe erosion, nutrients/fertilizer runoff, poor drainage and flooding in the watershed. Some of the restoration and protection strategies to address water quality concerns were discussed, including erosion mitigation and implementation of best management practices. Multiple follow-up visits were conducted to meet with some of the landowners participating in the meeting and discuss potential conservation practices at their properties.

In summary, the stakeholders prioritized erosion problems, loss of land, close proximity to the streams, high runoff areas and landowners' willingness to conserve the land as the main criteria for conservation projects in the critical areas. If funding were available landowners stated they would be interested in implementing stream bank erosion, cover crops, grassed waterways, soil sampling, nutrients management plans, cattle fencing and grazing plans.

The final version of this NPS-IS for HC-DF WR HUC-12 was developed using individual inputs from the local stakeholder organizations including Butler SWCD, Natural Resource Conservation Services (NRCS) and OKI.

Chapter 2: Watershed Characterization and Assessment Summary

2.1. Summary of Watershed Characterization for Howard Creek–Dry Fork Whitewater River HUC-12

2.1.1. Physical and Natural Features

The HC-DF WR HUC-12 is the one of three sub-watersheds within northeastern part Whitewater River HUC-10, which contain Dry Fork Whitewater River, a large tributary of the Whitewater River. It includes a central section of Dry Fork Whitewater River (approximately 10.7 miles) starting at Dry Fork Whitewater River confluence with Sours Run in Butler County, Ohio. The watershed's outlet is located in Hamilton County, Ohio at the confluence of Dry Fork Whitewater River with Howard Creek. All significant tributaries of Dry Fork Whitewater River within this HUC 12 include Sours Run and Sater Run with the headwaters in Franklin County, Indiana, and Kiata Creek, Bulls Run, and Howard Creek in Butler and Hamilton counties, Ohio.

This watershed is located mostly within the ECBP ecoregion and only a small southern portion of it transitions into the IP (Fig. 5). The ECBP ecoregion is defined as a primarily rolling plain with local end moraines and kames, extensively covered by Wisconsinan age glacier deposits. Originally, it 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 IP ecoregion is a deeply dissected, moderately rolling plain, mostly covered by pre-Wisconsinan till and discontinuous losses. Originally, in Ohio this region was dominated by mixed mesophytic forest, mixed oak forest and bottomland hardwood forest; and in Indiana it was covered by western mixed mesophytic forest and oak-hickory forest. Today, this ecoregion is mostly agricultural with forest growing on the steeper terrains and the urban – industrial activity occurring near Cincinnati, along the Ohio River.

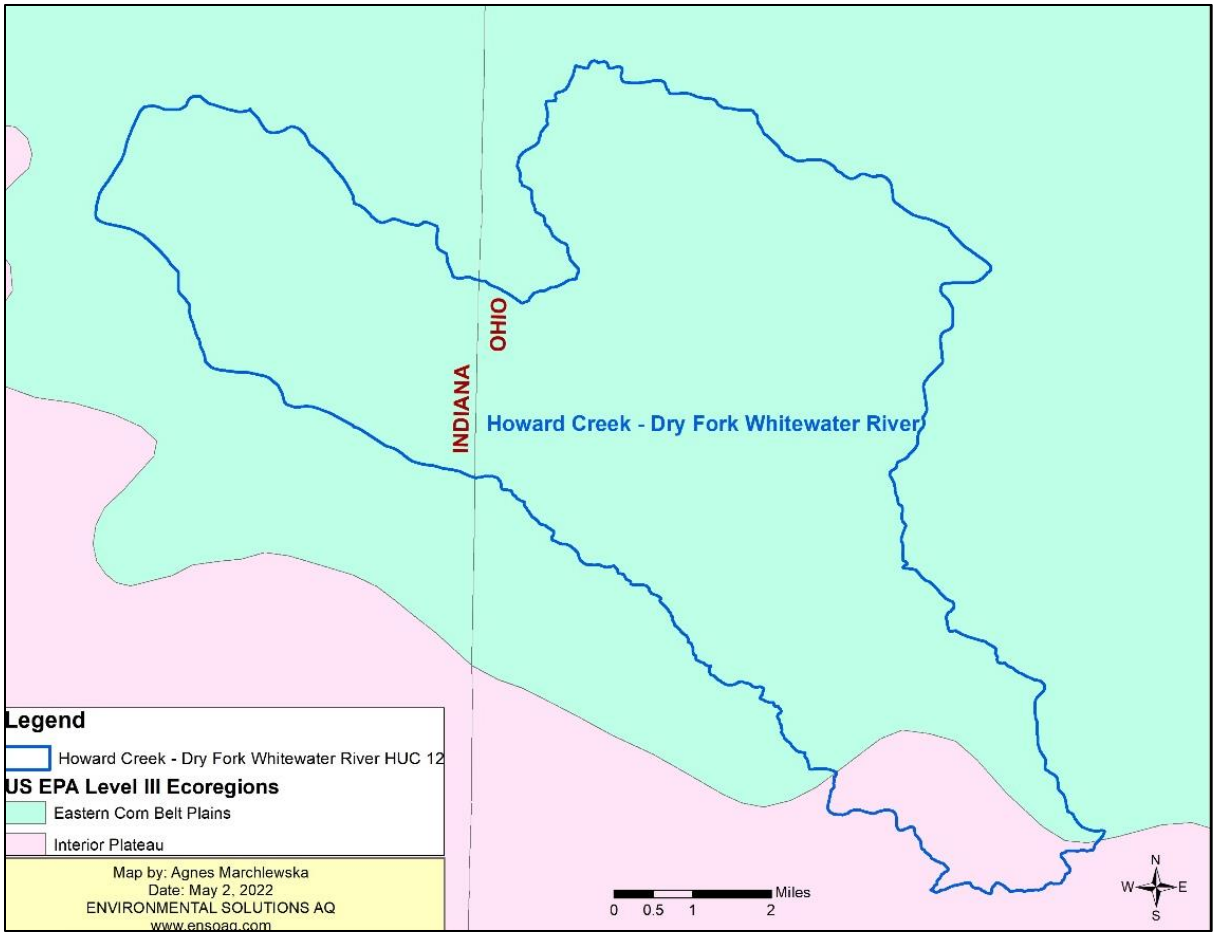

Figure 4 Ecoregion of Howard Creek- Dry Fork Whitewater River HUC-12

The HC-DF WR watershed is almost completely contained within the Southern Ohio Loamy Till Plains Region of the Central Lowland physiographic province. Only the southern tip of the watershed is located in the Outer Bluegrass Region of the Interior Low Plateaus province. (Ohio Geological Survey, 1998).

The topography of this area was shaped by the Pleistocene Epoch glaciations and it is characterized by flat to gently rolling hills with 0 - 12-degree slopes, cut by steeper stream valleys with up to approximately 58-degree slopes. Dry Fork Whitewater River flows southeast, then it gently turns south and southwest through the central portion of the watershed which alternates between flat, broader floodplains and steeper narrows. The steeper narrows are a place where often active stream bank erosion sites observed in the watershed (Fig. 6).

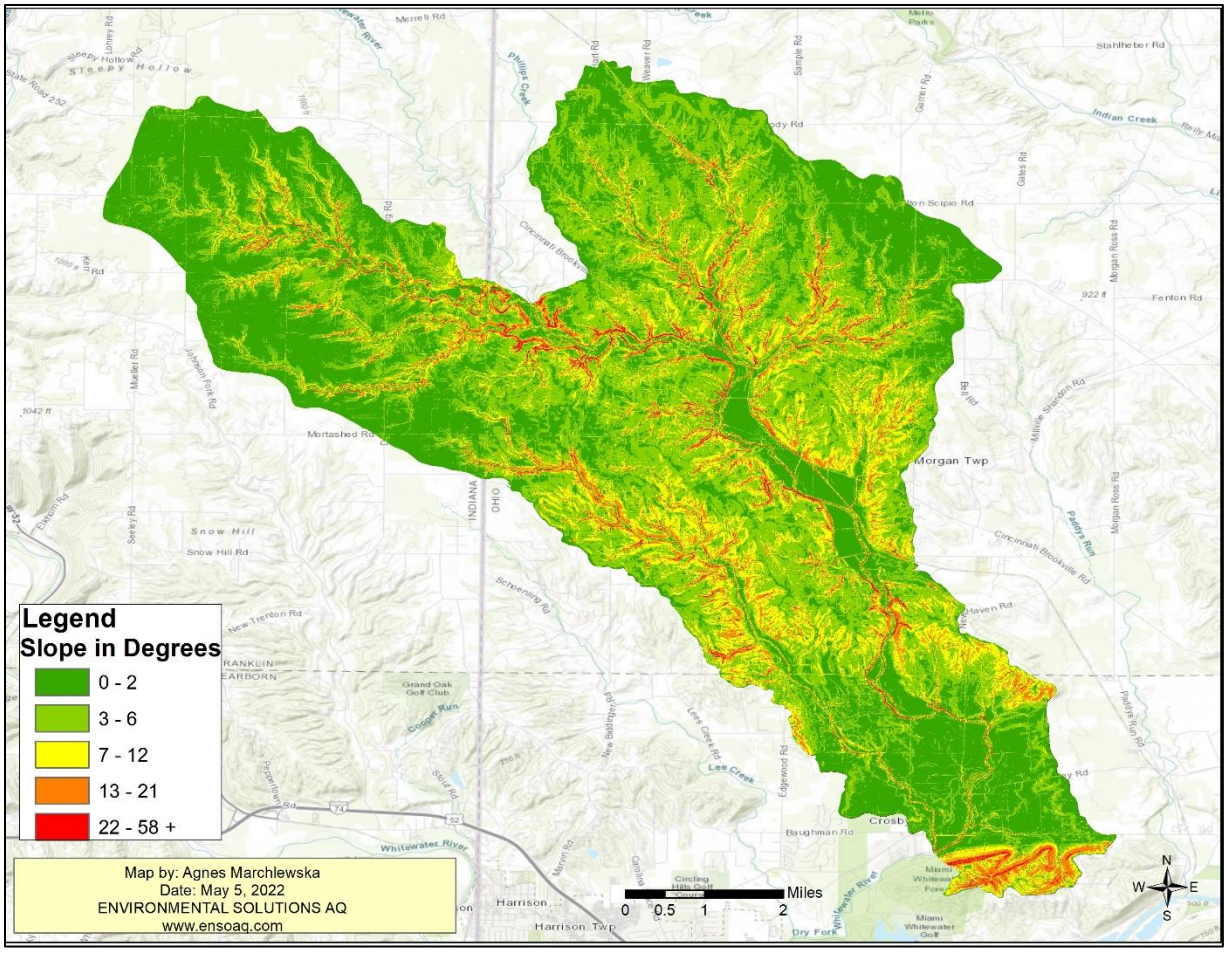

Figure 5 Slope Classification within the Howard Creek – Dry Fork Whitewater River HUC-12

The geologic units within the HC-DF WR 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 2005b). A small south portion of the watershed is formed from Illinoian glacial drift. Bedrock is comprised of interbedded fossiliferous limestone and shale.

The Whitewater and Dillsboro Formations, and Waynesville and the Arnheim Formation (undivided), compromise the majority of upland portion of the watershed (USGS, 2018). Whereas, the Grant Lake and Fairview Formations (undivided), Kope Formation and the Point Pleasant Formation are exposed in the Dry Fork Whitewater River Valley (Fig. 7). The Wisconsinan and Illinoian Epoch ground moraines, and the Wisconsinan ridge moraine comprise most of the unconsolidated sediments in the watershed (Ohio Geological Survey, 2005). Clayey glacial till, which overlays the Ordovician age bedrock in the upland portions of the watershed is often less than 35 feet thick. 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 HC-DF WR watershed vary to a considerable extent (Ohio Geological Survey, 1993).

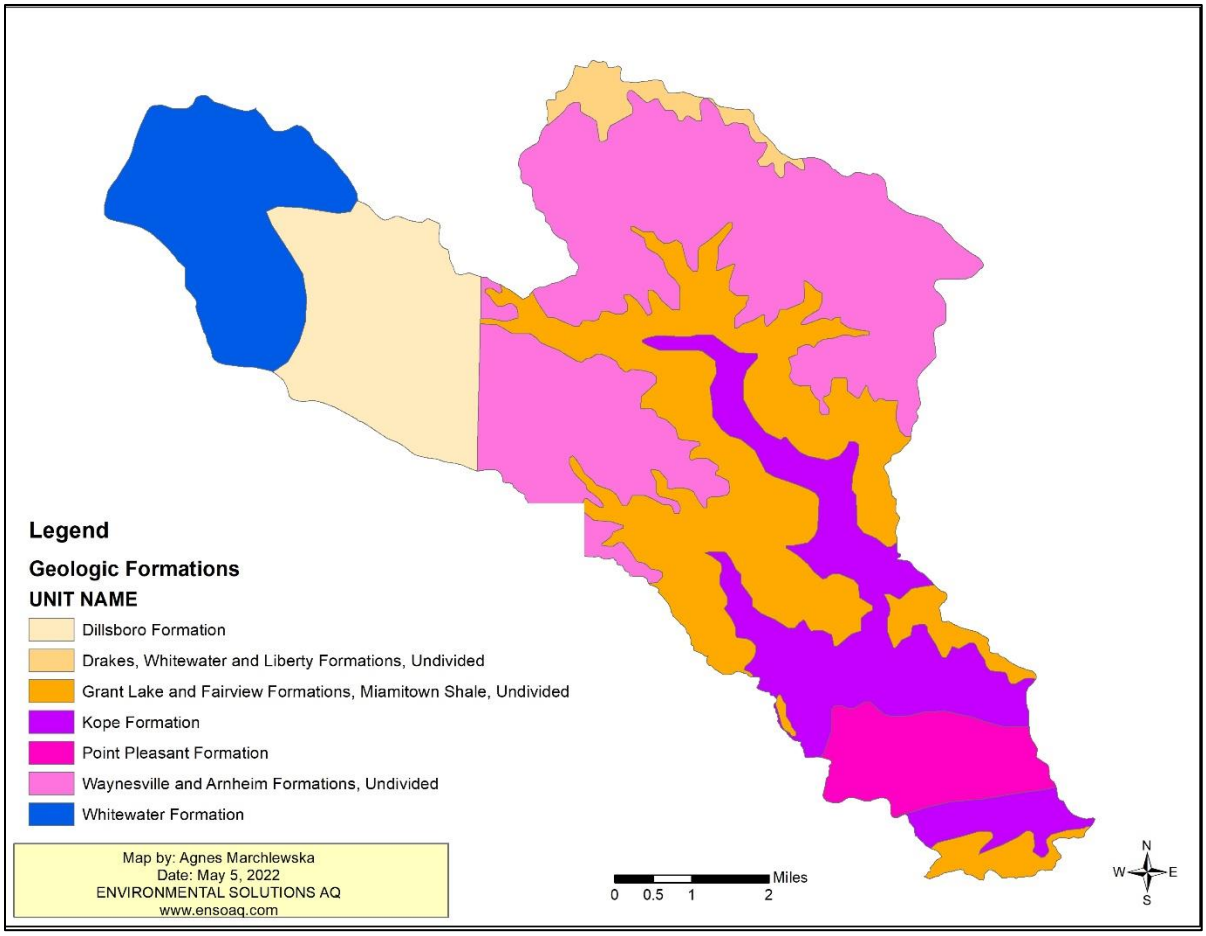

Figure 6 Geologic formations of Howard Creek – Dry Fork Whitewater River HUC-12

According to the USDA NRCS Web Soil Survey (WSS), the HC-DF WR watershed is comprised of 151 different types of soil (Fig. 8). The most common soil series are: Fincastle, Eden, Miamian-Russell, Miami and Russell silty loams, and Genesee loams. A detailed summary of the soil types is included in Appendix A. Approximately 16,294.7 acres (59.5% of total watershed area) are classified as prime or locally important soils. An additional 5,183.7 acres (18.9%) are classified as prime farmland if drained or protected from flooding. A total of 11,613.9 acres (42.30%) are rated as hydric soils on the NRCS 2022 Hydric Soils List. However, according to the National Land Cover Data (NLCD 2019) less than 0.2% (43.4 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 slightly higher acreage than the NLCD for areas designated as wetlands (80.43 acres or 0.3% of total watershed area) (Fig. 9). Most of natural wetlands within the HC-DF WR watershed are 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.

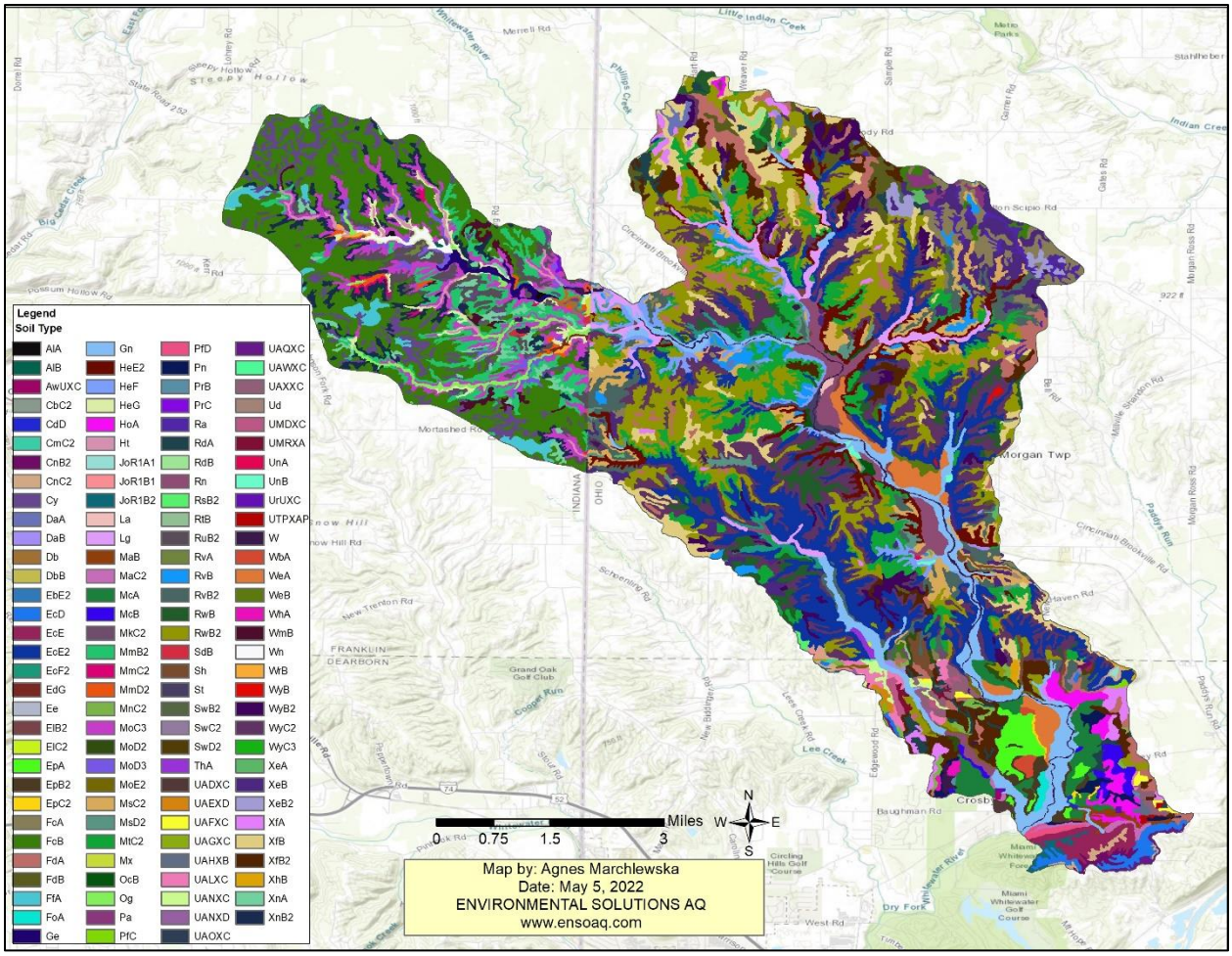

Figure 7 Soil Types within the Howard Creek – Dry Fork Whitewater River HUC-12

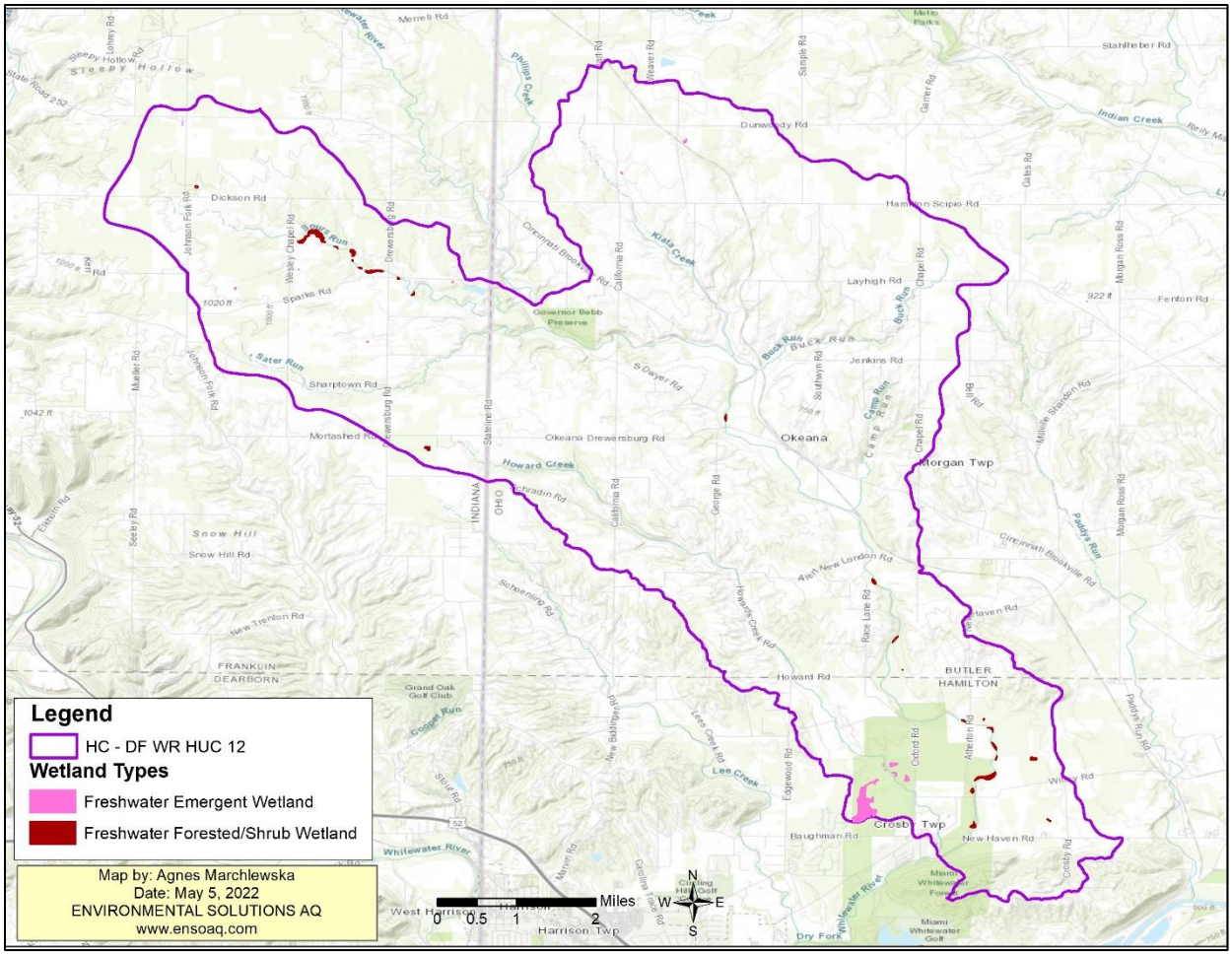

Figure 8 Wetlands within the Howard Creek – Dry Fork Whitewater River HUC-12

Table 2 summarizes soils in the watershed based on their hydrologic characteristics. The categories listed as “unclassified” describe areas covered by water bodies.

