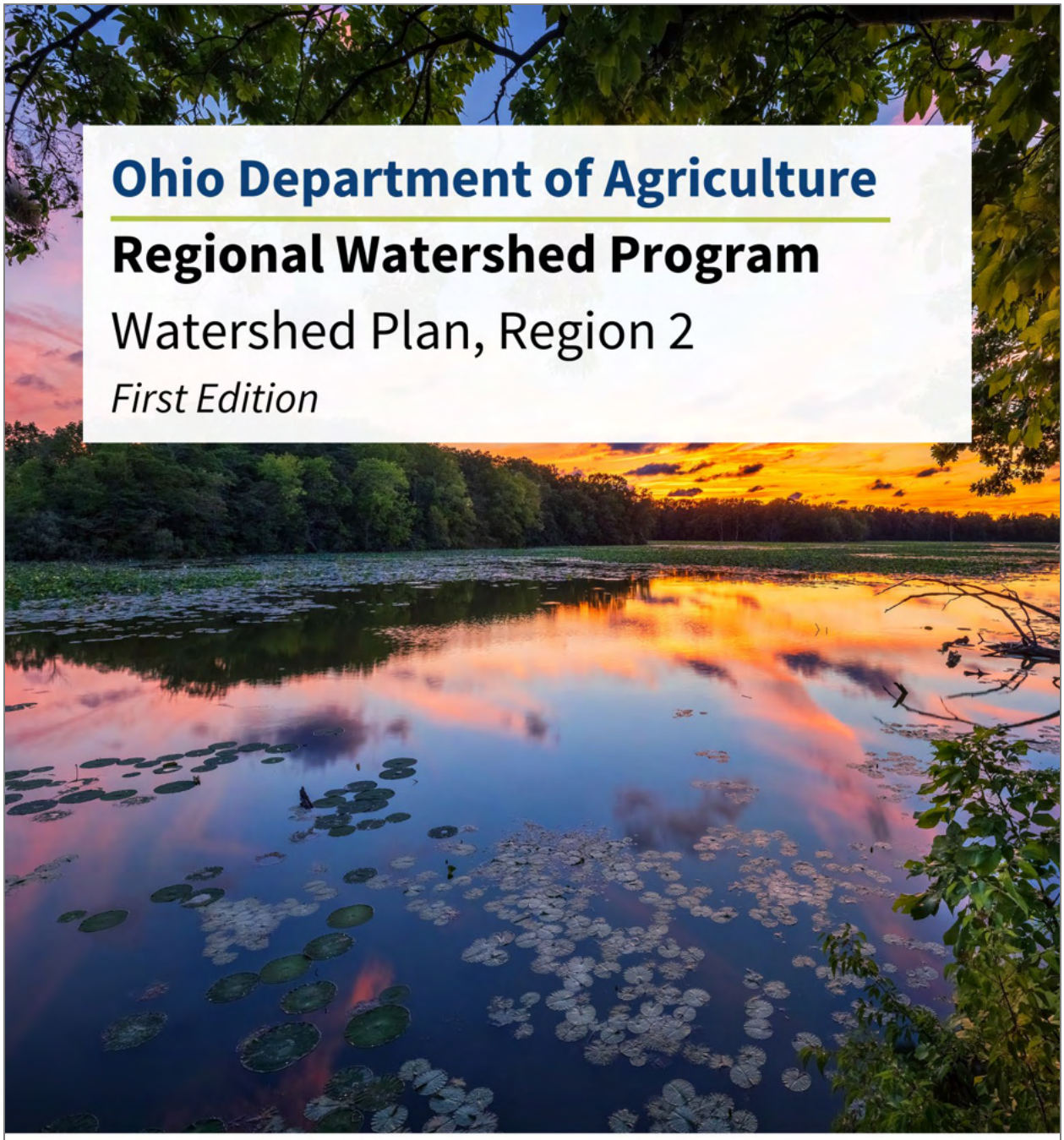

Ohio Department of Agriculture

Regional Watershed Program

Watershed Plan, Region 2

First Edition

Ohio Department of Agriculture
Division of Soil and Water Conservation
Regional Watershed Program
2023

Ohio Department of Agriculture

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Message from the Director

Dear Fellow Ohioans,

Protecting and conserving Ohio's most precious natural resources is one of the most important priorities at the Ohio Department of Agriculture (ODA). We are committed to safeguarding our soil, water, and land so Ohioans can enjoy our great state for generations.

ODA's Watershed Program is a statewide program dedicated to watershed planning and management, established by House Bill 7 in April 2021. Managed by the Division of Soil and Water Conservation, the program provides watershed planning for the state to enhance and protect Ohio's watersheds. Management is divided into seven regions, as specified in the legislation, with a watershed manager assigned to each region.

I am pleased by the work of our team on the completion of seven watershed plans. These plans will provide useful technical information that will aid in local watershed planning and implementation across the state.

This effort could not have been possible without the valuable input from our local and state partners and stakeholders. I thank you for your collaboration.

Ohio's future is bright. We know we are making progress through implementing watershed planning and supporting water quality efforts, like Governor DeWine's H2Ohio initiative. But we know we have more work to do. These watershed plans will lay the groundwork for each region to continue this momentum.

Sincerely,

Ohio Department of Agriculture

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Acronyms

ACEP-ALE	Agricultural Conservation Easement Program-Agricultural Land Easements
ACEP-WRE	Agricultural Conservation Easement Program-Wetlands Reserve Easements
ACF	Association of Consulting Foresters
ALU	Aquatic Life Use
AMD	Acid Mine Drainage
APAP	Agricultural Pollution Abatement Program
AU	Assessment Unit
BAV	Beach Action Value
BMP	Best Management Practice
CAFF	Concentrated Animal Feeding Facility
CAFO	Concentrated Animal Feeding Operations
CLEB	Central Lake Erie Basin
CNMP	Comprehensive Nutrient Management Plan
CORPS	U.S. Army Corps of Engineers
CPPE	Conservation Practice Physical Effect
CRD	Crop Reporting District
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSO	combined sewer overflow
CSP	Conservation Stewardship Program
CTIC	Conservation Technology Information Center
CWA	Clean Water Act
CWH	Coldwater Habitat
DLEP	Division of Livestock and Environmental Permitting
DSW	Division of Surface Water
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
EWH	Exceptional Warmwater Habitat
EWPP-FPE	Emergency Watershed Protection Program – Floodplain Easements
FCA	Fish Consumption Advisory
FMP	Forest Management Plans
FP3	Forestry Pollution Prevention Plan
FRPP	Farm and Ranch Lands Protection Program
FSA	Farm Service Agency
FWPCA	Federal Water Pollution Control Act
GIS	Geographic Information System
GLRI	Great Lakes Restoration Initiative
GLSM	Grand Lake St. Marys
GLWQA	Great Lakes Water Quality Agreement
gSSURGO	Gridded Soil Survey Geographic Database
HAB	Harmful Algal Blooms

HFRP	Healthy Forest Reserve Program
HSTS	Household Sewage Treatment Systems
HUC	hydrologic unit code
LEAU	Lake Erie assessment Unit
LEC	(Ohio) Lake Erie Commission
LEGP	Lake Erie Glaciated Plateau
LENT	Lake Erie nutrient targets
LEPF	(Ohio) Lake Erie Protection Fund
LRAU	Large River Assessment Units
LRW	Limited Resource Waters
MBI	Midwest Biodiversity Institute
MCM	Minimum Control Measures
MLRA	Major Land Resource Area
MRLC	Multi-Resolution Land Characteristics
MS4	Municipal Separate Storm Sewer Systems
MWH	Modified Warmwater Habitat
NASS	National Agricultural Statistics Service
NEORSD	Northeast Ohio Regional Sewer District
NGO	Non-Governmental Organization
NLCD	National Land Cover Database
NMP	Nutrient Management Plan
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NPSIS	Nonpoint Source Implementation Strategy
NRCS	Natural Resource Conservation Service
OAC	Ohio Administrative Code
OACI	Ohio Agricultural Conservation Initiative
ODA	Ohio Department of Agriculture
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
OFA	Ohio Forestry Association
ORC	Ohio Revised Code
OSL	Other Stewardship Lands
OVMLCP	Ohio Voluntary Master Logging Company Program
PCBs	Polychlorinated Biphenyls
PCR	Primary Contact Recreation
QHEI	Qualitative Habitat Evaluation Index
RCPP	Regional Conservation Partnership Program
RM	River Mile
SAF	Ohio Society of American Foresters
SCORP	Statewide Comprehensive Recreation Plan

SIC	Standard Industrial Classifications
SSO	Sanitary Sewer overflow
STP	Soil Test Phosphorus
SWCD	Soil and Water Conservation District
THP	Timber Harvest Plan
TMACOG	Toledo Metropolitan Area Council of Governments
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VNMP	Voluntary Nutrient Management Plan
WAU	Watershed Assessment Unit
WLEB	Western Lake Erie Basin
WRP	Wetland Reserve Program
WTP	Water Treatment Plant
WWH	Warmwater Habitat
WWTP	Wastewater Treatment Plant
WY	Water Year

Executive Summary

The Ohio Department of Agriculture (ODA) Watershed Program Region 2 consists of the Central Lake Erie Basin (CLEB) watershed and Conneaut Creek watershed. Region 2 is primarily forested and urbanized land. The western portion, Lorain and Medina County, have conventional row crop agriculture. The largest portion of urbanized areas are between the City of Cleveland in Cuyahoga County and Akron on the border of Region 2 in Summit county.

Developed land is the largest land use in the region at 34%. Forested land is 33%, and agriculture land use is 24%, with 10% cultivated crops and 14% hay and pasture. Urbanizing the landscape and protecting forest areas have been priorities in this region, which may account for the diminishing crop trends with wheat and hay forage and lower livestock numbers. The climate, geology, and proximity to Lake Erie have allowed a unique vineyard and nursery industry to be sustained and a hobby livestock trend to emerge. Major crops in Region 2 have been soybeans (7%) and corn (3%).

Habitat alteration is the most common cause of biological impairment across Region 2. This includes stream modifications and changes in flow patterns that degrade the habitat quality. Other significant impairments include nutrient pollution, organic enrichment, and sedimentation. Natural limitations, such as limited flow volume, are also a contributing factor.

Agricultural land makes up a smaller portion of Region 2, but still presents opportunities for adoption of conservation practices. The western portion of the region is primarily row crop agriculture, with characteristics similar to the Western Lake Erie Basin (WLEB). In these areas practices such as nutrient management planning, placement or incorporation of fertilizer and manure, and conservation cover will be beneficial. There is opportunity to increasing edge-of-field practices like wetlands, buffers, vegetation, and two-stage ditches. Drainage water management is also important on the western edge of the region due to the flat landscape and poorly drained soils. Across the southern and eastern portion of the region there are opportunities to implement practices related to hay and pastured livestock. Animal operations provide opportunity for livestock and manure management practices. Education and development of Nutrient Management Plans (NMPs) are an important area of need and opportunity in this region.

Forests are a major resource in Region 2 and have a significant impact on maintaining high water quality in streams. The Ohio Department of Natural Resources (ODNR) Division of Forestry is the principal agency responsible for forestry-related issues and management in other parts of the state, while in Region 2 park districts, land conservancies and private owners are responsible of management. ODNR manages 24 state forests, approximately 200,000 acres, and is dedicated to the mission of promoting and implementing management practices that promote sustainable use and protection of both private and public forest lands.

Forestry Pollution Prevention Plans, referred to as FP3s, are voluntary erosion control plans landowners, forestry companies, and consulting foresters may submit to their local Soil and Water Conservation District (SWCD). These plans aim to ensure sustainable logging and silviculture by listing the best management practices (BMPs) to be installed on the property.

The Ohio Forest Action Plan reveals that 85% of private landowners with over 10 acres of forest land do not have a forest management plan for their property. To address this, various training and guidance

programs are available to private forest landowners, including the Master Logger Program and the Timber Harvest Plan (THP) Program.

In Ohio, practices for maintaining urban water quality are not directly monitored by the ODA. However, there are state and local guidelines in place.

Water quality impairments to Aquatic Life Use (ALU) and Recreation beneficial uses are common in urban areas, as identified by the Ohio EPA. They are summarized as follows:

- Habitat modification resulting from changes in stream flow, removal of flood plains, and hydrological changes caused by dams, among others.
- Nutrient transport from impervious surfaces during precipitation events, leading to high loading events in streams.
- Increased erosion and sedimentation caused by impervious surfaces, culverts, and channelized streams.
- Bacteria transport to recreational areas during large stormwater flows, particularly in areas that experience Combined Sewer Overflow (CSO) events.

