Nine-Element Nonpoint Source Implementation Strategy (NPS-IS) for Delaware Run-Olentangy River HUC-12 (05060001 10 07)

Prepared for:

City of Delaware

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Cover photo: Delaware Run at Ruth Melvin Preserve. Photo courtesy of Civil & Environmental Consultants, Inc.

Acronyms and Abbreviations

The acronyms and abbreviations below are commonly used by organizations working to restore Ohio's watersheds and are found throughout this NPS-IS document.

Numbers	
§319	Section 319 of the Clean Water Act
A	
ALU	Aquatic Life Use
B	
BMP	Best Management Practice
BOD_5	Biological Oxygen Demand- 5 day
C	
CRP	Conservation Reserve Program
CSO	Combined Sewer Overflow
D	
DO	Dissolved Oxygen
E	
E. coli	*Escherichia coli*
ECBP	Eastern Corn Belt Plains
ECHO	Environmental Compliance and History Online
EPT	*Ephemeroptera, Plecoptera and Trichoptera* – sensitive macroinvertebrate species
EQIP	Environmental Quality Incentives Program
EWH	Exceptional Warmwater Habitat
F	
FLOW	Friends of the Lower Olentangy
FLS	Federally Listed Species
FOTG	Field Office Technical Guide
FSA	Farm Services Agency
H	
HSTS	Home Sewage Treatment System
HTF	Hypoxia Task Force
HUC	Hydrologic Unit Code
I	
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
M	
MARB	Mississippi/Atchafalaya River Basin
MHP	Mobile/Manufactured Home Park
MIwb	Modified Index of Well Being
MORPC	Mid-Ohio Regional Planning Commission

MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
MWH	Modified Warmwater Habitat

N

NH_3	Ammonia
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NPS-IS	Nonpoint Source-Implementation Strategy
NRCS	Natural Resources Conservation Service

O

ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
Ohio EPA	Ohio Environmental Protection Agency
OpTIS	Operational Tillage Information System
ORB	Ohio River Basin
ORBA	Ohio River Basin Alliance
OSU	Ohio State University
OWA	Olentangy Watershed Alliance

P

PAD-US	Protected Areas Database of the United States
PCR	Primary Recreational Contact
PSS	Project Summary Sheet

Q

QHEI	Qualitative Habitat Evaluation Index

R

RM	River Mile

S

SCR	Secondary Recreational Contact
SSO	Sanitary Sewer Overflow
SWCD	Soil and Water Conservation District

T

TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids

U

USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

V

VRT	Variable Rate Technology

W

WAP	Watershed Action Plan
WRP	Wetlands Reserve Program
WRRSP	Water Resource Restoration Sponsor Program
WQS	Water Quality Standards (Ohio Administrative Code 3745-1)
WTP	Water Treatment Plant
WWH	Warmwater Habitat
WWTP	Wastewater Treatment Plant

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CHAPTER 1: INTRODUCTION

The **Delaware Run-Olentangy River Hydrologic Unit Code (HUC)-12 (05060001 10 07)** is located in north central Delaware County and contains an area of 43.89 square miles (Figure 1). The **Delaware Run-Olentangy River HUC-12** contains a 6.6-mile segment of the Olentangy River, which flows from the Delaware Reservoir outlet (Delaware Dam) southerly through the watershed to eventually meet the Scioto River in the City of Columbus. The watershed is dominated by agricultural land use (68%), with a growing urban/residential area concentrated in the southern portion of the sub-watershed (~16%). The **Delaware Run-Olentangy River HUC-12** has been identified as an area of focus within the Ohio River Basin (ORB) due to the estimated loadings of total nitrogen that flows into the tributaries of the Ohio River, to the Mississippi River and its end-receiving waterbody, the Gulf of Mexico.

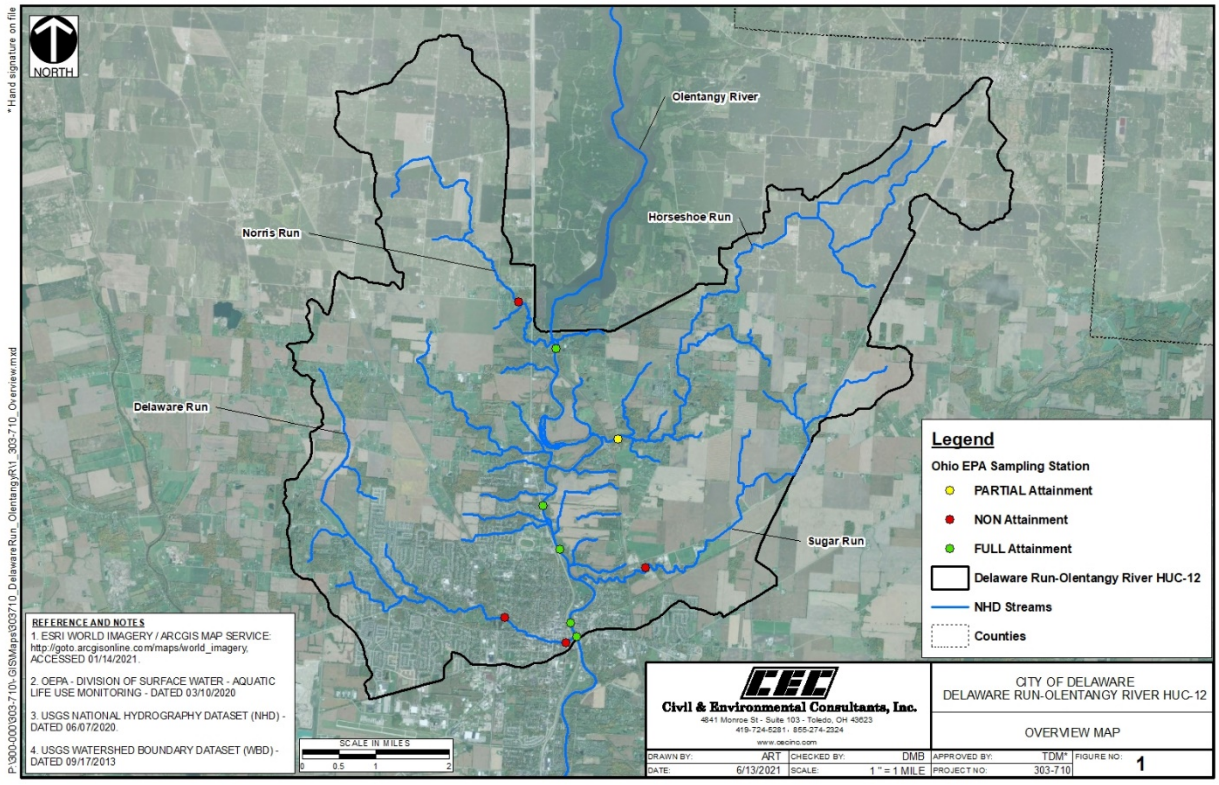

Figure 1: Delaware Run-Olentangy River HUC-12 Overview

1.1 Report Background

While watershed plans could be all-inclusive inventories, the US Environmental Protection Agency (USEPA) identified nine critical elements to include in strategic planning documents for impaired waters (Table 1). To ease implementation of projects addressing nonpoint source (NPS) management and habitat restoration, current federal and state NPS and habitat restoration funding opportunities require strategic watershed plans incorporate these nine key elements, concisely to HUC-12 watersheds. The Ohio Environmental Protection Agency (Ohio EPA) has historically supported watershed-based planning in many forms (Ohio EPA, 2016).

Table 1: Nine Elements for Watershed Plans and Implementation Projects

Element	Description
a	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve load reductions
b	Load reductions expected from management measures described under element (c) below
c	Description of the NPS measures that need to be implemented to achieve load reductions estimated under element (b) above and an identification 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 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 measures identified in this plans 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
i	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element (h) above

(Source: USEPA, 2008)

In 1997, Ohio EPA issued guidance for the development of Watershed Action Plans (WAP), which typically covered larger watersheds (HUC-10 to HUC-8 size). The WAPs included an outline and checklist to ensure USEPA's nine elements were included within each plan. The USEPA issued new guidance in 2013 and concluded Ohio's interpretation for WAP development did not adequately address critical areas, nor did it include an approach that detailed the nine elements at the project level (Ohio EPA, 2016). In response, Ohio EPA developed a new template for watershed planning in the form of a Nonpoint Source-Implementation Strategy (NPS-IS), ensuring NPS pollution is addressed at a finer resolution and that individual projects listed within each plan include each of the nine elements. The first NPS-IS plans were approved in 2017. Over time, these plans have evolved to not only address in-stream (near-field) water quality impairment from NPS pollution, but they also address reductions in nutrient loadings to larger bodies of water (far-field).

Hypoxia Task Force

The State of Ohio is an active participant in the Mississippi River/Gulf of Mexico Hypoxia Task Force (HTF), a multi-state agency effort established in 1997 to understand the causes and effects of eutrophication in the Gulf of Mexico and coordinate activities throughout the Mississippi/Atchafalaya River Basin (MARB) to reduce the size, severity and duration and ameliorate the effects of hypoxia within the Gulf (USEPA, 2020). The HTF has outlined a goal to reduce nutrient loadings from major sources of nitrogen and phosphorus in the MARB by 20% by 2025. Ohio EPA's *Nutrient Mass Balance Study for Ohio's Major Rivers* (2020) has identified high nitrogen and phosphorus loads within the Ohio portion of the ORB, particularly from the Scioto River and Great Miami River watersheds, citing 82% and

83%, respectively, of the nitrogen load and 69% and 66%, respectively, of the phosphorus load in these two watersheds is from NPS contributions (Ohio EPA, 2020d).

Through the *State of Ohio's Domestic Action Plan*, state agencies modeled and estimated nutrient loads for NPS classifications (agricultural, home sewage treatment system (HSTS) and urban contributions) at the HUC-12 level within the northwestern portion of the state, underlining the state's commitment to nutrient reduction from all landscapes (OLEC, 2020). While this level of modeling has not yet occurred within the ORB, approximate loads from agricultural and urban landscapes, based upon nutrient loss literature and *Mass Balance* results, have been estimated for select HUC-12s within the ORB, including those in the Upper Scioto, Great Miami River, Little Miami River and Paint Creek watersheds as a beginning step in setting reduction targets to make progress towards HTF goals *(personal communication with Rick Wilson, Ohio EPA, November 12, 2020).*

Upper Olentangy Watershed Management and Action Plan

In 1999, the Olentangy Watershed Alliance (OWA) was formed through the collaborative efforts of private citizens, Ohio EPA, the Ohio Department of Natural Resources (ODNR) and The Ohio State University (OSU) Extension Office (OWA, 2006). Through a series of grants from state agencies, OWA was able to maintain a Watershed Coordinator and the group's efforts focused on planning a balanced approach for water and natural resources within the upper reaches of the Olentangy River watershed, an area burgeoning with growth and development. The plan provided a framework of strategies for stakeholders to adopt to ultimately achieve attainment of water quality goals and standards from all waterbodies contained within the Upper Olentangy watershed (OWA, 2006). This WAP was endorsed in 2006 and will be updated through the NPS-IS planning process, beginning with the **Delaware Run-Olentangy River HUC-12**.

Delaware Run-Olentangy River HUC-12 NPS-IS

The development of NPS-IS in watersheds contained within the ORB is critical to the efforts focused on implementing the HTF's goal to reduce nutrient loadings from major sources of nitrogen and phosphorus to the Gulf, as well as to meet state water quality standards and local goals. Development of NPS-IS within Ohio's portion of the ORB also aligns with goals established by the Ohio River Basin Alliance (ORBA) for abundant clean water and healthy and productive ecosystems in the Ohio River (USACE, 2020). The *Delaware Run-Olentangy River HUC-12 NPS-IS* will address NPS pollution by accounting for both near-field (within stream/watershed) and far-field (loadings to the Ohio River) effects. The *Delaware Run-Olentangy River HUC-12 NPS-IS* serves as an update to the *Upper Olentangy Watershed Management and Action Plan* and is sponsored and developed by the City of Delaware in collaboration with partners in the OWA, funded through a sub-grant from the Ohio EPA from the HTF.

Removal of NPS impairments, reduction in overall sediment and nutrient loss and restoration of streambanks, floodplains and wetlands within the **Delaware Run-Olentangy River HUC-12** is crucial to the attainment of aquatic life use (ALU) standards both within the Olentangy watershed and on a greater scale within the context of the Ohio River watershed, the Mississippi River and its end-receiving waterbody, the Gulf of Mexico. Within the **Delaware Run-Olentangy River HUC-12**, five biological

sample locations were established in the Olentangy River between sampling events conducted in 2011 and 2016. Assessments conducted during these years were undertaken to document water quality conditions after the removal of lowhead dam impoundments located at Panhandle Road (River Mile (RM) 28.2) in 2010, Central Avenue (RM 26.0) in 2008 and River Street (RM 25.8) in 2005 (Ohio EPA, 2020a). All five sites within the Olentangy River were found to be in *Full Attainment* of the Warmwater Habitat (WWH) designation. Tributaries within the **Delaware Run-Olentangy River HUC-12** were last sampled in 1999 (Delaware Run and Horseshoe Run) and 2003 (Norris Run and Sugar Run) to support Total Maximum Daily Load (TMDL) development. One sampling location was chosen in each of the aforementioned tributaries, except Delaware Run, which had two sampling locations. All tributary sites yielded *Non-Attainment* results for the WWH designation, except Horseshoe Run, which was found to be in *Partial Attainment.* This NPS-IS will be used to strategically identify and outline key projects that should be implemented within the **Delaware Run-Olentangy River HUC-12** to address management of NPS pollution to not only maintain or achieve attainment of Water Quality Standards (WQS) within the sub-watershed boundaries, but to also make progress towards far-field watershed goals on a larger scale within the greater ORB, MARB and Gulf of Mexico.

1.2 Watershed Profile & History

The land area contained within the **Delaware Run-Olentangy River HUC-12** is part of the larger Scioto watershed (0506). The Scioto watershed is located in the central to south-central region of Ohio and drains a total of 6,517 square miles (ODNR, 2001). The Scioto River is approximately 239 miles[1] in length, flowing from Hardin County in northwest Ohio, through Columbus, to empty into the Ohio River at Portsmouth. Along its course, the watershed is broken into three HUC-8 basins: the Upper Scioto (05060001), Lower Scioto (05060002) and Paint Creek (05060003). The Upper Scioto watershed is broken into 23 sub-basins at the HUC-10 level, including tributary watersheds for Big Darby Creek, Big Walnut Creek, Bokes Creek, Mill Creek, the Little Scioto River and the Olentangy River (Figure 2). The Olentangy River, the Scioto's largest tributary (93.8 miles[2]), flows from its headwaters located southeast of Galion in Morrow County to its confluence with the Scioto River in the City of Columbus in Franklin County.

The entire Olentangy River watershed is divided into four HUC-10s, but is commonly split into the Upper Olentangy (*Headwaters Olentangy River HUC-10, Whetstone Creek HUC-10* and *Grave Creek-Olentangy River HUC-10*) and the Lower Olentangy (*Rush Run-Olentangy River HUC-10*) for watershed management purposes (Figure 3). The *Grave Creek-Olentangy River HUC-10 (05060001 10)* is referred to as the Middle Olentangy sub-watershed in the *Upper Olentangy Watershed Management and Action Plan*; however, the portion of it located below the Delaware Dam (including the **Delaware Run-Olentangy River HUC-12**) is often included in planning and conservation efforts for the Lower Olentangy watershed due to the hydrologic significance of the impoundment (Ohio EPA, 2007).

[1] The *Ohio Gazetteer of Streams* (ODNR, 2001) lists the Scioto River as 230.8 miles in length; however, the *River Mile Index* (Ohio EPA, 2020e) shows the Scioto River with an approximate length of 238.9 miles. Biological sampling stations utilize the river mile locations in the *River Mile Index*.

[2] The *Ohio Gazetteer of Streams* (ODNR, 2001) lists the Olentangy River as 88.5 miles in length; however, the *River Mile Index* (Ohio EPA, 2020e) shows the Olentangy River with a length of ~93.8 miles. Biological sampling stations utilize the river mile locations in the *River Mile Index*.

The *Grave Creek-Olentangy River HUC-10* is divided into seven HUC-12 sub-watersheds, in which the **Delaware Run-Olentangy River HUC-12** is contained (Table 2). The HUC-10 has a total drainage area of ~181 square miles or 116,051 acres. Land use within the *Grave Creek-Olentangy River HUC-10* is mainly agricultural, with the largest concentration of urban land use surrounding the City of Delaware, a community of approximately 41,280 people, estimated to be up 18% from 2010 census polls (US Census Bureau, 2021).

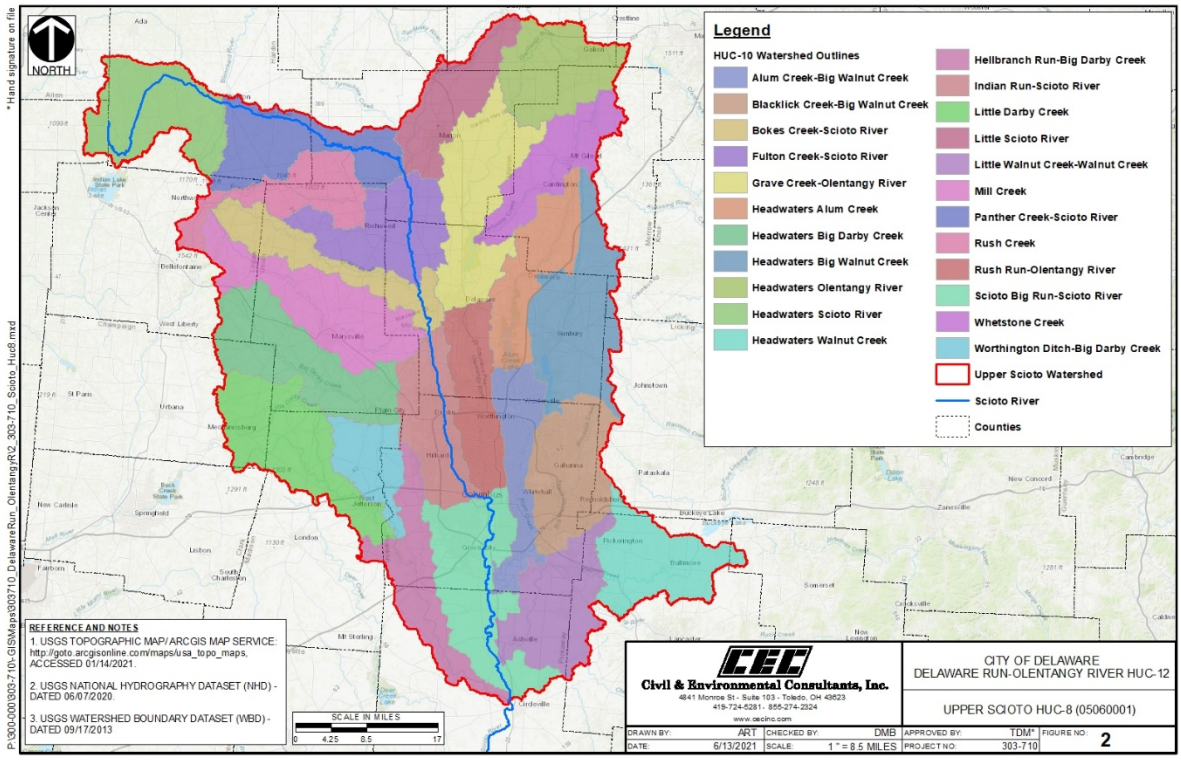

Figure 2: Upper Scioto River Watershed

Table 2: Sub-watersheds in the Grave Creek-Olentangy River HUC-10

Grave Creek-Olentangy River HUC-10 (05060001 10)		
HUC-12	**Area (Square miles)**	**Area (Acres)**
Otter Creek-Olentangy River (01)	22.86	14,631
Grave Creek (02)	28.83	18,451
Beaver Run-Olentangy River (03)	24.04	15,384
Qu Qua Creek (04)	16.91	10,824
Brandige Run-Olentangy River (05)	29.79	19,065
Indian Run-Olentangy River (06)	15.00	9,603
Delaware Run-Olentangy River (07)	43.89	28,093

(Source: Ohio EPA, 2020b)