The vast majority of soils within this HUC-12 are classified as well-drained (16,399.5 acres or 59.00% of the watershed area) or moderately well-drained (5,139.4 acres or 18.80% of the watershed area) (Fig. 10). The poorly drained soils (1,676.6 acres or 3.00% of the watershed area) and somewhat poorly drained soils (4,250.4 acres or 3.5% 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 – 2 degrees of slope) and frequently experience seasonal shallow water table.

Approximately 11,467.9 acres of soils (41.50% of total watershed area) and 5,946.8 acres (21.50% of total watershed area) are classified as C and 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 HC-DF WR HUC-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 (13,138.8 acres or 47.80% of total watershed area

and 13,026.0 acres or 47.40%, 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 2 Soil classifications for HC-DF WR Watershed

Soil Classification System	**Acres**	**Percent Coverage**
Drainage Class* - Somewhat excessively drained	0.6	0.00%
Drainage Class* - Well drained	16,399.6	59.00%
Drainage Class* - Moderately well drained	5,139.4	18.80%
Drainage Class* - Somewhat poorly drained	4,345.4	15.90%
Drainage Class* - Poorly Drained	1,676.6	3.5%
Drainage Class* - Not classified	561.3	1.90%
Hydrologic Soil Group** - A	424.4	1.50%
Hydrologic Soil Group** - B	3,131.4	11.50%
Hydrologic Soil Group** - B/D	2,011.7	7.30%
Hydrologic Soil Group** - C	11,467.9	41.50%
Hydrologic Soil Group** - C/D	3,666.4	13.50%
Hydrologic Soil Group** - D	5,946.8	21.50%
Soil Erodibility*** - High	13,138.8	47.80%
Soil Erodibility*** - Moderate	13,026.0	47.40%
Soil Erodibility*** - Low	483.8	1.60%
Soil Erodibility*** - Unclassified	641.5	2.20%

**Drainage classification range from "Somewhat excessively 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. "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. Values of K range from 0.02 to 0.69.*

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

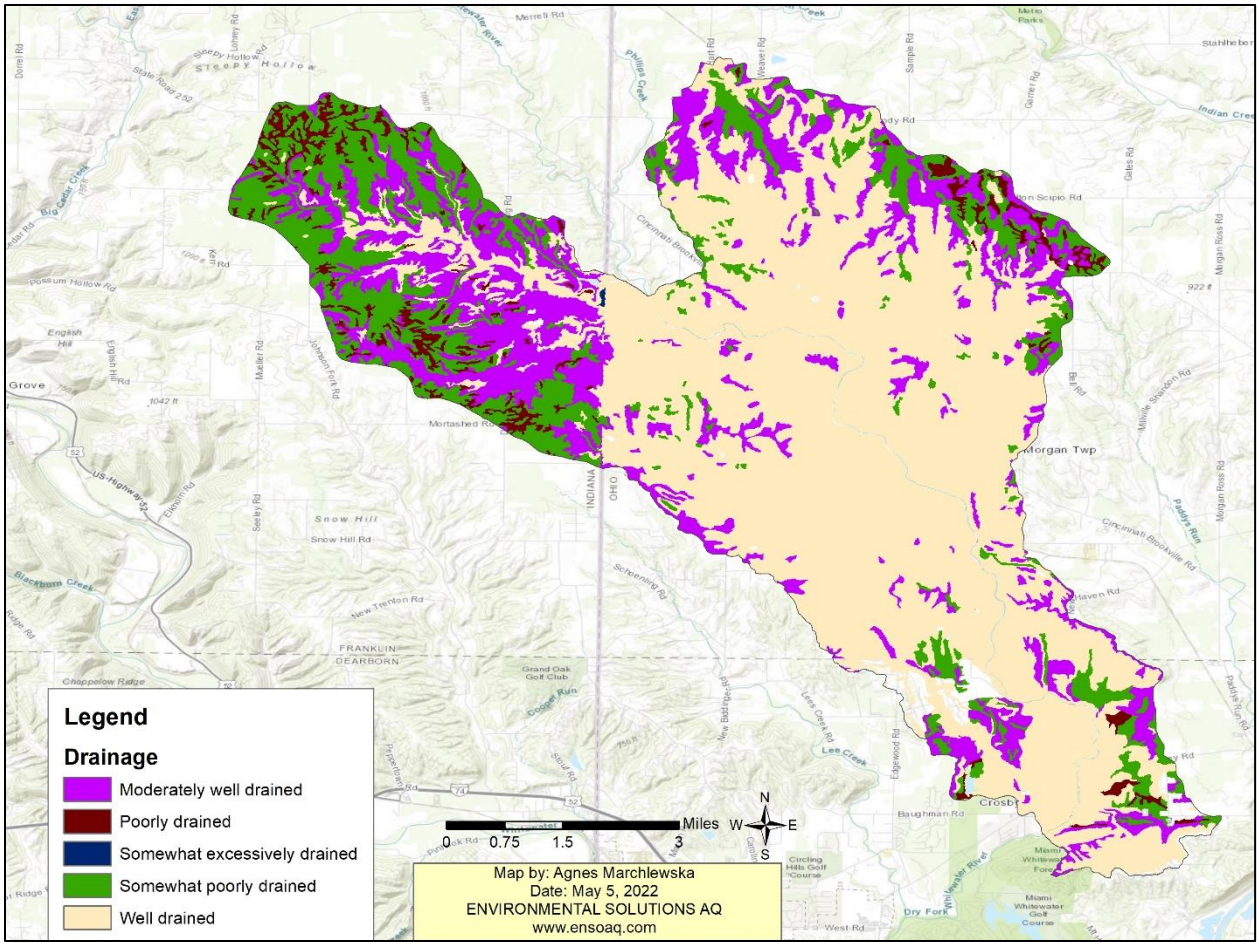

Figure 9 Drainage Classification of the soils within the Howard Creek – Dry Fork Whitewater River HUC-12

Furthermore, the USDA NRCS Web Soil Survey (WSS) classified approximately 26,405.2 acres of soils (96.8% of the watershed area) as “very limited” for septic tank absorption fields. This rating indicates that the vast majority of soils within the watershed are not naturally inclined to properly disperse and absorb liquid sewage effluents in a conventional septic drain field, and modifications to the site or septic system itself might be expensive or impossible. The OEPA designated Dry Fork Whitewater River and its tributaries 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, 2022). 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 to identify and prioritize areas within multiple counties in southwest Ohio, including Butler and Hamilton counties, where the HSTS might impact water quality the most (OKI, 2020). The HSTS were evaluated using available water resource, water quality and HSTS density data. According to a heat map developed for the HC -DF WR watershed, there are three high priority areas and five areas designated as medium – high priority identified (Fig. 10). The high priority areas include communities of Okeana and Alert

Butler County and New Haven in Hamilton County. The OKI study did not report the number of failing home systems in this watershed. Also, the HSTS management in the HC-DF WR watershed is not a priority for the Butler or Hamilton counties Health Departments. The HSTS load estimates and reductions will be added in the future version of the plan, once more data is available.

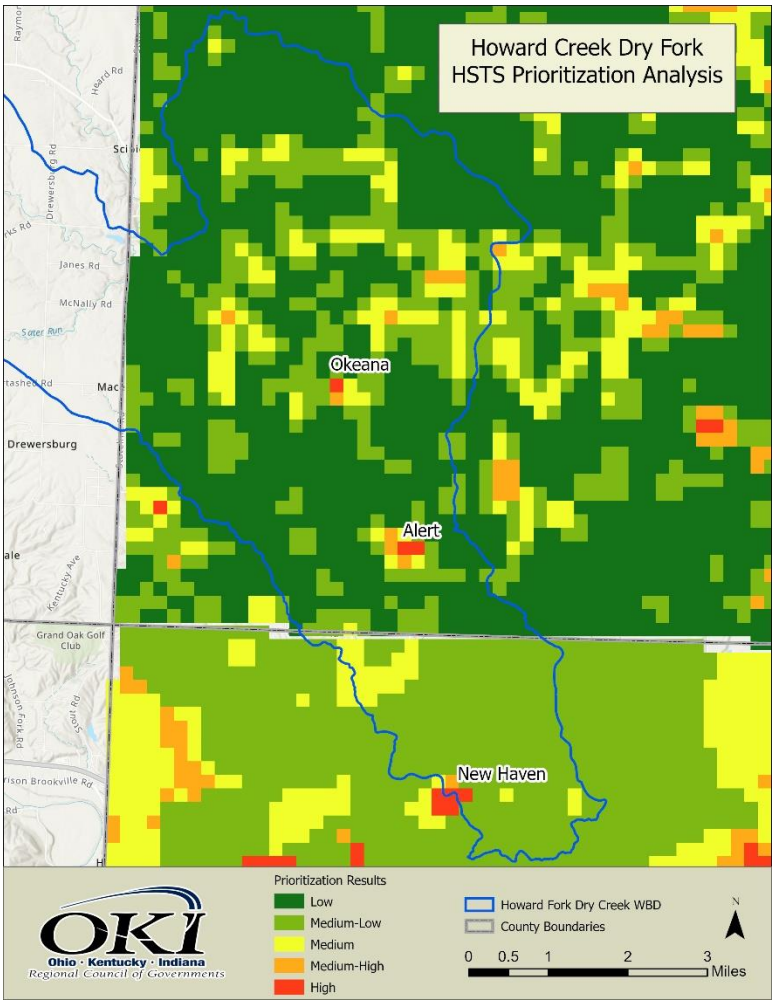

Figure 10 HSTS Priority Analysis for Howard Creek – Dry Fork Whitewater River HUC-12 (Source OKI)

2.1.2. Land Use and Protection

The HC–DF WR HUC-12 is predominantly an agricultural watershed (Fig. 12). Approximately 10,688.88 acres (34.18% of watershed area) are in cultivated crops and 8,563.58 acres (31.39% of watershed area) are in hay/pasture (Tab. 3).

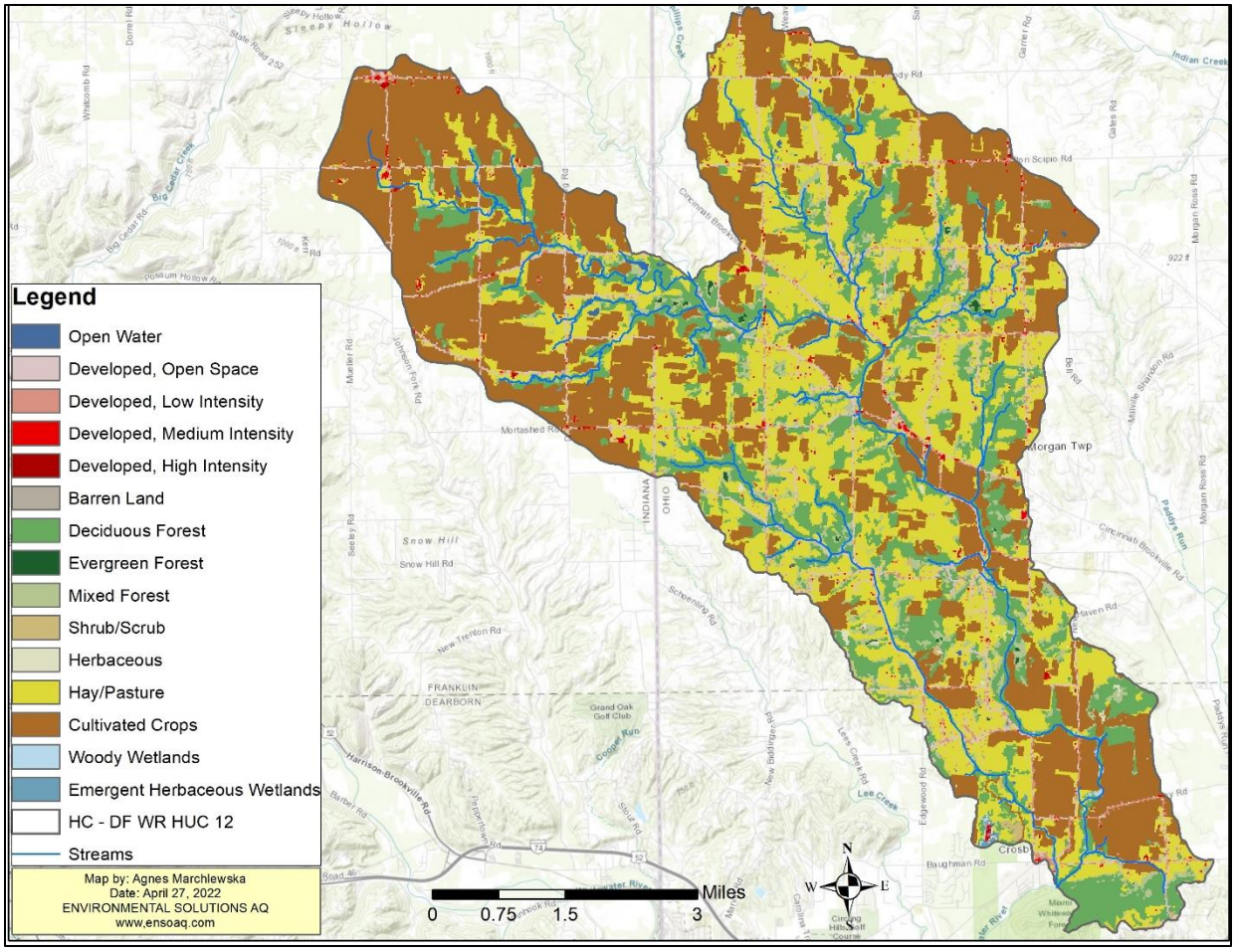

Figure 11 Land Use within the Howard Creek – Dry Fork Whitewater River HUC-12 (Source NLCD, 2019)

Table 3 Land Use within the HC – DF WR Watershed

Land Use	Area (Acres)	%
Cultivated Crops	10,688.88	39.18%
Hay/Pasture	8,563.58	31.39%
Deciduous Forest	4,860.21	17.81%
Mixed Forest	1,067.37	3.91%
Evergreen Forest	29.91	0.11%
Herbaceous	47.54	0.17%
Shrub/Scrub	48.63	0.18%
Barren Land	2.04	0.01%
Developed, Open Space	1,163.69	4.27%
Developed, Low Intensity	549.90	2.02%
Developed, Medium Intensity	152.53	0.56%
Developed, High Intensity	27.59	0.10%
Woody Wetlands	19.15	0.07%
Emergent Herbaceous Wetlands	24.24	0.09%
Open Water	39.05	0.14%
Total	27,284.32	100.00%

Source: NLCD 2019

The main crops growing in this watershed are corn and soybeans (Tab. 4). On average in the last five years 4,714.92 acres of land was in corn production and 6,016.68 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 4 Cropland Types and Acreage within Howard Creek – Dry Fork Whitewater River HUC-12

	2021	2020	2019	2018	2017
Corn	5,005.9	4,587.6	4,893.6	4,479	4,608.5
Soybeans	6,004.4	6,523.3	5,727.6	6,057.4	5,770.7
Winter Wheat	178.4	314.9	143	61.8	198.8
Grass/Pasture	7,264.1	5,866.1	6,349.8	7,674.4	7,858.8
Alfalfa	183.7	187	148.3	102.3	88.5
Other Hay/Non Alfalfa	236	360.7	305.8	256.4	216.8

Source: USDA NASS CropScape, 2022

No concentrated animal feeding facilities (CAFFs) and no permitted concentrated animal feeding operations (CAFOs) are in the HC-DF WR HUC-12. According to the Natural Resources Conservation Service in Butler County, there are many small to medium livestock operations (mostly cattle farms with less than 50 heads) in the watershed. However, no detailed data is currently available. Once available, this information will be added in the next version of the plan.

Deciduous forest covers the next largest portion of the watershed (4,860.21 acres or 17.81% watershed area). Its presence is mostly limited to the steeper portions of the watershed forming the riparian areas of Dry Fork Whitewater River 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 HC-DF WR HUC-12 are: multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata*) and Bradford pear (*Pyrus calleryana*).

Approximately 7% (1,893.71 acres) of the watershed is developed. Three major communities in HC – DF WR 12, include Mount Carmel in Springfield Township, Franklin County, Indiana (2020 population of 68); Okeana in Morgan Township, Butler County, Ohio (2020 population of 3610); and New Haven in Crosby Township, Hamilton County, Ohio (2020 population of 220).

Protected lands within the HC-DF WR watershed include 27 conservation easements on private and public properties held by TVCT (Fig. 13). These easements are part of the Paddys Run Conservation Project (PRCP) and protect approximately 3,092 acres (about 11% 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 the local park districts. These properties are public lands and include Governor Bebb MetroPark administrated by MetroParks of Butler County, and Miami Whitewater Forest and Hamilton Woods parcels preserved by the Great Parks of Hamilton County.

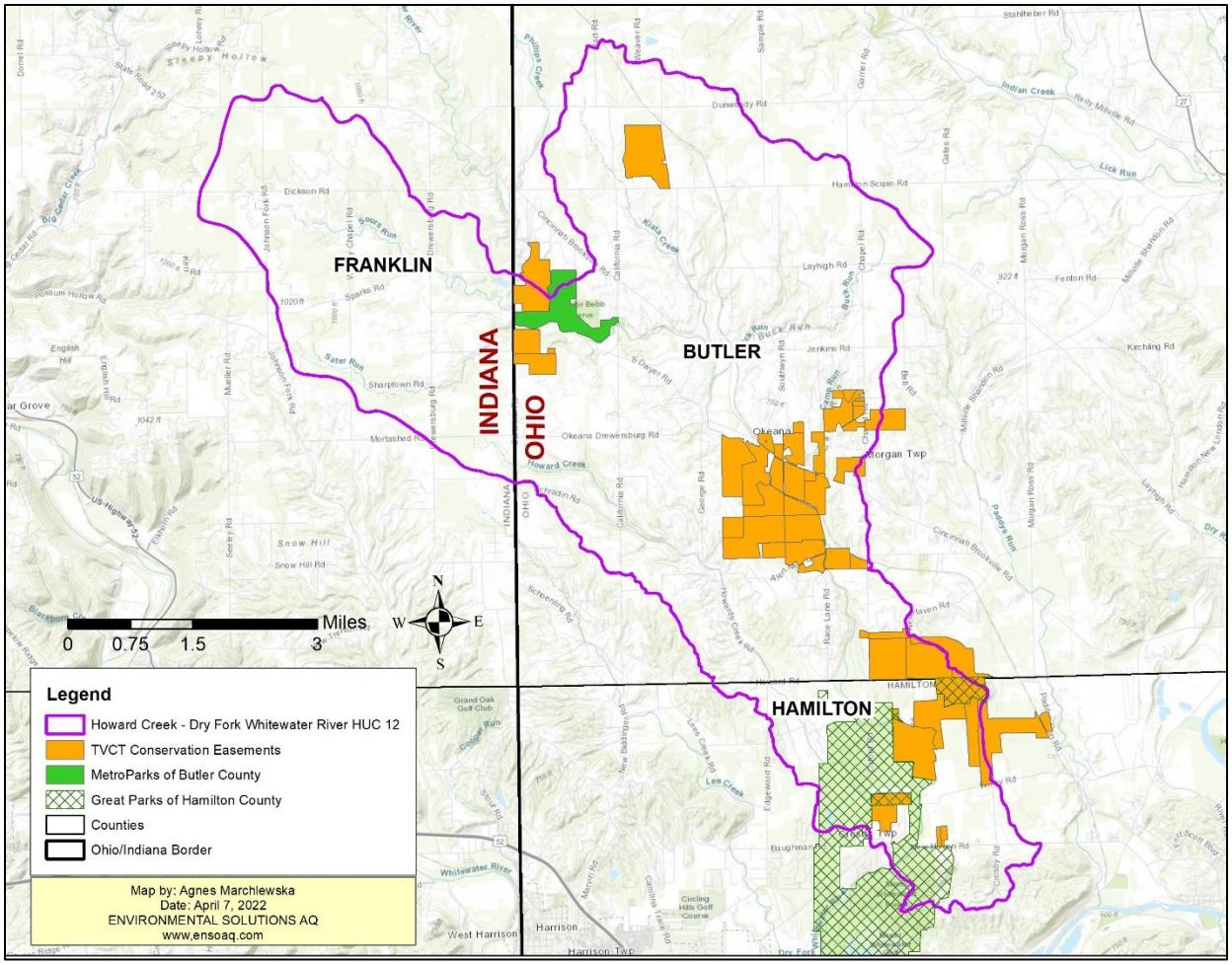

Figure 12 Protected Lands within the Howard Creek – Dry Fork Whitewater River HUC-12

Seven threatened or endangered species of wildlife and plants are federally listed for Butler and Hamilton counties by the US Fish and Wildlife Service (USFWS) (Table 5). The federally endangered Indiana Bat has been recently found in northern wooded areas along Paddys Run, in the watershed adjacent to the HC-DF WR HUC 12 (2022, USDE OLM). The wooded riparian areas of the HC- DF WR watershed might also provide a habitat for this species.