In urban areas, addressing issues requires different practices of varying scope and size. To tackle small scale needs in areas with high percentages of impervious surfaces, adoption of flow-reducing practices like onsite rainwater storage (rain barrels and rain gardens) is highly recommended to increase infiltration and reduce runoff flashiness, especially in headwaters.

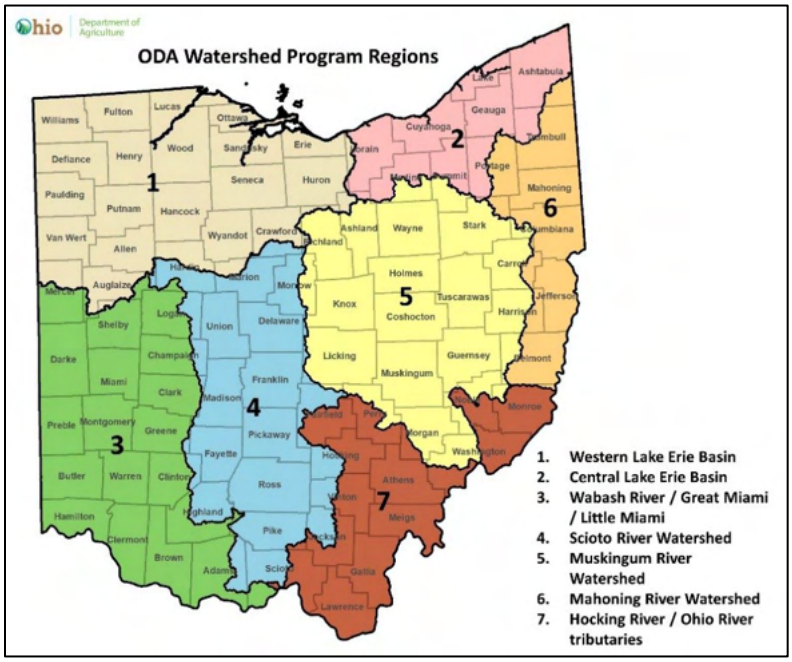
The region has a pressing need to reduce impervious surfaces and restore environmental services offered by riparian and aquatic habitats. The challenges faced in urban watersheds are varied and numerous, spanning from inadequate funding to limited space for project implementation. While stakeholder objectives may vary, commonalities do exist. Across different scales, land acquisition remains a pressing concern. Securing funding for extensive wetlands or stream restoration initiatives is challenging but important.

1. Introduction

1.1 Purpose and Scope

Fundamentally, the purpose of all watershed-based plans, is to document characteristics, problems, and potential solutions relevant to the watershed, and present them in an implementable framework that defines watershed partners, water quality challenges, improvement opportunities, goals, and best management practices. Furthermore, this plan and its development process serves many other valuable purposes as a program charter, work plan, organizing instrument, data reference resource, linkage mechanism, training exercise, communication tool, and more.

Specifically, this and its six companion Ohio Regional Watershed Plans, were developed to initiate implementation of Ohio House Bill 7 (133rd General Assembly), which was signed by Governor DeWine January 6, 2021. The bill, which became effective April 21, 2021, requires the Director of Agriculture to administer a statewide watershed planning and management program for the improvement and protection of Ohio watersheds, and staff the effort in each of seven major watershed basins of Ohio with professionals to coordinate planning and management activities with SWCDs and partners (Map 1).



Map 1. Ohio Department of Agriculture watershed Program Regions (Basins), as defined by United States Geological Survey six-digit hydrologic unit codes.

ORC 940.41 defines the roles and responsibilities of ODA watershed managers as follows: 1. Assist each soil and water conservation district to identify sources and areas of water quality impairment, including total phosphorous, dissolved reactive phosphorous, and nitrogen nutrient loading. A coordinator also may assist any political subdivision or organization in the watershed region to address water quality impairment; 2. Engage in watershed planning, restoration, protection, and management activities, including assisting a political subdivision or organization in the watershed region in developing and formulating a nine-element plan or its equivalent; 3. Collaborate with state agencies engaged in water quality activities; and 4. Provide an annual report to the director about water quality.

Development of this Regional Watershed Plan lays the groundwork for these responsibilities by:

- Delineating local water quality impairment and nutrient sources by local watersheds of the region,
- Developing and strengthening organizational networks through which assistance may be Provided and state agency collaboration may occur,

- Providing context, content, and references essential for effective local "nine-element" and other watershed-based planning within the watershed region, and
- Serving as the first and foundational annual water quality report to Director of Agriculture.

This watershed plan is based on U.S. EPA 9-Key-Elements and developed in alignment with U.S. EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters.

While nonpoint source pollution - contaminants and stressors associated with land runoff and flow of surface and ground waters - may be addressed through watershed management, point sources are not, but rather addressed through permit limits and other regulatory controls. Point-nonpoint source pollution trading programs may serve as a drivers and funding mechanisms for nonpoint source practice implementation; however, such programs are primarily focused on addressing nonpoint sources to meet point source permit requirements and is rooted in watershed planning and management. Therefore, point source information is provided for comprehensive watershed characterization, yet this plan is focused primarily on nonpoint sources of pollution, both agricultural and non-agricultural.

1.2 Plan Development

The beginning step of watershed planning on any scale is to build partnerships. Each plan was developed through a collaborative process involving a variety of stakeholders across the state. To accomplish this all stakeholders were identified, and three primary groups were established.

The first group of stakeholders, referred to as the SWCD core group, is comprised of SWCDs that make up each Region. SWCDs are locally led entities and governed by a board of supervisors who are elected to three-year terms. These are ODA's closest partners in conservation, and the relationship between the Watershed Program and SWCDs is important for the success of the program. The SWCD core group is composed of a representative from each SWCD within the region. For region 2 the group consisted of the following counties:

- Ashtabula
- Cuyahoga
- Geauga
- Lake
- Lorain
- Medina
- Portage
- Summit

The watershed manager for each region meets monthly or bi-monthly with their SWCD core group, providing updates on program activities, inviting feedback on planning efforts, and identifying ways they can collaborate and support each other's efforts. The Region 2 SWCD core group played an important role in the development of this watershed plan.

The second group of stakeholders assembled were Technical Advisory Teams (TAT). These are comprised of mainly regionally based governmental agency, academia, conservation related non-governmental agencies (NGOs), and watershed planning personnel. Individuals working within the region who have a professional background pertaining to water quality and land use management. These teams of regional professionals provided technical expertise at various stages of plan development. TATs included "data stewards" who work for the organizations generating the data used in the plans. Their guidance ensured that data was interpreted and represented accurately. The Region 2 TAT is made up of individuals from the following organizations:

- Chagrin River Watershed Partners
- Central Lake Erie Basin Collaborative
- Cleveland Metroparks
- Doan Brook Partnership
- NEORSD
- NOACA
- NRCS
- Ohio EPA
- Ohio Lake Erie Commission
- Ohio Sea Grant
- The Nature Conservancy
- USGS
- West Creek Conservancy

The third group of stakeholders identified are the "general" stakeholder group. This includes all of those who have interest or involvement in work related to water quality in the region, and includes state and federal agencies, academic institutions, SWCDs, township and county offices, city government, NGOs, commodity groups, watershed groups, private businesses, contractors, and corporations. This group is important as it contains a wide variety of organizations and entities. ODA watershed staff interact with this group through email updates, and by participating in local meetings and events that hosted by or including these stakeholders. Maintaining communication with a broad network of stakeholders provides opportunity to support their efforts, and benefit from their local knowledge and expertise. The full list of SWCD and TAT members can be found in Appendix A.

Each plan is founded on the best available data. The majority of the data was obtained from collaborating state and federal agencies, including the Ohio EPA and USDA-NRCS, or academic institutions. Water quality data was taken from the Ohio EPA 2022 Integrated Report. The only data collected by ODA Watershed staff came from a survey that the team carried out. All 88 SWCDs were surveyed to collect information for a preliminary baseline of conservation practice implementation across the state.

2. Watershed Description

2.1 Profile and History

This document aims to assist with watershed planning using hydrologic boundaries as a guide. The scope of planning is defined by House Bill 7 (133rd General Assembly), which recognizes seven United States Geological Survey (USGS) Hydrologic Unit Code 6 (HUC-6) basins as "Regional" boundaries in Ohio. These basins are determined by the natural flow of water and are not limited by political or geographic divisions.

Hydrologic Unit Codes (HUCs)

Name	Digits	Average size (square miles)	Number of Ohio HUs	Region 2 Example	Example HUC #
Region	2	177,560	2	Great Lakes Region	04
Subregion	4	16,800	10	Central Lake Erie Basin	0411
Basin	6	10,596	7	Same	041100
Subbasin	8	700	44	Cuyahoga River	04110002
Watershed	10	227 (40K–250K ac.)	333	Yellow Creek-Cuyahoga River	0411000204
Subwatershed (HUC-12 & WAU)	12	40 (10K–40K ac.)	1541	Furnace Run	041100020403

Figure 1. Hydrologic Unit Codes (HUC) and associated characteristics.

The ODA Watershed Program Region 2 consists of the CLEB, hydrologic unit code 041100, and Conneaut creek watershed, hydrologic unit code 041201.

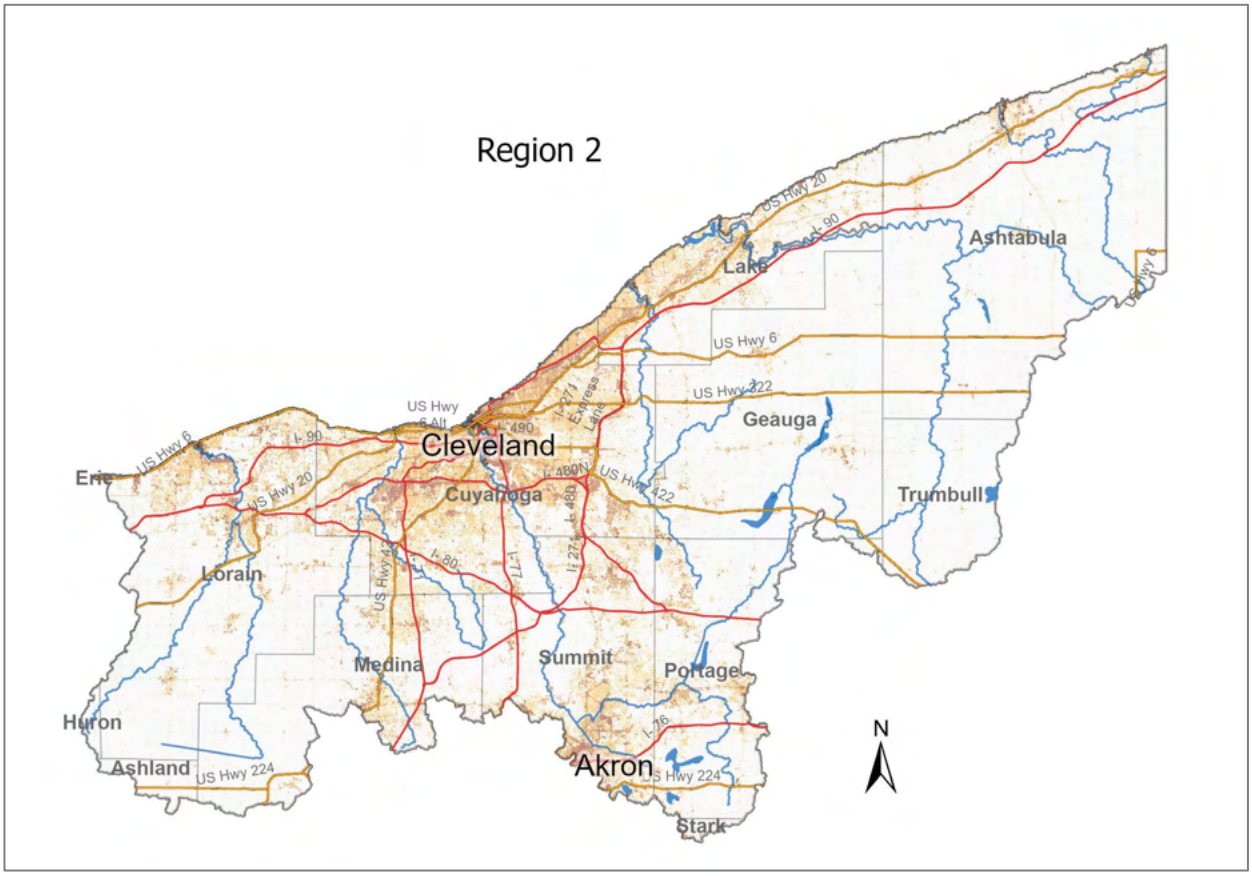
The CLEB borders Ohio and Pennsylvania in the United States as well as Ontario, Canada. While the drainage area of the CLEB reaches through multiple states and countries, this report will be directed towards Ohio's portion of this basin. This basin is part of a 4-digit HUC sub-basin, the Great Lakes Region. This ultimately flows to the St. Lawrence River and into the Atlantic Ocean.