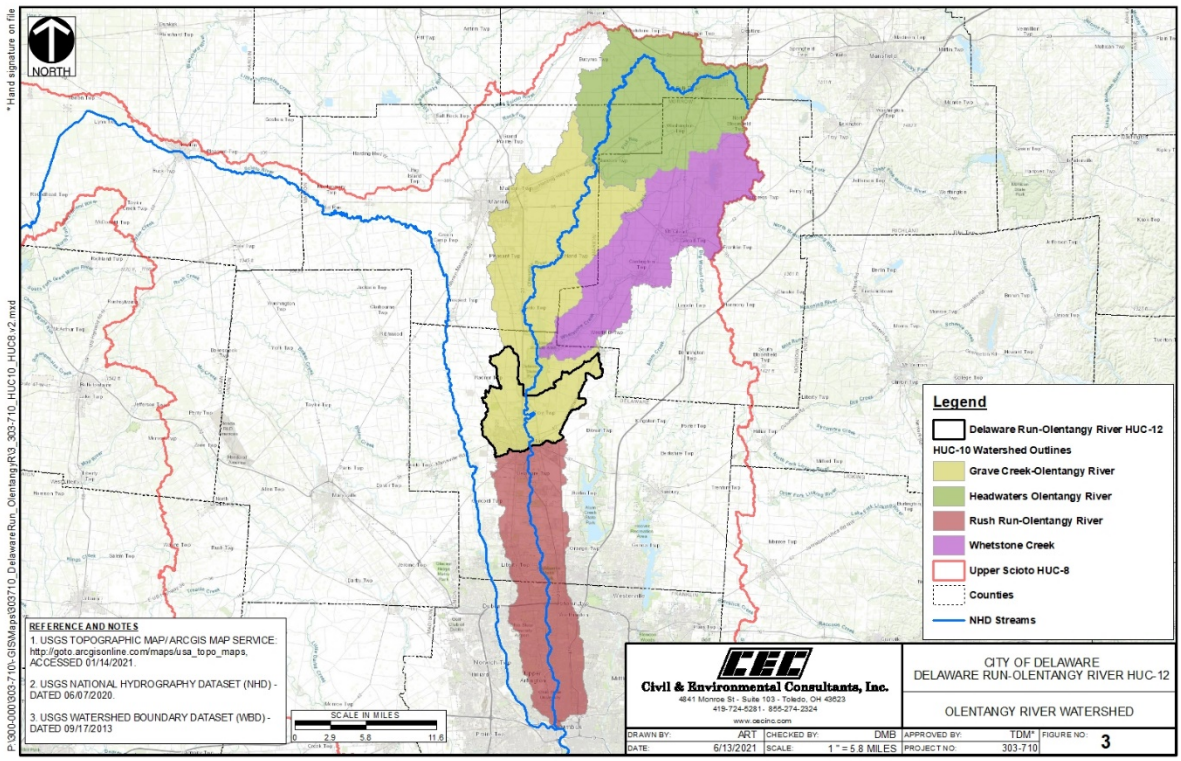

Figure 3: Location of the Delaware Run-Olentangy River HUC-12

The **Delaware Run-Olentangy River HUC-12** contains approximately 6.6 miles of the Olentangy River, from the outlet of the Delaware Reservoir at RM 32.4 to RM 25.8. The **Delaware Run-Olentangy River HUC-12** marks a transition zone for land use, where a rural landscape phases to a dense suburban setting along a southern trajectory leading to Columbus.

1.3 Public Participation and Involvement

Watershed planning is best accomplished by collaboration and input from a diverse group of entities, including governmental agencies, private businesses, academia, non-profit groups, neighborhood organizations and the public at large. A conglomerate of municipal agencies and stakeholders, led by the City of Delaware, spearhead watershed efforts in the **Delaware Run-Olentangy River HUC-12** through activities hosted by the OWA. The City of Delaware Public Utilities employs a Watershed and Sustainability Coordinator who focuses efforts on the improvement and protection of water quality within the Olentangy River watershed. The Watershed and Sustainability Coordinator facilitates the meetings of the OWA, and through this organization, contributes to watershed-wide activities, including: the implementation of the Delaware Run Storm Net Project, the establishment of an *Escherichia coli (E. coli)* monitoring program within Delaware Run, the removal of low head dams within the Olentangy River mainstem, invasive species removal, seedling plantings along local waterways and the establishment of a public-private partnership with Ohio Wesleyan University that engages students in hands-on, water quality monitoring projects while accomplishing annual stormwater goals tied to the City's Municipal Separate Storm Sewer System (MS4) Program. Since 2015, OWA has hosted the

Northern Olentangy Watershed Festival, an annual event that is designed to engage and educate the community on the Olentangy River and the importance of protecting natural resources.

OWA garners participation from many organizational stakeholders, including:

- Preservation Parks of Delaware County, an organization dedicated to preserving natural and historic features in Delaware County;
- Del-Co, a private public drinking water company serving seven counties within central Ohio;
- Delaware Soil and Water Conservation District (SWCD), an agency focused on managing the natural resources and environmental challenges in Delaware County;
- Ohio Wesleyan University, a private liberal arts university with an active Environment and Sustainability Department;
- Friends of the Lower Olentangy River (FLOW), a watershed organization tasked with maintaining clean and safe water within the Olentangy River and its tributaries; and,
- the ODNR Scenic Rivers Program, of which the Olentangy River has been designated.

These stakeholders provided watershed background knowledge and helped guide and formulate critical areas and potential projects within the **Delaware Run-Olentangy River HUC-12**.

Chapters 1, 2 and 3 were primarily prepared using the *2020 Ohio Integrated Report* (Ohio EPA, 2020b), *2016 and 2017 Biological and Habitat Studies of the Rivers and Streams in 33 Section 319(h) and SWIF/GLRI Project Areas in Ohio* (Ohio EPA, 2020a), *Biological and Water Quality Study of the Olentangy River, Whetstone Creek and Select Tributaries, 2003-2004* (Ohio EPA, 2005), *Total Maximum Daily Loads for the Olentangy River Watershed* (Ohio EPA, 2007), *Biological and Water Quality Study of the Olentangy River and Selected Tributaries 1999* (Ohio EPA, 2001) and the *Upper Olentangy Watershed Management and Action Plan* (OWA, 2006*)*. Project information for Chapter 4 was compiled by collaborative outreach with organizational stakeholders, community partners and local landowners, when possible. The *Delaware Run-Olentangy River HUC-12 NPS-IS* was developed during the Coronavirus Disease-2019 (COVID-19) pandemic occurring in 2020-2021, limiting in-person meetings and gatherings. Organizational stakeholder input was solicited and received through interpersonal electronic communications, virtual meetings and phone calls.

Potential restoration sites were visited on January 5, 2021 by the City of Delaware and consultants. In addition, landowners within the sub-watershed were invited to complete surveys regarding watershed issues in order to identify areas of concern and potential locations for projects on private property. The surveys were developed to query both agricultural and urban residents and were made available on the City of Delaware's website, http://www.delawareohio.net/about-the-public-utilities-department/olentangy-river-watershed/, and distributed through channels of OWA partners.

Site visit conducted in 2021

CHAPTER 2: HUC-12 WATERSHED CHARACTERIZATION AND ASSESSMENT SUMMARY

2.1 Summary of HUC-12 Watershed Characterization

2.1.1 Physical and Natural Features

The *Grave Creek-Olentangy River HUC-10* is comprised of seven HUC-12 watersheds; this document focuses on the #07 hydrologic unit—the **Delaware Run-Olentangy River HUC-12**. The largest waterbody within this sub-watershed is the Olentangy River, a 93.8 mile-long stream that rises southeast of Galion in Morrow County. It flows west, then south through agricultural lands to enter Delaware Lake. The Olentangy River outlets at the southern end of the lake through the Delaware Dam and flows due south through suburban and urban landscapes to discharge in the Scioto River at RM 132.33 in the City of Columbus in Franklin County. In total, the Olentangy River drains a watershed of 543 square miles (347,520 acres) over the duration of its length.

The **Delaware Run-Olentangy River HUC-12** contains a 6.6 mile-long segment of the Olentangy River, from its outlet at the Delaware Reservoir at RM 32.4 to RM 25.8, where the Olentangy River exits the HUC-12 and continues flowing south through the *Deep Run-Olentangy River HUC-12*. The segment starting at the Delaware Dam flowing through the sub-watershed to Old Wilson Bridge in Worthington was designated as a State Scenic River in 1973. The **Delaware Run-Olentangy River HUC-12** contains 43.89 square miles (28,092.70 acres) (refer to Figure 1, p.1). Four tributaries essentially split the sub-watershed into quadrants, with Norris Run and Delaware Run flowing from the west and Horseshoe Run and Sugar Run flowing from the east (Table 3). In total, 68.74 miles of stream segments flow in the sub-watershed.

Table 3: Tributary Characteristics in the Delaware Run-Olentangy River HUC-12

Stream	Entry Point to the Olentangy	Length (Miles)	Drainage Area (Square Miles)
Norris Run	RM 32.18	5.3	7.21
Horseshoe Run	RM 29.74	9.1	11.3
Sugar Run	RM 26.97	6.8	5.96
Delaware Run	RM 25.71	7.0	10.1

(Source: Ohio EPA, 2020e; USGS, 2021)

The Olentangy River is located in the Eastern Corn Belt Plains (ECBP) ecoregion (Ohio EPA, 2007). The ECBP consists of a rolling till plain with local end moraines (USEPA, 2013). Wisconsinan glacial deposits are extensive across the ecoregion and supported beech forests prior to settlement. The ecoregion today mostly supports corn, soybean and livestock production, which has negatively impacted stream chemistry and turbidity. Underlying bedrock in the area consists of the Olentangy and Ohio Shales, and the Delaware Limestone in the area of the Delaware Dam (ODNR, 2021a). Soils in the Olentangy River watershed are primarily clay-rich, high in lime and derived from glacial material that sits atop these bedrock layers (Ohio EPA, 2007). The dominant soil association in the **Delaware Run-Olentangy River**

HUC-12 includes the Blount-Pewamo, which are predominantly finer-grained particles with slow permeability and slow to moderate infiltration capacity (Figure 4). In the **Delaware Run-Olentangy River HUC-12**, the Pewamo silty clay loam and Blount silt loams cover over 60% of the sub-watershed (NRCS, 2019). These soils are typically not suitable for septic system use, and generally require surface and subsurface drainage systems for agricultural production (Ohio EPA, 2007).

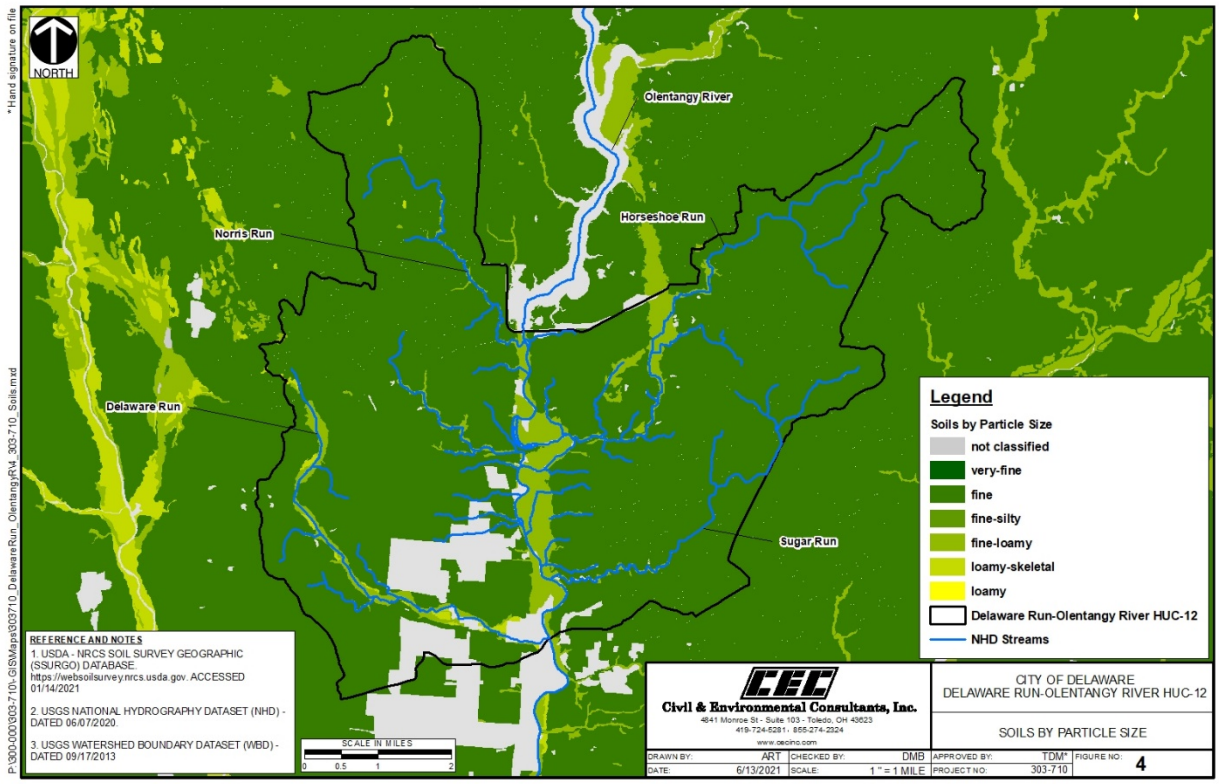

Figure 4: Soils Classified by Particle Size

Currently, eight National Pollutant Discharge Elimination System (NPDES)-permitted facilities are located within the **Delaware Run-Olentangy River HUC-12** (Table 4; Figure 5). Of these facilities, one is a municipal water treatment plant (WTP), one is a wastewater plant, three are package plants from manufactured home parks (MHPs), two are package plants from school/governmental facilities and one is an industrial facility (petroleum). The USEPA documents NPDES permit compliance through the Enforcement and Compliance History Online (ECHO) database (USEPA, 2021). Results discussed here cover the three year (12 quarters) compliance history from October 1, 2017 through September 30, 2020. Several facilities have remained in compliance with their NPDES permits over the last three years including Shroyers Home MHP, Delaware MHP, the United States Department of Agriculture (USDA) Forest Service and Berachah Church Waste Water Plant.

Table 4: NPDES-Permitted Facilities in the Delaware Run-Olentangy River HUC-12

Facility Name	Permit Number	Receiving Waterbody
McWherter Petroleum Services	4IN00168*ED	Olentangy River
Delaware WTP 2	4IZ00054*CD	Olentangy River
USDA Forest Service	4PN0001*GD	Olentangy River
Buckeye Valley Middle & High Schools	4PT00107*ED	Unnamed tributary to the Olentangy River
Crystal Lake MHP	4PV00010*FD	Unnamed tributary to Horseshoe Run
Shroyers Homes MHP	4PV00095*FD	Olentangy River
Delaware MHP	4PV00106*ED	Olentangy River
Berachah Church Waste Water Plant	4PX00001*ED	Olentangy River

(Source: Individual NPDES Permits Interactive Map (Ohio EPA, 2021))

NOTES
WWTP Wastewater Treatment Plant
WTP Water Treatment Plant
MHP Manufactured Home Park

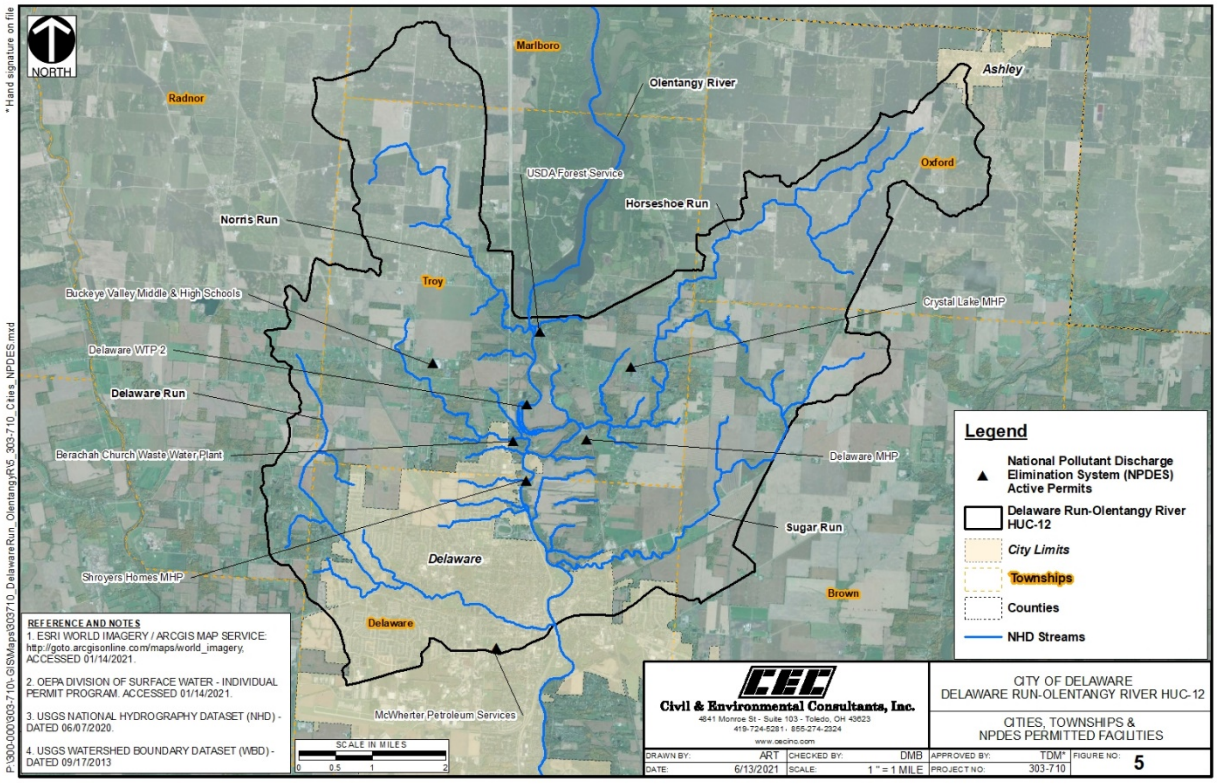

Figure 5: Urban Areas and National Pollutant Discharge Elimination Systems (NPDES) Facilities

Buckeye Valley Middle & High Schools has recorded violations of its permit in two of the last 12 quarters for exceedances in nitrogen as ammonia (NH_3) and total suspended solids (TSS). Exceedances in TSS and total recoverable strontium, as well as toxicity to the aquatic species *Ceriodaphnia dubia* (water flea) have been recorded in four of the last 12 quarters at the Delaware WTP. The Crystal Lake MHP and McWherter Petroleum Services have received numerous violations during the previous three years, earning past or current Significant Noncompliance (SNC) status. The Crystal Lake MHP recorded exceedances in Biological Oxygen Demand-5 day (BOD_5), NH_3, TSS and dissolved oxygen (DO) in eight of the last 12 quarters, with two of those in 2018 in SNC. McWherter Petroleum Services is currently listed in SNC for failure to report effluent results. Only one quarter of the last 12 has been clear of a violation or SNC status.

The City of Delaware is the major population center within the **Delaware Run-Olentangy River HUC-12** and serves as the county seat for Delaware County. Delaware covers an area of approximately 19.9 square miles (12,736 acres), of which approximately 39% lies within the **Delaware Run-Olentangy River HUC-12**. Population estimates cite over 41,280 people living within the City of Delaware in 2019, an 18.7% increase from the last census conducted in 2010 (US Census Bureau, 2021). Both the City of Delaware and Delaware County as a whole are known to be areas of intense development—the County has one of the fastest growing housing markets across the country, growing at about 2.2% (Hendrix, 2020). While the majority of the City of Delaware has storm and sanitary sewers, approximately 18.8 acres utilizes a Phase II MS4 permit, allowing stormwater to be directly discharged to local waterways (City of Delaware, 2007). Because these stormwater systems do not connect with water treatment systems, oil, grease, pesticides, herbicides, dirt and grit have a high potential to negatively impact water quality. The City utilizes a Stormwater Management Plan to minimize storm drain pollution.