The herpetological survey conducted on the PRCP properties between 2018 and 2020 for the TVCT and the Fernald Natural Resource Trustees (Ohio EPA, U.S. Department of Energy, and U.S. Fish and Wildlife Service) identified a diverse group of amphibians and reptiles in the HC-DF WR watershed. The survey confirmed presence of the Ohio Endangered cave salamanders, which were found at Hamilton Woods administrated by the Great Parks of the Hamilton County, and on one of the privately owned conservation easements. Three Ohio Species of Concern, which include: Blanchard's Cricket Frog, Queensnake and Eastern Box Turtles were also identified in streams and ponds, and in the riparian forest within the HC-DF WR watershed on multiple private properties, which are permanently protected with conservation easements by the TVCT.

The local streams and the deciduous forest growing in the riparian areas of Dry Fork Whitewater River and its tributaries provide or might provide habitats for many of threatened and/or

endangered species. Therefore, it is critical to protect these areas from further habitat degradation caused by invasive species, agriculture activities and increasing residential development.

Table 5 Federally Listed Threatened and Endangered Species in Butler and Hamilton Counties

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 HC-DF WR 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 HC-DF WR HUC-12 over the last 5 years.

Table 6 Estimates of Conservation Practices within the HC-DF WR Watershed

Conservation Practice	Estimated Acreage Treated	Sponsoring Program	Estimated Nitrogen Load Reduction (lb/yr)*	Estimated Phosphorous Load Reduction (lb/yr)*
Conservation Tillage** (no till, reduced till)	8,551	N/A	31,437	11,184
Grassed Waterways Pollinator Habitat/Filter Strips	5	Conservation Reserve Program (FSA/NRCS)/EQUIP	1,018	8.8
Cover Crops**	300	N/A	38	199

**Estimates calculated using Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Version 4.4 (USEPA, 2019)*
***Estimated by Butler SWCD office based on the field experience*

In addition to the listed conservation practices, one Animal Waste Facility sponsored via Environmental Quality Incentive Program (EQIP) will be constructed in summer/fall of 2022 on a private farm in Butler County (Personal Communication: NRCS Butler County, Ohio).

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 in the HC-DF WR HUC-12**.**

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, OKI conducted a study to evaluate the impact of development on the water quality of 82 watersheds in southwest Ohio, including the HC-DF WR 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 4.6% of the HC-DF WR 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 HC-DF WR watershed are presented in Table 7.

Table 7 Impervious Cover vs. Slope, Soil Erodibility, Riparian Corridors and Aquifer Area in HC-DF WR HUC-12

Impervious Acres with 0-10% slopes	**Impervious Acres with 11-20% slopes**	**Impervious Areas with > 20% slopes**
711.3 (3.4% of the watershed area)	158.9 (0.8% of the watershed area)	89.1 (0.43% of the watershed area)
Impervious Acres on Highly Erodible Soils	**Impervious Acres on Not Highly Erodible Soils**	**Impervious Acres on Potentially Highly Erodible Soils**
142.4 (0.68% of the watershed area)	210.1 (1.0% of the watershed area)	595.6 (2.9% of the watershed area)
Impervious Acres Outside of Riparian Corridors*	**Impervious Acres Inside of Riparian Corridors***	
867.1 (4.2% of the watershed area)	92.1 (0.44% of the watershed area)	
Impervious Acres Not Over an Aquifer Area	**Impervious Acres Over an Aquifer Area**	
739.9 (3.5% of the watershed area)	219.3 (1.05% of the watershed area)	

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

Also, OKI evaluated the residential development trends to determine anticipated growth and the wastewater facility planning areas (OKI, 2014).

OKI projected that the population of the HC-DF WR watershed will increase from 6,271 to 6,995, from 2010 to 2040 (OKI, 2014). Currently approximately 7% of the watershed is developed. With the growing population, the residential development and 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 HC-DF WR watershed healthy.

2.2. Summary of Biological Trends for Howard Creek – Dry Fork Whitewater River HUC-12

The most recent watershed assessment data collected between 2017 and 2019 in the Ohio part of the HC-DF WR HUC-12 watershed are published in the "Ohio EPA Biological and Water Quality Study of Whitewater River Study Area" (OEPA, 2020). Additional sampling locations are also described in 2013 Water Quality Assessment of the Great Miami River and Tributaries (MBI, 2014) and in the Whitewater River Watershed Management Plan (Dearborn County SWCD, 2016).

This section summarizes the major findings included in the 2020 OEPA supplemented with an additional available sampling information included in 2014 MBI reports and in the 2016 Whitewater River Watershed Management Plan (Fig. 15, Tab. 8).

Between 2017 and 2019, the OEPA collected samples at nine locations within the HC-DF WR HUC-12. Three of the sampling locations were located along Dry Fork, and the remaining six were located at Sours Run, Sater Run, Kiata Creek, Buck Run and Howard Creek.

In 2013, the Midwest Biodiversity Institute (MBI) selected two sampling locations within this HUC-12, one along Howard Creek and the other at the mouth of the unnamed tributary to the Dry Fork Whitewater River. Also, in 2014 the Indiana Department of Environmental Management (IDEM) evaluated one sampling location along Sours Run in the Indiana portion of the watershed.

Table 8 Recent Sampling Locations Within Howard Creek Dry Fork Whitewater River HUC-12

Stream Mile	Drainage Area (mi^2)	Sample Type	Location	Latitude	Longitude
Howard Creek					
2.90*	5.8	F, Mq	Downstream Howard Road	39.30483	-84.76288
0.9	7.5	F, Mq, C, B	At Oxford Rd.	39.283981	-84.740743
Sours Run					
8.94	5.2	F, M, C, B	At Drewersburg Road	39.378871	-84.836775
0.10	6.5	F, Mq, C	At mouth	39.372931	-84.810477
Kiata Creek					
0.10	6.0	F, Mq, C	Northwest of Okeana at mouth	39.3644	-84.7739
Buck Run					
0.10	4.1	F, Mq, C, B	Near mouth	39.361088	-84.768625
Sater Run					
0.20	3.3	F, Mq	At mouth	39.368211	-84.810651
Dry Fork					
18.10	33.0	F2, Mq, C, N	Northwest of Okeana at California Road	39.3675	-84.7958
13.3	46.0	F2, Mq, C, FT	At New London Road	39.3269	-84.7486
9.02	50.0	F2, Mq, C, O, N, B, FT	Upstream New Haven at Willey Road	39.2828	-84.7297
Unnamed Tributary to Dry Fork Whitewater River					
1.4/0.5	0.9	F, C	Behind residence immed. North of New Haven Road	39.277270	-84.72793

Sources: OEPA, 2020; Dearborn County SWCD, 2016; MBI, 2014;
* When more than one year of data was available, listed is the more recent result.

M - macroinvertebrate quantitative sample, Mq - macroinvertebrate qualitative sample, F – Fish sample (1 pass), F2 - fish sample (2 passes), FT – fish tissue, C - conventional water chemistry parameters, B - bacteria, S - sediment sample, D - datasonde monitor, O-organic water chemistry

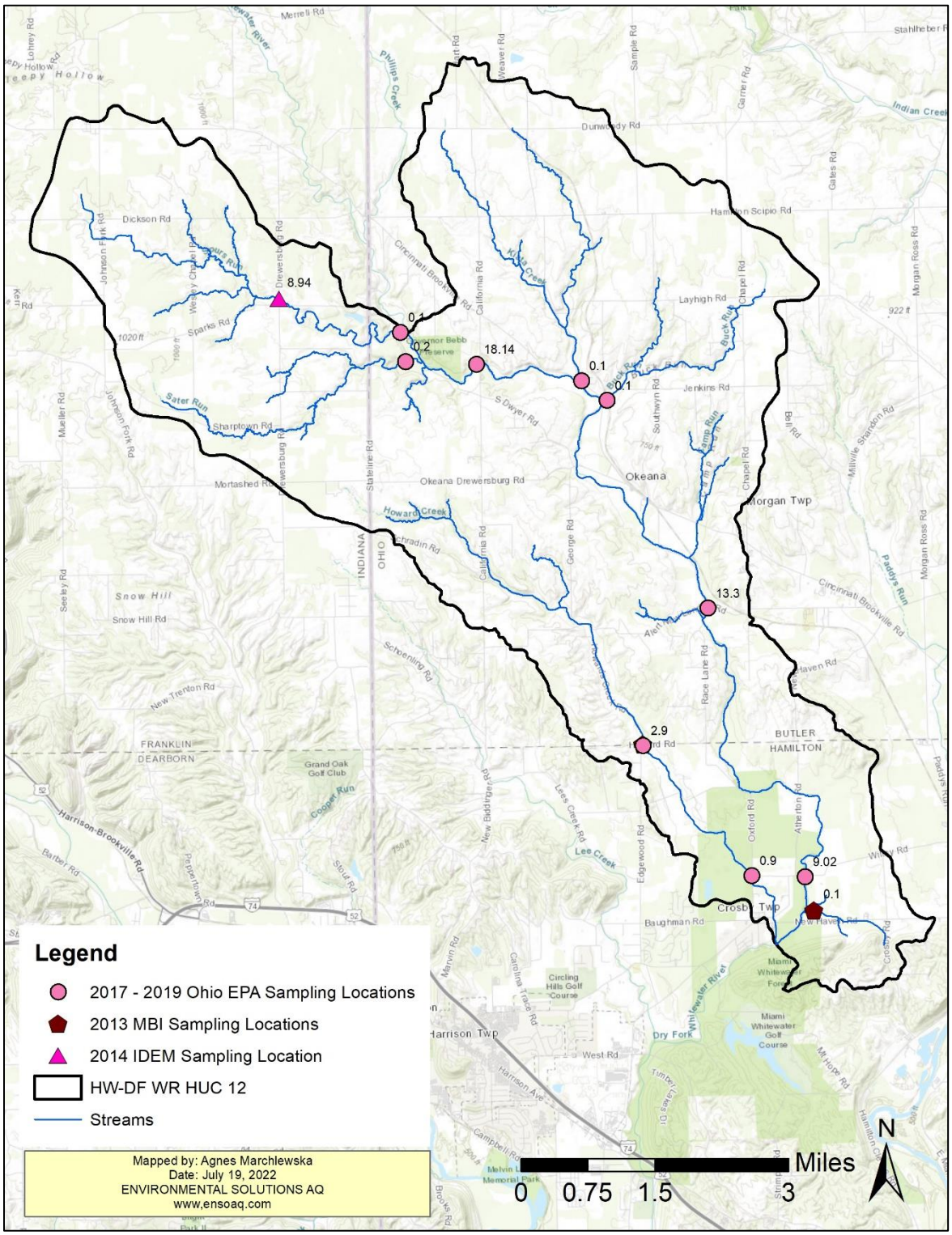

Figure 13 Sampling Locations in HC – DF WR HUC 12 by Stream Miles

A summary of the biological trends indicating the quality of near and in-stream habitats at eleven sampling locations within the HC-DF WR watershed is provided in Table 9.

The biological assemblages evaluated by the OEPA between 2017 to 2019 in Dry Fork Whitewater River and its tributaries were good to excellent and supported existing or recommended WWH or EWH Aquatic Life Use (ALU) designation. Aquatic life impairment was documented at Buck Run (RM 0.1) where the fish performance community was impacted by the presence of an armored, concrete bank structure protecting the local infrastructure from the erosion at the confluence of Buck Run and Dry Fork Whitewater River. A several feet high drop that occurs up and downstream from this structure prevents fish from passing and likely impacts quantity and quality of fish species in this stream.

Also, the biological indices scores evaluated in 2014 by the IDEM at Sours Run, RM 8.9 classified the biotic community as fair.

The unnamed tributary to Dry Fork Whitewater River sampled in 2013 as a part of the Great Miami River bioassessment conducted by the MBI was too small to attain the WWH Aquatic Life Use criterion. Due to low flow conditions, poor habitat, lack of amphibians or sufficient cold water and EPT taxa the MBI recommended classifying it as a Primary Headwater Class II stream (PHW2).

Table 9 Biological Indices Scores for the Sampling Sites

Stream Mile	Ecoregion	IBI	MIwb[a]	ICI[b]	QHEI	Aquatic Life Use Designation[c]	Attainment Status/Integrity Class	Causes
Howard Creek								
2.9	ECBP	{56}	-	{E}	{64.75}	WWH Existing - Unverified/EWH Recommended	Full	
0.9	IP	{56}	-	{VG^{NS}}	{71.5}	WWH Existing - Unverified/EWH Recommended	Full	
Sours Run								
8.94	ECBP	(38)	(36)	-	(58)	Undesignated	Fair Integrity Class	
0.10	ECBP	58	-	VG^{NS}	78.5	Existing EWH	Full	
Kiata Creek								
0.10	ECBP	52	-	VG^{NS}	69.25	WWH Existing - EWH Recommended	Full	
Buck Run								
0.10	ECBP	32*	-	VG	68.5	Undesignated - WWH Recommended	Partial	Fish passage barrier
Sater Run								
0.20	ECBP	[48]	-	[VG]	[71.0]	Undesignated - WWH Recommended	Full	
Dry Fork Whitewater River								
18.10	ECBP	54	9.62	VG^{NS}	82.75	EWH Existing	Full	
13.30	ECBP	52	10.13	E	72.75	EWH Existing	Full	
9.02	IP	56	10.33	E	74.5	WWH Existing - EWH Recommended	Full	
Unnamed Tributary to Dry Fork Whitewater River								
1.4/0.5	IP	(28)	(0)	-	(36.5)	Undesignated - PHW2 Recommended	-	

Sources: OEPA, 2020; Dearborn County SWCD, 2016; MBI, 2014
(Parenthesis for samples collected in 2013/2014)
No brackets – samples collected in 2017

[Brackets for samples collected in 2018]
{Braces for samples collected in 2019}
ECBP – Eastern Corn Belt Plains Ecoregion
IP – Interior Plateau Ecoregion
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).*
QHEI - Qualitative Habitat Evaluation Index
WWH - Warmwater Habitat
EWH - Exceptional Warmwater Habitat
PHW2 – Primary Headwater Class II Stream

2.2.1. Biological Assessment: Fish Assemblages

The fish assemblages of Dry Fork Whitewater River and its tributaries were surveyed and assessed as a part of a larger study of the Whitewater River watershed conducted by the OEPA in 2017-2019. A total of 26,165 fish comprising 68 species and 3 hybrids were collected from 25 locations in the study area, including nine sampling locations within the HC-DF WR HUC-12. Based on aggregated catch statistics, numerically predominant species residing in Dry Fork Whitewater River mainstem (No/0.3 km for headwaters and wading sites and No/1 km for boat sites) included central stone stoneroller (23.8%), rainbow darter (8.2%), bluntnose minnow (8.0%), longear sunfish (7.4%), striped shiner (6.7%), sand shiner (5.9%), fantail darter (5.7%), northern hog sucker (5.0%), silverjaw minnow (3.4%) and greenside darter (2.8%). In terms of percent of biomass, dominant species were black redhorse (19.0%), smallmouth bass (14.8%), northern hog sucker (14.6%, golden redhorse (13.2%), white sucker (9.5%), central stoneroller (9.2%), longear sunfish (4.1%), rock bass (3.7%), striped shiner (2.7%) and gizzard shad (1.1%).

All three sampling locations along Dry Fork Whitewater River section within the HC-DF WR HUC-12 showed a very high quality of fish assemblage, however 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. The sensitive, intolerant or otherwise noteworthy taxa collected at these locations included black redhorse and smallmouth bass. The IBI and MIwb scores ranged from IBI=54/MIwb=9.6 to IBI=56/MIwb=10.33 and consistently exceeded the existing or recommended EWH Aquatic Life Use criterion (Tab. 10).

The numerically dominant fish species in the Dry Fork tributaries included central stoneroller (28.7%), bluntnose minnow (16.2%), creek chub (10.2%), fantail darter (8.2%), w. blacknose dace (7.2%), striped shiner (5.4%), rainbow darter (4.3%) johnny darter (2.0%) and white sucker (1.7%). Community indices and accompanying narrative evaluations from these waters ranged from exceptional (IBI=56) to fair (IBI=32). Most scores met the existing or recommended Aquatic Life Use criterium. Fish assemblages in Buck Run were missing many species compared to other similarly sized streams in the area and supported only 5 species, three of which were highly tolerant. The existing dam/impoundment blocking the fish passage at the Buck Run and Dry Fork confluence is a possible factor negatively impacting the fish assemblance in this stream.

According to the TMDL report prepared by the IDEM the fair narrative for fish communities assessed in 2014 at Sours Run RM 8.94 on the Indiana side of the watershed could potentially result from low flow conditions during summer months, negative impact of nutrients from agriculture and increased erosion.

Table 10 Fish Community and Descriptive Statistics

Stream Mile	Ecoregion	Cumulative Species	Relative Number minus Tolerant	Relative Biomass minus Tolerant (kg)	IBI	MIwb	QHEI	Narrative Evaluation
Howard Creek								
2.90	ECBP	{22}	{1687}	-	{56}	-	{64.75}	Exceptional
0.9	IP	{24}	{973.5}	-	{56}	-	{71.5}	Exceptional
Sours Run								
8.94	ECBP	-	-	-	(38)	-	(58)	(Fair)
0.10	ECBP	22	936	-	58	-	78.5	Exceptional
Kiata Creek								
0.10	ECBP	15	1322	-	52	-	69.25	Exceptional
Buck Run								
0.10	ECBP	5	1200	-	32*	-	68.5	Fair
Sater Run								
0.10	ECBP	[12]	[120]	-	[48]	-	[71]	[Very good]
Dry Fork Whitewater River								
18.14	ECBP	22	1006.5	27.2	54	9.6	82.8	Exceptional
13.3	ECBP	29	2297.2	60.1	52	10.13	72.75	Exceptional
9.02	IP	30	1115.2	37.6	56	10.33	74.5	Exceptional
Unnamed Tributary to Dry Fork Whitewater River								
1.4/0.5	IP	(4)	(40)	-	(28)	-	(36.5)	-

Source: *OEPA, 2020; Dearborn County SWCD, 2016; MBI, 2014;*
(Parenthesis for samples collected in 2013 or 2014)
No brackets – samples collected in 2017
[Brackets for samples collected in 2018]
{Braces for samples collected in 2019}
ECBP – Eastern Corn Belt Plains Ecoregion
IP – Interior Plateau Ecoregion
** Indicates significant departure from applicable biocriterion (>4 IBI or ICI units, or >0.5 MIwb units).*

2.2.2. Biological Assessment: Macroinvertebrate Community

The macroinvertebrate assemblages of Dry Fork Whitewater River and its tributaries were surveyed and assessed as a part of a larger study of the Whitewater River watershed conducted by the OEPA in 2017-2019 with the majority of sampling taking place in 2017.

All nine sampling locations within the HC-DF WR HUC-12 produced very good to exceptional macroinvertebrate assemblages and supported existing or recommended WWH and the EWH expectations for the Aquatic Life Use criterium. The low flow conditions over the summer were likely a primary stressor impacting the macroinvertebrate communities' structure and diversity in the six selected locations at Dry Fork tributaries, which at the time of sampling were interstitial or intermittent. Total taxa, EPT and sensitive taxa evaluated at three sampling locations along Dry Fork mainstem were generally very high except at RM 18.14 where the riffle habitat was nearly dry when the qualitative sampling was conducted. Although the benthos at this location was not as robust, it still met the EWH criterium. The high diversity of macroinvertebrate taxa included rare, pollution sensitive species found in Dry Fork mainstem at RM 13.3 (*Perlinella drymo* and *Triaenodes perna*) at RM 9.2 (*Paracloeodes fleeki*, Telopelopia *Okoboji*), and in Sater Run at the RM 0.2 (*Pseudolimnophila sp.).* Also, the higher incidence of coldwater macroinvertebrate organisms were collected from Sours Run at RM 0.1 *(Parametriocnemus sp.),* Sater Run at RM 0.1 *(Diplectrona modesta, Parametriocnemus sp and Polypedilium aviceps),* and the Howard Creek at RM 2.9 *(Polypedilium aviceps) and RM 0.9 (Zavrelimyia sp*.) indicating possible contribution of cold groundwater to these streams and reflecting very good to exceptional conditions for the macroinvertebrate communities.