Unlike most other watershed systems in the United States, waterways in the Ohio portion of the CLEB flow from south to north, having headwaters that originate near the St. Lawrence Continental Divide. As part of the Great Lakes system, water that has reached Lake Erie then flows eastward and drains to Lake Ontario over Niagara Falls, and ultimately to the Gulf of Saint Lawrence in the North Atlantic Ocean.

Region 2 has land area in Ashland, Ashtabula, Cuyahoga, Geauga, Huron, Lake, Lorain, Medina, Portage, Stark, Summit, and Trumbull counties although Cuyahoga and Lake are the only two counties fully in Region 2. This poses a challenge with existing data being presented by a state or county basis. To simplify this, data will be presented by county basis with Table 1 showing the percentage of each county that falls within Region 2. The geographic extent of Region 2 can be seen in Map 2.

Region 2 Counties	
County	**%**
Ashland	5.6
Ashtabula	84
Cuyahoga	100
Geauga	99
Huron	1.4
Lake	100
Lorain	90
Medina	66
Portage	47
Stark	1.1
Summit	62
Trumbull	22

Table 1. Each county that touches Region 2 and the relative percentage within the Region.

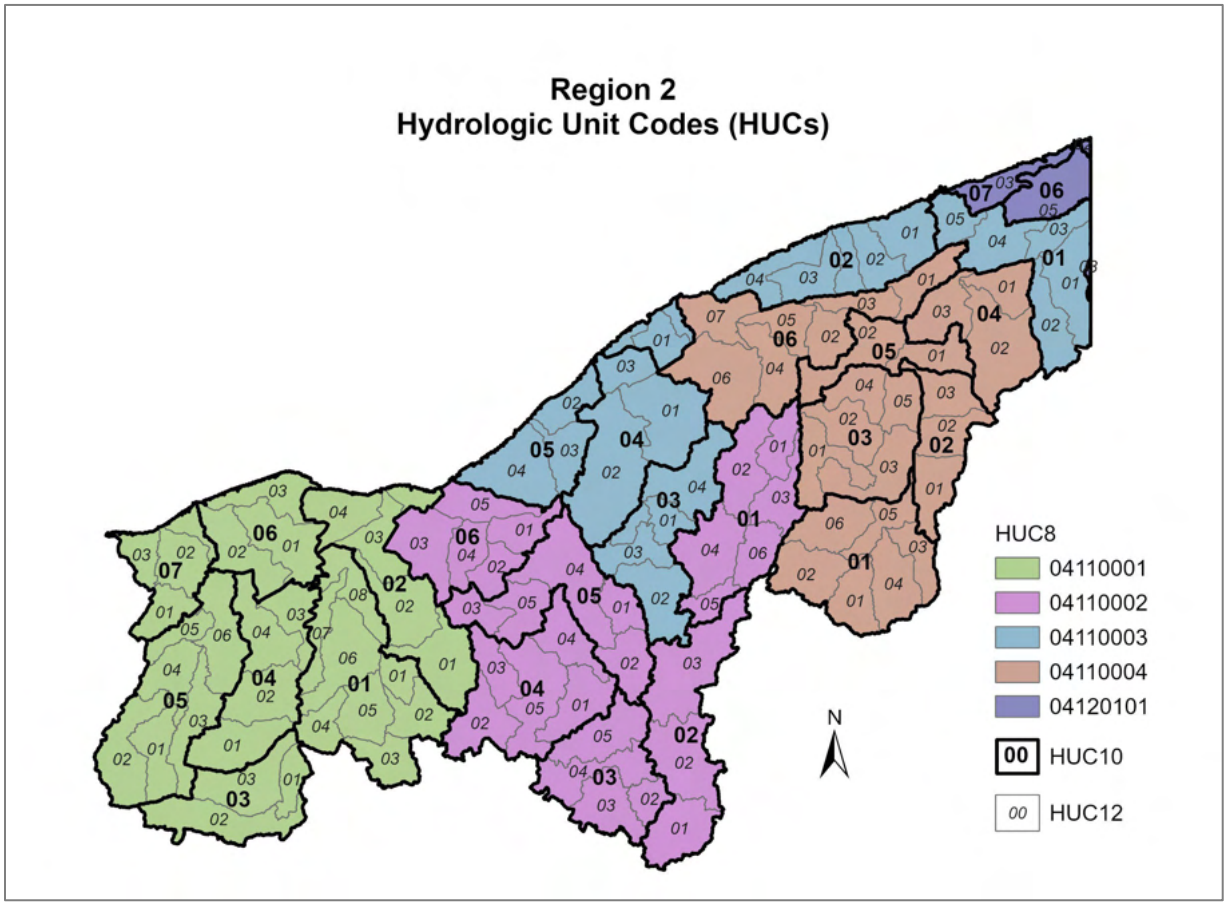


Map 2. Region 2, showing major roads, rivers, lakes, county boundaries and urban areas.

Region 2 contains the lands of 4 native American peoples: the Erie, Haudenosaunee, Kaskaskia, and Mississauga. The Erie people lived on the south shore of Lake Erie from before 1658, although their nation was badly hurt in the Beaver wars against the neighboring Iroquois. The Haudenosaunee (Iroquois) confederacy consisted of 5 nations, dubbed by the English, comprising of the Mohawk, Oneida, Onondaga, Cayuga, and Seneca peoples. the Kaskaskia region expands farther west. The Mississauga people are primarily from the southern portion of Ontario Canada. Native American land east of the Cuyahoga River was extinguished in the Treaty of Greenville in 1795 making most of that land available for sale and settlement, known as the Western Reserve. Also known as New Connecticut or the Connecticut Western Reserve, encompasses 3.3 million acres of land in present day northeast Ohio. In 1805 the Treaty of Fort Industry removed the remaining Native American claims the remaining western portion of the reserve (Barrow, 2020).

The CLEB can be dissected into smaller watersheds from 8-digit HUC watersheds like the Cuyahoga River, or even to 12-digit HUC watersheds like the Euclid Creek watershed. The 8-digit HUC watersheds that will be referenced throughout this report and are as follows: Black and Rocky, Cuyahoga, Ashtabula-Chagrin, Grand, and Chautauqua-Conneaut, from west to east respectively.

The HUC-6 (basin), HUC-8, HUC-10, and HUC-12 boundaries within Region 2 are shown below in Map 3.



Map 3. Region 2 Hydrologic Unit Codes (HUCs).

Region 2 is primarily forested and urbanized land. The western portion, Lorain and Medina County have conventional row crop agriculture. The largest portion of urbanized areas are between the City of

Cleveland in Cuyahoga County and Akron on the border of Region 2 in Summit county. The eastern portion of Region 2 is primarily forested but does contain agriculture in the form of vineyards, tree nurseries, hobby farms, and some conventional row crops.

Region 2 has many cities of varying populations and overall is very urbanized. Most notably Region 2 houses both the cities of Cleveland and Akron as well as Parma, Lorain, Elyria, Cuyahoga Falls and Lakewood. Region 2 connects these cities with a system of highways and major routes. Ohio legislative district boundaries can be found on the Ohio Secretary of State's website. Region 2 has a total land area of 1,977,931 acres, or 3,090 square miles. The entire CLEB is 3,305,065 acres, of which 60% is within the State of Ohio.

2.2 Physical and Natural Features

Region 2 has a variety of unique physical and natural features which will be described in this section.

As shown in Map 2, the major rivers in Region 2 include the Black River, Rocky River, Cuyahoga River, Chagrin River, Grand River, Ashtabula River and Conneaut Creek, all of which flow into Lake Erie on Ohio's border. In total, there are 7,355 stream miles in Region 2, including small waterways.

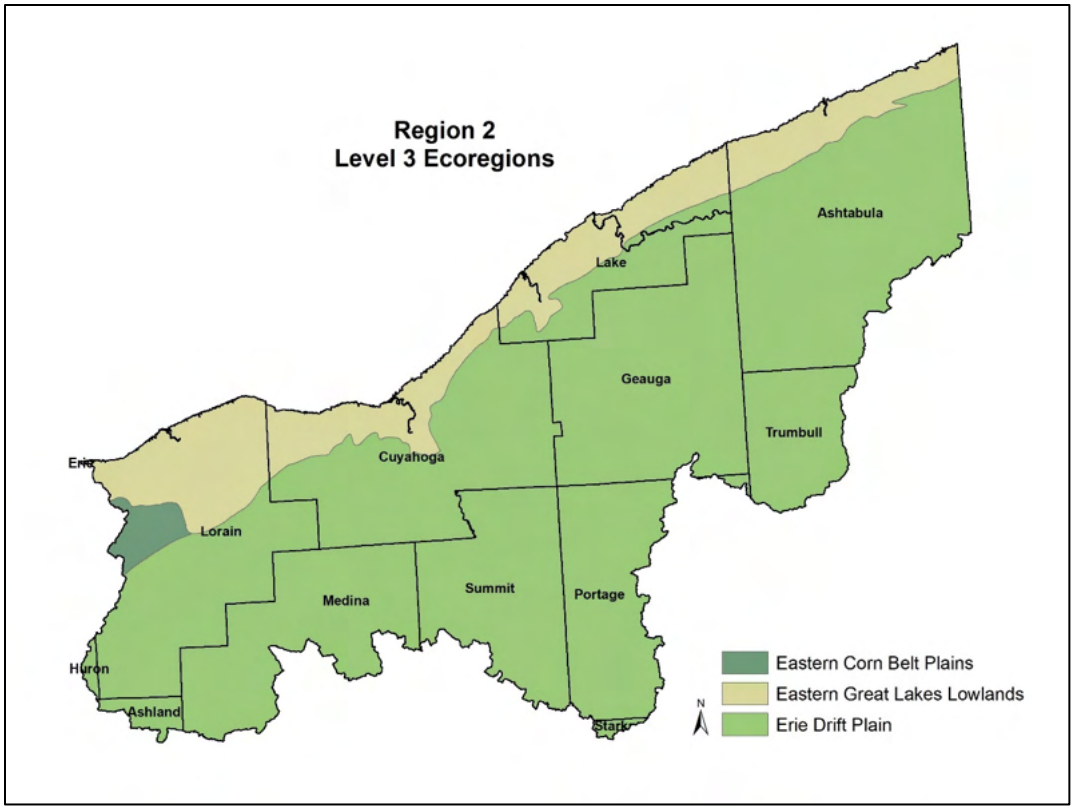
The Cuyahoga River has a unique situation on the border of the Muskingum River watershed where, through a lock, water is directed from the Tuscarawas River into the Cuyahoga a prescribed amount. That amount is calculated from the volume of water the City of Akron removed from the CLEB to service its communities in the Muskingum. This all is possible through a multinational agreement with the country of Canada.

2.2.1 Ecoregions

Ecoregions, as defined by U.S. EPA, are "areas where ecosystems (and the type, quality, and quantity of environmental resources) are generally similar. Designed to serve as a spatial framework for the research, assessment, and monitoring of ecosystems and ecosystem components, ecoregions denote areas of similarity in the mosaic of biotic, abiotic, terrestrial, and aquatic ecosystem components, with humans considered as part of the biota." (U.S. Environmental Protection Agency, 2013).

Ecoregions are directly applicable to the immediate needs of state agencies including the development of biological criteria and water quality standards as well as the establishment of management goals for nonpoint-source pollution. They are also relevant to integrated ecosystem management, an ultimate goal of most federal and state resource management agencies.

Region 2 is located in three level III ecoregions, Eastern Corn Belt Plains, Eastern Great Lakes Lowlands, Erie Drift Plain (Map 4). The majority of Region 2 is Erie Drift Plain, along the southern border and extending into the Western Basin and Ohio River watershed. The coast of Lake Erie is the Eastern Great Lakes Lowlands, which follows the lake into New York State. And the ecoregion with the smallest in Region 2 is the Eastern Corn Belt Plains, which encompasses the western half of Ohio and a large portion of Indiana.