The City of Delaware operates its own WWTP, and the City's wastewater system includes 175 miles of sewer line (City of Delaware, 2021a). Though rare, sanitary sewer overflows (SSOs) have been found to occur during heavy precipitation events, as documented in the May 2020 storm. These SSOs occurred at three locations along Delaware Run within the lower mile of the stream (*personal communication with Caroline Cicerchi, City of Delaware, January 13, 2021)*. Outside of the city limits, the remainder of the sub-watershed extends across six townships: Troy, Brown, Oxford, Delaware, Marlboro and Radnor. These townships have limited development and are predominantly rural. In these areas, homes and businesses rely upon HSTS for treatment of household wastewater (DCRSD, 2015). Housing densities in these areas are relatively low and are unlikely to drive connection to sanitary sewer infrastructure due to distance from current treatment plants and the need for extensive improvements to the collection systems. The Delaware County Public Health District maintains records of HSTS in the county. The Health District's database includes records of HSTS permits and inspections, and contains 717 records within the **Delaware Run-Olentangy River HUC-12**[3]. Studies conducted by the Ohio Department of Health (ODH) across Ohio have shown an average HSTS failure rate of 31% (ODH, 2013). Though the amount of NPS pollution from HSTS in the **Delaware Run-Olentangy River HUC-12** is estimated to be small, repair

[3] Database entries prior to 2013 may include addresses that have no previous HSTS records associated with the property, and properties connected to sanitary sewers may have not been removed from the list provided by the Delaware County Public Health District. HSTS locations were linked to parcel data in GIS but were not field verified.

or replacement of failing HSTS or connection to sanitary sewer lines reduces the potential for NPS pollution from this source.

Specific landmarks and features within this watershed include:

- a number of parks (see Section 2.1.2)
- Flying Acres Airport and Obi One Airport
- Buckeye Valley Middle School and High School
- Greenwood Lake
- Delaware County Transfer Station
- Whitesands Campgrounds
- Roy Rike Field
- Delaware Dam
- Selby Stadium
- Lone Oak Farm-Hunting Preserve
- Gleasoncamp Pond
- Marlboro Cemetery and Martin Cemetery
- Ohio Wesleyan University
- Veterans Park Splash Pad

2.1.2 Land Use and Protection

Land use within the **Delaware Run-Olentangy River HUC-12** is primarily agricultural, supporting mainly row crop production (~68%) with small amounts of pasture lands interspersed (Figure 6). Urban lands are found concentrated in the southern portion of the sub-watershed (~16%), while forested stands are concentrated in the northern and central portion of the sub-watershed (~12%) (Table 5).

Table 5: Land Use Classifications in the Delaware Run-Olentangy River HUC-12

Land Use	Delaware Run-Olentangy River HUC-12 (05060001 10 07)		
	Area (mi^2)	Area (acres)	% Watershed Area
Bare/Mines	0.61	45.38	0.13%
Commercial/Industrial/Transportation	0.45	329.79	1.15%
Crop	29.46	18,988.34	66.47%
Deciduous Forest	4.65	3,024.72	10.65%
Evergreen Forest	0.06	53.23	1.77%
Open Water	0.01	14.89	0.03%
Pasture	1.63	1,084.99	3.84%
Residential	6.65	4,299.22	15.19%
Urban/Recreational Grasses	0.37	252.14	0.77%
Total	**43.89**	**28,092.70**	**100.00%**

(Source: Homer et al., 2020)

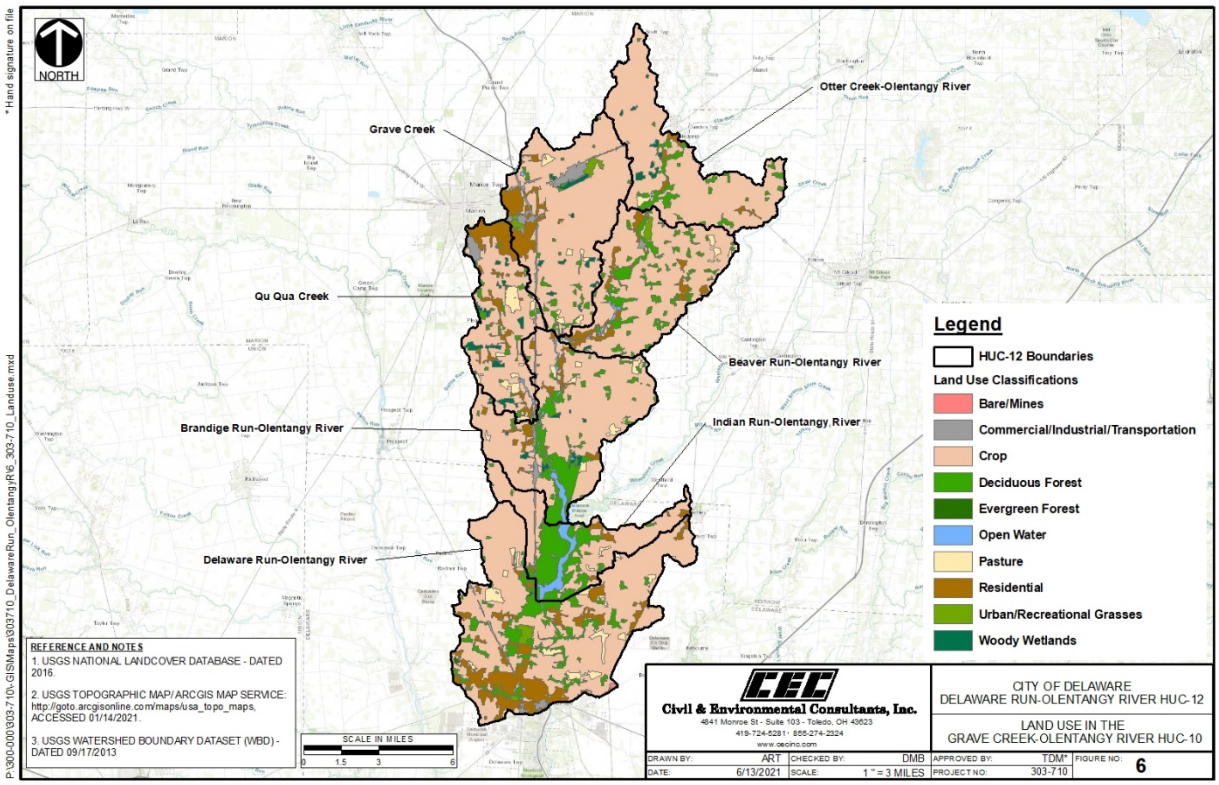

Figure 6: Land Use in the Grave Creek-Olentangy River HUC-10

Land protection at the local, state and federal level is prevalent throughout the **Delaware Run-Olentangy River HUC-12** (Figure 7). Listings within the United States Geological Survey's (USGS) Protected Areas Database of the United States (PAD-US) indicate 829 acres within the sub-watershed are held under management as park or protected land (Table 6). These protected lands may serve as habitat for the six threatened or endangered species listed in Delaware County by the United States Fish and Wildlife Service (USFWS) (Table 7). The Olentangy River is listed as a Group 2 Stream in the *Ohio Mussel Survey Protocol* (ODNR, 2020), indicating that it is a small to mid-sized stream where the presence of Federally Listed Species (FLS) is expected. Delaware Run is also listed within the *Ohio Survey Mussel Protocol*; however, it is classified as a Group 1 Stream, meaning FLS are not expected to be found. All other tributaries within the **Delaware Run-Olentangy River HUC-12** are unlisted, and though their drainage areas are >5 square miles, FLS are not expected to be found.

Table 6: Parks and Protected Lands in the Delaware Run-Olentangy River HUC-12

Name	Acreage	Description
Bicentennial Park	3	City of Delaware park
Blue Limestone Park	16	City of Delaware park providing picnic shelters, playground equipment, pickleball courts and a public fishing pier
Carson Farms Park*	6	City of Delaware park
Delaware County Fairgrounds	101	County fairgrounds and shelters
Delaware Recreation Area	151[a]	Reservoir created in 1951 by the US Army Corps of Engineers; State Park area providing boating, fishing, swimming and nature-based recreation opportunities

Name	Acreage	Description
Gallant Farm Park	19	Interpretive Depression-era farm owned by Preservation Parks of Delaware County
Gallant Woods Park	231	Old-growth woods and restored prairie and wetlands owned by Preservation Parks of Delaware County
Hidden Valley Golf Course	85	Golf course operated by the City of Delaware
Lexington Glen Park	8	City of Delaware park
Lincoln Sports Field	2	City of Delaware park
Locust Curve Park	3	City of Delaware park
Marvin Lane Park	2	City of Delaware park
Mingo Park	50	City of Delaware park offering picnic shelters, rental facilities, pool and a 1.1 mile trail
Nottingham Park	4	City of Delaware park
Oakhaven Golf Club	136	Private golf course
Oakhurst Park	11	City of Delaware park
Region 09 National Forest	181	Experimental forest area managed by the US Forest Service
River Run Park*	14	Kayak access and acreage along the Olentangy River owned by Preservation Parks of Delaware County
Riverview Park	25	City of Delaware park
Ross Street Park*	2	City of Delaware park
Shelbourne Forest Park	5	City of Delaware park
Smith Park	50	City of Delaware park providing picnic shelters, tennis and basketball courts, field space and playground equipment
Sunnyview PPG Park	5	City of Delaware park
Veterans Park*	15	City of Delaware park with 1.2 mile trail

(Source: USGS, 2019; City of Delaware, 2021b; Preservation Parks, 2021)

NOTES

a Total acreage is 9,191 acres, but most is located north of the Delaware Run-Olentangy River HUC-12

** Parks not listed in the PAD-US.*

Table 7: Threatened and Endangered Species in Delaware County

Species	Status	Habitat Characteristics
Indiana bat *(Myotis sodalis)*	Endangered	Hibernates in caves and mines and forages in small stream corridors with well-developed riparian woods, as well as upland forests
Northern long-eared bat *(Myotis septentrionalis)*	Threatened	Hibernates in caves and mines and swarms in surrounding wooded areas in autumn; roosts and forages in upland forests during late spring and summer
Rabbitsfoot *(Quadrula cylindrical cylindrica)*	Threatened	No information available
Rayed bean *(Villosa fabalis)*	Endangered	Mainly headwater creeks, but sometimes larger rivers
Snuffbox *(Epioblasma triquetra)*	Endangered	Small to mid-sized creeks and larger rivers in swift current areas
Running buffalo clover *(Trifolium stoloniferum)*	Endangered	Disturbed bottomland meadows and disturbed sites that are partially shaded

(Source: USFWS, 2018)

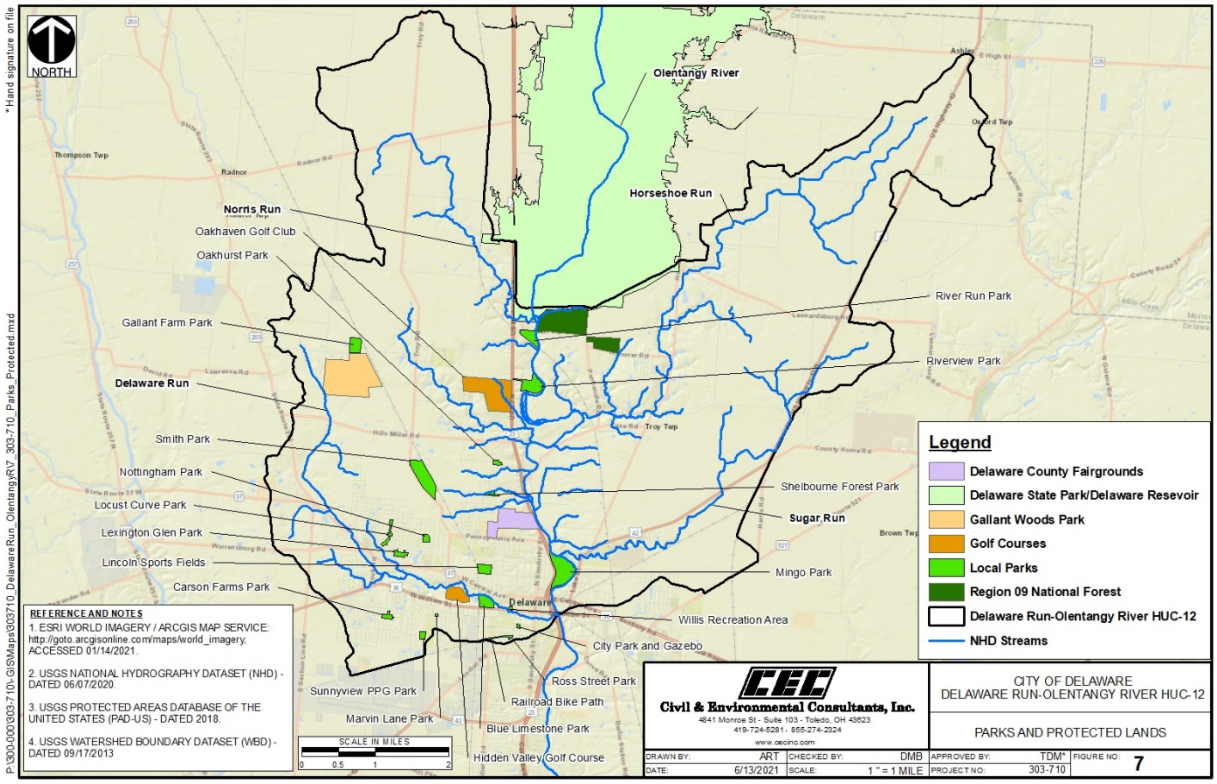

Figure 7: Parks and Protected Lands

Land protection is an important component of regional initiatives in the greater Olentangy watershed. The *Lower Olentangy Watershed Greenspace Plan* was a study spearheaded by FLOW in 2020 and identifies priority areas for greenspace protection to ensure the preservation of high quality natural areas and ample space for recreation (FLOW, 2020). Twenty-two (22) ecological and land restoration variables were assessed to generate a greenspace score. Scores were classified into five tiers. Tier 1 signified areas with the highest amount of overlapping variables, offering the most need for greenspace protection, with Tier 5 values indicating little overlap in variables and thus, lower priority areas for greenspace protection. The *Lower Olentangy Watershed Greenspace Plan* identified approximately 3,400 acres of Tier 1 and Tier 2 priority lands for potential greenspace protection in the **Delaware Run-Olentangy River HUC-12**.

Impoundments within the sub-watershed were once numerous along the length of the Olentangy River. Beginning in 2005 and ending in 2010, lowhead dams were removed from RM 25.8 (River Street), RM 26.0 (Central Avenue) and RM 28.2 (Panhandle Road), creating opportunities for fish passage and improving biological diversity throughout this reach of the river. An impoundment along Sugar Run that created Greenwood Lake breached after heavy rains in June 2020, causing a sinkhole in the overlying US 42. Greenwood Lake has since

New spillway and culvert along Sugar Run

been drained and a new spillway and culvert created in this area by the Ohio Department of Transportation (ODOT) (ODOT, 2020).

Flooding within the **Delaware Run-Olentangy River HUC-12** is of great concern. The same heavy rain event in May 2020 caused massive flash flooding that inundated streets, businesses and homes in the City of Delaware and caused the closure of Delaware State Park. Larger rain events, coupled with growing development and increasing impervious surface can contribute to the risk of more frequent and intense flooding events. Existing wetlands within the sub-watershed may present opportunities for water retention and filtration benefits (Figure 8), and opportunities to further restore or expand wetland complexes and/or retention basins, particularly in the headwaters sections of the sub-watersheds may help provide capacity for future flood level events.

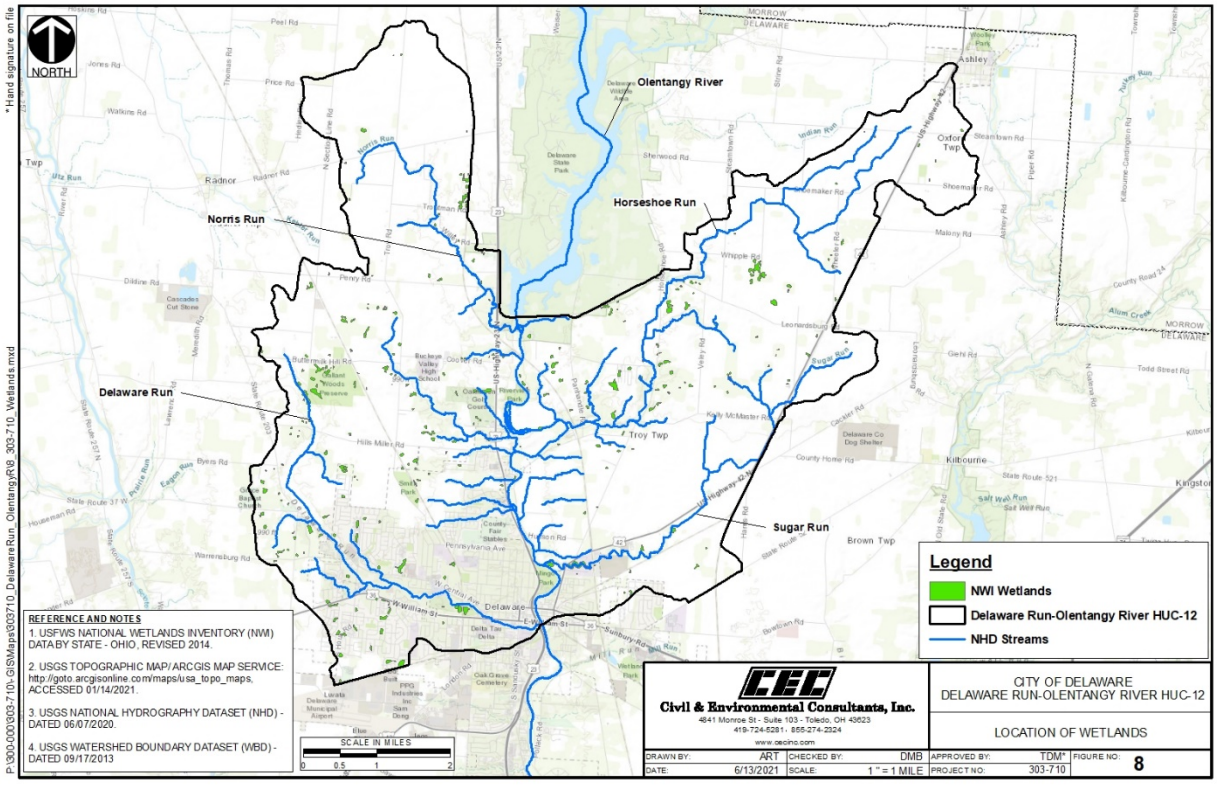

Figure 8: Wetlands within the Delaware Run-Olentangy River HUC-12

Most land within the **Delaware Run-Olentangy River HUC-12** is privately owned; therefore, knowledge of land use and conservation practices may be limited. The City of Delaware and partners from OWA deployed surveys to elicit information from local landowners and producers. Responses were garnered from more than 60 landowners, mainly from urban areas (62/64 responses). Approximately 65% lived within the sub-watershed boundaries. Urban development, followed by impervious surfaces, were cited as the most pressing issues within the sub-watershed. In the urban setting, the majority of landowners implemented some type of urban best management practice (BMP) (Table 8). Sixty percent (60%) and 55% of respondents have an interest in implementing rain gardens and rain barrels, respectively, which

may indicate potential actions to be taken in the sub-watershed to further the retention, detention and filtration of urban stormwater.

Table 8: Urban Best Management Practice Implementation Survey Results

Practice	Implementation (% of Respondents)
Leave leaves/grass clipping on lawn, mulch leaves	85%
Clear storm drains of debris	77%
Minimize salt application	73%
Organic lawncare	63%
Pick up pet waste	63%
Mow at 3-4" height, utilize no-mow areas	61%
Composting	56%
Rain barrels	31%
Rain gardens	11%

(Source: City of Delaware survey, 2021)

Within the agricultural portion of the sub-watershed, farms are generally of smaller size, averaging between 50-179 acres (USDA, 2019). Soybeans are the largest harvested crop in Delaware County, accounting for >45% of crop acres, while corn accounts for 25-34% of crops (USDA, 2019). Generally, livestock operations are not abundant and are smaller in size (Table 9).

Table 9: Estimated Animal Counts in the Delaware Run-Olentangy River HUC-12

Livestock Type	Animal Units
Beef	132
Dairy	42
Swine	1,623
Sheep	72
Horse	134
Chicken	143
Turkey	9
Duck	11

(Source: USDA Census of Agriculture, 2012, as presented in the STEPL Input Data Server (Tetra Tech, 2017))

Within agricultural areas, some conservation practices, such as the use of conservation tillage, can be estimated from remote sensing techniques used within the Operational Tillage Information System (OpTIS). From 2014-2018, OpTIS estimated an average of 34.1% of crop fields in the Upper Scioto watershed were under no-till conditions, 53.6% were under some form of reduced tillage and 12.3% were under traditional tillage regimes (Dagan, 2019). OpTIS also estimated cover crop usage across the Upper Scioto watershed to average 3.0% of fields utilized a winter commodity crop, while 2.1% utilized a winter cover crop over the same five-year period. County-wide estimations for till and reduced-till fields were well below the HUC-8 average (Table 10). According to summary data provided by Ohio EPA regarding the use of the Environmental Quality Incentives Program (EQIP) within the **Delaware Run-Olentangy River HUC-12**, one Nutrient Management Plan and 3.2 acres of Conservation Cover were certified between March 30, 2017 and mid-2019 within the sub-watershed *(personal communication*

with Rick Wilson, June 13, 2019). Additional data provided by the Farm Service Agency (FSA) on current contracts within Delaware County are found in Table 11.