Table 11 Macroinvertebrate Sampling Results

Stream RM	**Dr. Area (Sq. mi.)**	**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**
Howard Creek									
2.90	{5.8}	{57}	{17}	{15}	{M}	{1}	caddisflies (F,MI), mayflies (F,MI,),	-	{Exceptional}
0.9	{7.5}	{54}	{15}	{10}	{M}	{0}	caddisflies (F,MI), Heptageniid mayflies (F,MI)	-	{Very Good}
Sours Run									
0.10	6.5	52	18	12	L	1	Midges (F), Baetid mayflies (F), Caddisflies (MI,F),Blackflies	-	Very good
Kiata Creek									
0.10	6.0	49	16	12	L	0	Water pennies (F), Caddisflies (MI,F), Water mites (F)	-	Very good

Table continued next page

Table 11 continued

Stream RM	Dr. Area (Sq. mi.)	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
Buck Run									
0.10	4.1	51	16	11	M	0	Midges (F), Mayflies (MI, F), Caddisflies (MI,F)	-	Very good
Sater Run									
0.10	[3.3]	[54]	[16]	[15]	[L]	[3]	Mayflies (MI,F), Caddisflies (MI,F), Riffle beetles (F)	-	[Very good]
Dry Fork									
18.14	27.6	53	16	12	M	0	Midges (F), Caddisflies (MI,F)	-	Very good
13.3[a]	46	62	26	21	M	0	Midges (F), Baetid mayflies (F), Caddisflies (MI,F)	-	Exceptional
9.02[a]	50	59	25	18	M	0	Midges (F), Baetid mayflies (F), Caddisflies (MI,F)	-	Exceptional

Sources: OEPA, 2020
No brackets – samples collected in 2017
[Brackets for samples collected in 2018]
{Braces for samples collected in 2019}
a: ICI values invalidated due either to insufficient current speed over the artificial substrates or by suspected disturbance. The station evaluation at these sites is based on the qualitative sample narrative evaluation.
RM: River Mile.
Dr. Ar.: Drainage Area
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
EPT: Benthic macroinvertebrates from the Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies)

2.2.3. 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.

In the 2020 OEPA report, the QHEI evaluated at nine sampling locations within the Ohio part of the HC-DF WR HUC-12 varied from good to excellent with the scores ranging from 64.8 to 82.8 (Tab. 12). The most limiting factors influencing the QHEI scores were low flow, no fast current, fair to poor development of channel morphology, lack of riffles in the tributaries and high to moderate embeddedness at the sampling locations along the Dry Fork Whitewater River mainstem. The 2013 evaluation of the unnamed tributary to Dry Fork Whitewater River conducted by the MBI resulted in the QHEI score at 36.5. The poor habitat condition determined at this site was due to low-flow conditions, high bank erosion and heavily silted substrates. On the Indiana side of the watershed, the habitat evaluation performed in 2014 by the IDEM showed the QHEI score at 58 due to limited stream cover and severe bank erosion (not included in Table 12 as no detailed data is available).

Table 12 QHEI Matrix and Scores

Key QHEI Components				WWH Attributes											MWH Attributes															
River Mile	QHEI	Narr.	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
Howard Creek (Year: 2019)																																		
2.9	**64.8**	G	6.20	x	x				x			x	x	5						0					x	x			x	x		x	5	0.17	1.00
0.9	**71.5**	E	20.00	x	x			x	x			x	x	6						0					x				x	x		x	4	0.14	0.71
Sours Run (Year: 2017)																																		
0.1	**78.5**	E	60.00	x	x		x	x	x	x	x	x	x	9						0									x				1	0.10	0.20
Kiata Creek (Year: 2017)																																		
0.1	**69.3**	G	30.30	x	x		x		x		x		x	6					x	1						x			x				2	0.29	0.43
Buck Run (Year: 2017)																																		
0.1	**68.5**	G	30.30	x	x		x	x	x	x		x	x	8						0				x							x		2	0.11	0.33
Sater Run (Year: 2018)																																		
0.2	**71.0**	E	80.00	x	x		x		x		x	x	x	7						0						x		x	x				3	0.13	0.50
Dry Fork Whitewater River (Year: 2017)																																		
18.7	**82.8**	E	26.32	x	x		x	x	x	x		x	x	8						0											x	x		2	0.11	0.44
13.3	**72.8**	G	11.76		x		x	x	x	x		x		6						0	x			x	x	x					x	x		6	0.29	1.14
9.0	**74.5**	G	8.55	x	x		x	x	x	x		x		7						0				x	x						x	x		4	0.13	0.75
Unnamed Tributary to Dry Fork Whitewater River (Year: 2013)																																		
1.4	**36.5**	P	-	x				x	x					3		x			x	2		x			x			x	x	x		x	2	3	0.33

Source: OEPA, 2020; MBI, 2014

2.2.4. Water Quality

In addition to biological assessment, the OEPA also collected surface water samples from seven locations at Dry Fork and its selected tributaries within the HC-DF WR HUC-12. The samples were analyzed for metals, nutrients, polychlorinated biphenyls (PCBs), semi-volatile organic compounds, organochlorinated pesticides, bacteria, pH, temperature, DO, percent DO saturation, and suspended and dissolved solids.

No exceedances were found in the water chemistry grab samples. Four locations sampled in August of 2017 showed dissolved oxygen (DO) below the minimum water quality criteria (Tab. 13). They included Dry Fork at RM 18.1 and at RM 9.02 with DO values derived from diel monitoring, and sampling locations at Kiata Creek RM 0.1 and the Buck Run at RM 0.1 evaluated with a field meter. The identified DO exceedances at all 4 sampling locations were primarily related to low/interstitial stream flows observed during the summer months and excessive primary production from the filamentous algae.

Table 13 2017 Dissolved Oxygen Exceedances

Stream River Mile (use designation)[a]	**Parameter (value) – units are in mg/L for dissolved oxygen**
Kiata Creek (EWH, AWS, IWS)	
RM 0.1	Dissolved oxygen 3.23*
Buck Run (WWH, AWS, IWS)	
RM 0.1	Dissolved oxygen 2.14*
Dry Fork Whitewater River ECBP & IP – (EWH)	
RM 18.1	Dissolved oxygen min: 20(1.6)‡‡; 18 (1.4)‡‡
RM 9.02	Dissolved oxygen min. 3(4.7)‡‡; 2(4.7)‡‡

Source: OEPA 2020
[a] Use Designations:
EWH - Exceptional warmwater habitat
WWH – Warmwater habitat
AWS – Agicultural Water Supply
IWS – Industrial Water Supply
*Exceedance of OMZM (outside mixing zone maximum) numerical criteria for prevention of acute toxicity.
‡‡ Applicable minimum D.O. criterion: duration (magnitude) – EWH: 5 mg/L; WWH: 4.0 mg/L; MWH-HELP: 2.5 mg/L

Total phosphorous and dissolved inorganic nitrogen (DIN) were evaluated from samples collected between June 15 and October 15 of 2017. The concentrations measured at each sampling locations were below recommended by the OEPA thresholds of 0.131 mg/L for total phosphorous and 3.6 mg/L for DIN, putting this watershed in the low-risk category for nutrient enrichment and eutrophication potential (Tab. 14).

Table 14 2017 Nutrients Sampling Results (June 15-Oxtober 15, 2017)

Stream		Total Phosphorous		DIN (Ammonia + Nitrate + Nitrite)		Risk Category[a]
RM	Drainage Area (mi^2)	Sample (#)	Geometric Mean	Samples (#)	Geometric Mean	
Dry Fork Whitewater River						
18.1	33.0	4	0.07	8	0.19	L
13.3	46.0	4	0.05	8	0.35	L
9.02	50.0	5	0.05	10	0.38	L
Sours Run						
0.1	6.5	4	0.04	6	0.21	L
Kiata Creek						
0.1	6.0	4	0.02	8	0.21	L
Buck Run						
0.1	4.1	3	0.06	3	0.17	L
Howard Creek						
0.3	7.5	4	0.14	8	0.20	L

Source: OEPA, 2020

a Risk category are based on Ohio EP (2015c). Risk Categories: Low (L) – Total phosphorus < 0.131, DIN < 3.6; Medium (M) – Total phosphorous ≥0.131 and < 0.4, DIN < 3.6; High (H) – Total phosphorus ≥ 0.4, DIN ≥ 3.6.

Also, a single sample maximum concentration for the total phosphorous (0.166 mg/L) was measured in 2014 at Sours Run, RM 8.94 by the IDEM. This value was below the target of 0.30 mg/L, developed for the Southern Whitewater River Watershed TMDLs (IDEM, 2015 (revised in 2020)). At this site, nutrients exceeded 1.0 mg/L target concentrations on 4 out of 7 occurrences (67%) and had the geometric mean of 2.06 mg/L.

The only samples evaluated for organic parameters within this watershed were collected at Dry Fork Whitewater River RM 9.2. Two herbicides commonly used in agriculture and to maintain the residential lawns were detected; Atrazine and Metolachlor. The only other organic compound detected at the site was Bis (2-Ethylhexyl) phthalate, which is a plasticizer and its concentrations didn't exceed the established water quality standard.

No PCBs were detected in fish (reporting limit of 0.02 mg/kg), and all mercury concentrations were below 1.0 mg/kg, resulting in this watershed attaining the criterion for the Fish Tissue/Human Health use.

Bacterial data were collected in 2017 at three sampling locations within Ohio part of the HC-DF WR HUC-12 (Tab. 15). The *E. coli* results from each sampling location exceeded both; the 90-day geometric mean of 126 cfu/100 ml, and the Statistical Threshold Value (STV of 410 cfu/100

ml) maximum criteria for the Primary Contact Recreational Use designation. The data suggested direct access of livestock to the streams, storm water runoff from livestock areas or areas where manure is applied as fertilizer, failing onsite home sewage treatment systems, and point source human waste disposal maybe the source of this impairment. Also, samples collected in 2014 by the IDEM indicated the *E. coli* impairment at the Sours Run, RM 8.94.

Table 15 A summary of E. coli data for HC-DF WR HUC-12 Sampling locations (July - August, 2017 and 2014).

Stream RM	# Samples	Geometric Mean	% > STV	Maximum Value
Dry Fork Whitewater River				
9.02	5	263	40%	1,120
Buck Run				
0.1	5	387	40%	649
Howard Creek				
0.3	5	1,381	100%	4,490
Sours Run				
8.94	10	NA	70*	1732.9

Source: OEPA, 2020; IDEM, 2015 (revised in 2020)

*Percent of samples violating the Indiana TMDL Target for Southern Whitewater River Watershed of 235 cfu/100 mL

2.3. Summary of TMDL

Howard Creek – Dry Fork Whitewater River watershed has its headwaters in Indiana. The 2015 Total Maximum Daily Load (TMDL) Report prepared by the IDEM for Southern Whitewater River Watershed listed the stream segments within Indiana portion of the HC-DF WR HUC-12 as impaired due to *E. coli*. The report listed agriculture, manure spreading, and faulty septic systems as pollutant sources. Recommended strategies to achieve the *E. coli*, nutrients and sediment loads reductions in the watershed included; proper manure handling, storage, treatment and disposal, developing Nutrient Management Plans and establishing the filter strips.

No TMDL has been prepared for the Ohio part of HC-DF WR watershed. The HC-DF WR aquatic life beneficial use was determined to be EWH and WWH, and the watershed was listed as one of Ohio's impaired waters. All sampling locations along Dry Fork mainstem and most of its tributaries were full attainment. The Buck Run achieved partial attainment due to blocked fish passage by the existing dam/impoundment at the confluence of Buck Run and Dry Fork Whitewater River.

High levels of bacteria (*E. coli*) were detected when evaluating for recreational use and the results determined the impaired recreational use status. To address the recreational use impairment due to the presence of *E. coli*, a loading analysis plan (LAP) – multi-watershed bacteria TMDL is being prepared by OEPA. The HC – DF WR watershed is included in this TMDL document. The multi-watershed bacteria TMDL LAP project will provide actions (sampling, analyses, regulatory review) to be taken to address the impairment for the selected

watersheds (OEPA, 2020). Information will be updated in a future version of this NPS-IS when it becomes available.

2.4. Summary of Pollution Causes and Sources

As stated in the Biological and Water Quality Study of the Whitewater River Study Area (OEPA, 2020), all the stream sampling locations within Ohio portion of the HC- DR WR watershed were able to support an assemblage of aquatic organisms consistent with EWH or WWH. The partial attainment assigned for Buck Run was likely caused by existing fish passage barrier. The increased dissolved oxygen at Dry Fork and two of its tributaries was associated with low flow conditions during summer and increased filamentous algae productivity. In addition, the OEPA listed *E. coli* as a cause of recreational impairment.

The potential sources of the impairments in HC-DR WR HUC-12 may include natural sources, dam/impoundment on Buck Run, row crop agriculture, manure handling, cattle access to the streams, stream bank erosion, sedimentation and failing onsite home sewage treatment systems. Furthermore, row crop agriculture has been determined to be one of the main sources of excessive nutrient loads, and siltation/sedimentation in rural watersheds, and a major contributor to Gulf of Mexico hypoxia. Additionally, increasing development pressure and agricultural and residential encroachments, especially in the riparian corridors may be the source of habitat impairment, nutrient enrichment from wastewater, and drainage and storage capacity impairments.

Estimated baseline nutrient loads and estimated target load reduction for the HC-DF WR HUC-12 were calculated using a mass balance equation provided by Rick Wilson, OEPA (Tab. 16). The goal loads presented are 20 percent of the total estimated baseline loads for annual nitrogen contribution in the HC-DF WR watershed.

The 2020 report on management of onsite systems did not report the number of failing home systems at this watershed (OKI, 2020). Information about urban loading is limited since there are just three small communities in this agricultural watershed. This version of the Nine-Element NPS-IS for HC-DF WR HUC-12 will be focusing on reducing agricultural nutrient loads. Once more information is available for the urban loading, the next version of the plan will be updated to include them.

Table 16: Estimated Nitrogen and Phosphorus Loadings from Contributing NPS Sources in HC-DF WR HUC-12

	Agricultural Load (lbs Nitrogen/acre)	**Agricultural Load (lbs Phosphorus/acre)**
Current Estimates*	298,758	18,490
Target Reduction Goals*	59,752	3,698
Current load reduction estimates based on SWCD inventory**	32,493	4,444

*Estimates were calculated using mass balance spreadsheet provided by Rick Wilson, OEPA in May 2022 for the Great Miami River Watershed and assuming the land use, topographic and hydrologic similarity of the Howard Creek – Dry Fork Whitewater River HUC 12 to the adjacent Beals Run -Indian Creek HUC 12.
** See Table 2-6 for conservation practices. Estimates calculated using STEPL, 2019

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

2.5.1. Agricultural Conservation Planning Framework

The Agricultural Conservation Planning Framework (ACPF) is an agricultural watershed management tool using high-resolution spatial data and ArcGIS to identify opportunities for installing conservation practices within a watershed (Tomer et al., 2013). Developed by the US Department of Agriculture, the ACPF is being used in hundreds of watersheds to inform and engage local communities in agricultural conservation. The program spatially combines high resolution terrain, drainage, soils, land use and crop land data, and identifies and prioritizes potential areas for conservation (ARS, 2019). ACPF can engage stakeholders in the watershed planning process by proposing conservation solutions. The program is not prescriptive but provides various options and scenarios that can be evaluated at watershed and farm levels including conservation practices within fields, below fields and in riparian zones (Tomer et al., 2013). The following ACPF conservation practices 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 Practice code 393 - Filter Strips are not specifically identified in the ACPF but it are 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. This can be very effective for nutrient removal and treatment and will replace the Contour Buffer Strips identified in the ACPF.

The ACPF riparian assessment (riparian buffer and streambank stabilization) utilizes a matrix of two variables: the width of the riparian zone and runoff delivery. The output further provides specific riparian design types based on a cross-classification matrix. These design types include critical zones for sensitive sites, multi-species buffer for water uptake, nutrient and sediment trapping, stiff-stemmed grasses for trapping runoff and sediment, deep-rooted vegetation tolerant of saturated soil, and sections emphasizing streambank stability because of the narrow buffer width. The purpose of this riparian management assessment is to provide the most water quality benefits by identifying segments to install permanent vegetation specifically designed to intercept surface runoff, protect shallow groundwater in low-lying areas and stabilize stream banks. This is especially applicable in this watershed since the riparian zone is steep (Figure 5)

and many bare and exposed banks are the source of streambank erosion and siltation/sedimentation.

2.5.2. ACPF modeling for HC-DF WR HUC-12

The ACPF model was performed for the HC-DF WR HUC-12 using a 2.5 ft LIDAR DEM from Ohio Geographically Referenced Information Program (OGRIP), 5 ft LIDAR DEM from OpenTopography High-Resolution Topography Data and Tools Datasets and a file geodatabase provided by ARS (USDA, 2020). The tool was run using cropland data layers representing the years 2015 through 2020.

The ACPF model identified a number of possible in-field conservations practices, below-field practices and also riparian zone designs in the HC-DF WR watershed (Tab. 16). As estimated by the ACPF model, 14.7% of analyzed agricultural fields (16,629.4 acres of crops and pasture) at HC-DF WR HUC-12 are considered high or very high runoff risk and at least 65.4% of the crop fields are tile-drained. Figures 16 to 19 depict the ACPF model results.

Outputs from the ACPF model were presented and discussed with the stakeholders at the NPS-IS public meeting on May 19, 2022 as well as during follow-up field visits and ground verification at selected locations. The output has been beneficial in engaging discussions with landowners about potential conservation practices. The ACPF maps provide a visual tool for the landowners, making field visits and discussions more effective and efficient.

Table 17 Conservation Practices at HC-DF WR 12 Suggested by the ACPF

The ACPF Maps and estimates are only for planning purposes

Practice	Unit	Length (miles)	Average Length (feet)	Total Area (Acres)	Average Area (Acres)	Storage (Acre-Feet)
In-Field Practices						
Grassed Waterways	333 sites	30.9	490.8	112.6*	0.4*	NA
Contoured Buffer Strips	412 sites	95.2	1120.1	346.2*	0.8*	NA
Tile Drainage Management	67 sites	NA	NA	1630.6	24.3	NA
Depressions (potential wetland restoration sites)	3 depressions	NA	NA	195.3** Surface Area: 21.5	64.9	8993.74
Below-Field Practices						
Nutrient Removal Wetlands	35 wetlands	NA	NA	7933.8*** Pools:75.6 Buffers: 98.6	Pool: 2.2 Buffer: 2.8	Pool: 245.2 Buffer: 594.3
WASCOBs	161 sites	NA	NA	2132.2***	13.2***	No Data
Denitrifying Bioreactors	35 sites	NA	NA	8.9	0.3****	NA
Farm Ponds	163	NA	NA	5480.7**	Pool: 0.93 Buffer:0.4	Pool: 1208.8

				Pools: 152.8 Buffer: 60		Buffer: 594

Table 17 continued next page

Table 17 continued

Practice	Unit	Length (miles)	Average Length (feet)	Total Area (Acres)	Average Area (Acres)	Storage (Acre-Feet)
Riparian Zone Practices						
High Nutrient Sensitive Buffers	NA	0.1	NA	NA	NA	NA
Riparian Buffers Filters (various plants)	NA	43.6	NA	NA	NA	NA
Stream Bank Stabilization	NA	67.9	NA	NA	NA	NA
Saturated Buffer	NA	0.3	NA	NA	NA	NA
Saturated Buffer Requiring Carbon Enhancement	NA	9.6	NA	NA	NA	NA

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

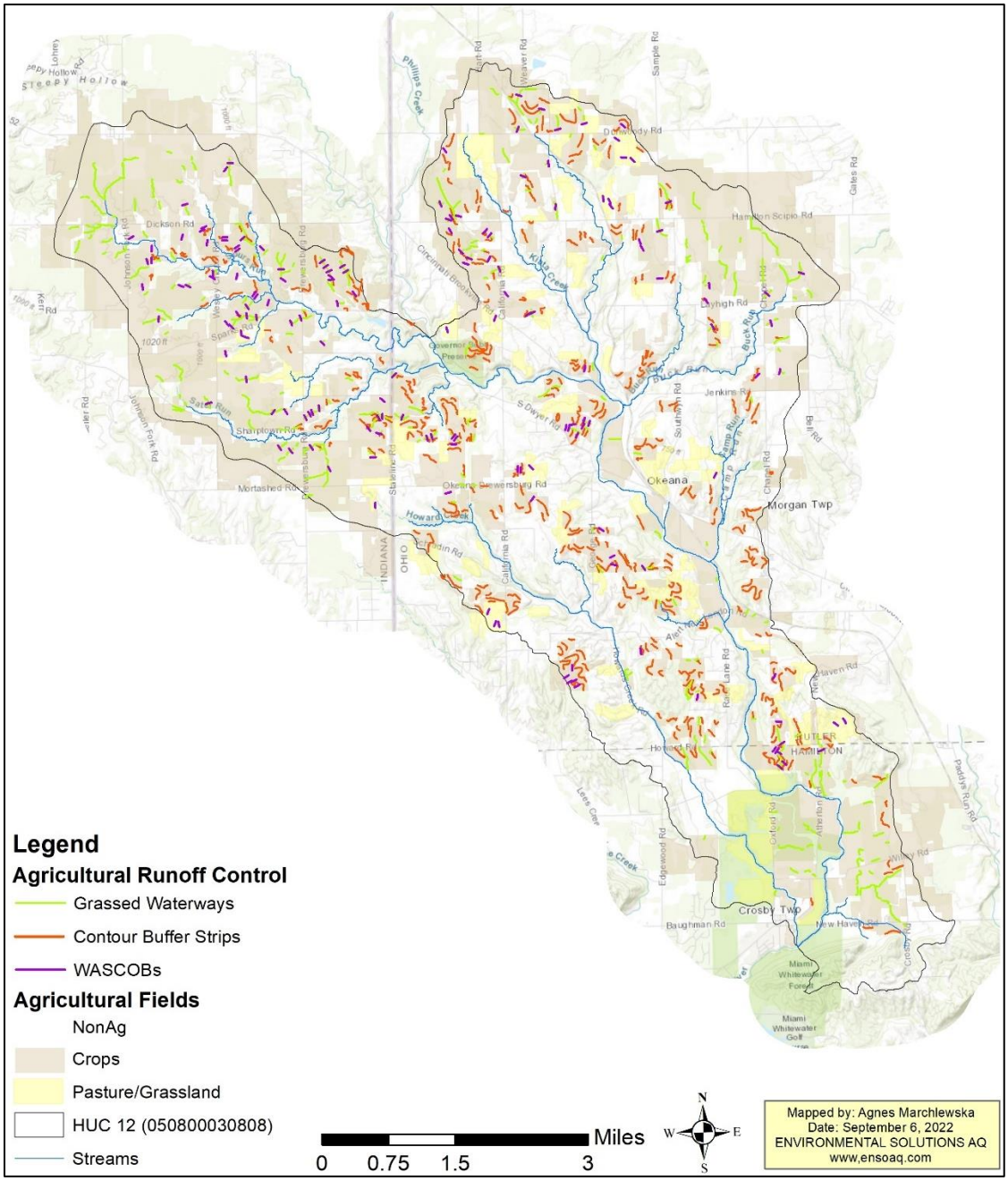

Figure 14 ACPF In-Field Agricultural Conservation Practice Opportunities in HC-DF WR HUC-12: Runoff Control