Map 4. EPA Level III Ecoregions within Region 2. (U.S. Environmental Protection Agency, 2022)

In the western portion of Region 2, around the Eastern Corn Belt Plains, there is more conventional agriculture row crop fields. This is in contrast to the coastal portion, around the Eastern Great Lakes Lowlands, which is glaciated and is suitable for nurseries and vineyards. The coast also supports a large portion of the urbanized land area with more impervious surfaces. The remaining majority, the Erie Drift Plain, also glaciated, more forested, with rolling hills and is associated with more dairy operations.

This glaciated region of irregular plains bordered by hills generally contains less surface irregularity and more agricultural activity and population density than the adjacent Northeastern Highlands (58) and Northern Allegheny Plateau (60). Although orchards, vineyards, and vegetable farming are important locally, a large percentage of the agriculture is associated with dairy operations. The portion of this ecoregion that is in close proximity to the Great Lakes experiences an increased growing season, more winter cloudiness, and greater snowfall.

Once largely covered by a maple-beech-birch forest in the west and northern hardwoods in the east, much of the Erie Drift Plain is now in farms, many associated with dairy operations. The Eastern Corn Belt Plains, which border the region on the west, are flatter, more fertile, and therefore more agricultural. The glaciated Erie Drift Plain is characterized by low rounded hills, scattered end moraines, kettles, and areas of wetlands, in contrast to the adjacent unglaciated ecoregions to the south and east that are more hilly and less agricultural. Areas of urban development and industrial activity occur locally. Lake Erie's influence substantially increases the growing season, winter cloudiness, and snowfall in the northernmost areas bordering the strip of the Eastern Great Lakes Lowland which fringes the lake.

The Eastern Corn Belt Plains ecoregion is primarily a rolling till plain with local end moraines; it had more natural tree cover and has lighter colored soils than the Central Corn Belt Plains. The region has loamier and better drained soils than the Huron/Erie Lake Plain, and richer soils than the Erie Drift Plain. Glacial deposits of Wisconsinan age are extensive. They are not as dissected nor as leached as the pre-Wisconsinan till which is restricted to the southern part of the region. Originally, beech forests were common on Wisconsinan soils while beech forests and elm-ash swamp forests dominated the wetter pre-Wisconsinan soils. Today, extensive corn, soybean, and livestock production occurs and has affected stream chemistry and turbidity.

2.3 Recreation, Economics and Culture

2.3.1 Transportation

Region 2 has a vast array of transportation networks, including major interstates and arterial roads that link urban areas both within Region 2 and beyond. Interstates like 71, 77, 80, 90, 271, and 480 play a significant role in the local economy and the daily work commute for citizens.

Rail transportation is also vital to the region's economy, especially in freight-shipping. Ohio has the fourth largest rail network in the US, generating a noteworthy $2.8 billion annually (Ohio Rail Development Commission, 2019).

In terms of air travel, Region 2 offers 11 airports, including two international airports: Cleveland Hopkins and Akron Fulton.

Region 2 is a shipping destination with trade harbors in Lorain, Cleveland, Painesville, Ashtabula, and Conneaut. These commercial harbors require annual dredging to maintain their viability, and the Ohio Lake Erie Commission now regulates the methods and placements for disposal of dredged materials to protect lake water quality.

Completed in 1833, the Ohio Erie Canal was a historic transportation gem that connected Lake Erie to the Ohio River, breaching the St. Lawrence Continental Divide. The Canal transferred from the Lake Erie to the Ohio River watersheds at the Portage Lakes, which offered manmade locks and dams to divert flows in either direction (Ohio Department of Natural Resources, 2018). More history on Ohio canals can be found at this website.

2.3.2 Water-Based Recreation

The Lake Erie Coast and its many rivers offer a wide range of exciting water-based activities and support major industries such as boating and fishing in Ohio. Fishing enthusiasts can enjoy catching walleye, perch, and steelhead in Region 2, while kayaking and canoeing communities thrive on high-quality rivers. Share the Rivers and other organizations in the region host fabulous events like the Blazing Paddles Paddlefest and the Cuyahoga Falls Fest to promote water quality and passage. However, certain rivers can pose safety concerns due to aquatic life and recreation impairments.

Moreover, the Cuyahoga River has been designated as a state recreation water trail thanks to the active support of advocacy groups like the Friends of the Crooked River who worked tirelessly to remove dams and restore vitality to the river. Region 2 boasts Ohio's only National Park, Cuyahoga Valley National Park, as well as multi-county Metroparks organizations like Cleveland and Summit Metroparks. Additionally, park districts at the county scale such as Lorain County Metroparks, Geauga Park District, Lake County Metroparks, Medina County Park District, Portage County Park District, and Ashtabula County

Metroparks expand the opportunities for outdoor recreation. These organizations acquire and designate land as parks, creating more places for people to explore and enjoy nature.

2.3.3 Economics and Culture

The Lake Erie Coastal areas in Region 2 offer ideal conditions for a thriving vineyard and nursery industry, as well as a growing tourism sector. Recreation activities, such as boating, fishing, and swimming, draw visitors to lakeshore communities and contribute to 30% of Ohio's tourism revenue, amounting to a staggering $10.7 billion (Great Lakes Commission, 2014). Notably, Lake Erie is home to more than half of the fish caught in the Great Lakes and hosts 40% of Great Lakes charter boats, according to Ohio Sea Grant.

Ohio's agriculture industry contributes over $105 billion to the state's economy and is the top industry according to Ohio Proud. With over 1,000 food processing companies and 200 commercial crops, Ohio is a leading producer in over 35 different sectors. In Region 2, the coastal area boasts a thriving nursery and vineyard industry while traditional row crops thrive outside of urban areas. Additionally, hobby livestock farms are a growing trend in the eastern part of the state.

Ohio's manufacturing sector is thriving with 705,900 employees driving the industry forward. Leading the nation in the production of plastics and rubber, fabricated metals, and electrical equipment and appliances, Ohio is also a top producer of steel, autos, and trucks. The industrial hubs of Cleveland and Akron stand out, with Akron known as the rubber capital of the world (State of Ohio, 2020).

Ohio's forests are not just a beautiful part of the scenery, they are a critical aspect of the state's ecosystem, economy, and public health. These natural areas are home to hundreds of terrestrial and aquatic species and offer numerous recreational opportunities. In addition, they have positive effects on air and water quality. The forests of Ohio also support a thriving industry centered around forest products, bringing in over $24 billion to the state's economy and creating over 116,000 jobs in forestry and the forest products industry (Appalachian Partnership for Economic Growth, 2017).

3. Watershed Characterization

3.1 Land Use

This section describes the primary land uses within Region 2 and the associated, common management practices. Region 2 land use is dominated by the densely populated metropolitan areas of Cleveland and Akron. However, the western portion of the basin, like the WLEB, has more land devoted to row crop agriculture. East of the cities, suburbs give way to forest and grazing lands extending into Pennsylvania.

The map below (Map 5), is from National Land Cover Database (NLCD) 2019 land cover database, and the pie chart (Figure 2) was made by combining the developed land categories, all row crop categories, hay and pasture categories, shrubland and wetlands categories, and forested categories.

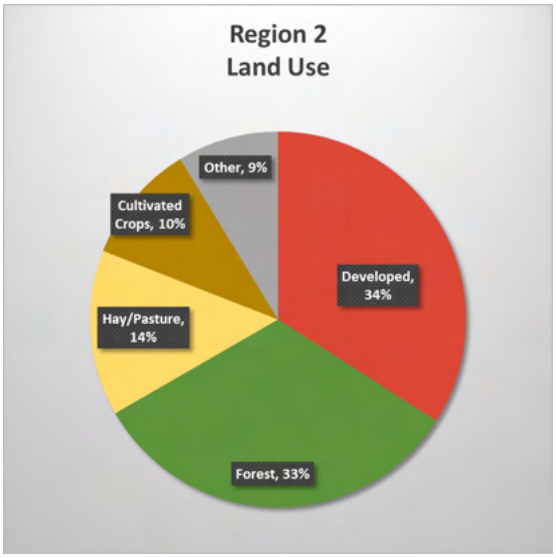
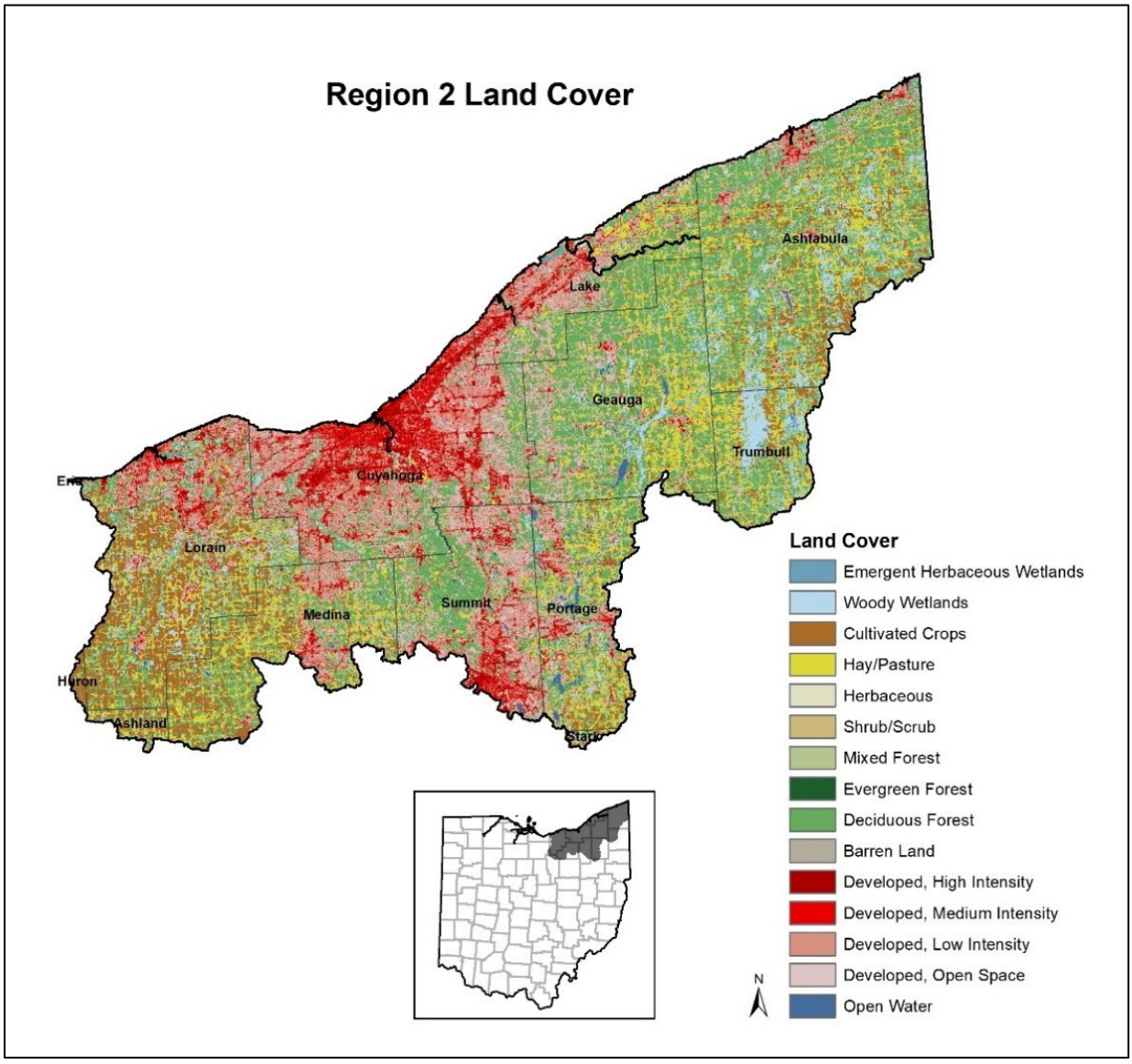
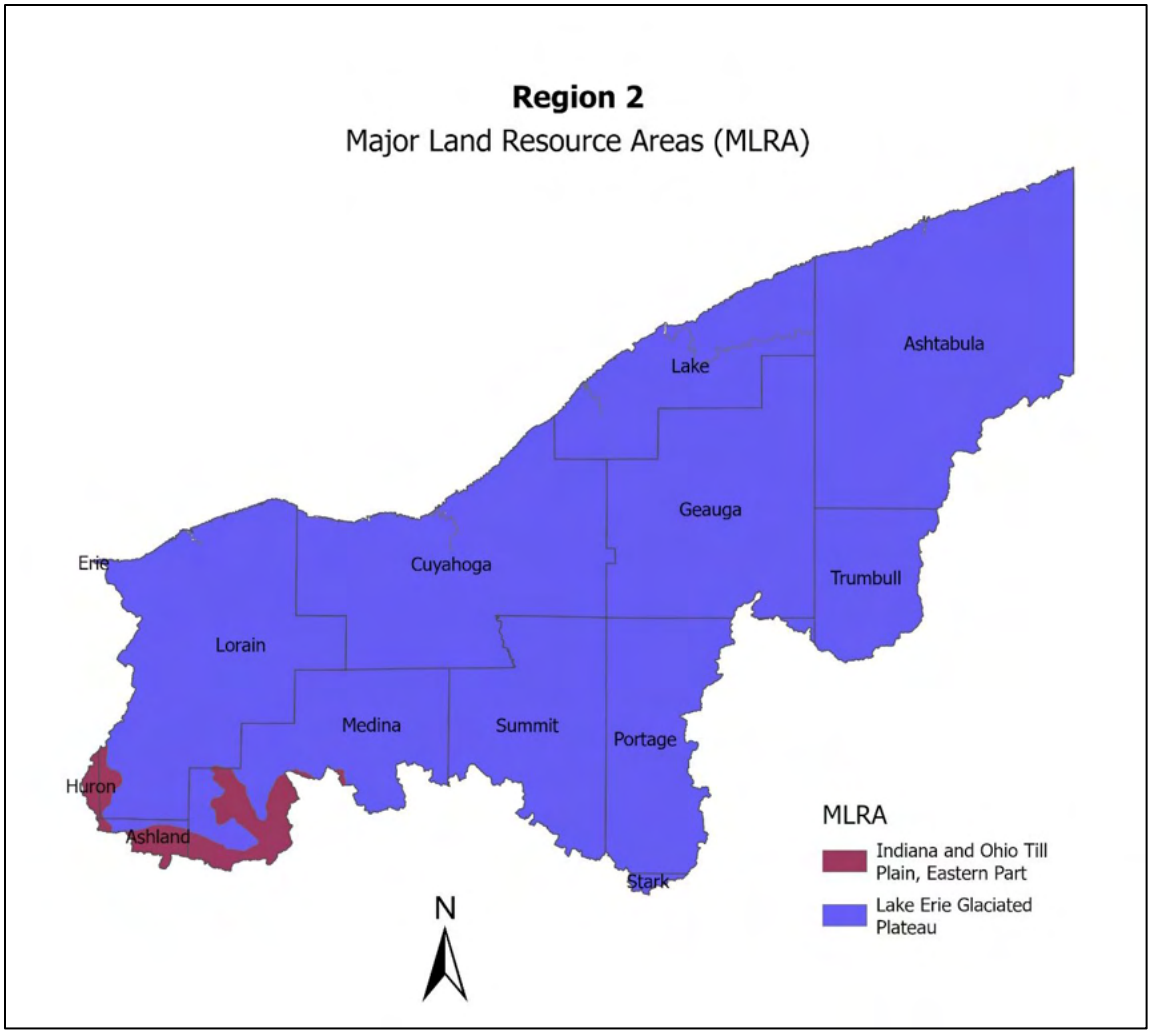