Table 10: OpTIS Countywide Conservation Practice Averages for 2014-2018 for Delaware County

	Upper Scioto HUC-8	Delaware
Practice	**% Usage**	**% Usage**
No-till conditions	34.1	24.7
Reduced till conditions	53.6	14.5
Conventional till	12.3	49.6
Winter commodity cover crop	3.0	2.5
Winter cover crop	2.1	3.0

(Source: Dagan, 2019; provided by The Nature Conservancy in 2021)

Table 11: Conservation Reserve Program (CRP) Contract Acreage by County

	Delaware
Practice	**Acres***
Establishment of Permanent Native Grasses	176.33
Filter Strips	352.99
Riparian Buffer	15.69
Wetland Restoration	22.47
Wetland Restoration, Non-Floodplain	30.19
Rare and Declining Habitat	21.99
Marginal Pastureland and Wildlife Buffer	4.02
Upland Habitat Buffers	134.74
Permanent Wildlife Habitat for Pheasants	14.55
Hardwood Tree Planting	21.40
Pollinator Habitat	105.20
Field Windbreak Establishment, Noneasement	3.90
Grass Waterways, Noneasement	104.74
Shallow Water Areas for Wildlife	8.66

(Source: USDA-NRCS, 2018)

NOTES
**Acres reported at the county level and may not necessarily fall within the Delaware Run-Olentangy River HUC-12 boundaries.*

2.2 Summary of HUC-12 Biological Trends

Ohio EPA last sampled the Olentangy River in the **Delaware Run-Olentangy River HUC-12** in 2011 and 2016 to document water quality conditions after removal of lowhead dam impoundments. Four tributaries in the sub-watershed were last sampled in 1999 and 2003 to support TMDL development. A summary of these sample locations and results are provided in Table 12. For reference, WQS for the ECBP ecoregion are presented in Table 13.

Table 12: Biological Indices Scores for Sites in Delaware Run-Olentangy River HUC-12

Delaware Run-Olentangy River HUC-12 (05060001 10 07)							
River Mile	**Drainage Area (mi^2)**	**IBI**	**MIwb[a]**	**ICI[b]**	**QHEI**	**Attainment Status**	**Location**
Olentangy River (WWH)							
[c]32.10[W]	393.0	46	10.8	38	80.5	Full	USGS Gage, Dst. Delaware Reservoir
[d]28.20[W]	409.0	50	10.3	38	82.3	Full	Panhandle Road
[c]27.50[W]	411.0	43	9.4	46	81.0	Full	Adj. Hudson Road, at Bend
[d]26.00[W]	421.0	48	11.0	46	83.0	Full	Central Avenue
[d]25.80[W]	421.1	48	9.6	48	77.5	Full	Williams Street
Norris Run (WWH)							
[e]1.3[H]	5.8	23*	N/A	LF*	62.0	Non	Penry Road
Horseshoe Run (WWH)							
[f]0.3[H]	11.3	38[ns]	N/A	F*	63.5	Partial	Panhandle Road
Sugar Run (WWH)							
[e]1.3[H]	3.5	29*	N/A	LF*	69.0	Non	Salt Storage Road
Delaware Run (WWH)							
[f]1.2[H]	9.5	34*	N/A	P*	61.0	Non	Limestone Park
[f]0.2[H]	10.1	30*	N/A	P*	40.0	Non	Henry Street

(Source: Ohio EPA, 2001; Ohio EPA, 2020a; Ohio EPA, 2020b)

NOTES

IBI Index of Biotic Integrity

a The Modified Index of Well Being (MIwb) is not applicable to headwater sites (drainage ≤20 mi^2).

ICI Invertebrate Community Index

b Narrative evaluation used in lieu of ICI (G=Good; MG=Marginally Good; H Fair =High Fair; F=Fair; L Fair=Low Fair; P=Poor; VP=Very Poor).

QHEI Qualitative Habitat Evaluation Index

W Wading site

H Headwater site

ns Nonsignificant departure from ecoregion biocriteria (≤4 IBI or ICI units, ≤5 MIwb units).

** Significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the poor to very poor range.*

N/A Not applicable

WWH Warmwater Habitat

c 2011 sample

d 2016 sample

e 2003 sample

f 1999 sample

Table 13: Water Quality Standards for the Eastern Corn Belt Plains (ECBP) Ecoregion

ECBP Ecoregion	EWH WQS			WWH WQS			MWH WQS		
	Wading	Headwater	Boat	Wading	Headwater	Boat	Headwater	Wading	Boat
IBI	50	50	48	40	40	40	24	24	24
MIwb	9.4	N/A	9.6	8.3	N/A	8.5	N/A	6.2	5.8
ICI	46	46	46	36	36	36	22	22	22
QHEI[a]	75	75	75	60	55	60	43.5	43.5	43.5

(Source: Ohio EPA, 2001)

NOTES
EWH Exceptional Warmwater Habitat
WWH Warmwater Habitat
MWH Modified Warmwater Habitat
WQS Water Quality Standards
a QHEI is not criteria included in Ohio WQS; however, it has been shown to be highly correlated with the health of aquatic communities. In general, sites scoring 60 or above (or above 55 for headwater sites) support healthy aquatic assemblages indicative of WWH (Ohio EPA, 2013). Sites scoring 75 or above support EWH assemblages (Ohio EPA, 1999).
N/A MIwb not applicable to headwater sampling locations with drainage areas ≤ 20 mi^2.

Fishes (Modified Index of Well-Being (MIwb] & Index of Biotic Integrity [IBI])

Fish communities within the Olentangy River in the **Delaware Run-Olentangy River HUC-12** were in *Full Attainment* in 1999. Communities at Panhandle Road (RM 28.1) showed signs of distress in 2003, with low MIwb scores resulting in a status change to *Partial Attainment* (Ohio EPA, 2005). Impoundment and siltation from the Panhandle Dam were listed as the primary causes for the decline in water quality. Sampling accomplished in 2005 indicated long-term effects of impoundment were detrimental to the aquatic communities in the Olentangy, as fish performance at RM 28.2, RM 26.0 and RM 25.8 had fallen to a Fair to Marginally Good range (IBI=30-38), necessitating the award of grant funding to remove the three impoundments found throughout this reach (Ohio EPA, 2020a). Notable gains in community performance were observed during sampling post-dam removal. Fish performance after dam removal ranged from 43-50, shifting to Very Good to Exceptional scores. Scores for MIwb at all sites met the threshold for Exceptional Warmwater Habitat (EWH) streams.

Of the four tributaries, only those within Horseshoe Run reached WQS for the WWH designation, though even at this site, communities marginally achieved the threshold, falling within the nonsignificant departure range. Fish communities within Norris Run scored poorly, mainly as a result of habitat alterations and siltation from riparian removal and urbanization. Communities within Delaware Run and Sugar Run performed at a Fair level, influenced by urban runoff and development.

Macroinvertebrates (Invertebrate Community Index [ICI])

Macroinvertebrate species within the Olentangy River in the **Delaware Run-Olentangy River HUC-12** followed a similar trend in performance as fish communities. In 1999, macroinvertebrate communities performed to meet WQS, but signs of stress first arose in 2003 at RM 28.1 at the Panhandle Dam. Samples obtained in 2005 indicated the macroinvertebrate communities had severely declined at this

location due to impoundment and continued siltation, with scores dropping to the Fair to Marginally Good range (ICI= 14-34) (Ohio EPA, 2020a). Post-dam removal, macroinvertebrate communities recovered with scores reaching Good to Exceptional levels (ICI=36-60).

Macroinvertebrate communities in tributary locations did not perform well. In Norris Run, Horseshoe Run and Sugar Run, scores fell in the Low Fair to Fair range (IBI= 14-30), while the macroinvertebrate communities in Delaware Run at both locations scored poorly, triggering the *Non-Attainment* status at both sites. The tributary locations lacked diversity in sensitive taxa and supported only tolerant populations (Ohio EPA, 2005).

Habitat (via Qualitative Habitat Evaluation Index [QHEI])

Ohio EPA sampling crews documented various water quality and habitat attributes during the QHEI assessments conducted in 1999, 2003, 2011 and 2016 (Table 14). Habitat in the Olentangy River was generally of high quality, with scores ranging from 77.5 to 83.0; however, the most downstream locations within the river exhibited lasting effects from siltation caused by impoundment. Habitat scores in the tributaries were high, with the exception of Delaware Run at RM 0.2 (Henry Street). Despite higher scores, the tributaries exhibited a notable number of negative habitat attributes, mostly related to low current, high embeddedness and low sinuosity. Generally, streams that have QHEI scores of at least 60 are capable of supporting WWH assemblages. Strong correlations exist between habitat attributes and a stream's ability to support healthy aquatic assemblages (Ohio EPA, 1999). The presence of certain attributes are shown to have a larger negative impact on fish and macroinvertebrate communities. Streams designated as WWH should exhibit no more than four total Modified Warmwater Habitat (MWH) attributes; additionally, no more than one of those four should be of high-influence (Ohio EPA, 2013). Habitat lends itself to being able to support WWH communities throughout this sub-watershed; however, channelization and removal of the riparian corridor is limiting in the tributaries.

Delaware Run at Limestone Park

Table 14: QHEI Matrix with WWH and MWH Attribute Totals for Sites in the Delaware Run-Olentangy River HUC-12

Delaware Run-Olentangy River HUC-12 (05060001 10 07)																																
Key QHEI Components			WWH Attributes											MWH Attributes																		
														High Influence						Moderate Influence												
River Mile	QHEI Score	Gradient (ft/mi)	Not Channelized or Recovered	Boulder/Cobble/Gravel Substrate	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Embeddedness	Max Depth >40 cm	Low/No Riffle/Run Embeddedness	WWH Attributes	Channelized/No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth <40 cm	High-Influence MWH Attributes	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrate (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1 or 2 Cover Types	Intermediate/Poor Pools	No Fast Current	High/Moderate Embeddedness	High/Moderate Riffle Embeddedness	No Riffle	Moderate-Influence MWH Attributes
Olentangy River (WWH)																																
32.10[W]	80.5	3.82	•	•			•	•	•	•	•	•	9						0		•			•	•				•	•		5
28.20[W]	83.0	6.58	•	•		•	•	•	•	•	•	•	9						0						•							1
27.50[W]	81.0	5.68	•	•		•		•	•		•		6			•			1		•				•				•	•		4
26.00[W]	77.5	6.58	•	•		•	•	•	•	•	•	•	9						0	•	•				•				•			4
25.80[W]	69.0	9.43	•	•		•	•	•	•	•	•	•	9						0	•	•				•				•			4
Norris Run (WWH)																																
1.3[H]	62.0	17.2	•	•			•	•	•		•		6	•					1		•			•			•		•	•	•	6
Horseshoe Run (WWH)																																
0.3[H]	63.5	23.7	•	•			•	•		•	•		6						0						•				•		•	3
Sugar Run (WWH)																																
1.3[H]	69.0	30.3	•	•		•	•	•	•	•	•	•	9						0		•						•		•		•	4
Delaware Run(WWH)																																
1.2[H]	61.0	13.3	•	•				•			•		4			•	•		2					•	•			•	•	•		5
0.2[H]	40.0	3.70		•									1	•		•	•	•	4					•	•	•		•	•	•		6

(Source: Ohio EPA, 2001; Ohio EPA, 2020a; Ohio EPA, 2020b)

NOTES
QHEI Qualitative Habitat Evaluation Index
WWH Warmwater Habitat
MWH Modified Warmwater Habitat

2.3 Summary of HUC-12 Pollution Causes and Associated Sources

Sampling conducted in 2011 and 2016 has demonstrated that the five sampling locations in the Olentangy River contained within the **Delaware Run-Olentangy River HUC-12** are meeting WQS for the WWH designation. In 1999 and 2003, no tributary sampling locations were meeting WQS. Near-field impairment in the tributaries is primarily driven by land use influences and habitat alterations (Table 15). These alterations leave streambanks vulnerable to excessive erosion through hydrologic shear

stress or reduction in the landscape's capacity to buffer sediment and nutrient-laden runoff from surface flow into waterways.

Table 15: Causes and Sources of Impairments for Sampling Locations in the Delaware Run-Olentangy River HUC-12

Delaware Run-Olentangy River HUC-12 (05060001 10 07)				
River Mile	**Primary Cause(s)**	**Primary Source(s)**	**Attainment Status**	**Location**
Olentangy River (WWH)				
32.10[W]	--	--	Full	USGS Gage, Dst. Delaware Reservoir
28.20[W]	--	--	Full	Panhandle Road
27.50[W]	--	--	Full	Adj. Hudson Road, at Bend
26.00[W]	--	--	Full	Central Avenue
25.80[W]	--	--	Full	Williams Street
Norris Run (WWH)				
1.3[H]	Habitat alteration, nutrient enrichment, siltation	Riparian removal, urbanization	Non	Penry Road
Horseshoe Run (WWH)				
0.3[H]	Low flow conditions	Natural sources	Partial	Panhandle Road
Sugar Run (WWH)				
1.3[H]	Siltation, nutrient enrichment	Urban influences	Non	Salt Storage Road
Delaware Run (WWH)				
1.2[H]	Flow hydrology, habitat alterations, sewage	Development, urban runoff, CSO/SSO	Non	Limestone Park
0.2[H]	Flow hydrology, habitat alterations, sewage	Development, urban runoff, CSO/SSO	Non	Henry Street

(Source: Ohio EPA, 2001; Ohio EPA, 2005; Ohio EPA, 2020a; Ohio EPA, 2020b)

NOTES
WWH Warmwater Habitat
CSO Combined Sewer Overflow
SSO Sanitary Sewer Overflow

In addition to the near-field impairments that exist in this sub-watershed, the presence and persistence of the hypoxic zone within the Gulf of Mexico has shown the need for reduced NPS pollution, particularly in regards to nitrogen, and to a lesser extent phosphorus, throughout the entire MARB, of which the Ohio River is a main tributary. Nitrogen loss within the **Delaware Run-Olentangy River HUC-12** contributes to this far-field impairment. Ohio EPA has estimated nitrogen loadings from individual sub-watersheds in targeted areas of the ORB. These estimates include a breakdown of estimated loads from contributing sources of NPS pollutants, including agricultural lands/activities and developed/urban lands (Table 16). Efforts to reduce nutrients from each of these contributing sources will focus on reaching the 20% reduction goal by 2025, as outlined by the HTF in 2014.

Table 16: Estimated Total Nitrogen Loadings from Contributing NPS Sources in the Delaware Run-Olentangy River HUC-12

	Agricultural Load (lbs/yr)	Developed/Urban Load (lbs/yr)
Current Estimates*	490,000	32,000
Target Loadings	392,000	25,500

(Source: personal communication with Rick Wilson, Ohio EPA, November 12, 2020)

NOTES
**Estimated using two significant figures*

2.4 Additional Information for Determining Critical Areas and Developing Implementation Strategies

Del-Co routinely conducts water quality sampling throughout the **Delaware Run-Olentangy River HUC-12**. Select results from 2016-2018 are shown in Table 17. While the State of Ohio does not have WQS for nutrients, target concentrations are recommended for biocriteria attainment. For headwaters streams, target values are 1.0 mg/L for nitrate+nitrite and 0.08 for total phosphorus (Ohio EPA, 1999). Average nutrient values in every tributary exceed these recommended concentrations for both nitrate+nitrite and total phosphorus, with the exception of Delaware Run. Average nitrate+nitrite concentrations are just under the threshold in Delaware Run.

Norris Run, Sugar Run and Delaware Run have the Primary Contact Recreation (PCR) use designation. Water samples obtained for *E.coli* should not exceed 126 Colony Forming Units (CFU)/100 mL[4]. For streams that have been given the Secondary Contact Recreation (SCR) use designation, like Horseshoe Run, WQS are set at 1,030 CFU/mL. The average values presented in Table 17 are not necessarily equivalent to the geometric mean of the dataset, but they do indicate elevated levels of *E.coli* in the tributaries. The *Upper Olentangy Watershed Management and Action Plan* indicates the majority of fecal contamination within the watershed is from failing HSTS (OWA, 2006).

Table 17: Select Water Quality Sampling Results in Tributary Locations, 2016-2018

Delaware Run-Olentangy River HUC-12 (05060001 10 07)				
Chemical Parameter	**Average Concentration (mg/L)**	**Minimum Concentration (mg/L)**	**Maximum Concentration (mg/L)**	**Count**
Norris Run (WWH)				
Total nitrogen	4.75	0.84	21.81	20
Nitrate	3.03	0.05	12.2	26
Total phosphorus	0.25	0.01	1.35	21
*Escherichia coli**	587.8	0.05	2,420.0	19
Horseshoe Run (WWH)				
Total nitrogen	5.01	0.65	14.94	11
Nitrate	3.54	0.06	13.90	23
Total phosphorus	0.18	0.04	0.44	21
*Escherichia coli**	686.9	54.0	2,420.0	20

[4] One Colony Forming Unit is equivalent to one Most Probable Number (MPN) unit.

Delaware Run-Olentangy River HUC-12 (05060001 10 07)				
Chemical Parameter	**Average Concentration (mg/L)**	**Minimum Concentration (mg/L)**	**Maximum Concentration (mg/L)**	**Count**
Greenwood Lake (Sugar Run) (WWH)				
Total nitrogen	5.03	1.36	27.96	20
Nitrate	3.76	0.05	14.90	24
Total phosphorus	0.18	0.04	0.51	21
*Escherichia coli**	156.7	10.0	961.0	22
Delaware Run (WWH)				
Total nitrogen	2.25	0.92	7.87	19
Nitrate	0.99	0.36	4.06	26
Total phosphorus	0.25	0.05	0.86	21
*Escherichia coli**	6,103.0	163.0	53,934.0	16

(Source: personal communication with Jeff Kaufmann, Del-Co and Caroline Cicerchi, City of Delaware)

NOTES

** Escherichia coli is measured in Most Probable Number (MPN)/100 mL*

Assessment data from the 1999 TMDL sampling event, the 2003 TMDL sampling event and the 2011 and 2016 post-dam removal studies referenced in the *2020 Ohio Integrated Report*, *2016 and 2017 Biological and Habitat Studies of the Rivers and Streams in 33 Section 319(h) and SWIF/GLRI Project Areas in Ohio*, *Biological and Water Quality Study of the Olentangy River, Whetstone Creek and Select Tributaries, 2003-2004, Total Maximum Daily Loads for the Olentangy River Watershed*, *Biological and Water Quality Study of the Olentangy River and Selected Tributaries 1999* and the *Upper Olentangy Watershed Management and Action Plan* were used in the development of this NPS-IS (Ohio EPA, 2020b; Ohio EPA, 2020a; Ohio EPA, 2005; Ohio EPA, 2007; Ohio EPA, 2001; OWA, 2006*)*. Any additional documents and/or studies created by outside organizations that were used as supplemental information to develop this NPS-IS are referenced in Chapter 5 (Works Cited), as appropriate.

CHAPTER 3: CRITICAL AREA CONDITIONS AND RESTORATION STRATEGIES

3.1 Overview of Critical Areas

Overall, ten sampling sites are located in the **Delaware Run-Olentangy River HUC-12**: five are within the Olentangy River mainstem and five are located in tributaries, including Norris Run (one site), Horseshoe Run (one site), Sugar Run (one site) and Delaware Run (two sites). The Olentangy River sites are all in *Full Attainment* of the WWH designation, while the tributary locations are not. Sites within Norris Run, Sugar Run and Delaware Run are in *Non-Attainment* of the WWH designation, and Horseshoe Run is in *Partial Attainment* of the WWH designation. Impairment within Horseshoe Run is attributed to natural sources (low flow conditions), while impairment within the other three tributaries results from urban runoff, urbanization and riparian area removal.