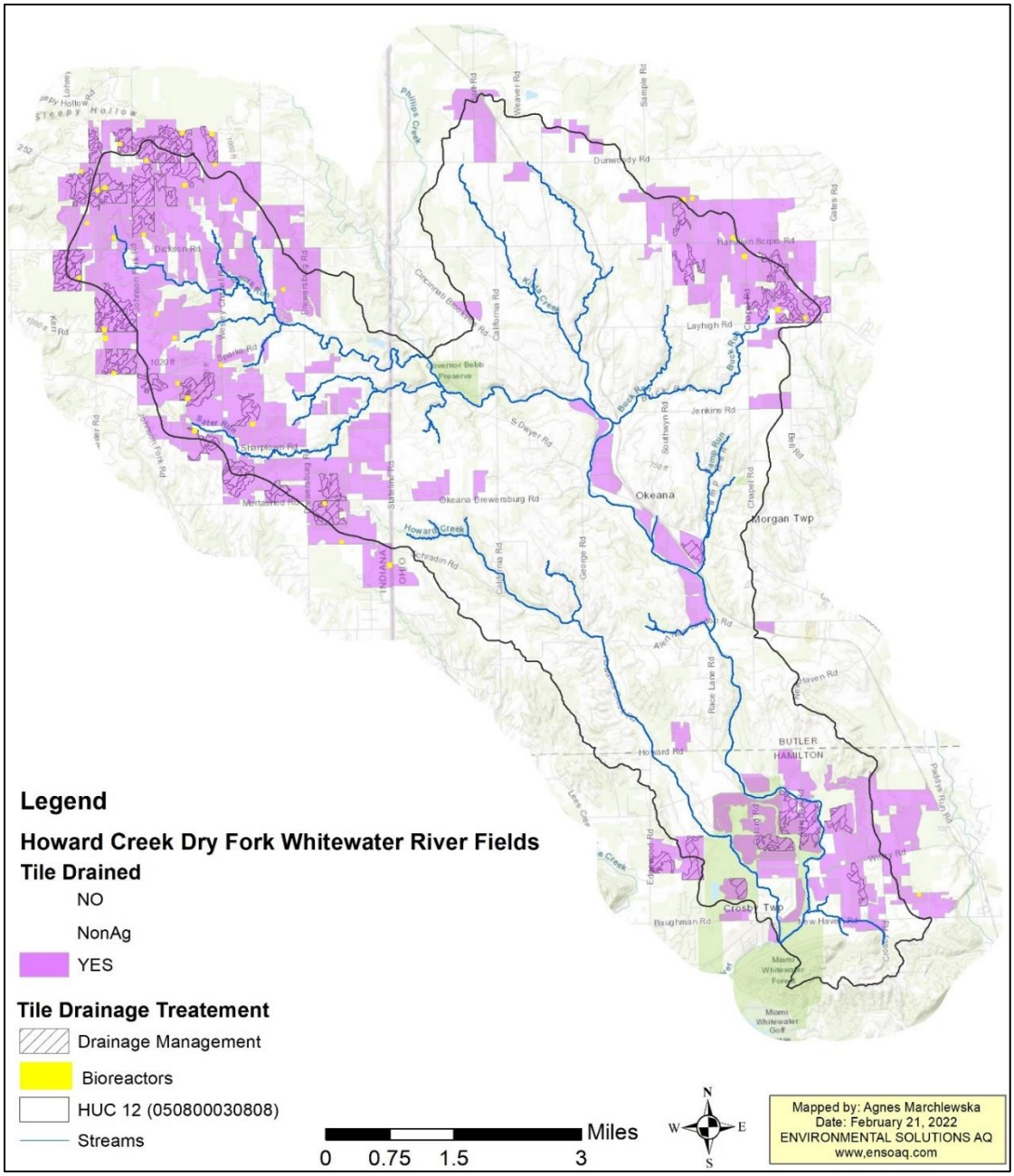

Figure 15 ACPF In-Field Agricultural Conservation Practice Opportunities in HC-DF WR HUC-12: Tile Drainage Treatment

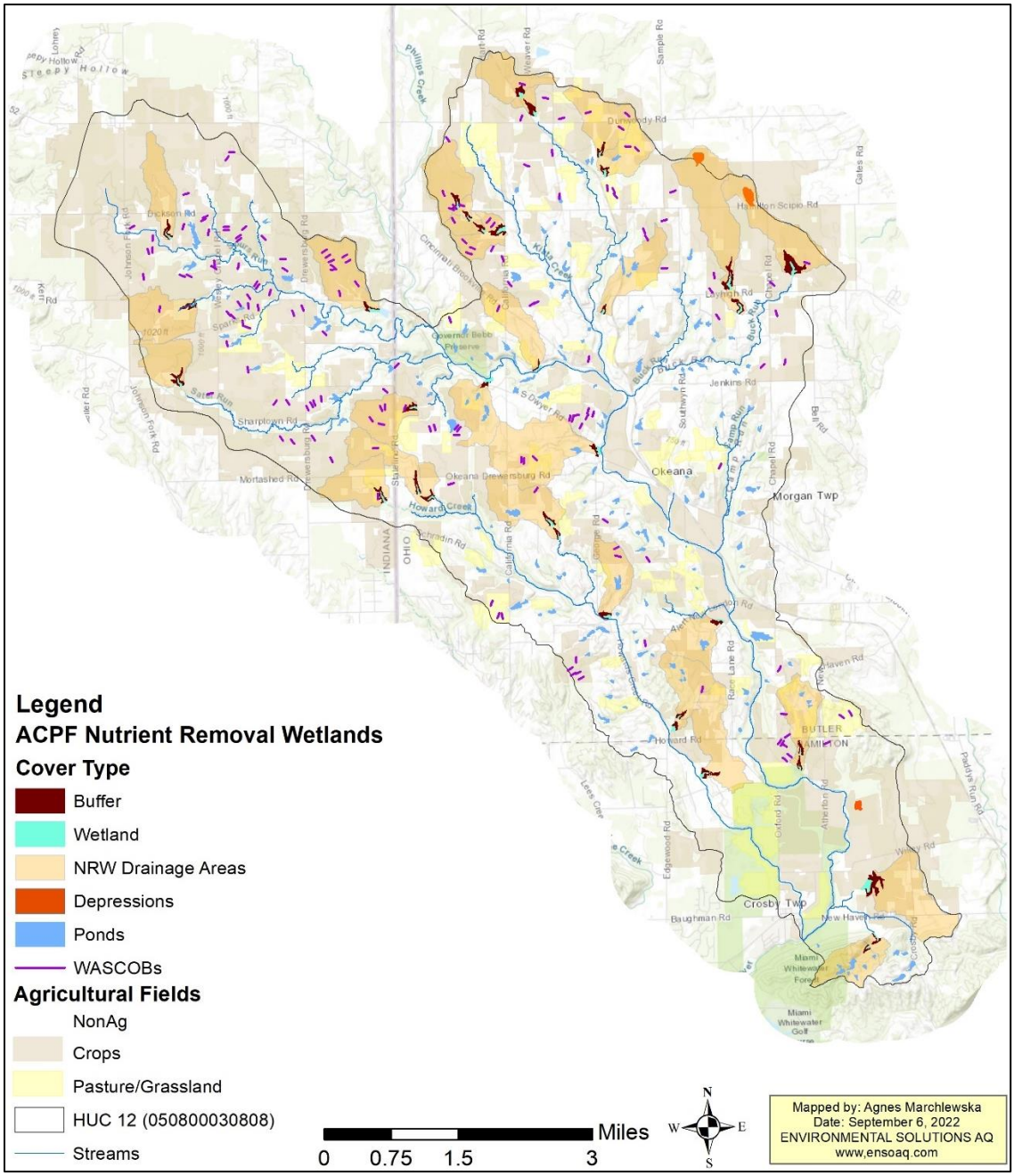

Figure 16 ACPF Below-Field Agricultural Conservation Practice Opportunities in HC-DF WR HUC-12: Water Retention and Storage

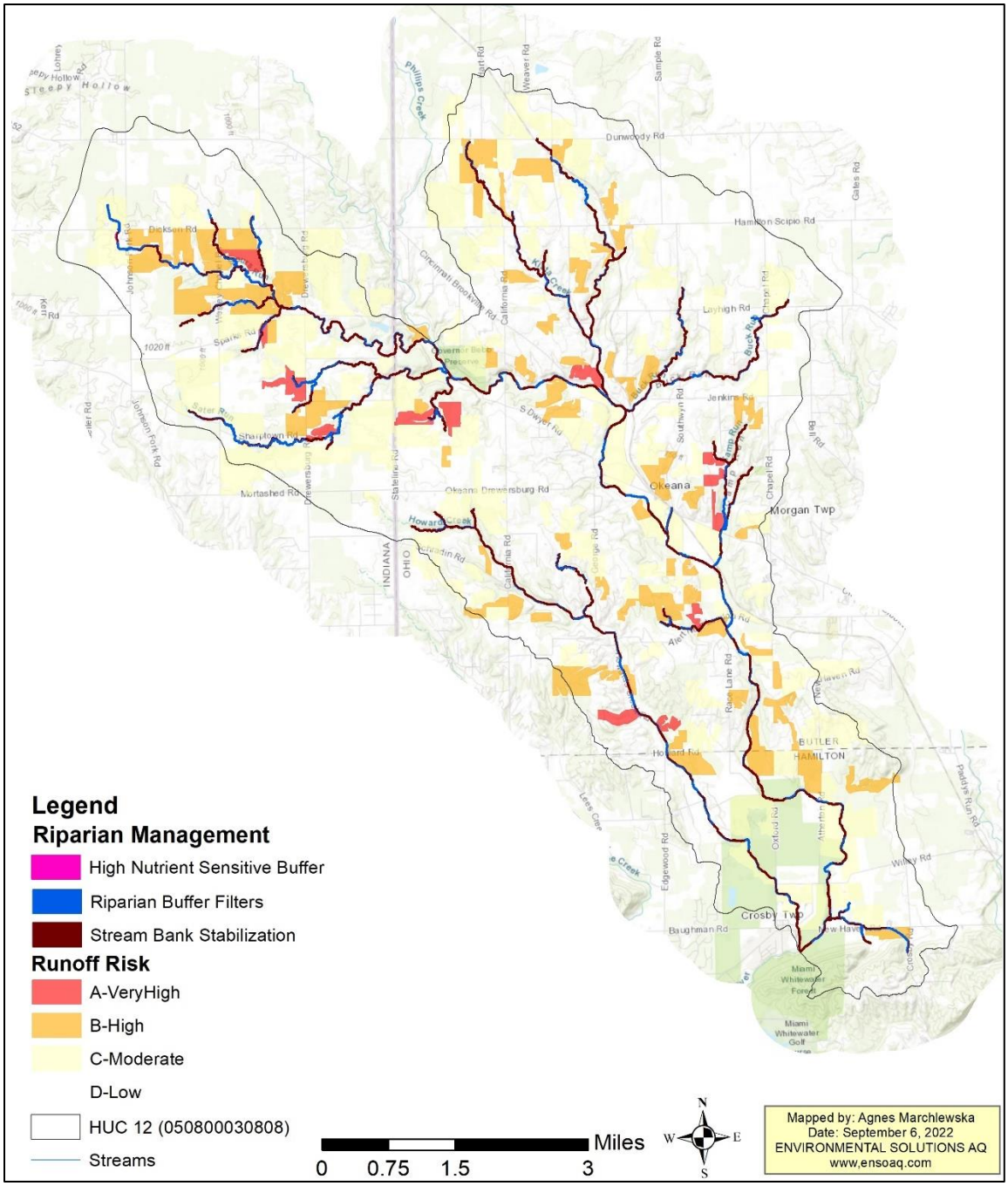

Figure 17 Riparian Function Management Suggested by ACPF IN HC-DF WR HUC-12: RIPARIAN MANAGEMENT

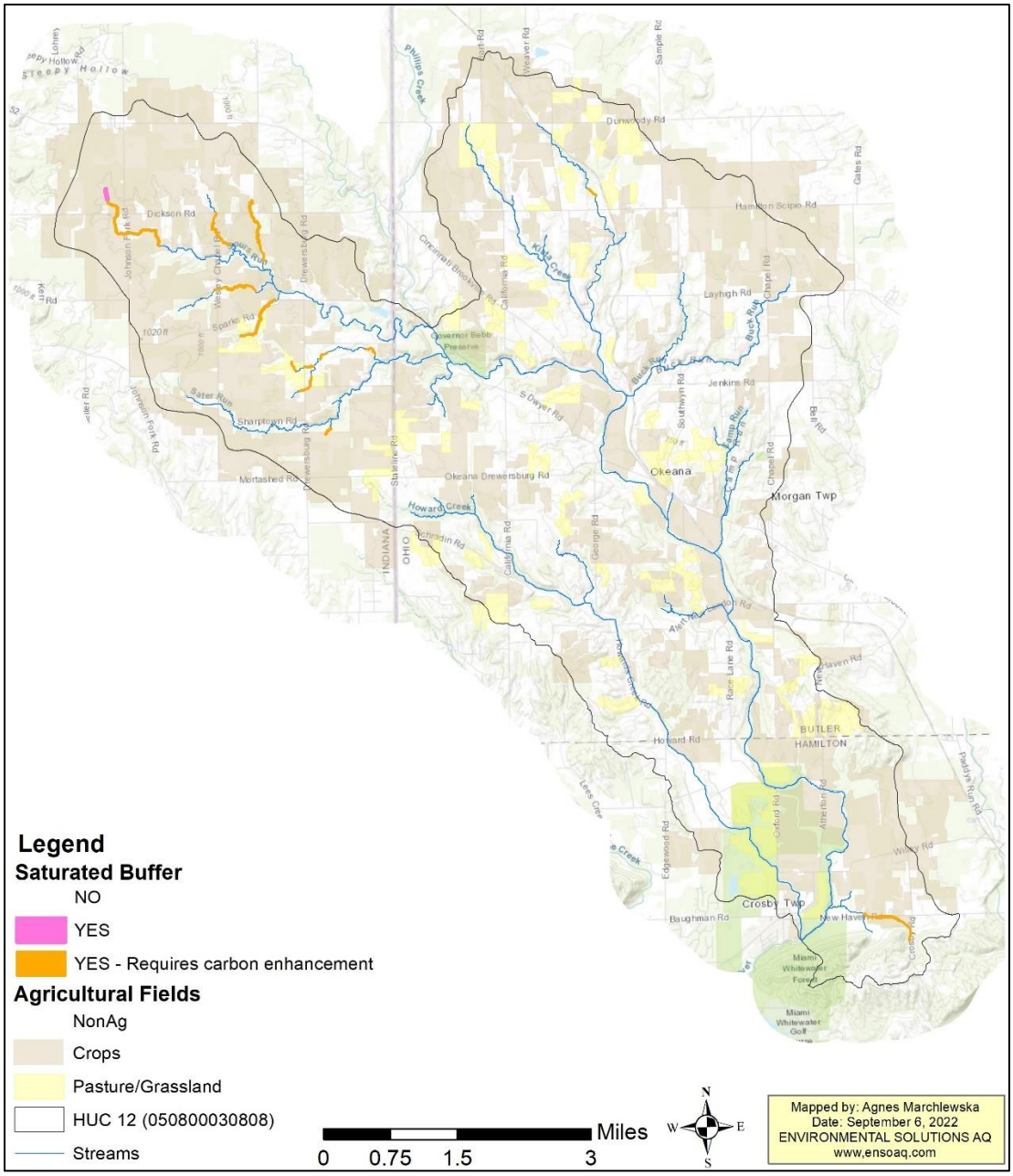

Figure 18 Riparian Function Management Suggested by ACPF IN HC-DF WR HUC-12: DENITRIFYING PRACTICES

2.5.3. Citizen Science

Over the last few years, several locations within the HC-DF WR watershed have been sampled for water quality data by the Butler County Stream Team. The initiative is a part of a citizen science project involving a group of Butler County volunteers led by the Institute for the Environment and Sustainability at Miami University in collaboration with the Butler County Storm Water District and the Butler SWCD. The Stream Team has collected and analyzed water samples for nitrates, total phosphorous, bacteria, conductivity, total dissolved solids, pH, turbidity. However, this data has not been approved for accuracy, and therefore, it is not included in this plan. Once the data is verified, it will be added in the future version of the plan.

Chapter 3: Conditions & Restoration Strategies for Howard Creek – Dry Fork Whitewater River HUC-12 Critical Areas

3.1 Overview of Critical Areas

In the 2016, the Watershed Management Plan developed by Dearborn County (IN) SWCD for Whitewater River watershed, the entire Howard Creek – Dry Fork Whitewater River HUC 12 was identified as one of the high priority critical areas for addressing biological and water quality impairments. The sources of these impairments included excessive nutrients, sediment and *E. coli* caused by agricultural runoff from cropland and pastures, animal access to streams, narrow riparian buffers, streambank erosion, farmland with highly erodible soils, and faulty HSTSs. The recommended actions to mitigate these impairments included implementing a wide range of the agricultural best management practices: grassed waterways, filter strips, cover crops, manure and nutrients management, restricting cattle access to streams, conservation tillage or no till, drainage water management and heavy use area protection.

The TMDL report for the Whitewater River watershed prepared by the IDEM in 2015 and revised in 2020 also recommended proper manure handling, storage, treatment and disposal, developing Nutrient Management Plans and establishing filter strips to reduce *E. coli*, sediment and nutrient loads in the local streams.

Between 2017 and 2019, Dry Fork mainstem and its tributaries located within the Howard Creek – Dry Fork Whitewater River HUC-12, were part of the OEPA Whitewater River Watershed biological and water quality assessment study completed by the Ohio EPA (OEPA, 2020). The biological indicators were evaluated at all 9 sampling locations selected within the HC-DF WR HUC-12 and 7 sampling locations were analyzed for water quality. Every sampling location along Dry Fork mainstem met criteria for the EWH designation and it was in full attainment for the Aquatic Life Use (ALU). All evaluated Dry Fork tributaries supported the WWH or EWH communities and all of them archived a full attainment for the Aquatic Life Use criterium, except the sampling location at Buck Run (RM 0.1). The partial ALU attainment of Buck Run was attributed to the fish community impairment caused by existing dam/impoundment blocking the fish passage at Buck Run and Dry Fork confluence. In addition, multiple sampling locations exceeded water quality values for dissolved oxygen caused likely by low flow conditions during summer and increased algal productivity. Currently, HC-DF WR HUC-12 is listed as impaired waters for recreation due to *E. coli*. Sources for these impairments may include row crop agriculture, manure application/runoff, cattle access to the creeks, streambank and top soil erosion and residential runoff from unsewered communities. Furthermore, increasing development pressure and residential and agricultural encroachments threaten high quality riparian habitats. Implementing and maximizing conservation and land management practices within this watershed are crucial in maintaining the high quality and environmentally sensitive habitats and improving health of the near-field and far-field waterways.

Two critical areas have been identified within the HC-DF WR HUC-12 (Fig. 19). Critical Area 1 will address the far-field (Gulf of Mexico) and near-field (local waterways) effects of nutrient enrichment, siltation and sedimentation from agricultural fields and activities. Critical Area 2 will focus on improving and protecting environmentally sensitive riparian habitats of Dry Fork Whitewater River and its tributaries (Tab. 18). Additional critical areas such as failed HSTS may be identified in subsequent versions of this Nine-Element NPS-IS when more information about HSTS becomes available.