Figure 2. Graph showing distribution of land use categories for Region 2. Source: Multi-Resolution Land Characteristics (MRLC) 2019 NLCD. (Dewitz & U.S. Geological Survey, 2021



Map 5. Region 2 Land use categories. Source: MRLC 2019 NLCD. (Dewitz & U.S. Geological Survey, 2021)

The United States Department of Agriculture (USDA)'s Natural Resources Conservation Service has established Major Land Resource Areas (MLRAs) (U.S Department of Agriculture, 2022) as a means of categorizing geographically related land areas, shown on Map 6. These regions are developed by aggregating similar units from the Natural Resource Conservation Service (NRCS) Land Resource Hierarchy classification system. Much like U.S. EPA ecoregions, MLRAs are distinguished by their comparable scope and purpose, delineating regions with similar geology, climate, soils, and land usage. Consequently, these divisions are helpful in analyzing regional water quality needs, particularly with regards to agricultural production, as they represent areas where soil-related resource concerns are consistent.



Map 6. Region 2 USDA Major Land Resource Areas (MLRA). (U.S. Department of Agriculture, Natural Resources Conservation Service, 2006)

The Indiana and Ohio Till Plain, eastern portion, is a region with ground moraines, kames, lake plains, outwash plains, terraces, and stream valleys. The soil layers primarily consist of glacial till, outwash, loess, alluvium, and glaciolacustrine sediment with deep and well-drained loam and silt deposits. Shale and sandstone layers underlay the soil layers, and the climate and soils support agricultural land use. Hardwood forests are more prevalent than in other regions, and groundwater from sand and gravel deposits is a substantial water source. The main resource concerns include protecting groundwater and surface water from nutrients and pesticides, surface water from sediment and erosion, habitat management, and soil quality maintenance.

The Lake Erie Glaciated Plateau (LEGP) features gently to strongly rolling glaciated topography, while a narrow band near Lake Erie is largely flat. The soils primarily consist of glacial till, outwash, and loess overlaying sandstone, siltstone, and shale. These deep soils are primarily loamy or clayey and range from well-drained to poorly drained. Historically, the area was dominated by beech forests, but today, remaining forests are roughly matched in area by both urban and agricultural land uses. Farms in the area typically grow feed grains and forage, along with some cow-calf operations. The region's hardwood

forests are utilized as farm woodlots. The main resource concerns include erosion and sedimentation, stormwater linked to sedimentation, and soil productivity maintenance.

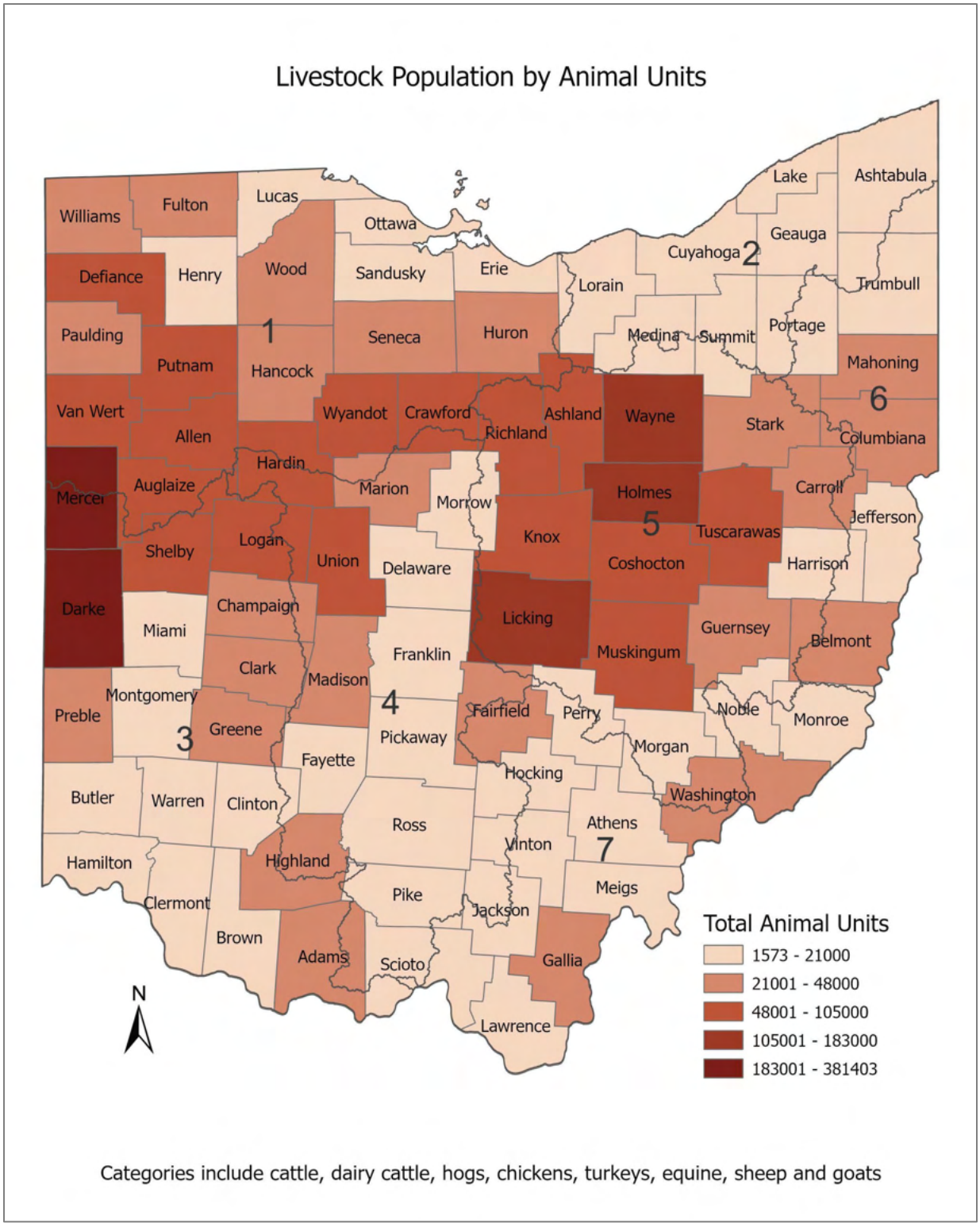
3.1.1 Agriculture

While agriculture land use is less than urban and forested areas in Region 2, it still counts for 10.3% cultivated crops and 14.3% hay and pastureland. Urbanizing the landscape or protecting forest areas has been a priority in this region, which may account for the diminishing crop trends with wheat and hay forage and lower livestock numbers. The climate, geology, and proximity to Lake Erie have allowed a unique vineyard and nursery industry to be sustained and a hobby livestock trend to emerge. Major crops in Region 2 have been soybeans (7%) and corn (3%).

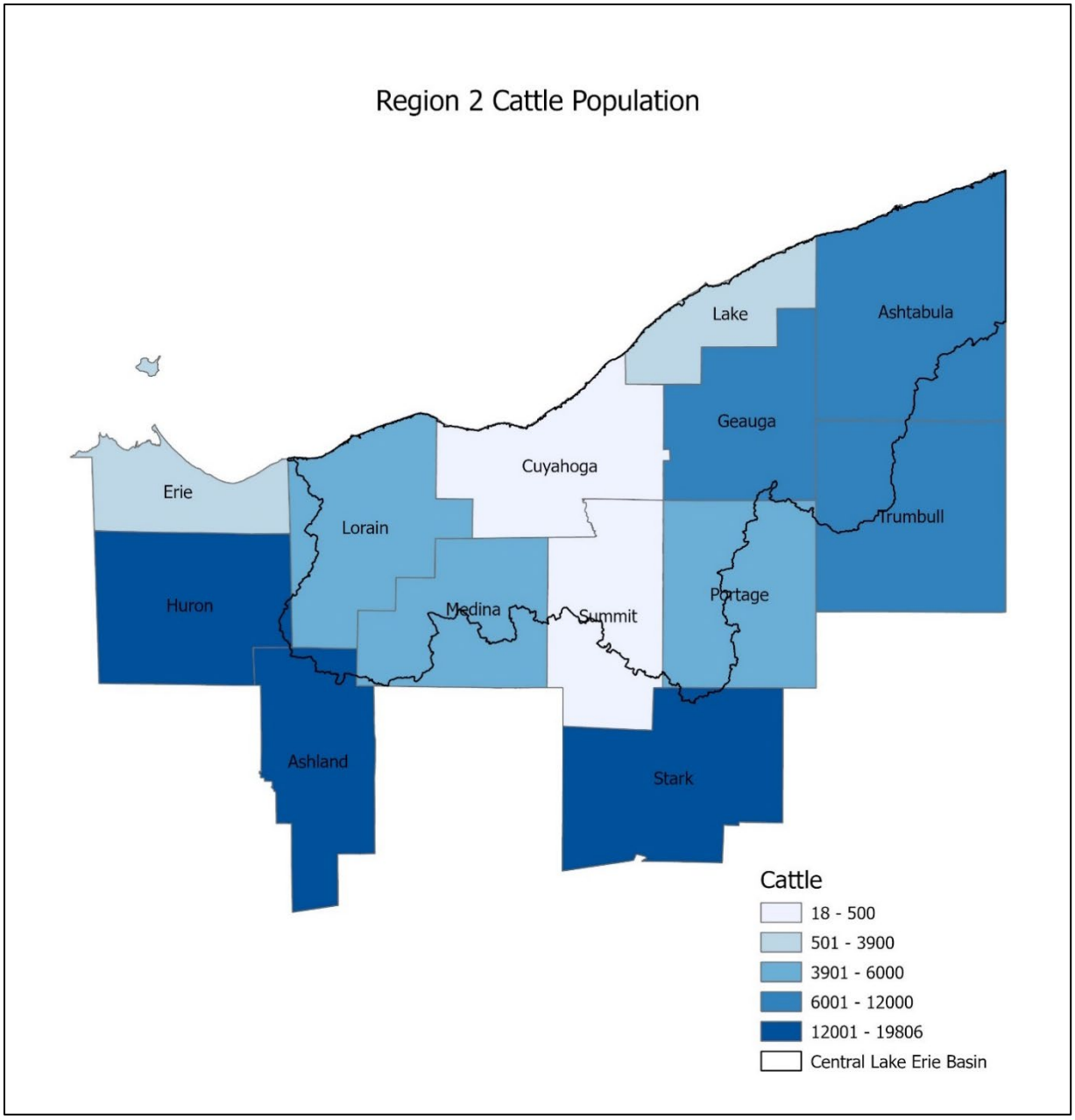
Characteristics of agricultural production can have important implications for water quality in the region. Cropping systems, pesticide and nutrient management, tillage regimes, drainage practices, and other land and water management strategies can all impact water quality, especially when streams are adjacent to row crop fields. Unmanaged activities of row crop farming and livestock grazing can contribute to sedimentation and nutrient enrichment of the region's streams and Lake Erie. Landscape changes to make farming more efficient can also result in channel modification and habitat degradation.