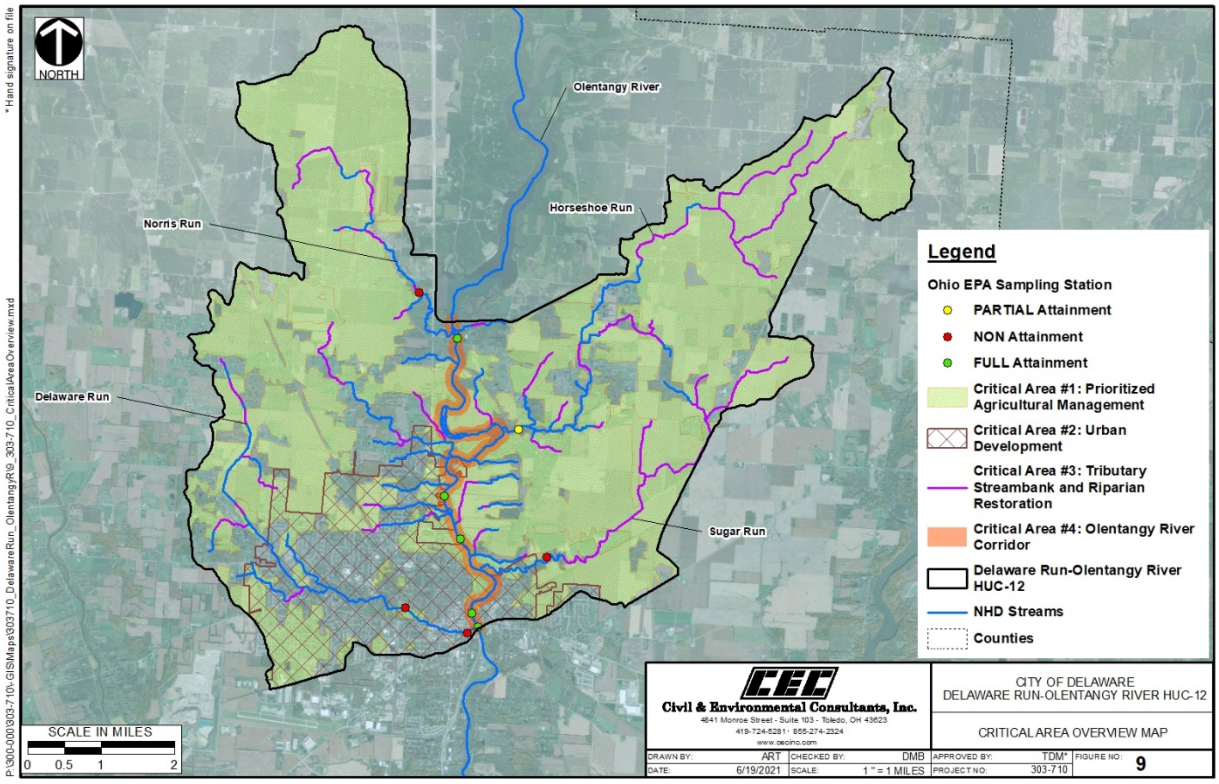

Figure 9: Delaware Run-Olentangy River HUC-12 Critical Area Overview[5]

Four critical areas have been identified within the **Delaware Run-Olentangy River HUC-12** (Figure 9). Several critical areas will address far-field effects of nutrients and sediments flowing to the Ohio River, Mississippi River and Gulf of Mexico, the end receiving waterbody of drainage from the **Delaware Run-Olentangy River HUC-12**. However, many BMP implementation activities nested within this sub-watershed also simultaneously benefit near-field effects in the tributaries and provide protection for the high quality waters of the Olentangy. Because many of these BMPs offer dual benefits of nutrient and

[5] Critical area maps developed with the most recently available digital geographic data and may not reflect current land use or existing conditions that have changed since digital publication.

sediment reduction and both agricultural and urban land prioritization is not substantially different for nutrient and sediment reduction within this sub-watershed, critical areas for each of these land use categories address both near-field and far-field impacts (Table 18). Additional critical areas may be developed in subsequent versions of this NPS-IS.

Table 18: Delaware Run-Olentangy River HUC-12 Critical Area Descriptions

Critical Area Number	Critical Area Description	NPS Pollutant Addressed	Focus Area
1	Prioritized Agricultural Lands	Sediment and nutrients	Far-field (with near-field effects)
2	Prioritized Urban Lands	Sediment and nutrients	Far-field (with near-field effects)
3	Streambank and Riparian Restoration	Sediment and nutrients	Near-field
4	Olentangy River Corridor	High Quality Waters Protection	Near-field

3.2 Critical Area #1: Conditions, Goals & Objectives for Prioritized Agricultural Lands

3.2.1 Detailed Characterization

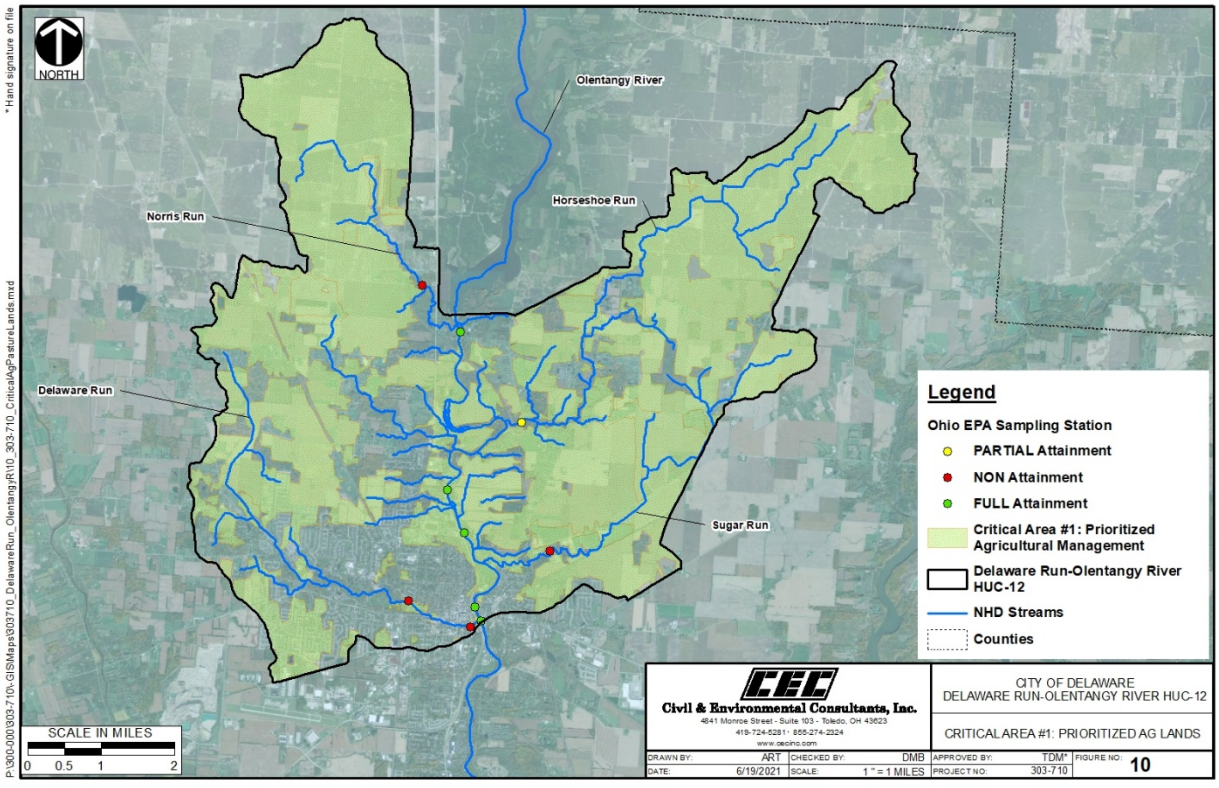

Figure 10: Delaware Run-Olentangy River HUC-12 Critical Area #1

Ohio's *Nutrient Mass Balance Study* (Ohio EPA, 2020c) estimated 82% of the nitrogen nutrient loading to the Ohio River via the Scioto River was primarily from nonpoint sources, related to land use activities,

with only small contributions from failing HSTS and NPDES-permitted facilities. Given the dominance of agricultural land use throughout the greater Scioto River watershed, the use of BMPs are recommended for agricultural operations to minimize nutrient and associated sediment loss to local waterways and drainage ditches through surface and tile flow. While BMPs are encouraged on all agricultural lands, certain lands are more prone to nutrient loss than others and are prioritized for BMP implementation. Lands that are proximal to streams and ditches or do not currently implement specific BMPs are most vulnerable to excessive nutrient and sediment loss, and these lands are prioritized as critical within this watershed. *Critical Area #1* contains prioritized agricultural lands throughout the **Delaware Run-Olentangy River HUC-12** (Figure 10). Of the 20,073 agricultural acres in the **Delaware Run-Olentangy River HUC-12**, prioritized lands are operations that meet one or more of the following criteria:

- Lands directly adjacent to streams or drainage waterways;
- Lands with recurrent gully erosion;
- Lands in need of surface water management;
- Lands with uncontrolled or unfiltered subsurface drainage water;
- Lands without a current (<3 years) nutrient management plan or soil test.

3.2.2 Detailed Biological Conditions

Fish community data for the ten sampling locations within the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 19). Analysis of the abundance, diversity and pollution tolerance of existing fish species found by Ohio EPA at each sampling location, in relation to the corresponding QHEI score, aids in the identification of causes and sources of impairment. Within the Olentangy River, fish communities performed well, with all sites exceeding biocriteria for WWH streams and reaching EWH thresholds, attributed to the removal of three lowhead dams along the mainstem (Ohio EPA, 2020a). In the tributaries, community diversity declined, with no site exceeding 17 species. Habitat scores met expected thresholds for WWH streams; however, fish communities generally fell within the Poor to Fair range, with the exception of Horseshoe Run, indicating stress from land use characteristics, particularly in the upstream reaches of each tributary.

Table 19: Critical Area #1 – Fish Community and Habitat Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)							
RM	**Drainage Area (mi^2)**	**Total Species**	**QHEI**	**IBI**	**MIwb[a]**	**Predominant Species (Percent of Catch)**	**Narrative Evaluation**
Olentangy River (WWH)							
[b]32.10[W]	393.0	34	80.5	46	10.8	Bluegill sunfish (15%), green sunfish (9%), black crappie (9%)	Very Good – Exceptional
[c]28.20[W]	409.0	29	82.3	50	10.3	Central stoneroller (38%), banded darter (13%), spotfin shiner (8%)	Exceptional
[b]27.50[W]	411.0	33	81.0	43	9.4	Bluntnose minnow (21%), bluegill sunfish (17%), spotfin shiner (11%)	Good – Exceptional
[c]26.00[W]	421.0	30	83.0	48	11.0	Smallmouth bass (14%), central stoneroller (14%), northern hog sucker (11%)	Very Good – Exceptional

[c]25.80[W]	421.1	23	77.5	48	9.6	Central stoneroller (23%), sand shiner (22%), northern hog sucker (13%)	Very Good – Exceptional
Norris Run (WWH)							
[d]1.3[H]	5.8	17	62.0	23*	N/A	Bluntnose minnow (70%), white sucker (8%), creek chub (7%)	Poor
Horseshoe Run (WWH)							
[e]0.3[H]	11.3	13	63.5	38[ns]	N/A	Central stoneroller (43%), creek chub (32%), rainbow darter (6%)	Marginally Good
Sugar Run (WWH)							
[d]1.3[H]	3.5	8	69.0	29*	N/A	Orangethroat darter (54%), green sunfish (27%), white sucker (8%)	Fair
Delaware Run (WWH)							
[e]1.2[H]	9.5	10	61.0	34*	N/A	Johnny darter (36%), fantail darter (22%), creek chub (11%)	Fair
[e]0.2[H]	10.1	8	40.0	30*	N/A	Johnny darter (24%), central stoneroller (22%), bluntnose minnow (15%)	Fair

(Source: Ohio EPA, 2001; Ohio EPA, 2005; Ohio EPA, 2020a; Ohio EPA, 2020b)

NOTES
QHEI Qualitative Habitat Evaluation Index
IBI Index of Biotic Integrity
a The Modified Index of Well Being (MIwb) is not applicable to headwater sites (drainage ≤20 mi^2).
W Wading site
H Headwater site
** Significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the poor to very poor range.*
N/A Not applicable
WWH Warmwater Habitat
b 2011 sample
c 2016 sample
d 2003 sample
e 1999 sample

Characteristics of the aquatic macroinvertebrate community for the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 20). Analysis of the abundance, diversity, and pollution tolerance of existing aquatic macroinvertebrates found by Ohio EPA at these sampling locations, related to QHEI scores, can aid in the identification of causes and sources of impairment. The macroinvertebrate communities within the Olentangy River mainstem performed well, despite persistence of MWH attributes that could affect them (i.e., heavy silt cover, high embeddedness, etc.). Improvement in many of these locations is a direct result of the removal of three lowhead dams within the sub-watershed. No macroinvertebrate community within the four tributaries met WWH thresholds, with scores falling in the Poor to Fair range. Tributary communities were consistently populated with intolerant taxa and counts of sensitive and *Ephemeroptera, Plecoptera* and *Trichoptera* (EPT) species were relatively low.

Table 20: Critical Area #1 – Macroinvertebrate Community Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)			
RM	**ICI Score-Narrative[a]**	**Notes (Density of Ql./Qt.)**	**Predominant Species**
Olentangy River (WWH)			
[b]32.10[W]	38 – Good 14 sensitive taxa	--	*Rheotanytarsus* sp (F), *Polypedilum (Uresipedilum) flavum* (F), *Cheumatopsyche sp* (F)
[c]28.20[W]	38 – Good 23 sensitive taxa	--	*Polypedilum (Uresipedilum) flavum* (F), *Baetis intercalaris* (F), *Cheumatopsyche sp* (F)
[b]27.50[W]	46 – Exceptional 36 sensitive taxa	--	*Polypedilum (Uresipedilum) flavum* (F), *Cheumatopsyche sp* (F), *Maccaffertium pulchellum* (MI)
[c]26.00[W]	46 – Exceptional 29 sensitive taxa	--	*Baetis intercalaris* (F), *Cheumatopsyche sp* (F), *Maccaffertium pulchellum* (MI)
[c]25.80[W]	48 – Exceptional 31 sensitive taxa	--	*Baetis intercalaris* (F), *Polypedilum (Uresipedilum) flavum* (F), *Cheumatopsyche sp* (F)
Norris Run (WWH)			
[d]1.3[H]	N/A – Low Fair* 5 sensitive taxa	Moderate	Blackflies (F)
Horseshoe Run (WWH)			
[e]0.3[H]	N/A – Fair* 4 sensitive taxa	--	Alder flies, midges
Sugar Run (WWH)			
[d]1.3[H]	N/A – Low Fair* 9 sensitive taxa	Moderate	Blackflies (F), sow bugs (F)
Delaware Run (WWH)			
[e]1.2[H]	N/A – Poor* 1 sensitive taxa	--	River snails
[e]0.2[H]	N/A – Poor* 2 sensitive taxa	--	River snails

(Source: Ohio EPA, 2001; Ohio EPA, 2005; Ohio EPA, 2020a; Ohio EPA, 2020b)

NOTES

a Narrative evaluation used in lieu of ICI

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

b 2011 sample

c 2016 sample

d 2003 sample

e 1999 sample

H Headwater site

W Wading site

WWH Warmwater Habitat

3.2.3 Detailed Causes and Associated Sources

Five sampling sites in the Olentangy River mainstem in the **Delaware Run-Olentangy River HUC-12** are currently in *Full Attainment* of the WWH designation. One sampling site within Norris Run is in *Non-*

Attainment of the WWH designation due to habitat alteration, nutrient enrichment and siltation from riparian removal and urbanization. One sampling location in Horseshoe Run is in *Partial Attainment* of the WWH designation due to naturally occurring low flow conditions, and one sampling location within Sugar Run is in *Non-Attainment* of the WWH designation due to siltation and nutrient enrichment from urban influences. Two sampling locations within Delaware Run are in *Non-Attainment* of the WWH designation due to flow hydrology, habitat alterations and sewage from development, urban runoff and CSO/SSO impacts. The headwaters of these tributaries are agricultural in nature, and land use activities upstream are also contributing to impairment in downstream reaches and beyond. Despite the high performing communities in the Olentangy River mainstem, residual negative habitat attributes persist. The data summarized previously in Table 14 (p.22) reveal a direct link between the presence of attributes in the watershed that have influence on the aquatic communities throughout the streams in *Critical Area #1*. These contributing attributes in *Critical Area #1* include:

- Heavy/Moderate Silt Cover (Olentangy River, Norris Run, Sugar Run)
- Low Sinuosity (Olentangy River, Horseshoe Run, Delaware Run)
- High/Moderate Embeddedness (all streams)
- High/Moderate Riffle Embeddedness (Olentangy River, Norris Run, Delaware Run)
- Lack of Riffle (Norris Run, Horseshoe Run, Sugar Run)

Many of the habitat attributes found during the QHEI sampling event (i.e., low sinuosity, substrate embeddedness, etc.) are likely a result of land use activities, which include impacts from agricultural operations within the headwaters portions of the watershed. From a far-field perspective, agricultural land use activities contribute to excessive nutrient loadings to the Ohio River, eventually reaching the Mississippi and then the Gulf of Mexico, contributing to its extensive hypoxic zone. The use of a variety of BMPs on private agricultural lands, at both in-field and edge-of-field locations can help reduce the amount and concentration of nutrient-laden surface runoff and tile drainage. Many BMPs can not only address reduction of nutrients in surface and drainage water, but they can also simultaneously address the loss of sediment from agricultural lands, which contributes to sediment-covered substrates in local waterways. In addition, a reduction of sediment loss to local waterways can also reduce nutrient loss to near-field and far-field waterbodies, as nutrients will also adsorb to sediment particles, potentially becoming dissolved at a later time. The implementation of BMPs on agricultural lands that are prone to sediment and nutrient loss serves as a benefit for both near-field and far-field waterbodies.

3.2.4 Outline Goals and Objectives for the Critical Area

The overarching goal of any NPS-IS is to improve water quality scores in order to remove a waterbody's impairment status or protect quality areas to maintain attainment status. Agricultural land use activities in *Critical Area #1* contribute to not only near-field impairment and stressed aquatic communities in the four tributaries, but also far-field impairment through excessive nutrient loss to local waterways that flow to the Ohio River. The Ohio EPA has estimated nutrient loadings associated with various land uses and sources within targeted HUC-12s in the ORB, and has set nitrogen reduction goals for agricultural and urban sources. To achieve the desired nitrogen reduction from agricultural land use in the **Delaware Run-Olentangy River HUC-12**, the following goal has been established:

Goal 1. Reduce nitrogen loading contributions in the **Delaware Run-Olentangy River HUC-12** to a level at or below 392,000 lbs/year (20% reduction).
NOT ACHIEVED: Current estimated load contribution is 490,000 lbs/year.

Simultaneous goals relate to the improvement of in-stream conditions within the Olentangy River, Norris Run, Horseshoe Run, Sugar Run and Delaware Run in order to improve and/or maintain the health of aquatic communities. Implementation of BMP objectives geared towards nutrient reduction efforts will generally also help make incremental progress towards the following goals:

Goal 2. Maintain IBI score at or above 40 at a USGS gage downstream of the Delaware Reservoir in Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 46.

Goal 3. Maintain MIwb score at or above 8.3 at a USGS gage downstream of the Delaware Reservoir in the Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 10.8.

Goal 4. Maintain ICI score at or above 36 at a USGS gage downstream of the Delaware Reservoir in the Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 38.

Goal 5. Maintain QHEI score at or above 60 at a USGS gage downstream of the Delaware Reservoir in the Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 80.5.

Goal 6. Maintain IBI score at or above 40 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 50.

Goal 7. Maintain MIwb score at or above 8.3 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 10.3.

Goal 8. Maintain ICI score at or above 36 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 38.

Goal 9. Maintain QHEI score at or above 60 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 82.3.

Goal 10. Maintain IBI score at or above 40 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 43.

Goal 11. Maintain MIwb score at or above 8.3 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 9.4.

Goal 12. Maintain ICI score at or above 36 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 46.

Goal 13. Maintain QHEI score at or above 60 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 81.

Goal 14. Maintain IBI score at or above 40 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 48.

Goal 15. Maintain MIwb score at or above 8.3 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 11.

Goal 16. Maintain ICI score at or above 36 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 46.

Goal 17. Maintain QHEI score at or above 60 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 83.