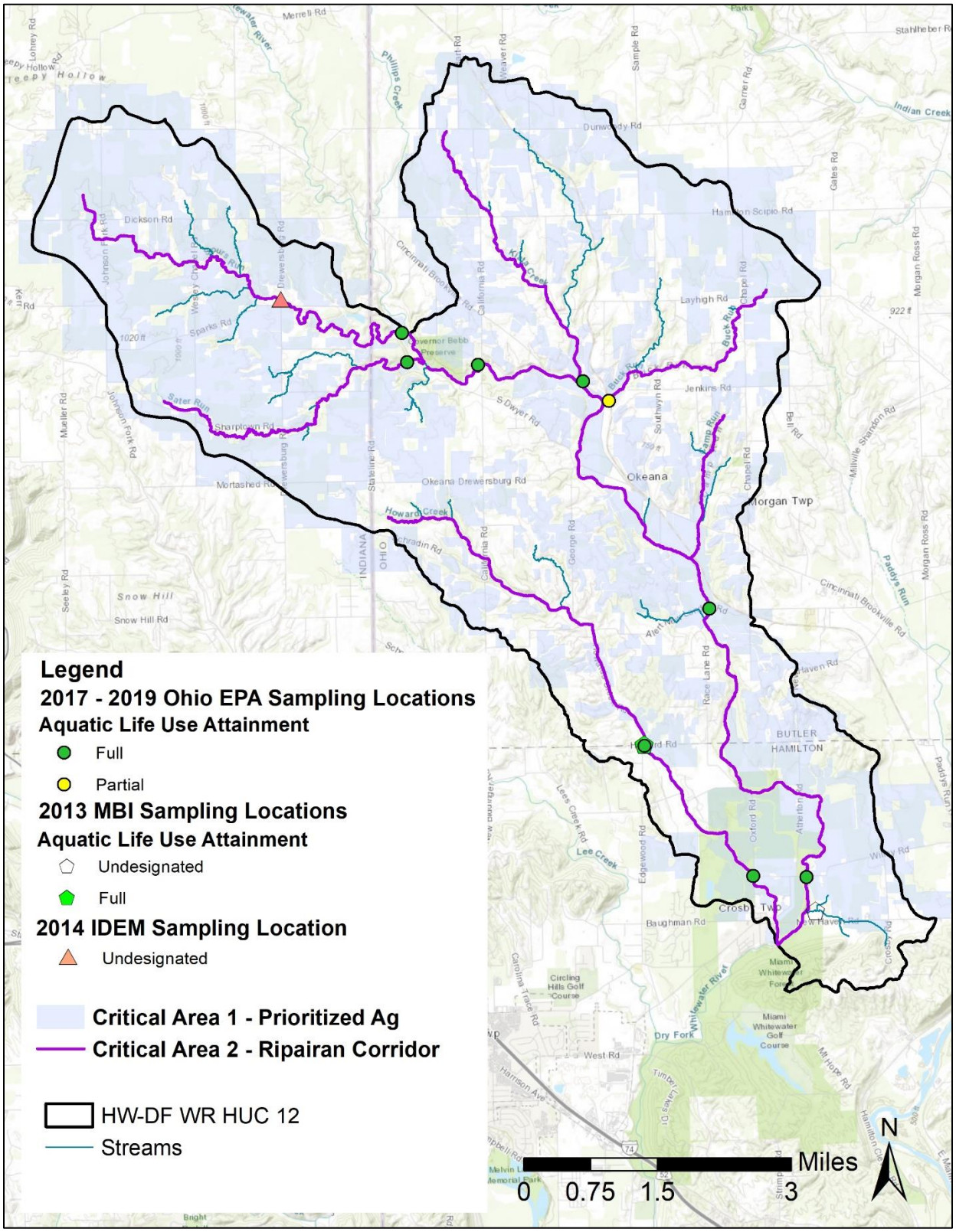

Figure 19 HC-DF WR HUC-12Critical Areas Overview

Table 18 Critical Areas of HC-DF WR HUC-12

Critical Area	Critical Area Description	Addressed Impairments	Area (Acres)
1	Agricultural fields as determined by ACPF	Nutrient Management in Prioritized Agricultural Lands *(Near-Field and Far-Field Impairment – Gulf of Mexico hypoxia – N and P Reduction))*	16,630
2	Riparian Corridor (100 ft buffer at each stream side)	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*)	1,031

3.2. Critical Area 1: Conditions, Goals, & Objectives for Nutrient Reduction and Management in Howard Creek-Dry Fork Whitewater River HUC-12 Agricultural Fields

3.2.1. Detailed Characterization

Given the dominance of agricultural land use throughout the Whitewater River watershed, including the HC-DF WR HUC-12, use of BMPs targeting nutrient loss from local farm fields and agricultural activities is recommended. In addition, employment of BMPs may help to reduce siltation and sedimentation in local streams. Although BMPs are encouraged on all agricultural lands, certain lands are more susceptible to nutrient loss and erosion than others are; and therefore, they need to be prioritized for BMP implementation.

Critical Area # 1 is comprised of all agricultural lands throughout the HC-DF WR HUC-12 and prioritized based on the criteria set by the local stakeholders (Fig. 20). The ACPF model was used to identify 85 high runoff fields covering 2,441.1 acres of the agricultural land (14.7 %) within the HC-DF WR watershed.

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

- Lands identified as high runoff fields;
- Lands directly adjacent to Dry Fork or its tributaries;
- Lands experiencing gully erosion;
- Lands currently under conventional tillage regimes and/or underutilizing cover crops;
- Lands without current nutrient management plan or current soil test results (< 3 years).

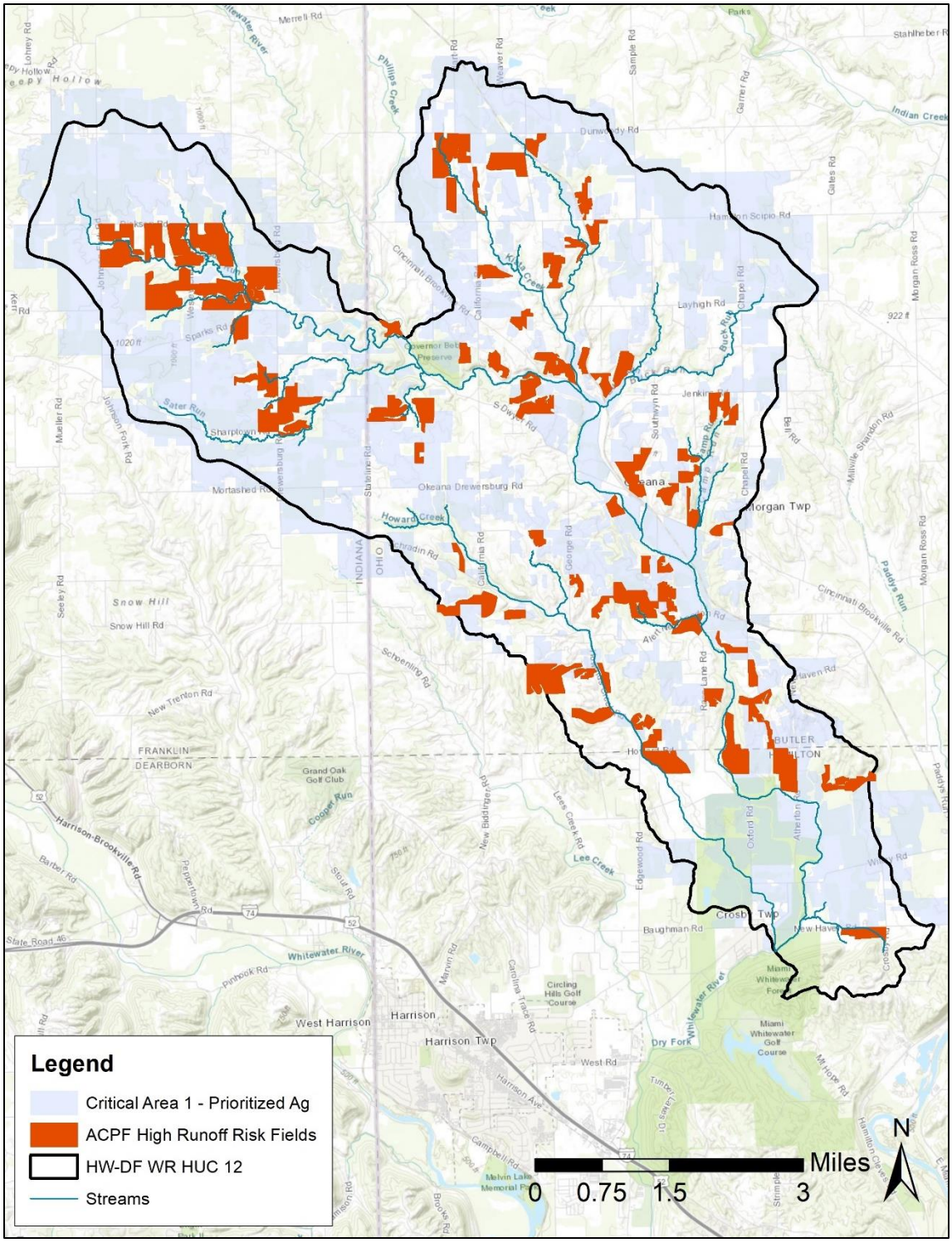

Figure 20 HC-DF WR HUC-12 Critical Area #1

3.2.2. Detailed Biological Conditions

The most recent fish community assessment in Whitewater River watershed was conducted by the OEPA between 2017 and 2019 (OEPA, 2020). Nine sampling locations were evaluated within the HC-DF WR HUC-12 (Tab. 19). All sampling locations evaluated in this HUC-12 along Dry Fork mainstem and its tributaries supported fish communities consistent with either EWH or WWH. The biological indicators for three sampling locations along Dry Fork mainstem were exceptional with the IBI score of 54 at the upstream site, and 56 at the downstream site. The fish communities evaluated in the Dry Fork tributaries at six selected locations ranged from fair to exceptional with the lowest IBI score of 32 at Buck Run (RM 0.1), and the highest IBI score of 58 at Sours Run (RM 0.1). The fish assemblage impairment identified at Buck Run was caused by the existing fish barrier passage at the confluence of Buck Run and Dry Fork Whitewater River.

In addition, one sampling location at Sours Run (RM 8.94) on the Indiana side of the HC-DF WR watershed was evaluated in 2014 by IDEM (No detailed data are available; therefore, this site is not included in Tab. 19). The fish community at this site was evaluated as fair with the IBI score of 38. The IDEM listed low flow conditions during summer months, negative impact of nutrients from agriculture and increased erosion as potential reasons for the fish community impairment (TMDL, 2015).

In 2017 – 2019, the OEPA also evaluated the physical stream features and riparian conditions within the HC-DF WR watershed (Tab. 19). The QHEI values of Dry Fork mainstream ranged between 72.75 and 82.8 and for its tributaries from 64.75 to 78.5. Six sampling locations within the HC-DF WR HUC-12 had QHEI scores above 60, which generally indicated a level of macrohabitat quality sufficient to support aquatic communities consistent with WWH and two locations had QHEI scores above 75 indicating the macrohabitats able to support the EWH Aquatic Life Use designation. The sampling locations at Sours Run (RM 8.94) and at unnamed tributary to Dry Fork Whitewater River (RM 0.1) evaluated between 2013 and 2014 by the MBI and IDEM showed QHEI scores of 36.5 and 58, respectively. The low habitat scores were caused by the narrow or non-existent stream cover, high streambank erosion and heavily silted substrate.

Table 14 Fish Community and Habitat Data

RM	QHEI	Drainage Area (mi^2)	Cumulative Species	Predominant species (% of catch)*	Mean MIwb	IBI	Narratives
Howard Creek							
2.9	{64.75}	5.8	{22}		-	{56}	Exceptional
0.9	{71.5}	7.5	22/{24}		-	{56}	Exceptional
Sours Run							
0.10	78.5	6.5	22		-	58	Exceptional
Kiata Creek							
0.10	69.25	6.0	15		-	52	Exceptional
Buck Run							
0.10	68.5	4.1	5		-	32*	Fair
Sater Run							
0.10	[71]	3.3	[12]		-	[48]	[Very good]
Dry Fork Whitewater River							
18.14	82.8	27.6	22	central stone stoneroller (23.8%), rainbow darter (8.2%), bluntnose minnow (8.0%), longear sunfish (7.4%), striped shiner (6.7%), sand shiner (5.9%), fantail darter (5.7%), northern hog sucker (5.0%), silverjaw minnow (3.4%) and greenside darter (2.8%)	9.6	54	Exceptional
13.3	72.75	46	29		10.13	52	Exceptional
9.02	74.5	50	30		10.33	56	Exceptional

OEPA, 2020
No brackets – samples collected in 2017
[Brackets for samples collected in 2018]
{Braces for samples collected in 2019}
**Only aggregate sampling results from the Dry Fork mainstream were reported (OEPA, 2020)*
QHEI Qualitative Habitat Evaluation Index
MIwb Modified Index of Well Being
IBI Index of Biotic Integrity

The most recent evaluation of macroinvertebrate community performance within the HC-DF WR watershed was conducted by Ohio EPA in 2017- 2019 (Tab. 20). Of 9 sampling sites selected for macroinvertebrate evaluation, 3 were located along Dry Fork mainstem and 6 were distributed in Dry Fork tributaries. The condition of macroinvertebrates in Dry Fork mainstem ranged from very good to exceptional.

Despite low flow conditions in the summer months, the macroinvertebrate communities evaluated in the Dry Fork tributaries also ranged from very good to exceptional supporting WWH or EWH criteria.

Table 20 Macroinvertebrate Community

Stream RM	**Dr. Area (Sq. mi.)**	**Density Ql. Qt.**	**Predominant Organisms on the Natural Substrates With Tolerance Category(ies) in Parentheses**	**ICI[a]**	**Narrative Evaluation**
Howard Creek					
2.90	{5.8}	{M}	Caddisflies (F,MI), Mayflies (F,MI,),	-	{Exceptional}
0.9	{7.5}	{M}	Caddisflies (F,MI), Heptageniid mayflies (F,MI)	-	{Very Good}
Sours Run					
0.10	6.5	L	Midges (F), Baetid mayflies (F), Caddisflies (MI,F),Blackflies	-	Very good
Kiata Creek					
0.10	6.0	L	Water pennies (F), Caddisflies (MI,F), Water mites (F)	-	Very good
Buck Run					
0.10	4.1	M	Midges (F), Mayflies (MI, F), Caddisflies (MI,F)	-	Very good
Sater Run					
0.10	[3.3]	[L]	Mayflies (MI,F), Caddisflies (MI,F), Riffle beetles (F)		[Very good]
Dry Fork					
18.14	27.6	M	Midges (F), Caddisflies (MI,F)	-	Very good
13.3[a]	46	M	Midges (F), Baetid mayflies (F), Caddisflies (MI,F)	-	Exceptional
9.02[a]	50	M	Midges (F), Baetid mayflies (F), Caddisflies (MI,F)	-	Exceptional

Source: OEPA, 2020
RM - River Mile
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
a ICI values invalidated due either to insufficient current speed over the artificial substrates or by suspected disturbance. The station evaluation at these sites is based on the qualitative sample narrative evaluation.

The water quality data evaluated within HC-DF WR watershed were generally good and met the water quality standards, except for dissolved oxygen at four sampling locations; two at Dry Fork mainstem (RM 18.1 and 9.02), one at Kiata Creek (RM 0.1) and one at Buck Run (RM 0.1). These exceedances were attributed to low flow conditions and increased productivity by the filamentous algae. One sampling location at Dry Fork, RM 9.02 evaluated for organic parameters showed elevated concentrations of two herbicides; Atrazine and Metolachlor, chemicals commonly used in agriculture and on residential lawns. The nutrient concentrations evaluated in 2017 by the OEPA were below recommended thresholds for total phosphorous and dissolved inorganic nitrogen (DIN) and the OEPA classified the HC-DF WR HUC-12 in the low-risk category for nutrients enrichment and eutrophication potential. The sampling location at Sours Run (RM 8.94) evaluated by the IDEM in 2014 showed total phosphorous above target value of 0.30 mg/L and the nutrients exceeded the geometric mean of 2.06 mg/L on 4 out of 7 occurrences. High agricultural runoff and very narrow riparian buffer at the sampling site was listed as potential reasons for this impairment. The entire HC-DF WR watershed was also impaired with *E. coli* caused by agricultural productions and failing HSTSs.

3.2.3. Detailed Causes and Associated Sources

The 2017- 2019 Ohio EPA survey demonstrated that the Dry Fork mainstem and most of its tributaries were in full attainment for the ALU. One partial attainment status was assigned to the sampling location at RM 0.1 on Buck Run due to underperforming fish communities caused by the existing fish passage barrier. Protecting and maintaining health of the streams within this watershed is critical for sustaining and improving its aquatic biodiversity, therefore, nutrient management is necessary.

Agricultural land use and activities in the Whitewater River watershed along with discharges from wastewater treatment facilities and failing septic systems have been found a leading cause of nutrient enrichment in local streams and rivers. Also, these excessive nutrient loads ultimately contribute to Gulf of Mexico hypoxia. Practical and property-specific BMPs can help reduce the amount and concentration of nutrient-laden surface runoff. These BMPs can also address the loss of sediment/topsoil from agricultural lands and retain and maximize the nutrients in the fields. In addition, the implementation of BMPs on agricultural lands can address the causes of sediment/topsoil and nutrient loss in the fields and reduce the sources of these excess nutrients and sediments into the waterways.

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 Whitewater River, 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 HC-DF WR HUC-12 is set at levels 20% of the current

estimated agricultural loadings. To achieve the nutrient loading goals at the HC-DF WR HUC-12, the following goal and objectives have been established:

Goal 1 – Reduce nitrogen loading contributions in Critical Area 1 by 20%. Current total nitrogen load for the agricultural lands is estimated to be 298,758 lb and the reduction goal is 59,752 lb.

NOT ACHIEVED: Based on the Spreadsheet Tool for Estimating Pollutant Loads (STEPL) calculation using the combined current and recent past conservation practices, the load reduction is currently 32,493 lb/yr. We will need an additional 27,259 lb/yr to meet the reduction goal. Future target load reductions may also include phosphate when appropriate baselines are provided by OEPA.

Goal 2 – Reduce phosphorus loading contributions in Critical Area 1 by 20%. Current total phosphorus load is estimated to be 11,392 lb/yr and the reduction goal is 3,698 lb.

ACHIEVED: Based on the STEPL calculation, the load reduction has exceeded the target goal. The significant reduction is largely due to practice of conservation tillage that is very common in this watershed. This practice is used on approximately 80% of the cultivated fields and it will continue to be promoted together with cover crops and other best management practices by the local SWCDs, TVCT and other conservation organizations.

OBJECTIVES

In order to reach the load reduction goal of 20% within the HC-DF WR HUC-12, the 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. 17).

Objective 1: Implement 1,000 acres of conservation tillage to add to the current 8,551 acres and plant 3,000 acres of cover crops in addition to the 300 acres that have already been planted.

Objective 2: Implement nutrient management planning (plan development, soil testing and variable rate fertilization) on at least 2,000 acres.

Objective 3: 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 results.

Objective 4: Reduce nutrient loss from subsurface tile drainage or below-field practices through the installation of drainage water management structures such as WASCOBs and nutrient removal wetlands at locations suggested by the ACPF model results on at least 90 acres.

Objective 5: Protect at least 1,000 acres of farmland; including flooded cropland, farmed wetland, riparian areas, and pastures with permanent conservation easements, in addition to 3,092 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 15 Estimated Nutrient Loading Reductions from Each Objective

Objective Number	Best Management Practice	Acreage Treated Each Year	Estimated Nitrogen (N)/Phosphorus (P) Load Reduction (lbs/yr)*

1	Conservation Tillage	1000	3,674 lb/yr (N)/ 1309 lb/yr (P)
1	Cover Crops	3,000	10,171 lb/yr(N)/851 lb/yr (P)
3	Nutrient Management (Soil Sampling and variable rate)	2,000	7708 lb/yr (N)/ 2,497 lb/yr (P)
3	In-field BMPs: Grassed Waterway and Filter Strips	100	707 lb/yr (N)/ 166 lb/yr (P)
4	Below-field BMPs: Nutrient removal wetlands and WASCOBs	90**	6058 lb/yr(N)/ 781 lb/yr (P)
5	Conservation Easements and CRP	1,000/50***	862 lb/yr(N)/151lb/yr (P)
TOTAL			29,181 lb/yr (N)/ 5,754 lb/yr (P)

**Estimates calculated using Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Version 4.4 (USEPA, 2019)*
*** **Estimated using the Controlled Drainage function in STEPL with assumed 1000 acres of catchment area*
****50 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 HC-DF WR 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 sensitive areas including prairies, forested stream buffers and wetlands filtering agricultural runoff. The TVCT will continue to promote conservation easements to help farmers permanently protect their land and improve overall health of HC-DF WR watershed.

The future project-specific monitoring efforts will be conducted by Ohio EPA or another 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 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 Howard Creek-Dry Fork Whitewater River and Tributaries' Riparian Zones.

3.3.1. Detailed Characterization

Critical Area # 2 contains approximately 1,031 acres of riparian corridors, including 37 acres of freshwater forested/shrub wetlands, and 42.5 miles of Dry Fork Whitewater River and its main tributaries (Fig. 21). In 2017- 2019, 9 sampling locations selected at Dry Fork mainstem and its tributaries were evaluated for biological indices and water quality (previously presented). All sampling sites along Dry Fork mainstem and most of its tributaries were in full attainment for the ALU designation. The sampling location at Buck Run (RM 0.1) achieved a partial attained due fish community impairment caused by fish barrier passage. The most recent water quality data evaluated by the OEPA showed nutrient levels below water quality standards and QHEI scores supporting WWH and EWH communities. The high quality of riparian habitats including wetlands and riparian buffers within the HC-DF WR watershed are critical in mitigating the negative impacts of excessive nutrients and sediments from the surrounding physical landscape. These habitats also support a wide range of wildlife, including some threatened or endangered species identified in the watershed. Therefore, it is critical to protect these areas from further habitat degradation caused by invasive species, agriculture activities and increasing residential development.

In addition, the landowners participating in the stakeholder public meetings voiced their concerns for riparian areas severely impacted by erosion. Many segments of the streams have been altered and native vegetation has been removed to expend agricultural production and accommodate the local infrastructure, resulting in increasing streambank erosion and sedimentation. Streambank stabilization and replanting the riparian buffers may help to alleviate some of these negative effects.