In the region, agriculture occupies approximately 720,000 acres and roughly 13% of these areas receive manure applications, totaling about 96,000 acres yearly.

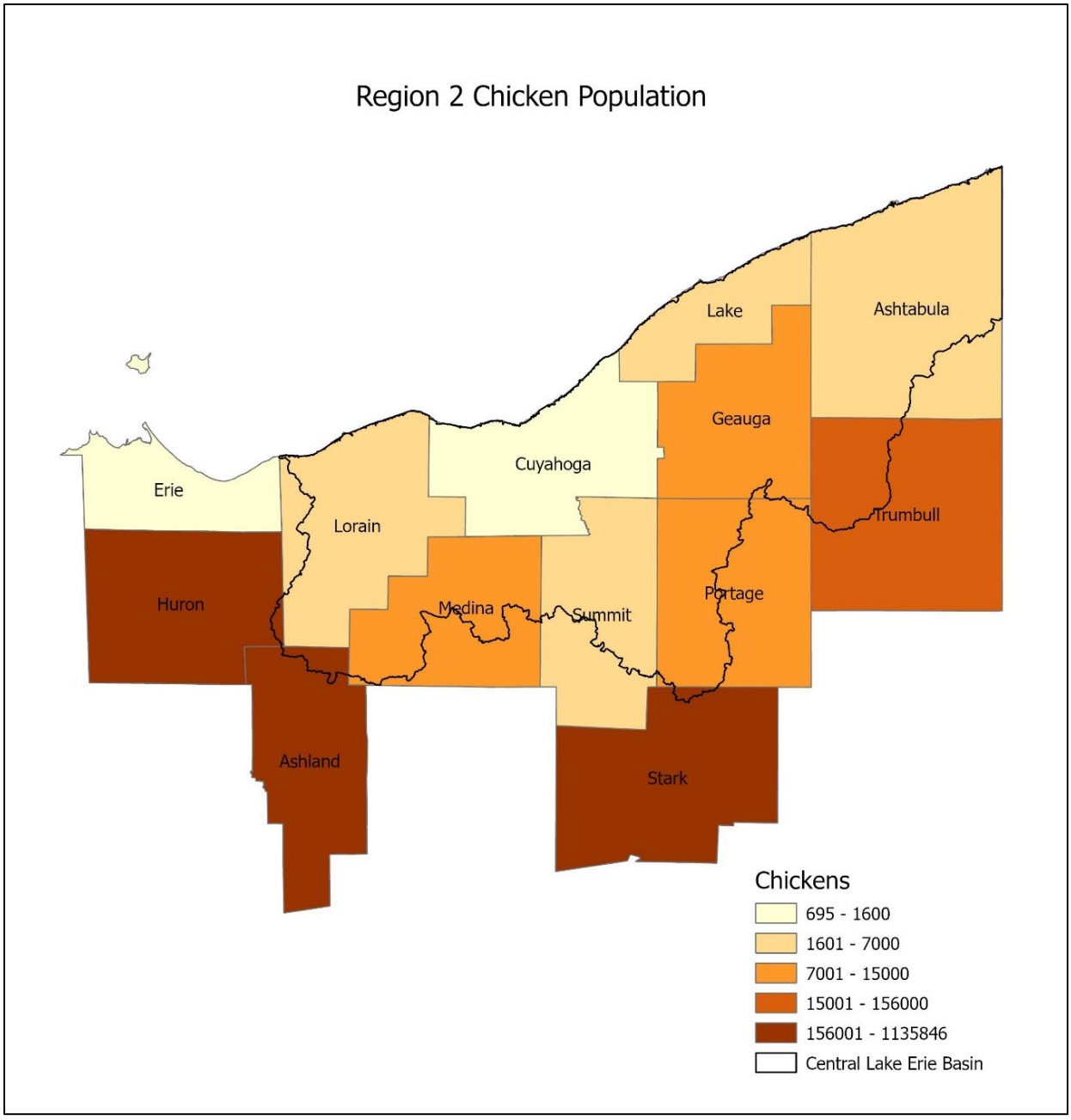
To better understand the impact of livestock, it is important to consider statewide and county-level animal populations by animal units, which is a calculated value that normalizes livestock population across species. Map 7 provides visualizations of these trends across the state, and Maps 7-14 show regional trends using actual population counts from the National Agricultural Statistics Service (NASS), with regional boundaries overlaid for context.



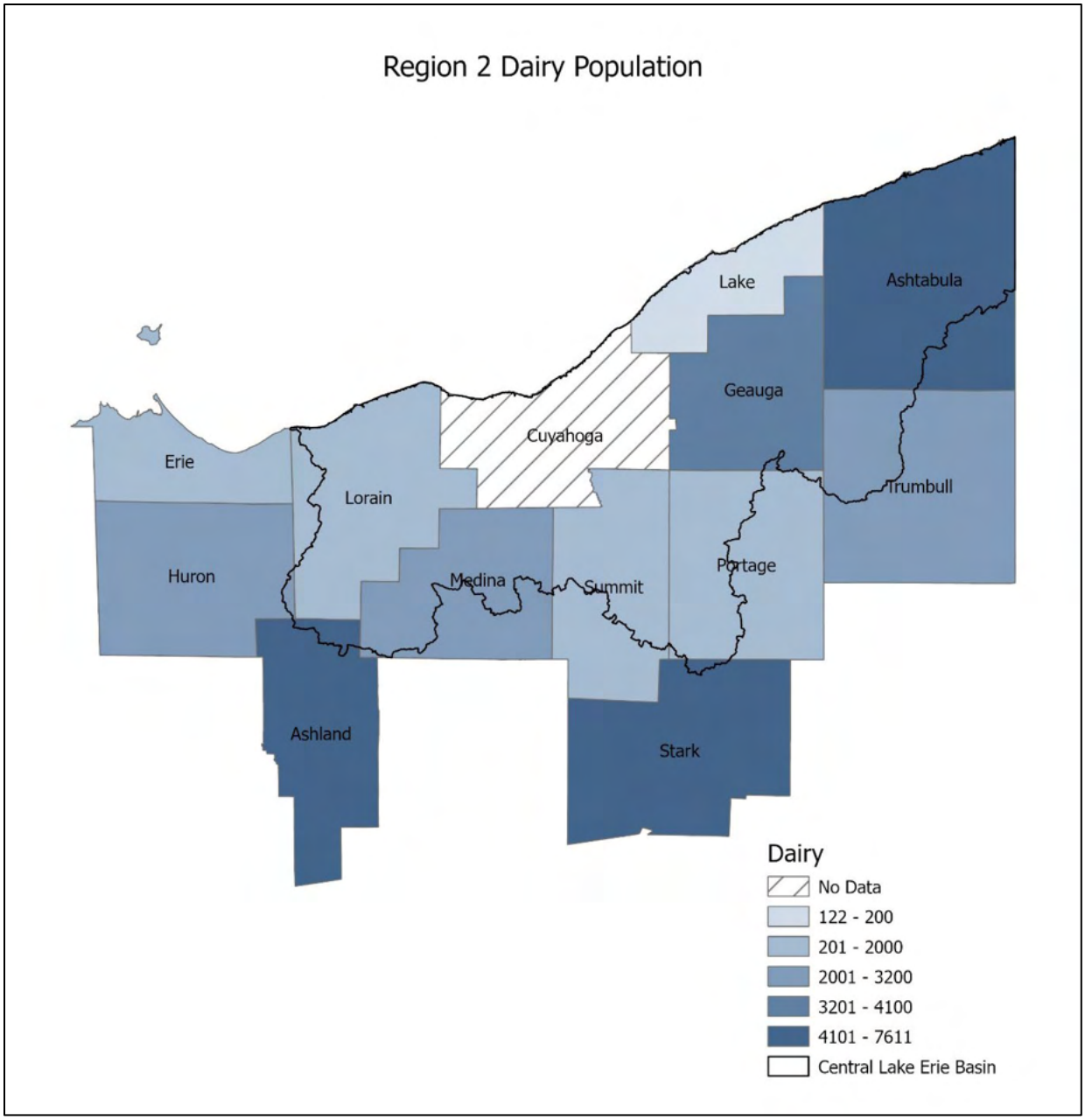
Map 7. Statewide, county-level animal population by animal units. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)



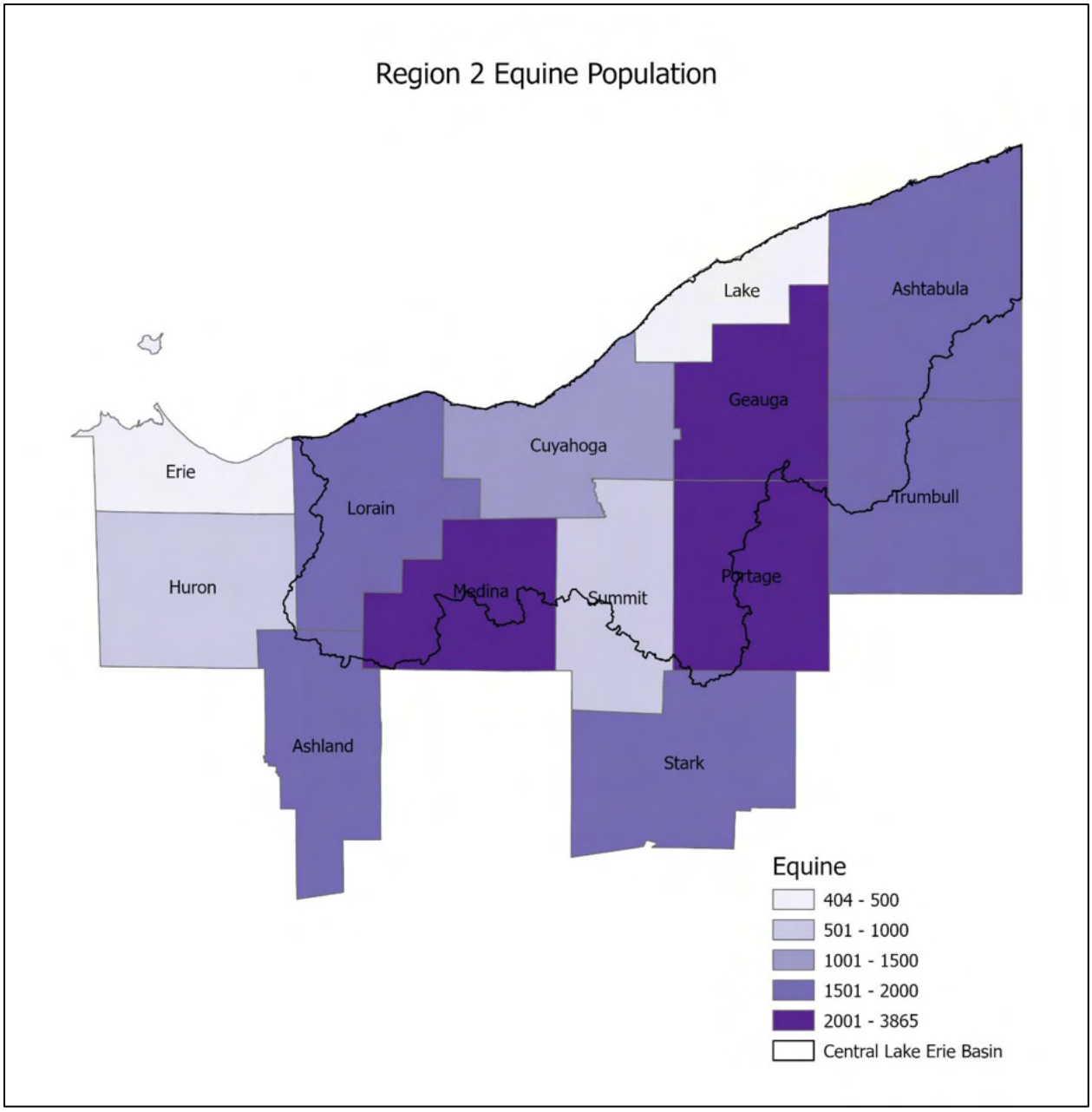
Map 8. Region 2 county-level cattle population. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)