Goal 18. Maintain IBI score at or above 40 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 48.

Goal 19. Maintain MIwb score at or above 8.3 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 9.6.

Goal 20. Maintain ICI score at or above 36 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 48.

Goal 21. Maintain QHEI score at or above 60 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 77.5.

Goal 22. Achieve IBI score at or above 40 at Penry Road in Norris Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of 23.

Goal 23. Achieve ICI score at or above 36 (Good) at Penry Road in Norris Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of Low Fair (~28).

Goal 24. Maintain QHEI score at or above 60 at Penry Road in Norris Run (RM 1.3).
✓ ACHIEVED: Site currently has a score of 62.

Goal 25. Achieve IBI score at or above 40 at Panhandle Road in Horseshoe Run (RM 0.3).
NOT ACHIEVED: Site currently has a score of 38.

Goal 26. Achieve ICI score at or above 36 (Good) at Panhandle Road in Horseshoe Run (RM 0.3).
NOT ACHIEVED: Site currently has a score of Fair (~32).

Goal 27. Maintain QHEI score at or above 60 at Panhandle Road in Horseshoe Run (RM 0.3).
✓ ACHIEVED: Site currently has a score of 63.5.

Goal 28. Achieve IBI score at or above 40 at Salt Storage Road in Sugar Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of 29.

Goal 29. Achieve ICI score at or above 36 (Good) at Salt Storage Road in Sugar Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of Low Fair (~28).

Goal 30. Maintain QHEI score at or above 60 at Salt Storage Road in Sugar Run (RM 1.3).
✓ ACHIEVED: Site currently has a score of 69.

Goal 31. Achieve IBI score at or above 40 at Limestone Park in Delaware Run (RM 1.2).
NOT ACHIEVED: Site currently has a score of 34.

Goal 32. Achieve ICI score at or above 36 (Good) at Limestone Park in Delaware Run (RM 1.2).
NOT ACHIEVED: Site currently has a score of Poor (~22).

Goal 33. Maintain QHEI score at or above 60 at Limestone Park in Delaware Run (RM 1.2).
✓ ACHIEVED: Site currently has a score of 61.

Goal 34. Achieve IBI score at or above 40 at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of 30.

Goal 35. Achieve ICI score at or above 36 (Good) at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of Poor (~22).

Goal 36. Achieve QHEI score at or above 60 at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of 40.

Objectives

In order to make substantive progress toward the achievement of the nitrogen load reduction goal of 98,000 lbs for the **Delaware Run-Olentangy River HUC-12**, efforts must commence on more widespread implementation, according to the following objectives within *Critical Area #1.* Additionally, actions taken to address nutrient reduction will also help reduce stressors on aquatic communities within the Olentangy River and its tributaries, Norris Run, Horseshoe Run, Sugar Run and Delaware Run.

Objective 1: Implement nutrient management (planning and implementation through soil testing and Variable Rate Technology (VRT)) on at least at least 5,700 additional acres.

Objective 2: Plant cover crops on at least 3,800 additional acres annually.[6]

[6] Cover crop usage is estimated to occur on approximately 570 acres, based upon OpTIS data (Dagan, 2019). Cover crop plantings may be implemented in the absence of grant funding.

Objective 3: Implement conservation tillage (30-50% residue) on at least 3,800 additional acres[7].

Objective 4: Reduce nutrient loss from subsurface tile drainage through the installation of drainage water management structures that drain at least 500 acres.

Objective 5: Reduce erosion and nutrient loss through the installation or rehabilitation of grassed waterways (as a standalone practice or coupled with erosion control structures/other drainage management practices) that receive/treat surface water from at least 1,000 acres.

Objective 6: Reduce erosion and nutrient loss through the installation of filter strips/buffers (of at least a 50 ft setback) that receive/treat surface water from at least 1,300 acres.

Objective 7: Reduce erosion and nutrient loss through the installation of forested riparian buffers (of at least a 100 ft setback) that receive/treat surface water from at least 80 acres.

Objective 8: Install nitrogen bioreactors to treat subsurface drainage water from 50 acres.

Objective 9: Create, enhance and/or restore at least 50 acres of wetlands and/or water retention basins for treatment of agricultural runoff and/or nutrient reduction purposes from 1,250 total agricultural acres.

Objective 10: Reduce erosion from agricultural streambanks and drainage conveyances through natural channel design or two-stage ditch design stabilization techniques to at least 9,300 linear feet (1.75 miles).

Objective 11: Increase the retirement of marginal and highly vulnerable lands by enrolling at least 50 acres into programs such as the Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP).

These objectives will be directed towards implementation on prioritized agricultural lands and are estimated to reach the nitrogen reduction goal (Table 21). Additional conservation activities within the **Delaware Run-Olentangy River HUC-12**, both on priority and secondary lands, may also make incremental progress towards nitrogen reduction goals. The implementation of BMPs included in these objectives, as well as BMPs implemented through federal and state programs and other voluntary efforts may be tracked to monitor progress towards nitrogen reduction goals within the watershed.

[7] Current estimates indicate reduced tillage occurs on approximately 7,400 acres, based upon OpTis data (Dagan, 2019).

Table 21: Estimated Annual Nutrient Load Reductions from Each Objective

Objective Number	Best Management Practice	Total Acreage Treated	Estimated Annual Nitrogen Load Reduction (lbs)
1	Nutrient Management (Planning and Implementation through Soil Testing and VRT)[a]	5,700	20,340
2	Cover Crops	3,800	17,710
3	Conservation Tillage (30-50% Residue)	3,800	15,050
4	Drainage Water Management Structures	500	4,500
5	Grassed Waterways[b]	1,000	7,730
6	Filter Strips/Buffers (of at least 35 ft)[c]	1,300	11,020
7	Forested Buffers (of at least 100 ft)	80	940
8	Bioreactor	50	530
9	Wetlands[d] and/or Water Retention Basins	1,250[e]	8,070
10	Stream Stabilization and/or Two-Stage Ditch	650[f]	11,120
11	Land Retirement	50	1,110
	TOTAL	**18,180**	**98,120**

(Source Model: Spreadsheet Tool for Estimating Pollutant Loads (STEPL), Version 4.4, (USEPA, 2018))

NOTES

a Nutrient Management consists of "managing the amount (rate), source, placement (method of application) and timing of plant nutrients and soil amendments to budget, supply and conserve nutrients for plant production; to minimize agricultural nonpoint source pollution of surface and groundwater resources; to properly utilize manure or organic byproducts as a plant nutrient source; to protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen) and the formation of atmospheric particulates; and/or to maintain or improve the physical, chemical and biological condition of soil," as defined by the STEPL guidance documents (Tetra Tech, 2018).

b Grassed waterway nitrogen reduction efficiency estimated from urban grass swale efficiencies in STEPL.

c Concentrated flow must be distributed so the area can slow, filter, and/or soak in runoff. Design specifications will be Field Office Technical Guide (FOTG) 393 Filter strips/area, and/or CRP CP-11 or CP2 Filter recharge areas. Conservation Cover (FOTG 327 and CRP CP-21) would not be designed to treat contributing runoff.

d Nitrogen load reduction for wetlands was calculated using the estimated 5-year average cropland nutrient yield in the Scioto River watershed from 2013-2017 (12.9 lbs/acre nitrogen), provided by Heidelberg University National Center for Water Quality Research.

e If drainage water is routed through restored/created wetlands, it is assumed a 50% reduction in nitrogen from total nutrient yield for the drainage area, with a 25:1 ratio of drainage area to receiving wetland (Hoffmann et al., 2012; Woltemade, 2000). For this objective of 50 wetland acres, total drainage area is 1,250 acres.

f One linear foot of stream is estimated to drain 0.077 acres in this sub-watershed.

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

Source Management Plan Update (Ohio EPA, 2020c) will be utilized as a reevaluation tool for its listing of all eligible NPS management strategies to consider including:

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

3.3 Critical Area #2: Conditions, Goals & Objectives for Nutrient Reduction from Urban Lands

3.3.1 Detailed Characterization

In urban environments, NPS contributions to stormwater runoff can come from a variety of sources, including fertilizers, detergents, leaves and detritus, wild and domesticated animal excrement, lubricants, sediment erosion, and organic and inorganic decomposition processes (Carpenter *et. al*, 1998; Burton and Pitt, 2001). Urbanization and development often leads to increased pollutant availability, increased runoff, increased peak flows and stream "flashiness", stream instability, decreased stream function, decreased storage and retention capabilities and decreased pollutant assimilation in soils (ODNR, 2006b). Many of these effects have a direct impact on aquatic life. Even in areas of low amounts of urbanization (5-10% imperviousness), stream ecosystems can rapidly decline (Schueler, 1994). The *Olentangy Watershed Planning Partnership Balanced Growth Plan* recognizes stormwater runoff as one of the primary sources of impairment in the Olentangy watershed (MORPC, 2012).

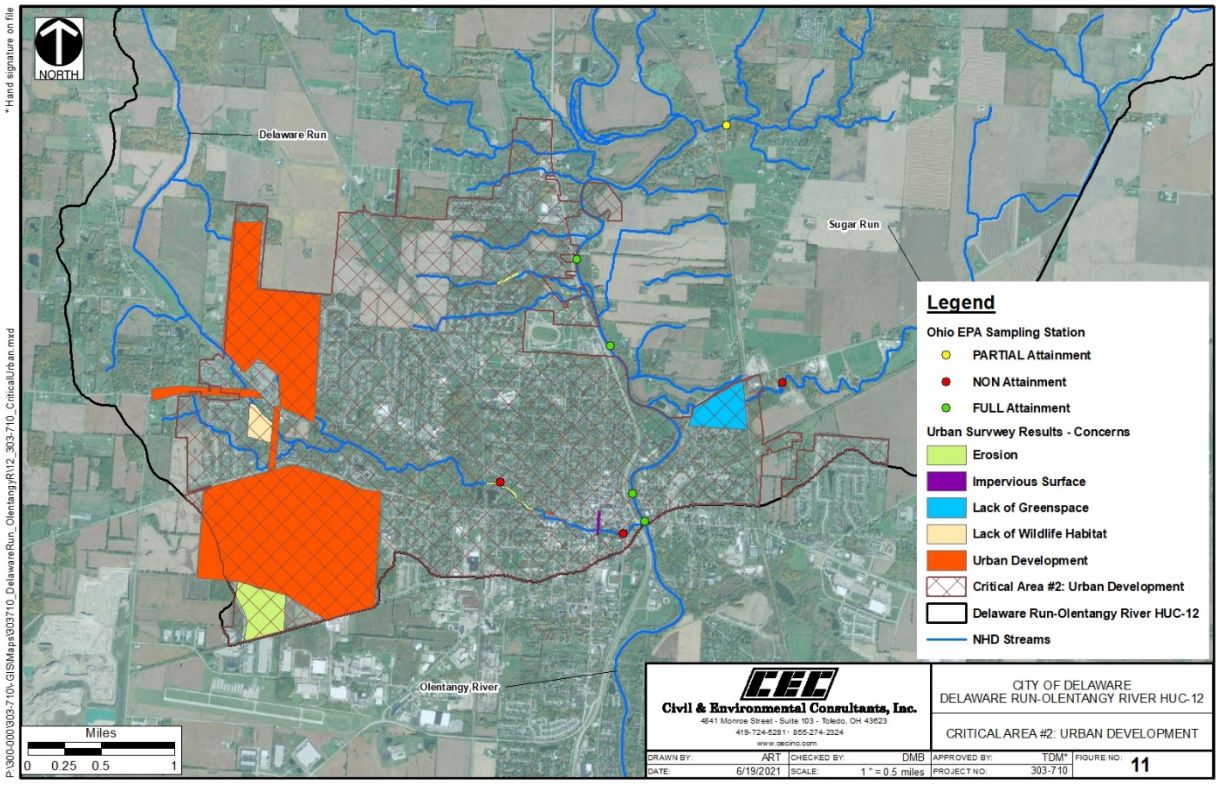

Figure 11: Delaware Run-Olentangy River HUC-12 Critical Area #2

Critical Area #2 contains priority urban lands within the City of Delaware, where development pressure is high and effects of urban runoff are apparent in Delaware Run and portions of Sugar Run. Delaware is the major population center within the **Delaware Run-Olentangy River HUC-12** and covers an area of approximately 19.9 square miles (12,736 acres), of which approximately 39% lies within the **Delaware Run-Olentangy River HUC-12** (~4,939 acres). Approximately 55% of *Critical Area #2* consists of impervious surface dedicated to residential, commercial, industrial or transportation uses (Table 22). *Critical Area #2* contains the final mile of Sugar Run and the lower 4.0 miles of Delaware Run. While *Critical Area #2* contains or is adjacent to a 3.0 mile segment of the Olentangy River (RM 28.8 – 25.8), the Olentangy River Corridor is not listed within *Critical Area #2*, but is instead listed in *Critical Area #4* for its objectives related to protection of High Quality Waters.

Table 22: Critical Area #2 – Land Use Classifications

Land Use	Delaware Run-Olentangy River HUC-12 (05060001 10 07)		
	Area (mi^2)	Area (acres)	% Critical Area
Commercial/Industrial/Transportation	0.35	227.21	4.60%
Crop	2.63	1,682.36	34.06%
Deciduous Forest	0.75	478.50	9.69%
Open Water	0.01	8.75	0.18%
Pasture	0.05	33.32	0.67%
Residential	3.86	2,472.16	50.06%
Urban/Recreational Grasses	0.06	36.61	0.74%
Total	**7.71**	**4,938.91**	**100.00%**

(Source: Homer et al., 2020)

Both the City of Delaware and Delaware County as a whole are known to be areas of intense development—the County has one of the fastest growing housing markets across the country, growing at about 2.2% (Hendrix, 2020). Population estimates cite over 41,280 people living within the City of Delaware in 2019, an 18.7% increase from the last census conducted in 2010 (US Census Bureau, 2021). The 2007 TMDL cited that "the most serious threat to channel stability, and possibly overall water quality and biological integrity in the Olentangy watershed is the rapid conversion of land to urban uses, resulting in increased runoff and sediment transport capacity" (Ohio EPA, 2007). A survey conducted in 2020-2021 as part of the NPS-IS planning effort revealed residents are also concerned with urban development, particularly in the western portion of the city. Areas of concern identified through the survey are shown on Figure 11 (p. 37).

3.3.2 Detailed Biological Conditions

Fish community data for the two sampling locations within *Critical Area #2* in the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 23). Analysis of the abundance, diversity and pollution tolerance of existing fish species found by Ohio EPA at each sampling location, in relation to the corresponding QHEI score, aids in the identification of causes and sources of impairment. In Delaware Run, fish communities scored in the Fair range. Diversity in catch was low, with only 8-10 species observed at each location. Habitat in Delaware Run was of relatively high quality at RM 1.2 (Limestone Park), despite the abundance of high-influence and moderate-influence MWH attributes and

severely eroding banks. Habitat at RM 0.2 (Henry Street) severely declined, with a score of 40 and a two-fold increase of high-influence MWH attributes from the upstream sampling location in Limestone Park.

Table 23: Critical Area #2 – Fish Community and Habitat Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)							
RM	**Drainage Area (mi^2)**	**Total Species**	**QHEI**	**IBI**	**MIwb[a]**	**Predominant Species (Percent of Catch)**	**Narrative Evaluation**
Delaware Run (WWH)							
[b]1.2[H]	9.5	10	61.0	34*	N/A	Johnny darter (36%), fantail darter (22%), creek chub (11%)	Fair
[b]0.2[H]	10.1	8	40.0	30*	N/A	Johnny darter (24%), central stoneroller (22%), bluntnose minnow (15%)	Fair

(Source: Ohio EPA, 2001)

NOTES
QHEI Qualitative Habitat Evaluation Index
IBI Index of Biotic Integrity
a The Modified Index of Well Being (MIwb) is not applicable to headwater sites (drainage ≤20 mi^2).
H Headwater site
** Significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the poor to very poor range.*
N/A Not applicable
WWH Warmwater Habitat
b 1999 sample

Characteristics of the aquatic macroinvertebrate community for the two sampling locations in *Critical Area #2* in the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 24). Analysis of the abundance, diversity, and pollution tolerance of existing aquatic macroinvertebrates found by Ohio EPA at these sampling locations, related to QHEI scores, can aid in the identification of causes and sources of impairment. Macroinvertebrate communities at both Delaware Run locations scored poorly. Few sensitive species were found at each location; EPT species were also very low (three at RM 1.2 and one at RM 0.2). Habitat characteristics contributing to these poorly performing communities include sparse to no cover and high amounts of substrate and riffle embeddedness (Ohio EPA, 2001).

Delaware Run is highly channelized and constrained by development. Photo from E.P. Ferris and Associates, 2020.

Table 24: Critical Area #2 – Macroinvertebrate Community Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)			
RM	**ICI Score-Narrative[a]**	**Notes (Density of Ql./Qt.)**	**Predominant Species**
Delaware Run (WWH)			
[b]1.2[H]	N/A – Poor* 1 sensitive taxa	--	River snails
[b]0.2[H]	N/A – Poor* 2 sensitive taxa	--	River snails

(Source: Ohio EPA, 2001)

NOTES
a Narrative evaluation used in lieu of ICI
b 1999 sample
H Headwater site
WWH Warmwater Habitat

3.3.3 Detailed Causes and Associated Sources

The data summarized previously in Table 14 (p.22) reveal a direct link between the presence of attributes in the watershed that have an influence on the aquatic communities throughout Delaware Run in *Critical Area #2*. These contributing attributes in *Critical Area #2* include:

- Channelization
- No Sinuosity
- Fair/Poor Development
- No Fast Current
- High/Moderate Embeddedness
- High/Moderate Riffle Embeddedness

Near-field impairment in Delaware Run is attributed to flow hydrology, habitat alterations and sewage from development, urban runoff and CSO/SSO impacts. Actions taken to address habitat through in-stream work, as well upland activities to make progress towards a reduction in urban nutrients can help address both near-field impairment and impairment on a far-field scale. Reductions in nutrients in urban areas through the use of green infrastructure for the retention, detention and filtration of urban pollutants can help decrease overall NPS pollution and improve aquatic communities. Compared with natural land cover, shallow and deep infiltration, as well as evapotranspiration, decreases while surface runoff increases in urban lands (USEPA, 2003). When watersheds have as little as 10% impervious surface, studies have shown that not only does runoff increase substantially, but pollutant loads also increase (CWP, 1998). The *Lower Olentangy WAP in 2003* encourages the minimization of stormwater, the preservation of existing natural features in the urban landscape, improvements to site design and implementation of stormwater BMPs for the treatment of water quantity and quality throughout the Olentangy watershed (FLOW, 2003).

3.3.4 Outline Goals and Objectives for the Critical Area

The overarching goal of any NPS-IS is to improve water quality scores in order to remove a waterbody's impairment status or protect quality areas to maintain attainment status. Urban land use activities in *Critical Area #2* contribute to not only near-field impairment and stressed aquatic communities in the Delaware Run, but also far-field impairment through excessive nutrient loss to local waterways that flow to the Ohio River. Ohio EPA has estimated nutrient loadings associated with various land uses and sources within targeted HUC-12s in the ORB, and has set nitrogen reduction goals for agricultural and urban sources. To achieve the desired nitrogen reduction from urban land use in the **Delaware Run-Olentangy River HUC-12**, the following goal has been established:

Goal 1. Reduce nitrogen loading contributions in the **Delaware Run-Olentangy River HUC-12** to a level at or below 25,500 lbs/year (20% reduction).
NOT ACHIEVED: Current estimated load contribution is 32,000 lbs/year.

Simultaneous goals relate to the improvement of in-stream conditions within Delaware Run in order to improve and/or maintain the health of aquatic communities. Implementation of BMP objectives geared towards nutrient reduction efforts will generally also help make incremental progress towards the following goals:

Goal 2. Achieve IBI score at or above 40 at Limestone Park in Delaware Run (RM 1.2).
NOT ACHIEVED: Site currently has a score of 34.

Goal 3. Achieve ICI score at or above 36 (Good) at Limestone Park in Delaware Run (RM 1.2).
NOT ACHIEVED: Site currently has a score of Poor (~22).

Goal 4. Maintain QHEI score at or above 60 at Limestone Park in Delaware Run (RM 1.2).
✓ ACHIEVED: Site currently has a score of 61.

Goal 5. Achieve IBI score at or above 40 at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of 30.

Goal 6. Achieve ICI score at or above 36 (Good) at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of Poor (~22).

Goal 7. Achieve QHEI score at or above 60 at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of 40.