In this critical area, the ACPF model identified 58 miles of eroding stream banks and 31 miles of banks suitable for enhancing or restoring riparian buffers along Dry Fork mainstem and its tributaries. Stakeholders recognize a need for restorative actions in strategic places; therefore, the following criteria have been set to prioritize areas and restoration projects:

- Riparian area of Dry Fork and its main tributaries near the high runoff fields
- Riparian area with severe encroachment by agricultural or residential activities
- Riparian area with extremely severe erosion threatening land and properties
- Riparian areas with narrow or nonexistent buffers
- Riparian areas suitable from wetland enhancement or/and restoration

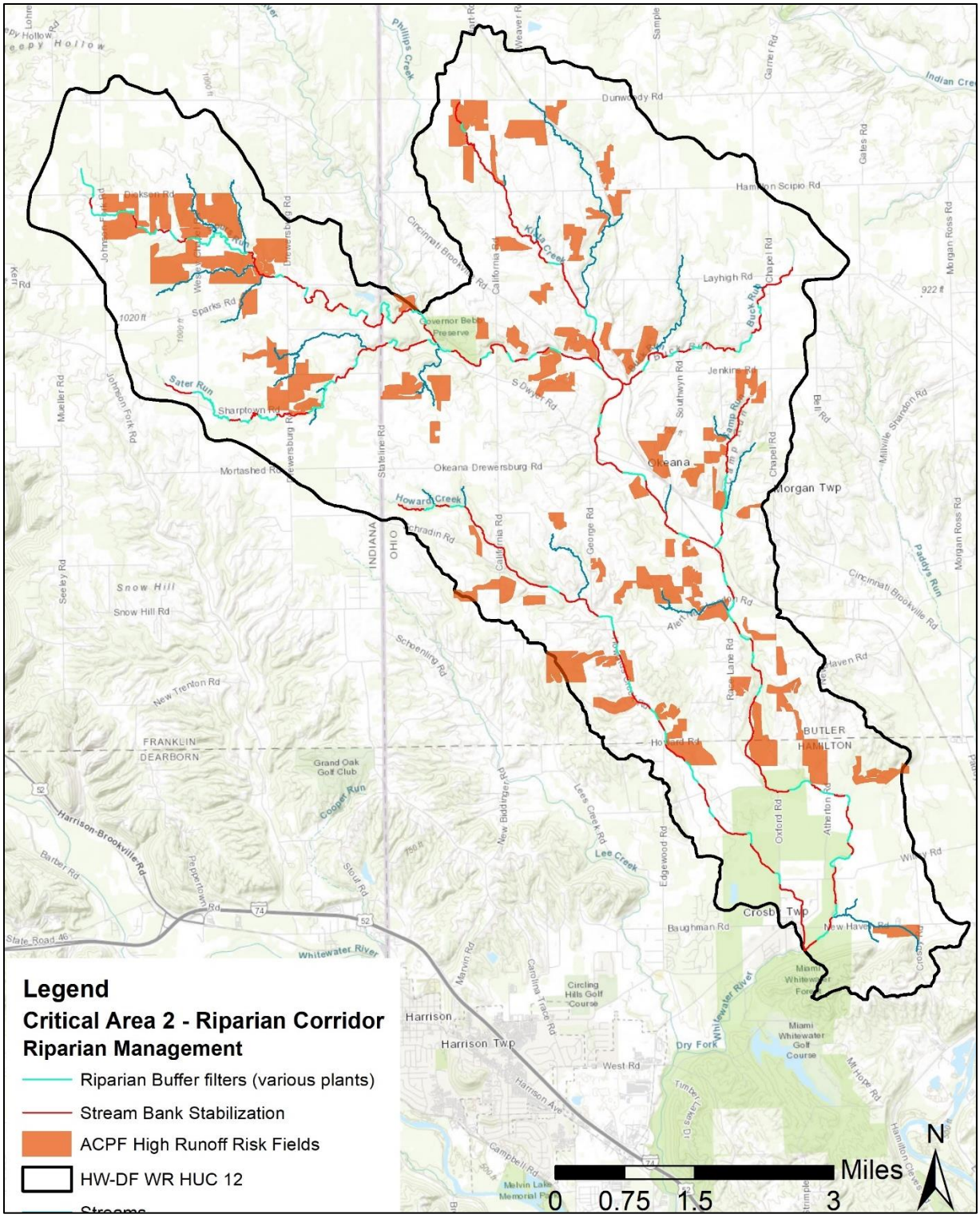

Figure 21 Howard Creek – Dry Fork Whitewater River HUC-12 Critical Area #2

3.3.2 Detailed Biological Conditions

As previously presented in Tab.19 and 20, the biological assessment of 9 sampling sites conducted in 2017- 2019 by the Ohio EPA supported the HC-DF WR HUC-12 either the EWH or WWH status designation. Fish community indices in this watershed ranged from exceptional at the Dry Fork mainstem (IBI = 54/MIwb = 9.6 to IBI= 56/10.33) to fair/exceptional at its tributaries (IBI = 32 to IBI = 58). The fish community impairment caused by the existing fish passage barrier was identified at Buck Run (RM 0.1). Also, the fish community evaluated in 2014 by IDEM at Sours Run (RM 8.94) indicated possible impairment due to the negative impact of agricultural runoff, excessive nutrients, low flows and narrow riparian buffer.

Macroinvertebrate community performance in the Dry Fork mainstem and its tributaries evaluated between 2017 and 2019 was very good to exceptional. The QHEI scores at these sampling sites ranged from 64.75 to 82.8 and supported WWH and EWH communities. Two sampling locations along Dry Fork tributaries evaluated between 2013 and 2014 showed much lower QHEI scores of 36.5 and 58. The habitat impairments were attributed to the narrow or non-existent stream cover, high bank erosion and heavily silted substrate.

3.3.3 Detailed Causes and Associated Sources

The 2017-2019 Ohio EPA survey demonstrated that the Dry Fork mainstream and most of its tributaries were in full attainment for the ALU designation. One partial attainment was assigned for Buck Run at RM 0.1. The ALU impairment status at this location was caused by existing fish passage barrier at the confluence of Buck Run and Dry Fork Whitewater River. The QHEI scores evaluated at these sampling locations ranged from 64.75 to 82.5 indicating high quality habitats at the sampling sites, able to support aquatic organisms consistent with the WWH and EWH Aquatic Life Use designation. However, many sections of Dry Fork Whitewater River and its tributaries have no stream cover or have a very limited stream cover, and are affected by severe erosion due to agricultural and residential encroachments and negative impact of local infrastructure.

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

3.3.4 Outline Goals and Objectives for the Critical Area

The goal of the NPS-IS is to improve water quality, meet nutrient reduction goals and improve impairment status. In Critical Area 2, the samples collected between 2017 - 2019 by the OEPA showed the Dry Fork mainstem and most its tributaries in full attainment and supported the WWH or EWH designations for the ALU. Only one sampling location at Buck Run (RM 0.1) evaluated by this study had the fair fish assemblage and was assigned the partial attainment. The fish community sampled in 2014 by IDEM at Sours Run also was evaluated as fair.

Narrow stream buffers and severe stream erosion and siltation/sedimentation, which are common in the HC-DF WR watershed, might cause water quality degradation and contribute to Gulf of Mexico hypoxia. Protection and management of riparian corridors, including wetlands,

can help reduce nutrients and sediments – and improve water quality and aquatic life in both near-field and far-field waterways.

Currently BMPs are underutilized in most of the HC-DF WR HUC-12. To maintain and improve the habitat, wetlands and riparian areas need to be protected, enhanced or restored. The stream segments severely affected by streambank erosion need to be stabilized and buffers need to be planted with specific and effective plant species. Wetland enhancement or restoration, and riparian buffer planting will provide great benefits to maintain and improve stream health and aquatic life attainment.

Goal 1 – To maintain or achieve an IBI score at or above 40 at all 2013 - 2019 sampling locations within this watershed;

Not Achieved – The IBI at Buck Run RM 0.1 has a score of 32 and the IBI at the Sours Run RM 8.94 has a score of 38.

Goal 2 – To maintain or achieve a MIwb score at or above 9.6 at all 2013 - 2019 at sampling locations along the streams with drainage area > 20 mi^2

Achieved - The MIwb scores at sampling locations within the HC-DF WR HUC 12 ranged from MIwb = 9.6 to the MIwb = 10.33 and all supported the existing or recommended WWH and the EWH expectations for the Aquatic Life Use criterium.

Goal 3 – To maintain or achieve an ICI score at or above 36 (ECBP)/ 30 (IP) for the 2013-2019 sampling currently meeting the WWH criterium and the ICI score of 46 for sampling locations currently meeting the EWH criterium.

Achieved – The ICI values at the sampling locations within the HC-DF WR HUC 12 were invalidated due either to insufficient current speed over the artificial substrates or by suspected disturbance. The station evaluation at these sites is based on the qualitative sample narrative evaluation and it ranged from very good to exceptional, supporting existing or recommended WWH and the EWH expectations for the Aquatic Life Use criterium.

Goal 4 – To maintain or achieve a QHEI score at or above 60 at all 2013 – 2019 sampling locations

Not Achieved: The QHEI scores were 59 at Sours Run(RM 8.94) and 36.5 at the unnamed tributary to Dry Fork Whitewater River (RM 0.1)

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 3 miles of the severe streambank erosion at Dry Fork Whitewater River and its main tributaries. [1]

Objective 2: Create, enhance and/or restore floodplain/riparian wetlands for habitat restoration and/or sediment attenuation on at least 30 acres.

Objective 3: Create, enhance and/or restore floodplain/riparian buffer along impacted or barren stretches of Dry Fork Whitewater River and its main tributaries within *Critical Area #2* (at least 50 feet each side) by establishing and enhancing at least 18 acres of riparian habitats. [1]

Objective 4: Protect with conservation easements or via land acquisitions at least 2 miles of Dry Fork Whitewater River and its main tributaries in addition to 5.7 miles already protected by TVCT. Retire at least 20 acres of riparian corridor from farming.

Table 16 Nutrient Reductions from Each Objective

Objective Number	Best Management Practice	Total Length/Acreage Treated	Estimated Load Reduction using STEPL*
1	Streambank stabilization/restoration	3 miles/ 18 Acres (avg 50 feet wide)	258 lb/yr (N)/48 lb/yr (P) and sediment of 14 tons/yr
2	Floodplain/Wetland enhancement/restoration	30 acres**	1819 lb/yr (N)/ 234 lb/yr (P)
3	Riparian Buffer as designed using ACPF modeling based on the width of the riparian zone and runoff delivery (see Section 2.5.1).	3 miles/18 Acres (avg 50 feet wide)	171 lb/yr (N)/ 32 lb/yr (P) and sediment of 11 tons/yr
4	Protecting riparian areas and wetland with conservation easements and retire 20 acres.	20 Acres*** (riparian corridor width: 100 feet at each side of the stream)	349 lb/yr (N)/61 lb/yr (P) and sediment of 20 tons/yr

**Estimated using Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Version 4.4 (USEPA, 2019) N-Nitrogen; P-Phosphate and sediment*
***Estimated using the Controlled Drainage function in STEPL with assumed 300 acres of catchment area*
****20 acres of land retirement is used for this estimate*

The future project-specific monitoring efforts will be conducted by Ohio EPA 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

[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.*

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

Chapter 4: Projects and Implementation Strategy

The Great Miami River Basin which also includes the Whitewater River watershed is one of the major nutrient contributors to Ohio River and Gulf hypoxia (OEPA, 2020). It is important and beneficial for the NPS-IS initiatives to be implemented in this region as soon as possible. HC-DF WR HUC-12 is an agricultural watershed and implementation of proposed conservation practices is targeted to reduce nutrient load reduction by 20%.

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

4.1 Overview Tables and Project Sheets for Critical Areas

Project and Implementation Strategy Overview tables and associated project summary sheets for each of the critical areas (Agricultural fields and riparian corridor of Dry Fork Whitewater River) are presented in this Chapter. The presented opportunities provide a general concept and will be further evaluated as landowners provide additional feedback on the projects and each project is adequately funded. The estimated project costs and the time frame are both dependent upon funding opportunities and coordination with landowners and project partners.

In addition to the detail provided in previous chapters, the project summary sheets outline how the nine minimum elements of watershed planning are being met by each opportunity, as shown in the first column of each table. Moreover, this NPS-IS will be updated periodically to address stakeholder input and additional project opportunities may be added. If a future critical area is identified (e.g. Critical Area for addressing faulty HSTSs) within the HC-DF WR HUC-12, supplemental information will be provided as funding allows.

The Project Overview Tables present a summary of each strategy identified for each critical area. BMP strategies are divided into several categories, including urban storm water runoff

management, altered stream and habitat restoration strategies, and other nonpoint source causes and associated sources of impairment.

Table 17 Projects and Implementation Strategy Overview - Critical Area 1

For HC-DF WR HUC-12 (050800030808) Critical Area 1							
Goal	**Objective**	**Project**	**Project Title (EPA Criteria g)**	**Lead Organization (EPA Criteria f)**	**Time Frame (EPA Criteria f)**	**Estimated Cost (EPA Criteria d)**	**Funding/Actual Sources (EPA Criteria d)**
Urban Sediment and Nutrient Reduction Strategies							
Altered Stream and Habitat Restoration Strategies							
Agricultural Nonpoint Source Reduction Strategies							
1	1, 2	1	Agricultural BMPs – 500 Acres Cover Crops and 250 Acres Nutrient Management (Plan Development, Soil Testing and Variable Rate Technology (VRT) Implementation)	Butler SWCD	Short (1-3 years)	$25,250	Ohio EPA §319, H2Ohio, USDA-NRCS EQIP
1	3	2	Agricultural BMPs – 10 Acres Grassed Waterways	Butler SWCD	Short to Medium (1-7 years)	$100,000	Ohio EPA §319, H2Ohio, USDA-NRCS EQIP
High Quality Waters Protection Strategies							
Other NPS Causes and Associated Sources of Impairment							

The Project Summary Sheets provided below were developed based on the objectives set to achieve nutrient reduction targets in the HC-DF WR 12. These projects are considered next step or priority/short term projects and are ready to be implemented. The projects, which need more outreach and thorough planning, will have the Project Summary Sheets developed and added to the plan when they are ready for the implementation.

Table 18 Critical Area #1 - Project #1

Project #1 – HC-DF WR HUC-12 Critical Area 1		
Nine Element Criteria	**Information needed**	**Explanation**
n/a	Title	Agricultural BMPs – Cover Crops and Nutrient Management
criteria d	Project Lead Organization & Partners	Butler Soil and Water Conservation District
criteria c	HUC-12 and Critical Area	HC-DF WR HUC-12 (050800030808) – Critical Area 1
criteria c	Location of Project	Private landowner – exact location not disclosed
n/a	Which strategy is being addressed by this project?	Agricultural Nonpoint Source Reduction
criteria f	Time Frame	Short (1-3 years)
criteria g	Short Description	Administer cost-share program for cover crop plantings and nutrient management Implementation (soil testing and VRT)
criteria g	Project Narrative	Butler SWCD will administer a cost-share program to local landowners in prioritized agricultural lands to plant cover crops on at least 500 acres annually. Landowners will enroll no less than 10 acres, and the maximum amount enrolled by one operation will not exceed 400 acres. Cost-share will pay out at $50 per acre. In addition, the Butler SWCD develop nutrient management plans and enroll at least 250 acres for soil testing and VRT application. Cost share for nutrient management plan development will be up to $2,000 per plan (estimated 100 to 150 acres). Soil testing will pay $9 per acre, VRT cost-share will be $24 per acre. Butler SWCD has a list of willing landowners prepared to implement this project if funds are available.
criteria d	Estimated Total cost	$35,250
criteria d	Possible Funding Source	H_2Ohio, USDA-NRCS EQIP
criteria a	Identified Causes and Sources	Cause: Nutrient loadings leading to far-field impacts Source: Agricultural land use activities
criteria b & h	Part 1: How much improvement is needed to remove the NPS impairment for the whole critical area?	Objective #1: Plant at least 3300 acres of cover crops, resulting in plantings of 3,000 additional acres. Objective # 2: Implement nutrient management planning (develop plans, soil testing and variable rate fertilization) on at least 2,000 acres. The overall goal in Critical Area #1 is to reduce estimated total nitrogen load for agricultural lands by 20% (59,752 lb). Current estimates indicate 32,493 lb/year reduction load based on the BMPs already implemented within this watershed. In order to meet the Gulf of Mexico hypoxia reduction goals, the total nitrogen loadings must be reduced by additional 27,259 lb/year.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	Goal: This project is expected to achieve 9.7% of remining nitrogen reduction goal.

	Part 3: Load Reduced?	**Cover crops**: estimated 1,696 lb/yr(N)/64 lb/yr (P)/52 tons sediment per year of load reduction based on STEPL 4.4. **Nutrient management**: estimate of 964 lb/yr (N)/0.2 lb/yr (P)/sediment reduction not applicable - load reduction based on STEPL 4.4.
criteria i	How will the effectiveness of this project in addressing the NPS impairment be measured?	It is generally not possible to determine load reduction from individual agricultural practices; Some agencies periodically conduct sampling such Ohio EPA. Butler SWCD will conduct follow-up activities with landowners if appropriate, to document and track progress of cover crop planting.
criteria e	Information and Education	Project information will be shared at the Butler SWCD annual meeting and at applicable field days. Project highlights will also be shared on social media and/or Butler SWCD's website.

Table 19 Critical Area #1 - Project #2

Project #2– HC-DF WR HUC-12 Critical Area 1		
Nine Element Criteria	**Information needed**	**Explanation**
n/a	Title	Agricultural BMPs – Grassed Waterways
criteria d	Project Lead Organization & Partners	Preble Soil and Water Conservation District
criteria c	HUC-12 and Critical Area	HC-DF WR HUC-12 (050800030808) – Critical Area 1
criteria c	Location of Project	Private landowner – exact location not disclosed
n/a	Which strategy is being addressed by this project?	Agricultural Nonpoint Source Reduction
criteria f	Time Frame	Short to Medium (1-7 years)
criteria g	Short Description	Administer cost-share program for grassed waterways installation
criteria g	Project Narrative	Butler SWCD will administer a cost-share program to local landowners in prioritized agricultural lands to install about 10 acres of grassed waterways to capture sediment and nutrients and prevent further gully erosion within their cropland. Grassed waterways will receive cost share according to the current CRP cost list. The proposed project will include design and construction of the grassed waterway to provide adequate sediment/nutrient capture and erosion reduction. The Butler SWCD has been contacted by a several landowners interested in implementing this practice on their farms if funds are available.
criteria d	Estimated Total cost	$100,000
criteria d	Possible Funding Source	Ohio EPA §319, H2Ohio, NRCS-USDA, CRP, EQIP
criteria a	Identified Causes and Sources	Cause: Nutrient loadings Source: Agricultural land use activities
criteria b & h	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	**Objective 3:** 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 results. The overall goal in Critical Area #1 is to reduce estimated total nitrogen load for agricultural lands by 20% (59,752 lb). Current estimates indicate 32,493 lb/year reduction load based on the BMPs already implemented within this watershed. In order to meet the Gulf of Mexico hypoxia reduction goals, the total nitrogen loadings must be reduced by additional 27,259 lb/year.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	Goal: This project is expected to achieve 0.24% of remining nitrogen reduction goal
	Part 3: Load Reduced?	Estimate of 68 lb/yr (N)/16 lb/yr (P) load reduction based on STEPL 4.4b Spreadsheet Model for 10 Watersheds.
criteria i	How will the effectiveness of this project in addressing the NPS impairment be measured?	It is generally not possible to determine load reduction from individual agricultural practices; Some agencies periodically conduct sampling such as Miami Conservancy District or OEPA. Preble SWCD will conduct follow-up activities with landowners if appropriate, to document and track progress of installing the in fields practices.

criteria e	Information and Education	Project information will be shared at the Butler SWCD annual meeting and at applicable field days. Project highlights will also be shared on social media and/or Butler SWCD's website.

Table 26 Projects and Implementation Strategy Overview - Critical Area #2

For HC-DF WR HUC-12 (050800030808) Critical Area 2							
Goal	**Objective**	**Project**	**Project Title (EPA Criteria g)**	**Lead Organization (EPA Criteria f)**	**Time Frame (EPA Criteria f)**	**Estimated Cost (EPA Criteria d)**	**Funding/Actual Sources (EPA Criteria d)**
Urban Sediment and Nutrient Reduction Strategies							
Altered Stream and Habitat Restoration Strategies							
Agricultural Nonpoint Source Reduction Strategies							
High Quality Waters Protection Strategies							
Other NPS Causes and Associated Sources of Impairment							

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 2022.

Agricultural Research Service. 2022. ACPF formatted geodatabase for Howard Creek – Dry Fork whitewater River 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.

Davis Jeffrey G.. 2020. Composite Report: Amphibian and Reptile Surveys at Paddys Run Conservation Project Properties 2018 – 2020.

Dearborn County SWCD, 2016, Whitewater River Watershed Management Plan

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

Indiana Department of Environmental Management, 2015 (Revised in 2020), Total Maximum Daily Load Report for the Southern Whitewater River Watershed

MetroParks of Butler County, Ohio. 2022. MetroParks description available at https://www.yourmetroparks.net/parks/indian-creek-metropark. Accessed January 2022.

Midwest Biodiversity Institute, 2014, Biological and Water Quality Assessment of the Great Miami River and Tributaries 2013, Technical Report MBI/2014-6-8

National Land Cover Database, 2019 (NLCD 2019). Multi-Resolution Land Characteristics Consortium (MRLC). https://data.nal.usda.gov/dataset/national-land-cover-database-2019-nlcd-2011. Accessed February 2022.

Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey (WSS). http://websoilsurvey.sc.egov.usda.gov/. Accessed April 2022.

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

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

Ohio 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 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 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 Department of Natural Resources, Davison of Wildlife 2022. Ohio's Listed Species. Wildlife That Are Considered to Be Endangered, Threatened, Species of Concern, Special Interest, Extirpated, or Extinct in Ohio.

Ohio Environmental Protection Agency (OEPA), 2021. Loading Analyses Plan and Supporting Data Acquisition Needed for the Whitewater River Watershed Total Maximum Daily Load Development, Ohio EPA Technical Report AMS/2017-WHITE-3

Ohio Environmental Protection Agency (OEPA), 2020. Biological and Water Quality Study of the Whitewater River Study Area Drake, Preble, Butler and Hamilton Counties, Ohio. Division of Surface Water, Columbus, OH.

Ohio Environmental Protection Agency (OEPA), 2020a. Ohio 2020 Integrated Water Quality Monitoring and Assessment Report, Final Report, January 2022

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

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 2017-2021. Published crop-specific data layer. Available at https://nassgeodata.gmu.edu/CropScape/. Accessed June 2022.