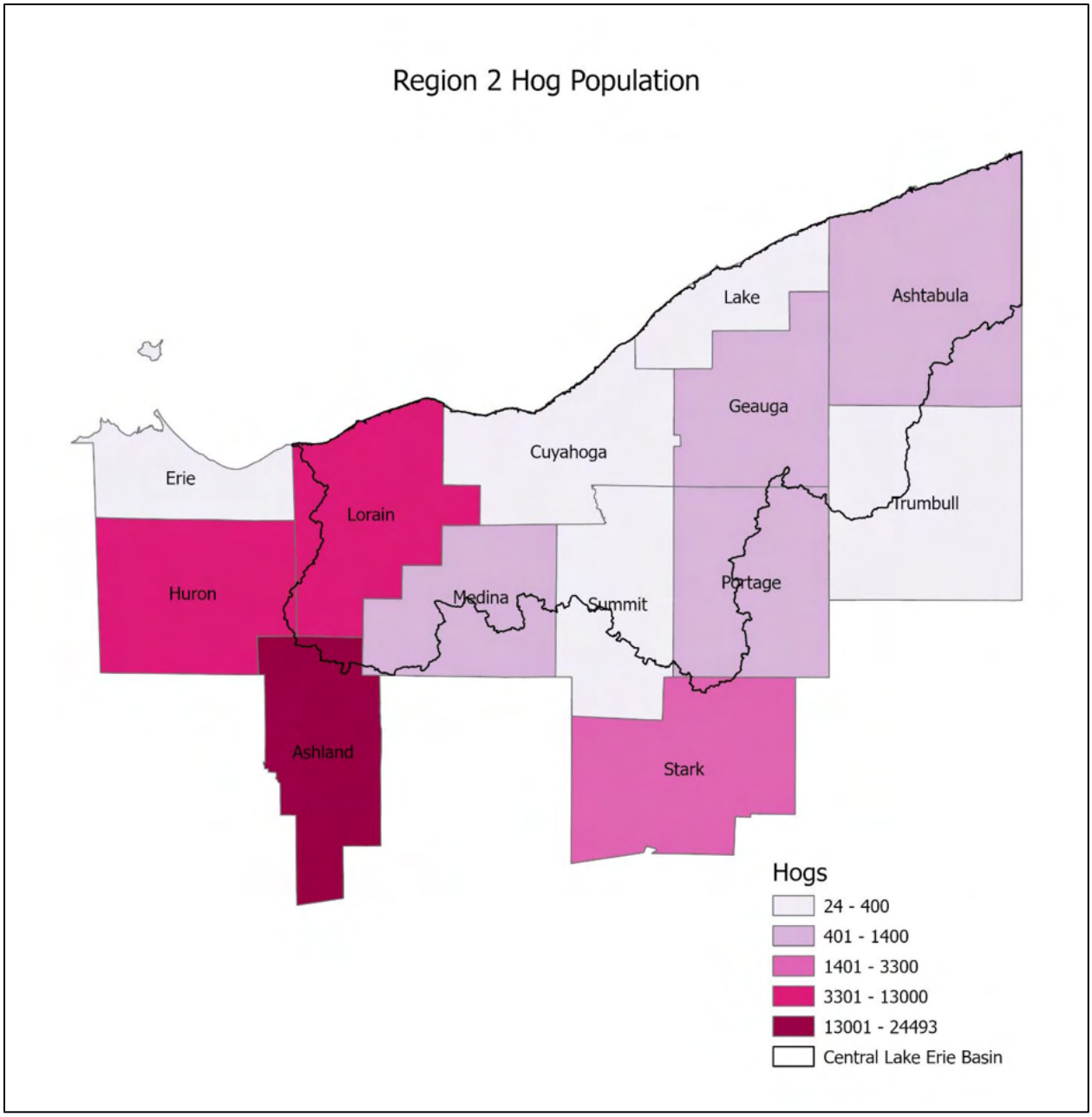
Map 9. Region 2 county-level chicken population. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)



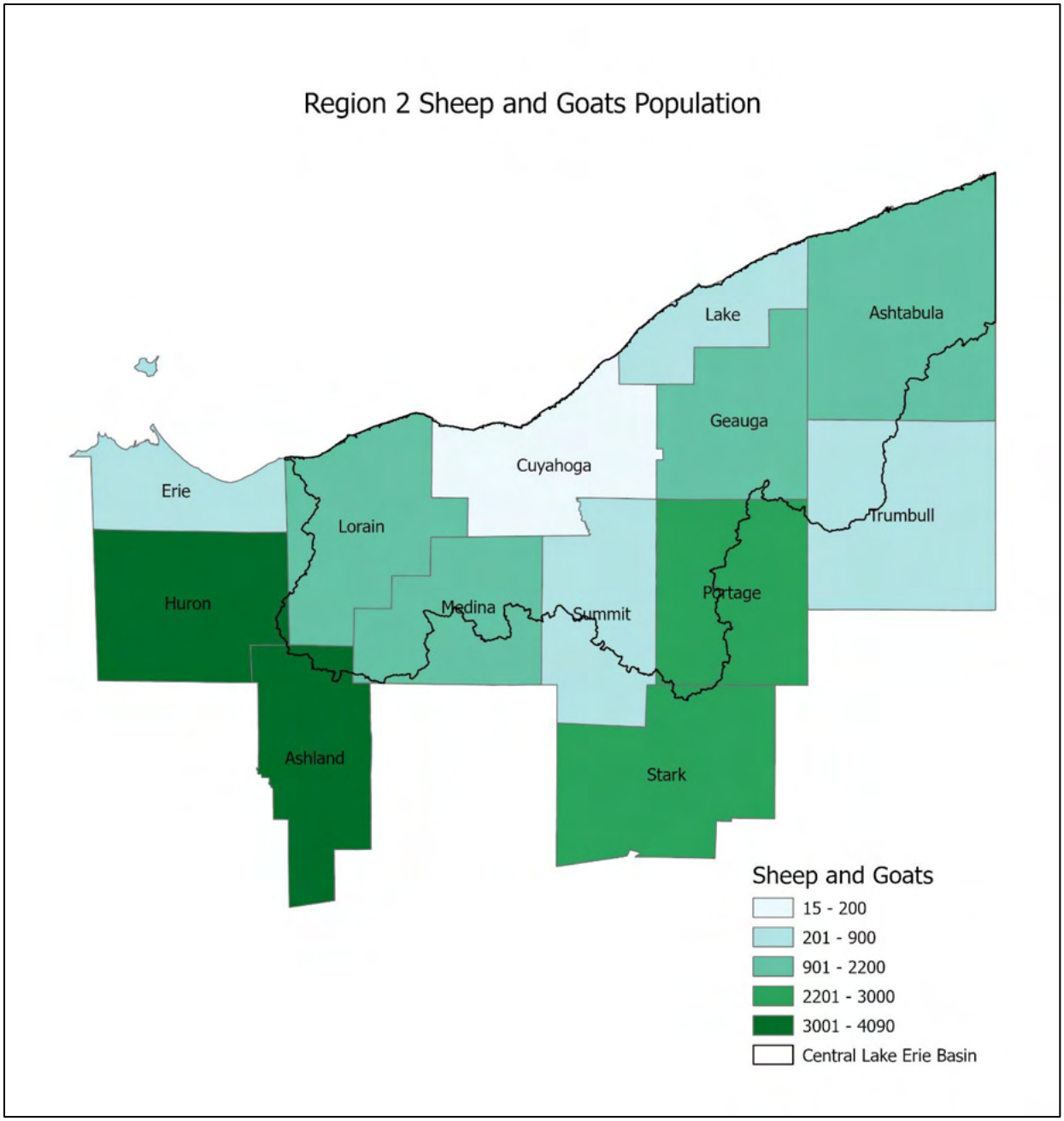
Map 10. Region 2 county-level dairy population. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)



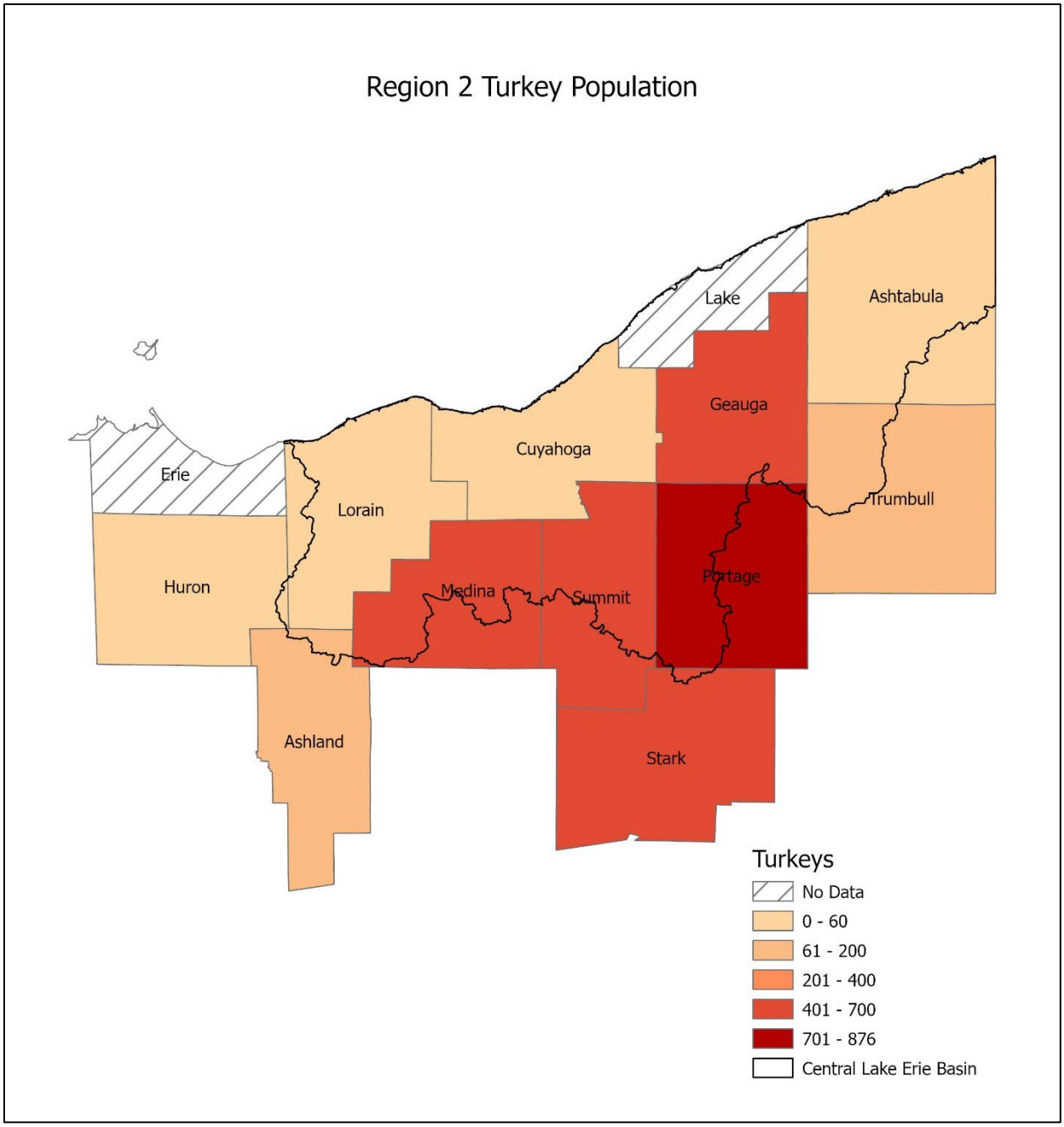
Map 11. Region 2 county-level equine population. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)