Objectives

In order to make substantive progress toward the achievement of the nitrogen load reduction goal of 6,500 lbs for the **Delaware Run-Olentangy River HUC-12**, effort must commence on more widespread implementation, according to the following objectives within *Critical Area #2.*

Objective 1: Reduce stormwater inputs and impacts in the sub-watershed by implementing green infrastructure projects within *Critical Area #2* that retain, detain, and/or treat runoff

from at least 2,000 acres of urbanized impermeable surfaces (i.e., parking lots, roads, etc.).

Objective 2: Reduce stormwater inputs and impacts in the sub-watershed by restoring and/or creating floodplain and wetland detention/storage basins to retain, detain and/or treat urban drainage from at least 200 acres.

Objective 3: Reduce excessive sedimentation and associated nutrients by restoring and stabilizing at least one mile (5,280 linear feet) of urban, scoured streambanks in the sub-watershed.

Water quality monitoring is an integral part of the project implementation process. Both project-specific and routinely scheduled monitoring will be conducted to determine progress towards meeting the goals (i.e., water quality standards and nutrient reduction targets). Through an adaptive management process, the aforementioned objectives will be reevaluated and modified as necessary. Objectives may be added to make further progress towards attainment or reduction goals, or altered, as a systems approach of multiple BMPs can accelerate the improvement of water quality conditions. The *Nonpoint Source Management Plan Update* (Ohio EPA, 2020c) will be utilized as a reevaluation tool for its listing of all eligible NPS management strategies to consider including:

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

3.4 Critical Area #3: Conditions, Goals & Objectives for Tributary Streambank and Riparian Restoration

3.4.1 Detailed Characterization

The *Upper Olentangy WAP* addresses the need for streambank stabilization and riparian and floodplain restoration throughout the **Delaware Run-Olentangy River HUC-12** in areas where land use has resulted in bare/denuded banks susceptible to erosion and perennial streams have been disconnected from their floodplains (OWA, 2006). The *Upper Olentangy WAP* identified that at least 88.9 acres of riparian corridor were in need of restoration in order to meet a minimum 33-foot buffer around all streams within the **Delaware Run-Olentangy River HUC-12**, but the plan also recognized that aerial imagery used for that analysis was dated and that this number is likely an underestimation of needs specific to 2006 when the plan was published. Analysis of aerial imagery as part of this NPS-IS planning effort identified 146,360 linear feet (27.72 miles) of denuded banks within tributary locations.

Specific actions suggested for this sub-watershed in the TMDL include replanting and forestation of riparian and floodplain corridors, as well as restoration of streambanks through natural channel design techniques, two-stage ditch installation and bio-engineering techniques (Ohio EPA, 2007). Using the rationale described in the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*

(USEPA, 2008)(Section 10.3.4): "In general, management practices are implemented immediately adjacent to the waterbody or upland to address the sources of pollutant loads", *Critical Area #3* includes approximately 146,360 linear feet (27.72 miles) of stream length and a 75-foot buffer width on each side[8] (Figure 12). The potential for restoration of approximately 500 acres of riparian corridor and floodplain exists in *Critical Area #3*.

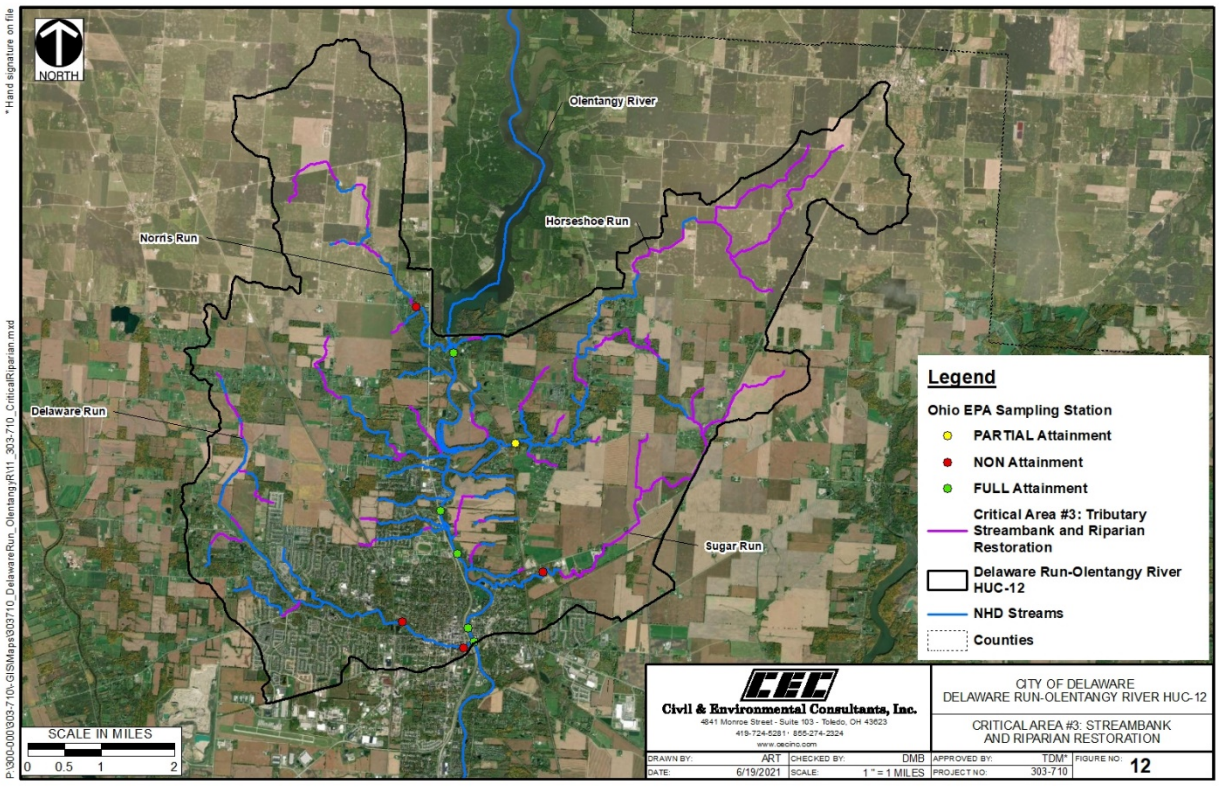

Figure 12: Delaware Run-Olentangy River HUC-12 Critical Area #3

3.4.2 Detailed Biological Conditions

Fish community data for the five sampling locations within the tributaries of Norris Run, Horseshoe Run, Sugar Run and Delaware Run in the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 25). Analysis of the abundance, diversity and pollution tolerance of existing fish species found by Ohio EPA at each sampling location, in relation to the corresponding QHEI score, aids in the identification of causes and sources of impairment. Habitat scores met expected thresholds for WWH streams (QHEI ≥ 60), with the exception of Delaware Run (addressed in *Critical Area #2* for urban nutrient reduction). However, fish communities generally scored within the Poor to Fair range, indicating stress from adjacent and upstream land use, which was apparent in the abundance of high to moderate-influence MWH attributes.

[8] Recommended width for tributary drainage area size (Cuyahoga SWCD, undated).

Table 25: Critical Area #3 – Fish Community and Habitat Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)							
RM	**Drainage Area (mi^2)**	**Total Species**	**QHEI**	**IBI**	**MIwb[a]**	**Predominant Species (Percent of Catch)**	**Narrative Evaluation**
Norris Run (WWH)							
[b]1.3[H]	5.8	17	62.0	23*	N/A	Bluntnose minnow (70%), white sucker (8%), creek chub (7%)	Poor
Horseshoe Run (WWH)							
[c]0.3[H]	11.3	13	63.5	38[ns]	N/A	Central stoneroller (43%), creek chub (32%), rainbow darter (6%)	Marginally Good
Sugar Run (WWH)							
[b]1.3[H]	3.5	8	69.0	29*	N/A	Orangethroat darter (54%), green sunfish (27%), white sucker (8%)	Fair
Delaware Run (WWH)							
[c]1.2[H]	9.5	10	61.0	34*	N/A	Johnny darter (36%), fantail darter (22%), creek chub (11%)	Fair
[c]0.2[H]	10.1	8	40.0	30*	N/A	Johnny darter (24%), central stoneroller (22%), bluntnose minnow (15%)	Fair

(Source: Ohio EPA, 2001; Ohio EPA, 2005)

NOTES

QHEI Qualitative Habitat Evaluation Index

IBI Index of Biotic Integrity

a The Modified Index of Well Being (MIwb) is not applicable to headwater sites (drainage ≤20 mi^2).

H Headwater site

** Significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the poor to very poor range.*

N/A Not applicable

WWH Warmwater Habitat

b 2003 sample

c 1999 sample

Characteristics of the aquatic macroinvertebrate community for the tributaries in the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 26). Analysis of the abundance, diversity, and pollution tolerance of existing aquatic macroinvertebrates found by Ohio EPA at these sampling locations, related to QHEI scores, can aid in the identification of causes and sources of impairment. No macroinvertebrate community within the four tributaries met WWH thresholds, with scores falling in the Poor to Fair range. Communities were consistently populated with intolerant taxa, and counts of sensitive and EPT species were relatively low.

Table 26: Critical Area #3 – Macroinvertebrate Community Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)			
RM	**ICI Score-Narrative[a]**	**Notes (Density of Ql./Qt.)**	**Predominant Species**
Norris Run (WWH)			
[b]1.3[H]	N/A – Low Fair* 5 sensitive taxa	Moderate	Blackflies (F)
Horseshoe Run (WWH)			
[c]0.3[H]	N/A – Fair* 4 sensitive taxa	--	Alder flies, midges
Sugar Run (WWH)			
[b]1.3[H]	N/A – Low Fair* 9 sensitive taxa	Moderate	Blackflies (F), sow bugs (F)
Delaware Run (WWH)			
[c]1.2[H]	N/A – Poor* 1 sensitive taxa	--	River snails
[c]0.2[H]	N/A – Poor* 2 sensitive taxa	--	River snails

(Source: Ohio EPA, 2001; Ohio EPA, 2005)

NOTES
a Narrative evaluation used in lieu of ICI
Tolerance Categories: VT=Very Tolerant, T=Tolerant, MT=Moderately Tolerant, F=Facultative, MI=Moderately Intolerant, I=Intolerant.
b 2003 sample
c 1999 sample
H Headwater site
WWH Warmwater Habitat

3.4.3 Detailed Causes and Associated Sources

Horseshoe Run. Photo courtesy of Erin Wolfe.

One sampling site within Norris Run is in *Non-Attainment* of the WWH designation due to habitat alteration, nutrient enrichment and siltation from riparian removal and urbanization. One sampling location in Horseshoe Run is in *Partial Attainment* of the WWH designation due to naturally occurring low flow conditions, and one sampling location within Sugar Run is in *Non-Attainment* of the WWH designation due to siltation and nutrient enrichment from urban influences. Two sampling locations within Delaware Run are in *Non-Attainment* of the WWH designation due to flow hydrology, habitat alterations and sewage from development, urban runoff and

CSO/SSO impacts. The data summarized previously in Table 14 (p.22) reveal a direct link between the presence of attributes in the watershed that have influence on the aquatic communities throughout the streams in *Critical Area #3*. These contributing attributes in *Critical Area #3* include:

- Heavy/Moderate Silt Cover (Norris Run, Sugar Run)
- Low Sinuosity (Horseshoe Run, Delaware Run)
- High/Moderate Embeddedness (all streams)
- High/Moderate Riffle Embeddedness (Norris Run, Delaware Run)
- Lack of Riffle (Norris Run, Horseshoe Run, Sugar Run)

Habitat, as scored by the QHEI, is not a WQS; however, habitat is highly correlated with the performance of aquatic communities. In general, sites that score at least 60 (or 55 for headwater streams) are successful at supporting WWH aquatic assemblages. Projects that address the above described habitat-related attributes (e.g., embeddedness, sinuosity, etc.) through in-stream and riparian restoration will have a positive effect in the QHEI scoring index. As the habitat score (QHEI) becomes better, IBI and ICI index scores are also expected to improve.

3.4.4 Outline Goals and Objectives for the Critical Area

The overarching goal of any NPS-IS is to improve water quality scores or meet nutrient reduction goals in order to remove a waterbody's impairment status. For *Critical Area #3,* addressing streambank and riparian habitat conditions within Norris Run, Horseshoe Run, Sugar Run and Delaware Run and their contributing tributaries will help ameliorate stresses from land use and boost index values for aquatic communities.

The remaining goals for *Critical Area #3* of the **Delaware Run-Olentangy River HUC-12** are to reduce sedimentation/siltation and habitat alteration effects to improve the aquatic scores through stabilizing streambanks and restoring floodplains and riparian corridors. These goals are to specifically:

Goal 1. Achieve IBI score at or above 40 at Penry Road in Norris Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of 23.

Goal 2. Achieve ICI score at or above 36 (Good) at Penry Road in Norris Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of Low Fair (~28).

Goal 3. Maintain QHEI score at or above 60 at Penry Road in Norris Run (RM 1.3).
✓ ACHIEVED: Site currently has a score of 62.

Goal 4. Achieve IBI score at or above 40 at Panhandle Road in Horseshoe Run (RM 0.3).
NOT ACHIEVED: Site currently has a score of 38.

Goal 5. Achieve ICI score at or above 36 (Good) at Panhandle Road in Horseshoe Run (RM 0.3).
NOT ACHIEVED: Site currently has a score of Fair (~32).

Goal 6. Maintain QHEI score at or above 60 at Panhandle Road in Horseshoe Run (RM 0.3).
✓ ACHIEVED: Site currently has a score of 63.5.

Goal 7. Achieve IBI score at or above 40 at Salt Storage Road in Sugar Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of 29.

Goal 8. Achieve ICI score at or above 36 (Good) at Salt Storage Road in Sugar Run (RM 1.3).
NOT ACHIEVED: Site currently has a score of Low Fair (~28).

Goal 9. Maintain QHEI score at or above 60 at Salt Storage Road in Sugar Run (RM 1.3).
✓ ACHIEVED: Site currently has a score of 69.

Goal 10. Achieve IBI score at or above 40 at Limestone Park in Delaware Run (RM 1.2).
NOT ACHIEVED: Site currently has a score of 34.

Goal 11. Achieve ICI score at or above 36 (Good) at Limestone Park in Delaware Run (RM 1.2).
NOT ACHIEVED: Site currently has a score of Poor (~22).

Goal 12. Maintain QHEI score at or above 60 at Limestone Park in Delaware Run (RM 1.2).
✓ ACHIEVED: Site currently has a score of 61.

Goal 13. Achieve IBI score at or above 40 at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of 30.

Goal 14. Achieve ICI score at or above 36 (Good) at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of Poor (~22).

Goal 15. Achieve QHEI score at or above 60 at Henry Street in Delaware Run (RM 0.2).
NOT ACHIEVED: Site currently has a score of 40.

Objectives

The implementation of these objectives, partnered with implementation throughout other identified critical areas will help ameliorate negative impacts from channelization and habitat alterations made within the tributaries of the **Delaware Run-Olentangy River HUC-12**, and positive gains will be made towards removing both near-field and far-field impairments. In order to achieve the overall NPS restoration goals of reaching *Full Attainment* at all sites within Norris Run, Horseshoe Run, Sugar Run and Delaware Run, the following objectives need to be achieved within *Critical Area #3.*

Objective 1: Stabilize and restore at least six miles (31,680 linear feet) of eroding streambanks through recontouring, regrading and/or natural channel design methods.

Objective 2: Create, enhance or restore at least 120 acres of riparian corridor and/or riparian floodplain wetlands.

Water quality monitoring is an integral part of the project implementation process. Both project-specific and routinely scheduled monitoring will be conducted to determine progress towards meeting the goals (i.e., water quality standards and nutrient reduction targets). Through an adaptive management process, the aforementioned objectives will be reevaluated and modified as necessary. Objectives may be added to make further progress towards attainment or reduction goals, or altered, as a systems approach of multiple BMPs can accelerate the improvement of water quality conditions. The *Nonpoint Source Management Plan Update* (Ohio EPA, 2020c) will be utilized as a reevaluation tool for its listing of all eligible NPS management strategies to consider including:

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

3.5 Critical Area #4: Conditions, Goals & Objectives for High Quality Waters Protection for the Olentangy River

3.5.1 Detailed Characterization

Approximately 22 miles of the Olentangy River, stemming from the Delaware Dam to Old Wilson Bridge in Worthington, Ohio, were adopted into the Ohio Scenic Rivers Program on August 24, 1973. The Ohio Scenic Rivers Program, led by ODNR, works to cooperatively involve local governments, businesses, landowners, non-profit organizations and other state and federal agencies in the protection of resources and terrestrial communities dependent on healthy riparian habitats (ODNR, 2021b). The Scenic Rivers Program recommends a stream buffer of at least 120 linear feet be maintained on each side of a state-designated scenic river (Ohio EPA, 2020c). Construction within this corridor is discouraged, and various mitigation requirements are initiated under the Olentangy Construction General Permit when development is permitted within a streamside buffer of 100 linear feet or an outer buffer within the 100-year floodplain (MORPC, 2012).

Specific actions suggested for the protection of High Quality Waters include stream restoration activities using natural channel design techniques, dedicated management of invasive species and regulated use within riparian corridors (Ohio EPA, 2020c). Recent restoration work within the Olentangy River mainstem has included removal of three lowhead dams, all located within the **Delaware Run-Olentangy River HUC-12**. As development pressures and threats to water quality increase throughout the Olentangy watershed, the protection and further restoration of the Olentangy corridor is of utmost importance to maintain attainment of high-performing aquatic communities. *Critical Area #4* is dedicated to the restoration, enhancement and protection of the riparian corridor of the Olentangy River mainstem, which includes a 120-foot buffer on each side, and any remaining acreage included in the 100-year floodplain (Figure 13). In total, this area covers 6.6 miles of the Olentangy River and 870 acres.

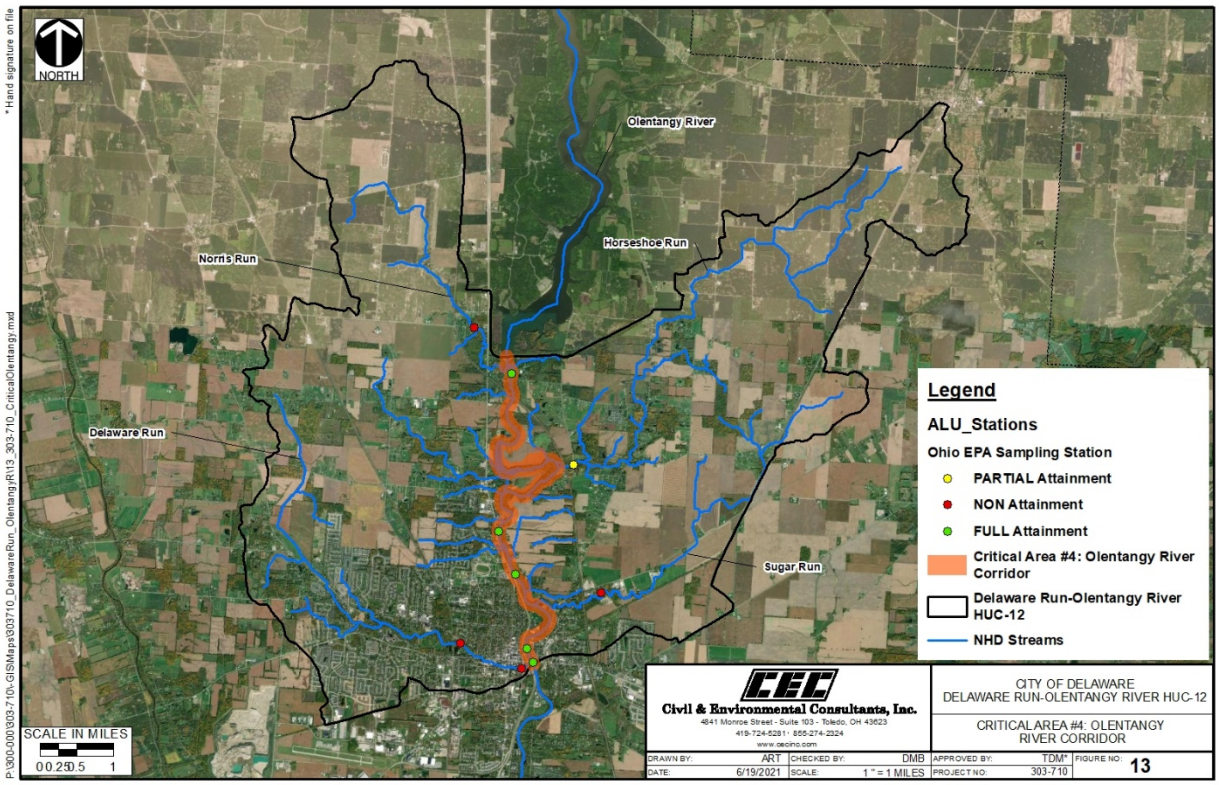

Figure 13: Delaware Run-Olentangy River HUC-12 Critical Area #4

3.5.2 Detailed Biological Conditions

Fish community data for the five sampling locations within the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 27). Analysis of the abundance, diversity and pollution tolerance of existing fish species found by Ohio EPA at each sampling location, in relation to the corresponding QHEI score, aids in the identification of causes and sources of impairment. Within the Olentangy River, fish communities performed well, with all sites exceeding biocriteria for WWH streams to reach EWH thresholds. The high performance in this stretch of the river is attributed to the removal of three lowhead dams along the mainstem (Ohio EPA, 2020a).