United States Department of Agriculture (USDA) 2020 – Howard Creek – Dry Fork Whitewater River HUC 12 geodatabase

United States Department of Energy, Office of Legacy Management (USDE OLM) 2022, Fernald Preserve - 2021 Site Environmental Report.

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. Accessed April 2022

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 April 2022)

United States Fish and Wildlife Service, 2017. Ohio County Distribution of Federally-Listed Endangered, Threatened, and Proposed Species. Accessed February 2022.

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 2021.

APPENDIX

Soils Summary — Butler County, Ohio						
Map unit symbol	**Map unit name**	**Drainage Rating**	**Hydrologic Soils Groups**	**Farmland Classification Rating**	**Acres in AOI**	**Percent of AOI**
CnC2	Cincinnati silt loam, 6 to 12 percent slopes, eroded	Well drained	C	Farmland of local importance	11.4	0.00%
DaA	Dana silt loam, 0 to 2 percent slopes	Moderately well drained	B	All areas are prime farmland	46.6	0.20%
DaB	Dana silt loam, 2 to 6 percent slopes	Moderately well drained	C	All areas are prime farmland	12.1	0.00%
DbB	Dana silt loam, bedrock substratum, 2 to 8 percent slopes	Moderately well drained	B	All areas are prime farmland	1.6	0.00%
EcE2	Eden silty clay loam, 15 to 25 percent slopes, moderately eroded	Well drained	D	Not prime farmland	2,169.30	7.90%
EcF2	Eden silty clay loam, 25 to 50 percent slopes, moderately eroded	Well drained	D	Not prime farmland	119.5	0.40%
Ee	Eel silt loam, 0 to 2 percent slopes, occasionally flooded	Moderately well drained	B	All areas are prime farmland	7	0.00%
ElB2	Eldean loam, 2 to 6 percent slopes, eroded	Well drained	B	All areas are prime farmland	28.5	0.10%
ElC2	Eldean loam, 6 to 12 percent slopes, moderately eroded	Well drained	B	Farmland of local importance	1.4	0.00%
FcA	Fincastle silt loam, southern ohio till plain, 0 to 2 percent slopes	Somewhat poorly drained	B/D	Prime farmland if drained	330.1	1.20%

FcB	Fincastle silt loam, Southern Ohio Till Plain, 2 to 4 percent slopes	Somewhat poorly drained	C/D	Prime farmland if drained	77.1	0.30%
FdA	Fincastle silt loam, bedrock substratum, 0 to 2 percent slopes	Somewhat poorly drained	C	Prime farmland if drained	441.3	1.60%
FdB	Fincastle silt loam, bedrock substratum, 2 to 6 percent slopes	Somewhat poorly drained	C	Prime farmland if drained	203.7	0.70%
Gn	Genesee loam	Well drained	B	All areas are prime farmland	514.4	1.90%
HeE2	Hennepin-Miamian silt loams, 18 to 25 percent slopes, moderately eroded	Well drained	C	Not prime farmland	624.4	2.30%
HeF	Hennepin-Miamian silt loams, 25 to 50 percent slopes	Well drained	C	Not prime farmland	305.2	1.10%
HoA	Henshaw silt loam, 0 to 2 percent slopes	Somewhat poorly drained	C/D	Prime farmland if drained	10.8	0.00%
JoR1B1	Jonesboro-Rossmoyne silt loams, 2 to 6 percent slopes	Moderately well drained	C	All areas are prime farmland	6.4	0.00%
La	Landes sandy loam	Well drained	A	All areas are prime farmland	8.6	0.00%
Lg	Lanier fine sandy loam	Well drained	A	All areas are prime farmland	352.6	1.30%
MkC2	Miamian silt loam, 8 to 15 percent slopes, eroded	Well drained	C	Not prime farmland	12.9	0.00%
MoD2	Miamian-Hennepin silt loams, 15 to 25 percent slopes, eroded	Well drained	C	Not prime farmland	13.2	0.00%
MsC2	Miamian-Russell silt loams, 6 to 12 percent slopes, eroded	Well drained	C	Farmland of local importance	572.1	2.10%

MsD2	Miamian-Russell silt loams, 12 to 18 percent slopes, moderately eroded	Well drained	C	Farmland of local importance	187.6	0.70%
MtC2	Miamian-Russell silt loams, bedrock substratum, 6 to 12 percent slopes, eroded	Well drained	C	Farmland of local importance	1,359.30	5.00%
OcB	Ockley silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes	Well drained	B	All areas are prime farmland	32.7	0.10%
Pa	Patton silty clay loam, 0 to 2 percent slopes	Poorly drained	B/D	Prime farmland if drained	61.5	0.20%
Ra	Ragsdale silty clay loam, 0 to 2 percent slopes	Poorly drained	B/D	Prime farmland if drained	143.2	0.50%
RdA	Raub silt loam, 0 to 2 percent slopes	Somewhat poorly drained	D	Prime farmland if drained	79.7	0.30%
RdB	Raub silt loam, 2 to 6 percent slopes	Somewhat poorly drained	D	Prime farmland if drained	25.3	0.10%
Rn	Ross loam, 0 to 2 percent slopes, occasionally flooded	Well drained	B	All areas are prime farmland	314.6	1.20%
RsB2	Russell silt loam, 3 to 8 percent slopes, eroded	Well drained	B	Not prime farmland	10.7	0.00%
RtB	Russell silt loam, 2 to 6 percent slopes	Well drained	B	All areas are prime farmland	2.8	0.00%
RvB	Russell-Miamian silt loams, 2 to 6 percent slopes	Well drained	C	All areas are prime farmland	203.7	0.70%
RvB2	Russell-Miamian silt loams, 2 to 6 percent slopes, moderately eroded	Well drained	C	All areas are prime farmland	552.1	2.00%
RwB	Russell-Miamian silt loams, bedrock substratum, 2 to 6 percent slopes	Well drained	D	All areas are prime farmland	485.5	1.80%
RwB2	Russell-Miamian silt loams, bedrock substratum, 2 to 6	Well drained	D	All areas are prime farmland	2,552.00	9.40%

	percent slopes, moderately eroded					
Sh	Shoals silt loam, 0 to 2 percent slopes, frequently flooded, brief duration	Somewhat poorly drained	B/D	Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season	52.7	0.20%
St	Stonelick fine sandy loam	Well drained	A	All areas are prime farmland	41.6	0.20%
ThA	Thackery silt loam, 0 to 2 percent slopes	Moderately well drained	C	All areas are prime farmland	17.7	0.10%
Ud	Udorthents			Not prime farmland	3.1	0.00%
UnA	Uniontown silt loam, 0 to 2 percent slopes	Well drained	C	All areas are prime farmland	2.2	0.00%
UnB	Uniontown silt loam, 2 to 6 percent slopes	Well drained	C	All areas are prime farmland	17.8	0.10%
W	Water			Not prime farmland	102.3	0.40%
WeA	Wea silt loam, 0 to 2 percent slopes	Well drained	B	All areas are prime farmland	180.4	0.70%
WeB	Wea silt loam, 2 to 6 percent slopes	Well drained	B	All areas are prime farmland	26.9	0.10%
WyB	Wynn silt loam, 2 to 6 percent slopes	Well drained	C	All areas are prime farmland	11	0.00%
WyB2	Wynn silt loam, 2 to 6 percent slopes, eroded	Well drained	C	All areas are prime farmland	384.4	1.40%
WyC2	Wynn silt loam, 6 to 12 percent slopes, eroded	Well drained	C	Farmland of local importance	2,272.60	8.30%
XeA	Xenia silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes	Moderately well drained	C/D	All areas are prime farmland	24.1	0.10%
XeB	Xenia silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes	Moderately well drained	C	All areas are prime farmland	547.7	2.00%

XeB2	Xenia silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes, eroded	Moderately well drained	C/D	All areas are prime farmland	86.8	0.30%
XfA	Xenia silt loam, bedrock substratum, 0 to 2 percent slopes	Moderately well drained	C	All areas are prime farmland	95.3	0.30%
XfB	Xenia silt loam, bedrock substratum, 2 to 6 percent slopes	Moderately well drained	C	All areas are prime farmland	965.3	3.50%
XfB2	Xenia silt loam, bedrock substratum, 2 to 6 percent slopes, moderately eroded	Moderately well drained	C	All areas are prime farmland	377.4	1.40%
Subtotals for Soil Survey Area					**17,090.1**	**62.60%**

Soils Summary — Franklin County, Indiana

Map unit symbol	Map unit name	Drainage Rating	Rating	Farmland Classification Rating	Acres in AOI	Percent of AOI
AlA	Alvin sandy loam, 0 to 2 percent slopes	Well drained	A	All areas are prime farmland	7.2	0.00%
AlB	Alvin sandy loam, 2 to 6 percent slopes	Well drained	A	All areas are prime farmland	2.7	0.00%
CbC2	Carmel silt loam, 6 to 12 percent slopes, eroded	Well drained	C	Not prime farmland	5.4	0.00%
Cy	Cyclone silt loam, 0 to 2 percent slopes	Poorly drained	B/D	Prime farmland if drained	548.5	2.00%
Db	Dearborn loam, frequently flooded	Well drained	B	Not prime farmland	12.6	0.00%
EbE2	Eden flaggy silty clay, 15 to 25 percent slopes, eroded	Well drained	D	Not prime farmland	5.1	0.00%
EdG	Eden flaggy silty clay, 25 to 50 percent slopes	Well drained	D	Not prime farmland	11.4	0.00%
FcB	Fincastle silt loam, 1 to 3 percent slopes	Somewhat poorly drained	C/D	Prime farmland if drained	2,406.60	8.80%

FfA	Fincastle-Reesville silt loams, 0 to 1 percent slopes	Somewhat poorly drained	C/D	Prime farmland if drained	161.2	0.60%
Ge	Gessie loam, sandy substratum, occasionally flooded	Well drained	B	All areas are prime farmland	78.2	0.30%
HeG	Hennepin loam, 25 to 50 percent slopes	Well drained	C	Not prime farmland	141.8	0.50%
Ht	Holton silt loam, occasionally flooded	Somewhat poorly drained	B/D	Prime farmland if drained	101.4	0.40%
MmB2	Miami silt loam, 2 to 6 percent slopes, eroded	Moderately well drained	C	All areas are prime farmland	656.5	2.40%
MmC2	Miami silt loam, 6 to 12 percent slopes, eroded	Moderately well drained	C	Not prime farmland	33.9	0.10%
MmD2	Miami silt loam, well drained, 12 to 18 percent slopes, eroded	Well drained	C	Not prime farmland	59.1	0.20%
MoC3	Miami clay loam, 6 to 12 percent slopes, severely eroded	Moderately well drained	C	Not prime farmland	679.6	2.50%
MoD3	Miami clay loam, 12 to 18 percent slopes, severely eroded	Moderately well drained	C	Not prime farmland	123.8	0.50%
Mx	Moundhaven sandy loam, occasionally flooded	Somewhat excessively drained	A	Not prime farmland	6.1	0.00%
Og	Oldenburg silt loam, occasionally flooded	Moderately well drained	B/D	All areas are prime farmland	130.3	0.50%
PrC	Princeton fine sandy loam, 4 to 12 percent slopes	Well drained	A	Not prime farmland	5.6	0.00%
RuB2	Russell silt loam, 2 to 6 percent slopes, eroded	Well drained	B	All areas are prime farmland	388.7	1.40%

RvA	Russell silt loam, bedrock substratum, 0 to 2 percent slopes	Well drained	C	All areas are prime farmland	9.8	0.00%
SdB	Sidell silt loam, 1 to 4 percent slopes	Well drained	C	All areas are prime farmland	10	0.00%
W	Water			Not prime farmland	19.6	0.10%
WmB	Williamstown silt loam, 2 to 6 percent slopes, eroded	Moderately well drained	C/D	All areas are prime farmland	95.8	0.40%
Wn	Wirt loam, occasionally flooded	Well drained	B	All areas are prime farmland	46.4	0.20%
WrB	Wynn silt loam, 2 to 6 percent slopes	Well drained	C	All areas are prime farmland	12.9	0.00%
WyC3	Wynn silty clay loam, 6 to 12 percent slopes, severely eroded	Well drained	D	Not prime farmland	1.7	0.00%
XnA	Xenia silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes	Moderately well drained	C/D	All areas are prime farmland	208.1	0.80%
XnB2	Xenia silt loam, 2 to 6 percent slopes, eroded	Moderately well drained	B/D	All areas are prime farmland	436.9	1.60%
Subtotals for Soil Survey Area					**6,406.8**	**23.50%**

Soils Summary — Hamilton County, Ohio

Map unit symbol	Map unit name	Drainage Rating	Rating	Farmland Classification Rating	Acres in AOI	Percent of AOI
AwUXC	Alfic Udarents-Urban land complex, loamy substratum over outwash, 0 to 12 percent slopes	Well drained	D	Not prime farmland	4.3	0.00%
CdD	Casco loam, 15 to 25 percent slopes	Well drained	B	Not prime farmland	5.4	0.00%
CmC2	Cincinnati silt loam, 6 to 12 percent slopes, eroded	Well drained	C	Not prime farmland	2.7	0.00%

CnB2	Cincinnati silt loam, 3 to 8 percent slopes, eroded	Well drained	C	Not prime farmland	45	0.20%
CnC2	Cincinnati silt loam, 8 to 15 percent slopes, eroded	Well drained	C	Not prime farmland	50.9	0.20%
DaB	Dana silt loam, 0 to 4 percent slopes	Moderately well drained	B	All areas are prime farmland	7.4	0.00%
EcD	Eden silty clay loam, 15 to 25 percent slopes	Well drained	D	Not prime farmland	133.8	0.50%
EcE	Eden silty clay loam, 25 to 40 percent slopes	Well drained	D	Not prime farmland	162.6	0.60%
EcE2	Eden silty clay loam, 15 to 25 percent slopes, moderately eroded	Well drained	D	Not prime farmland	60.2	0.20%
EpA	Eldean loam, 0 to 2 percent slopes	Well drained	B	All areas are prime farmland	192	0.70%
EpB2	Eldean loam, 2 to 6 percent slopes, eroded	Well drained	B	All areas are prime farmland	101.7	0.40%
EpC2	Eldean loam, 6 to 12 percent slopes, eroded	Well drained	B	Not prime farmland	15.6	0.10%
FdA	Fincastle silt loam, southern ohio till plain, 0 to 2 percent slopes	Somewhat poorly drained	B/D	Prime farmland if drained	122	0.40%
FoA	Fox loam, 0 to 2 percent slopes	Well drained	B	All areas are prime farmland	26.8	0.10%
Gn	Genesee loam, occasionally flooded	Well drained	B	All areas are prime farmland	396.9	1.50%
HoA	Henshaw silt loam, 0 to 2 percent slopes	Somewhat poorly drained	C/D	Prime farmland if drained	182.8	0.70%
JoR1A1	Jonesboro-Rossmoyne silt loams, 0 to 2 percent slopes	Moderately well drained	C	All areas are prime farmland	5.6	0.00%
JoR1B2	Jonesboro-Rossmoyne silt loams, 2 to 6 percent slopes, eroded	Moderately well drained	D	All areas are prime farmland	40	0.10%

MaB	Markland silty clay loam, 2 to 6 percent slopes	Moderately well drained	C	All areas are prime farmland	52.4	0.20%
MaC2	Markland silty clay loam, 6 to 12 percent slopes, eroded	Moderately well drained	C	Not prime farmland	46.9	0.20%
McA	Martinsville silt loam, 0 to 2 percent slopes	Well drained	B	All areas are prime farmland	331.4	1.20%
McB	Martinsville silt loam, 2 to 6 percent slopes	Well drained	B	All areas are prime farmland	95.8	0.40%
MnC2	Miamian silt loam, 8 to 15 percent slopes, eroded	Well drained	C	Not prime farmland	67	0.20%
MoD2	Miamian-Hennepin silt loams, 15 to 25 percent slopes, eroded	Well drained	C	Not prime farmland	28.4	0.10%
MoE2	Miamian-Hennepin silt loams, 25 to 35 percent slopes, eroded	Well drained	C	Not prime farmland	34	0.10%
MsC2	Miamian-Russell silt loams, bedrock substratum, 6 to 12 percent slopes, eroded	Well drained	C	Not prime farmland	8.1	0.00%
OcB	Ockley silt loam, 2 to 6 percent slopes	Well drained	B	All areas are prime farmland	0.3	0.00%
PfC	Pate silty clay loam, 8 to 15 percent slopes	Well drained	D	Not prime farmland	7.7	0.00%
PfD	Pate silty clay loam, 15 to 25 percent slopes	Well drained	D	Not prime farmland	32.6	0.10%
Pn	Patton silty clay loam, 0 to 2 percent slopes	Poorly drained	B/D	Prime farmland if drained	85.1	0.30%
PrB	Princeton sandy loam, 2 to 6 percent slopes	Well drained	B	All areas are prime farmland	5.4	0.00%
RdA	Raub silt loam, 0 to 2 percent slopes	Somewhat poorly drained	C	Prime farmland if drained	100	0.40%
Rn	Ross loam, rarely flooded	Well drained	B	All areas are prime farmland	37.6	0.10%

RuB2	Russell-Miamian silt loams, 2 to 6 percent slopes, moderately eroded	Well drained	C	All areas are prime farmland	0.4	0.00%
RvB2	Russell-Miamian silt loams, bedrock substratum, 2 to 6 percent slopes, moderately eroded	Well drained	D	All areas are prime farmland	27.8	0.10%
RwB	Russell silt loam, 2 to 6 percent slopes	Well drained	B	All areas are prime farmland	0.7	0.00%
RwB2	Russell silt loam, 3 to 8 percent slopes, eroded	Well drained	B	Not prime farmland	74.9	0.30%
Sh	Shoals silt loam	Somewhat poorly drained	C	Prime farmland if drained	31.2	0.10%
SwB2	Switzerland silt loam, 3 to 8 percent slopes, eroded	Well drained	D	Not prime farmland	12.4	0.00%
SwC2	Switzerland silt loam, 8 to 15 percent slopes, eroded	Well drained	D	Not prime farmland	9.9	0.00%
SwD2	Switzerland silt loam, 15 to 25 percent slopes, eroded	Well drained	D	Not prime farmland	6	0.00%
UADXC	Urban land-Alfic Udarents-Eldean complex, 0 to 12 percent slopes	Well drained		Not prime farmland	17.9	0.10%
UAEXD	Urban land-Alfic Udarents-Eden complex, 12 to 25 percent slopes			Not prime farmland	18.2	0.10%
UAFXC	Urban land-Alfic Udarents-Fincastle complex, 0 to 12 percent slopes			Not prime farmland	29.7	0.10%
UAGXC	Urban land-Alfic Udarents-Rossmoyne complex, 0 to 12 percent slopes			Not prime farmland	12.9	0.00%
UAHXB	Urban land-Alfic Udarents-Henshaw complex, 0 to 6 percent slopes			Not prime farmland	13.6	0.00%

UALXC	Urban land-Alfic Udarents-Russell complex, 0 to 12 percent slopes			Not prime farmland	90.9	0.30%
UANXC	Urban land-Alfic Udarents-Miamian complex, 0 to 12 percent slopes	Well drained		Not prime farmland	46.4	0.20%
UANXD	Urban land-Alfic Udarents-Miamian complex, 12 to 25 percent slopes	Well drained		Not prime farmland	10.9	0.00%
UAOXC	Urban land-Alfic Udarents-Princeton complex, 0 to 12 percent slopes	Well drained		Not prime farmland	2.7	0.00%
UAQXC	Urban land-Alfic Udarents-Cincinnati complex, 0 to 12 percent slopes			Not prime farmland	31.2	0.10%
UAWXC	Urban land-Alfic Udarents-Wynn complex, 0 to 12 percent slopes	Well drained		Not prime farmland	2.3	0.00%
UAXXC	Urban land-Alfic Udarents-Xenia complex, 0 to 12 percent slopes			Not prime farmland	106.8	0.40%
UMDXC	Urban land-Mollic Udarents-Dana complex, 0 to 12 percent slopes			Not prime farmland	37.8	0.10%
UMRXA	Urban land-Mollic Udarents-Raub complex, 0 to 2 percent slopes			Not prime farmland	26.5	0.10%
UrUXC	Urban land-Udorthents complex, 0 to 12 percent slopes			Not prime farmland	6.6	0.00%
UTPXAP	Urban land-Typic Endoaquents-Patton complex, 0 to 2 percent slopes, ponded			Not prime farmland	10.9	0.00%
W	Water			Not prime farmland	51.2	0.20%

WbA	Warsaw variant sandy loam, 0 to 2 percent slopes	Well drained	B	All areas are prime farmland	35.6	0.10%
WeA	Wea silt loam, 0 to 2 percent slopes	Well drained	B	All areas are prime farmland	110.4	0.40%
WhA	Whitaker loam, 0 to 2 percent slopes	Somewhat poorly drained	C	Prime farmland if drained	19.5	0.10%
WyB2	Wynn silt loam, 2 to 6 percent slopes, eroded	Well drained	C	All areas are prime farmland	4.6	0.00%
WyC2	Wynn silt loam, 6 to 12 percent slopes, eroded	Well drained	C	Not prime farmland	20.5	0.10%
XfA	Xenia silt loam, Southern Ohio Till Plain, 0 to 2 percent slopes	Moderately well drained	C/D	All areas are prime farmland	118.3	0.40%
XfB2	Xenia silt loam, Southern Ohio Till Plain, 2 to 6 percent slopes, eroded	Moderately well drained	C/D	All areas are prime farmland	294.8	1.10%
XhB	Xenia silt loam, bedrock substratum, 2 to 6 percent slopes	Moderately well drained	C	All areas are prime farmland	21.1	0.10%
Subtotals for Soil Survey Area					**3,792.70**	**13.90%**
Totals for Area of Interest					**27,289.50**	**100.00%**