Table 27: Critical Area #4 – Fish Community and Habitat Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)							
RM	**Drainage Area (mi^2)**	**Total Species**	**QHEI**	**IBI**	**MIwb[a]**	**Predominant Species (Percent of Catch)**	**Narrative Evaluation**
Olentangy River (WWH)							
[b]32.10[W]	393.0	34	80.5	46	10.8	Bluegill sunfish (15%), green sunfish (9%), black crappie (9%)	Very Good – Exceptional
[c]28.20[W]	409.0	29	82.3	50	10.3	Central stoneroller (38%), banded darter (13%), spotfin shiner (8%)	Exceptional
[b]27.50[W]	411.0	33	81.0	43	9.4	Bluntnose minnow (21%), bluegill sunfish (17%), spotfin shiner (11%)	Good – Exceptional

[c]26.00[W]	421.0	30	83.0	48	11.0	Smallmouth bass (14%), central stoneroller (14%), northern hog sucker (11%)	Very Good – Exceptional
[c]25.80[W]	421.1	23	77.5	48	9.6	Central stoneroller (23%), sand shiner (22%), northern hog sucker (13%)	Very Good – Exceptional

(Source: Ohio EPA, 2020a; Ohio EPA, 2020b)

NOTES
QHEI Qualitative Habitat Evaluation Index
IBI Index of Biotic Integrity
a The Modified Index of Well Being (MIwb) is not applicable to headwater sites (drainage ≤20 mi^2).
W Wading site
** Significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the poor to very poor range.*
N/A Not applicable
WWH Warmwater Habitat
b 2011 sample
c 2016 sample

Characteristics of the aquatic macroinvertebrate community for the **Delaware Run-Olentangy River HUC-12** are summarized below (Table 28). Analysis of the abundance, diversity, and pollution tolerance of existing aquatic macroinvertebrates found by Ohio EPA at these sampling locations, related to QHEI scores, can aid in the identification of causes and sources of impairment. The macroinvertebrate communities within the Olentangy River mainstem performed well, despite persistence of MWH attributes (i.e., heavy silt cover, high embeddedness, etc.). The prevalence of these habitat characteristics are of particular concern. As impervious surface area increases within the greater Olentangy watershed, water volume and velocity, and the associated sediment and nutrient loads, during storm events become a main threat to the aquatic communities within the river.

Table 28: Critical Area #4 – Macroinvertebrate Community Data

Delaware Run-Olentangy River HUC-12 (05060001 10 07)			
RM	**ICI Score-Narrative[a]**	**Notes (Density of Ql./Qt.)**	**Predominant Species**
Olentangy River (WWH)			
[b]32.10[W]	38 – Good 14 sensitive taxa	--	*Rheotanytarsus* sp (F), *Polypedilum (Uresipedilum) flavum* (F), *Cheumatopsyche sp* (F)
[c]28.20[W]	38 – Good 23 sensitive taxa	--	*Polypedilum (Uresipedilum) flavum* (F), *Baetis intercalaris* (F), *Cheumatopsyche sp* (F)
[b]27.50[W]	46 – Exceptional 36 sensitive taxa	--	*Polypedilum (Uresipedilum) flavum* (F), *Cheumatopsyche sp* (F), *Maccaffertium pulchellum* (MI)
[c]26.00[W]	46 – Exceptional 29 sensitive taxa	--	*Baetis intercalaris* (F), *Cheumatopsyche sp* (F), *Maccaffertium pulchellum* (MI)
[c]25.80[W]	48 – Exceptional 31 sensitive taxa	--	*Baetis intercalaris* (F), *Polypedilum (Uresipedilum) flavum* (F), *Cheumatopsyche sp* (F)

(Source: Ohio EPA, 2020a; Ohio EPA, 2020b)

NOTES

a Narrative evaluation used in lieu of ICI

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

b 2011 sample

c 2016 sample

WWH Warmwater Habitat

3.5.3 Detailed Causes and Associated Sources

Five sampling sites in the Olentangy River mainstem in the **Delaware Run-Olentangy River HUC-12** are currently in *Full Attainment* of the WWH designation. While these sites are meeting (and exceeding WWH) thresholds due to recent dam removal, protection and restoration of problem areas, mainly related to eroding streambanks, along the mainstem are necessary to protect the high-quality status of the river. The data summarized previously in Table 14 (p.22) reveal a direct link between the presence of attributes in the Olentangy mainstem that have influence on the aquatic communities in *Critical Area #4*. These contributing attributes in *Critical Area #4* include:

- Heavy/Moderate Silt Cover
- Low Sinuosity
- High/Moderate Embeddedness
- High/Moderate Riffle Embeddedness

The ODNR samples QHEI throughout the mainstem as well. A comparison of ODNR data from 2007, 2012 and 2017 reveals a general decrease in scores across the river, both within and downstream of the **Delaware Run-Olentangy River HUC-12** (*personal communication and documentation from Caroline Cicerchi, November 18, 2020)*.

Table 29: Ohio Department of Natural Resources Olentangy River QHEI Study Results

River Mile	Site Location	2007 Score	2012 Score	2017 Score
31.0	**City of Delaware WWTP**	**84**	**85**	**77.5**
24.45	Stratford Road	81	85	77.75
19.7	Chapman Road	86.5	82	79.25
17.7	State Route 315 and Home Road	--	87	81.25
16.4	State Route 315 and Orange Road	--	82	76.75
14.55	Highbanks	88.5	84.5	81
13.3	Highbanks: River Bluff	82	81	77.25

(Source: Comparison data provided to Caroline Cicerchi, City of Delaware from ODNR Scenic Rivers)

NOTES

Site in bold is located in the Delaware Run-Olentangy River HUC-12.

Habitat, as scored by the QHEI, is not a WQS; however, habitat is highly correlated with the performance of aquatic communities. In general, sites that score at least 60 (or 55 for headwater streams) are successful at supporting WWH aquatic assemblages. Sites that score at least 75 are generally supportive of EWH communities. Projects that address the above described habitat-related attributes (e.g., embeddedness, silt cover, etc.) through in-stream and riparian restoration will have a positive effect in the QHEI scoring index and will help maintain attainment within the Olentangy River.

3.5.4 Outline Goals and Objectives for the Critical Area

The overarching goal of any NPS-IS is to improve water quality scores or meet nutrient reduction goals in order to remove a waterbody's impairment status. For *Critical Area #4,* addressing any degradation to the streambank and riparian habitat conditions within the Olentangy River will aid in the protection of these high quality waters. The remaining goals for *Critical Area #4* of the **Delaware Run-Olentangy River HUC-12** are to maintain and/or improve the aquatic scores within the Olentangy River through the restoration of degrading streambanks and riparian habitat. These goals are to specifically:

Goal 1. Maintain IBI score at or above 40 at a USGS gage downstream of the Delaware Reservoir in Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 46.

Goal 2. Maintain MIwb score at or above 8.3 at a USGS gage downstream of the Delaware Reservoir in the Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 10.8.

Goal 3. Maintain ICI score at or above 36 at a USGS gage downstream of the Delaware Reservoir in the Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 38.

Goal 4. Maintain QHEI score at or above 60 at a USGS gage downstream of the Delaware Reservoir in the Olentangy River (RM 32.10).
✓ ACHIEVED: Site currently has a score of 80.5.

Goal 5. Maintain IBI score at or above 40 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 50.

Goal 6. Maintain MIwb score at or above 8.3 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 10.3.

Goal 7. Maintain ICI score at or above 36 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 38.

Goal 8. Maintain QHEI score at or above 60 at Panhandle Road in the Olentangy River (RM 28.20).
✓ ACHIEVED: Site currently has a score of 82.3.

Goal 9. Maintain IBI score at or above 40 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 43.

Goal 10. Maintain MIwb score at or above 8.3 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 9.4.

Goal 11. Maintain ICI score at or above 36 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 46.

Goal 12. Maintain QHEI score at or above 60 at Hudson Road in the Olentangy River (RM 27.50).
✓ ACHIEVED: Site currently has a score of 81.

Goal 13. Maintain IBI score at or above 40 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 48.

Goal 14. Maintain MIwb score at or above 8.3 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 11.

Goal 15. Maintain ICI score at or above 36 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 46.

Goal 16. Maintain QHEI score at or above 60 at Central Avenue in the Olentangy River (RM 26.00).
✓ ACHIEVED: Site currently has a score of 83.

Goal 17. Maintain IBI score at or above 40 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 48.

Goal 18. Maintain MIwb score at or above 8.3 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 9.6.

Goal 19. Maintain ICI score at or above 36 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 48.

Goal 20. Maintain QHEI score at or above 60 at Williams Street in the Olentangy River (RM 25.80).
✓ ACHIEVED: Site currently has a score of 77.5.

Objectives

The implementation of these objectives, partnered with implementation throughout other identified critical areas will help ameliorate stressors that may negatively impact the high performing communities of the Olentangy River. In order to protect these high quality waters and maintain *Full Attainment* within the Olentangy River within the **Delaware Run-Olentangy River HUC-12**, the following objectives need to be achieved within *Critical Area #4.*

Objective 1: Stabilize and restore at least 1.5 miles (7,920 linear feet) of eroding streambanks through recontouring, regrading and/or natural channel design methods.

Objective 2: Create, enhance or restore at least 220 acres of riparian corridor through active invasive species management and native plantings.

Water quality monitoring is an integral part of the project implementation process. Both project-specific and routinely scheduled monitoring will be conducted to determine progress towards meeting the goals (i.e., water quality standards and nutrient reduction targets). Through an adaptive management process, the aforementioned objectives will be reevaluated and modified as necessary. Objectives may be added to make further progress towards attainment or reduction goals, or altered, as a systems approach of multiple BMPs can accelerate the improvement of water quality conditions. The *Nonpoint Source Management Plan Update* (Ohio EPA, 2020c) will be utilized as a reevaluation tool for its listing of all eligible NPS management strategies to consider including:

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

Steep, exposed banks at Mingo Park. Photo courtesy of Erin Wolfe.

CHAPTER 4: PROJECTS AND IMPLEMENTATION STRATEGY

Projects and evaluation needs identified for the **Delaware Run-Olentangy River HUC-12** are based upon identified causes and associated sources of NPS pollution. Over time, these critical areas will need to be reevaluated to determine progress towards meeting restoration, attainment and nutrient reduction goals. Time is an important variable in measuring project success and overall status when using biological indices as a measurement tool. Some biological systems may show fairly quick response (i.e., one season), while others may take several seasons or years to show progress towards recovery. In addition, reasons for the impairment other than those associated with NPS sources may arise. Those issues will need to be addressed under different initiatives, authorities or programs that may or may not be accomplished by the same implementers addressing the NPS issues.

Implementation of practices described in this NPS-IS may also contribute to nutrient load reduction (specifically the interim 20% reduction in nitrogen and phosphorus loading in the MARB). Nutrient load reduction efforts are consistent with the HTF Action Plan and New Goal Framework (HTF, 2014).

For the **Delaware Run-Olentangy River HUC-12** there are four *Project and Implementation Strategy Overview Tables* (subsection 4.1, 4.2, 4.3 and 4.4). Future versions of this NPS-IS may include subsequent sections as more critical areas are refined and more projects become developed to meet the requisite objectives within a critical area. The projects described in the *Overview Table* have been prioritized using the following three-step prioritization method:

Priority 1 — Projects that specifically address one or more of the listed Objectives for the Critical Area.

Priority 2 — Projects where there is land-owner willingness to engage in projects that are designed to address the cause(s) and source(s) of impairment or where there is an expectation that such potential projects will improve water quality in the **Delaware Run-Olentangy River HUC-12**.

Priority 3 — In an effort to generate interest in projects, an information and education campaign will be developed and delivered. Such outreach will engage citizens to spark interest by stakeholders to participate and implement projects like those mentioned in Priority 1 and 2.

Project Summary Sheets (PSS) follow the *Overview Tables*, if projects were identified; these provide the essential nine elements for short-term and/or next step projects that are in development and/or in need of funding. As projects are implemented and new projects developed, these sheets will be updated. Any new PSS created will be submitted to the state of Ohio for funding eligibility verification (i.e., all nine elements are included).

4.1 Critical Area #1 Project and Implementation Strategy Overview Table

Table 30: Delaware Run-Olentangy River HUC-12 (05060001 10 07) — Critical Area #1							
Goal	**Objective**	**Project #**	**Project Title (EPA Criteria g)**	**Lead Organization (EPA criteria d)**	**Time Frame (EPA Criteria f)**	**Estimated Cost (EPA Criteria d)**	**Potential/Actual Funding Source (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							

At this time, no short-term projects have been identified for *Critical Area #1*; therefore, no Project Summary Sheets are included.

4.2 Critical Area #2 Project and Implementation Strategy Overview Table

Table 31: Delaware Run-Olentangy River HUC-12 (05060001 10 07) — Critical Area #2							
Goal	**Objective**	**Project #**	**Project Title (EPA Criteria g)**	**Lead Organization (EPA criteria d)**	**Time Frame (EPA Criteria f)**	**Estimated Cost (EPA Criteria d)**	**Potential/Actual Funding Source (EPA Criteria d)**
Urban Sediment and Nutrient Reduction Strategies							
Altered Stream and Habitat Restoration Strategies							
1-7	2,3	1	Hidden Valley Golf Course Stream Restoration	City of Delaware	Short (1-3 years)	$275,000	Ohio EPA §319, Ohio EPA WRRSP
1-7	2,3	TBD	Blue Limestone Park Restoration	City of Delaware	TBD	TBD	TBD
1-7	2,3	TBD	Ruth Melvin Preserve Restoration	City of Delaware	TBD	TBD	TBD
Agricultural Nonpoint Source Reduction Strategies							
High Quality Waters Protection Strategies							
Other NPS Causes and Associated Sources of Impairment							

4.2.1 Project Summary Sheet(s)

The Project Summary Sheets provided below were developed based on the actions or activities needed to achieve urban nutrient reduction targets in the **Delaware Run-Olentangy River HUC-12**. These projects are considered next step or priority/short term projects and are considerably ready to implement. Medium and longer-term projects will not have a Project Summary Sheet, as these projects are not ready for implementation or need more thorough planning.

Table 32: Critical Area #2 – Project #1

Nine Element Criteria	Information needed	Explanation
n/a	Title	Hidden Valley Golf Course Stream Restoration
criteria d	Project Lead Organization & Partners	City of Delaware
criteria c	HUC-12 and Critical Area	Delaware Run-Olentangy River HUC-12: *Critical Area #2*
criteria c	Location of Project	40.301703, -83.087033
n/a	Which strategy is being addressed by this project?	Altered Stream and Habitat Restoration
criteria f	Time Frame	Short (1-3 years)
criteria g	Short Description	Stream restoration to a golf course tributary draining to Delaware Run
criteria g	Project Narrative	Approximately 1,000 linear feet of an unnamed tributary flows through the City of Delaware-owned Hidden Valley Golf Course to empty into Delaware Run, just upstream of the Blue Limestone Park (and current biological sampling station at RM 1.2). This unnamed tributary drains approximately 62 acres of heavily fertilized golf course. Currently, the unnamed tributary has no riparian buffer, and erosive flows have eroded the streambanks, causing near vertical banks along a substantial stretch of the stream, which flows directly to empty into Delaware Run. The length of the stream (~1,000 linear feet) will be restored using natural channel design techniques to stabilize the banks and a native grass/shrub riparian buffer will be established along its length to provide surface water filtration benefits for nutrients and pesticides.
criteria d	Estimated Total cost	$275,000
criteria d	Possible Funding Source	Ohio EPA §319, Ohio EPA WRRSP
criteria a	Identified Causes and Sources	Cause: Nutrient loadings, leading to far-field impacts Source: Urban land use activities

Table 32: Critical Area #2 – Project #1		
Nine Element Criteria	**Information needed**	**Explanation**
criteria b & h	Part 1: How much improvement is needed to remove the NPS impairment for the whole Critical Area?	The overall goal in *Critical Area #2* is to reduce estimated total nitrogen loads. Current estimates indicate the urban contribution to the annual load is 32,000 lbs. of nitrogen. In order to meet the HTF nutrient reduction goals, annual loads must be reduced by 20%, or 6,500 lbs.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	It is expected that this project will cause a decrease in annual nitrogen loadings by 323 lbs. through incremental progress made on Objective #2 and #3 (5% progress).
	Part 3: Load Reduced?	Estimated annual reduction: 324 #N/year; 111 #P/year; 147.4 tons sediment/year
criteria i	How will the effectiveness of this project in addressing the NPS impairment be measured?	Ambient monitoring is conducted throughout the ORB by organizations such as Ohio EPA and Heidelberg University. These entities will continue long term monitoring on various tributaries in the ORB to track load reduction trends. Staff from the Ohio EPA-Division of Surface Water Ecological Assessment Unit may also perform both pre- and post-project in-stream monitoring. The Blue Limestone Park sampling site (Delaware Run, RM 1.2) will be monitored as part of the State of Ohio's ongoing surface water monitoring program cycle to determine progress from *Non-Attainment* to *Full Attainment*.
criteria e	Information and Education	The City of Delaware will promote the project through press releases, website and social media announcements and newsletters, as well as through events hosted by the Olentangy Watershed Alliance and its partnering organizations (i.e., the Olentangy Watershed Forum). Once restoration is complete, the City will host a tour of the site and will install permanent informational signage regarding the importance of stormwater management and providing buffers in urban streams to create awareness of urban nutrient reduction and encourage public practices on their own land. Given the location on a City-owned golf course, a high amount of public exposure is expected.

4.3 Critical Area #3 Project and Implementation Strategy Overview Table

Table 33: Delaware Run-Olentangy River HUC-12 (05060001 10 07) — Critical Area #3							
Goal	**Objective**	**Project #**	**Project Title (EPA Criteria g)**	**Lead Organization (EPA criteria d)**	**Time Frame (EPA Criteria f)**	**Estimated Cost (EPA Criteria d)**	**Potential/Actual Funding Source (EPA Criteria d)**
Urban Sediment and Nutrient Reduction Strategies							
Altered Stream and Habitat Restoration Strategies							
Agricultural Nonpoint Source Reduction Strategies							
1	4	TBD	Horseshoe Run Stream Stabilization and Restoration	TBD	TBD	TBD	Ohio EPA §319, Ohio EPA WRRSP
High Quality Waters Protection Strategies							
Other NPS Causes and Associated Sources of Impairment							

At this time, no short-term projects have been identified for *Critical Area #3*; therefore, no Project Summary Sheets are included.

4.4 Critical Area #4 Project and Implementation Strategy Overview Table

Table 34: Delaware Run-Olentangy River HUC-12 (05060001 10 07) — Critical Area #4							
Goal	**Objective**	**Project #**	**Project Title (EPA Criteria g)**	**Lead Organization (EPA criteria d)**	**Time Frame (EPA Criteria f)**	**Estimated Cost (EPA Criteria d)**	**Potential/Actual Funding Source (EPA Criteria d)**
Urban Sediment and Nutrient Reduction Strategies							
Altered Stream and Habitat Restoration Strategies							
13-20	1,2	TBD	Mingo Park Restoration	TBD	TBD	TBD	Ohio EPA §319, Ohio EPA WRRSP
Agricultural Nonpoint Source Reduction Strategies							
High Quality Waters Protection Strategies							
Other NPS Causes and Associated Sources of Impairment							

At this time, no short-term projects have been identified for *Critical Area #4*; therefore, no Project Summary Sheets are included.

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