Map 12. Region 2 county-level hog population. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)



Map 13. Region 2 county-level sheep and goats population. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)



Map 14. Region 2 county-level turkey population. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)

Concentrated Animal Feeding Facility (CAFFs) of a certain size – such as over 1,000 beef cows or 82,000 laying hens - require permits from the ODA Division of Livestock and Environmental Permitting (DLEP). These permits cover installation, operations, and environmental standards. To install the facility, the permits require geological, siting, and manure storage sizing assessments, among others. CAFFs are also required to submit insect and rodent control plans, manure management strategies, mortality management plans, and emergency response plans when applying for permits to operate. In some cases,

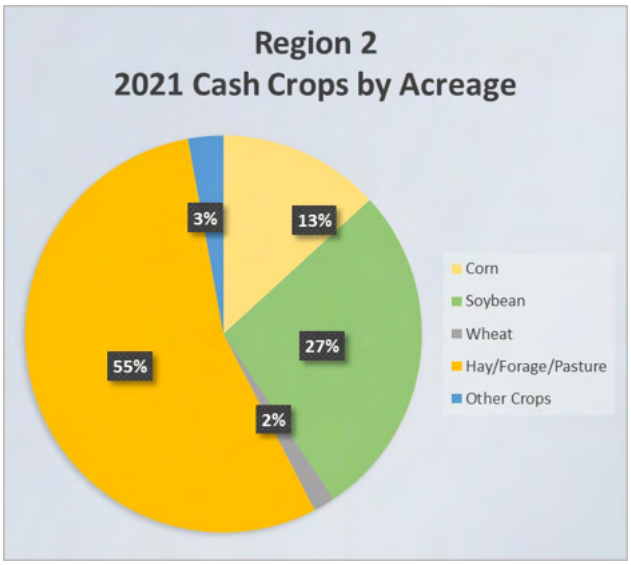


Figure 4. The proportion of cropland in Region 2 devoted to corn, soybeans, forages and wheat. Data is from the 2021 Cropland Data Layer, USDA-NASS. (U.S. Department of Agriculture, Natural Resources Conservation Service, 2021)

groundwater monitoring may be necessary as well. The DLEP oversees the regulatory compliance of two CAFFs in Region 2.

Region 2's most prominent crops are corn and soybeans (Figure 3), and recent data analysis from 1950 to 2017 shows an upward trend in both. Although corn acreage declined slightly from 1950 to 2017, the recent trend is increasing (Figure 4). In contrast, soybean acreage has steadily risen with a much steeper trend line, increasing from 51,462 acres in 1950 to nearly 400,000 acres in 2017. Meanwhile, wheat and hay/forage acreage has declined over the same time span. According to the Conservation Technology Information Center, conservation and reduced tillage techniques covered 69% of Black-Rocky HUC 8 watershed acres in 2018, while conventional tillage accounted for only 19%, and no till usage amounted to 31%.

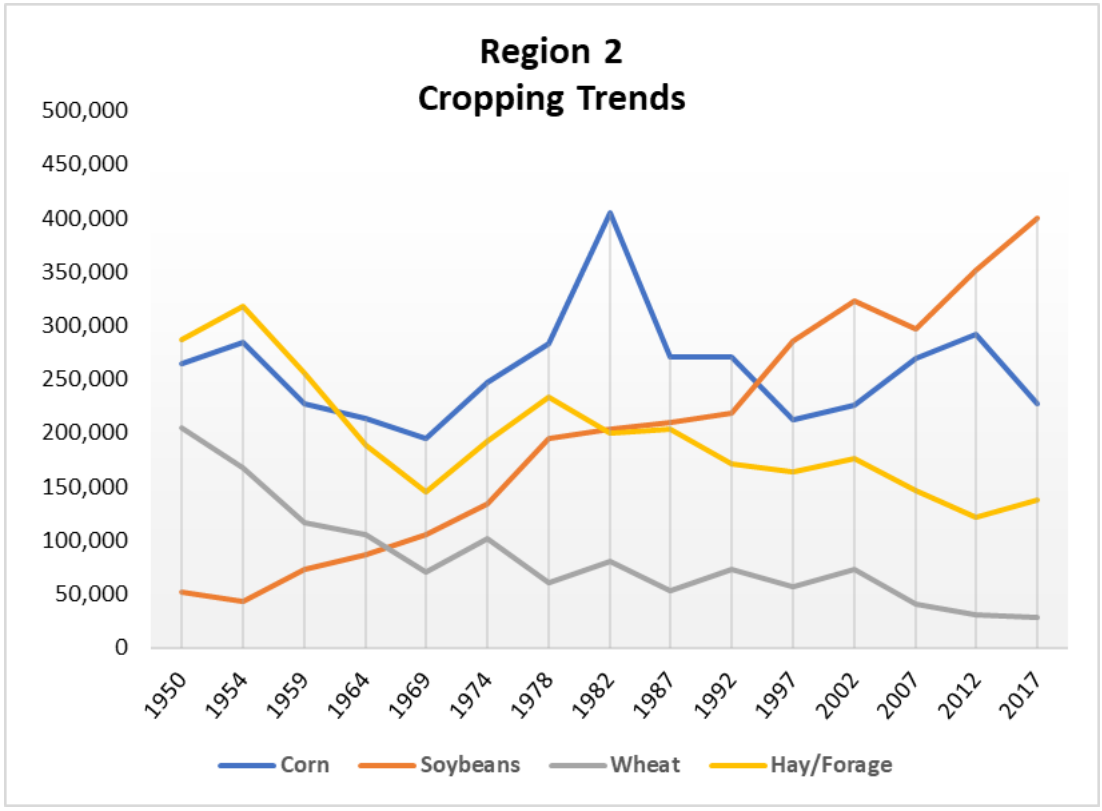


Figure 3. Historical trends for corn, soybeans, wheat, and hay/forage in Region 2. (U.S. Department of Agriculture, National Agricultural Statistics Service, 1950-2017).

Region 2 contains 113,110 drained acres via tiling, a concerning issue as drainage practices influence water quality. Tiled systems lower the groundwater table and discharge water quickly, increasing the amount of unutilized nutrients entering the watershed. Map 15, developed by Valayamkunnath et al., provides a spatial estimation of tile drainage extent across the United States, incorporating additional factors such as slope and USDA-NASS data.

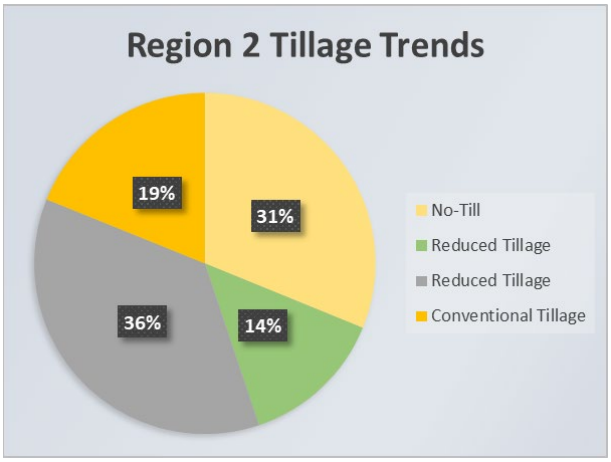
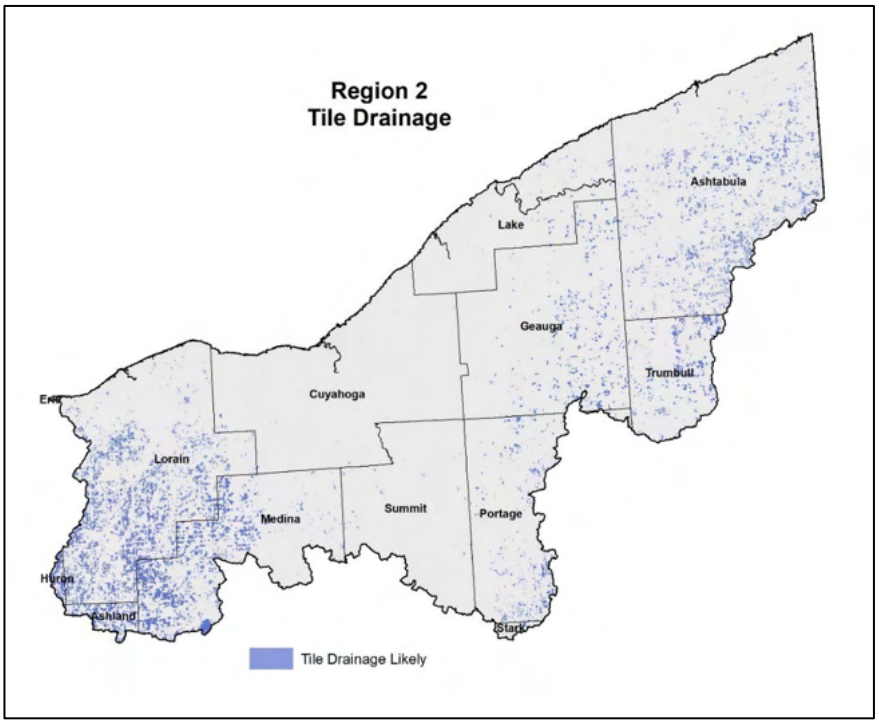


Figure 5. Tillage trends in Region 2. (Conservation Technology Information Center, 2019)

4R certification is gaining popularity as a recommended practice for agricultural retailers and nutrient service providers. The certification program, which began in 2017, rewards professionals who adhere to the best practices of using the appropriate source of nutrients, at the right rate and time, and in the right location. Nutrient applications play a crucial role in crop production, and guidelines and resources are available to help producers apply nutrients effectively.

In Ohio, farmers are advised to follow the 590 standards established by the Natural Resources Conservation Service when making nutrient applications. Additionally, the ODA collaborates with local SWCD to implement the Ohio Agricultural Pollution Abatement Program, which sets statewide standards for farming and animal feeding operations to prevent soil erosion and water pollution caused by sediment and animal manure.



Map 15. Estimated extent of subsurface tile drainage in Region 2. Map uses data from "AgTile-US" dataset (Valayamkunnath, Barlage, Chen, Gochis, & Franz, 2020).

It's mandatory for anyone applying or supervising the application of commercial fertilizers on 50 or more acres of land intended for sale to obtain certification. The number of acres with fertilizer and manure applied in the region are included below in Table 2.

Region 2 Nutrient Applied Acres			
County	Commercial fertilizer, lime, & soil conditioners	Manure	Organic Fertilizer
	---------- *Acres* ----------		
Ashland	86,871	24,231	2,350
Ashtabula	64,739	11,270	958
Cuyahoga	359	54	29
Geauga	16,634	7,178	730
Huron	150,149	14,306	1,417
Lake	4,469	519	16
Lorain	65,191	4,765	995
Medina	52,139	5,829	828
Portage	40,065	5,119	418
Stark	67,237	15,694	1,487
Summit	6,196	1,054	45
Trumbull	58,293	6,371	1,122

Table 2. Acres of nutrients application within Region 2. Data sourced from USDA-NASS. (U.S. Department of Agriculture, National Agricultural Statistics Service, 2019)

3.1.2 Urban

Region 2 has a high density of developed land at 34% land cover, concentrated in Cleveland, Akron, and the surrounding area. Over the past decade, the population of Region 2 has remained stable with only a slight decrease of less than 0.5%. The 12 counties bordering Region 2 had a population of 3,578,005 in 2010 and it only dropped to 3,558,866 by 2021 according to the U.S. Census Bureau. These counties now make up 30% of Ohio's total population.

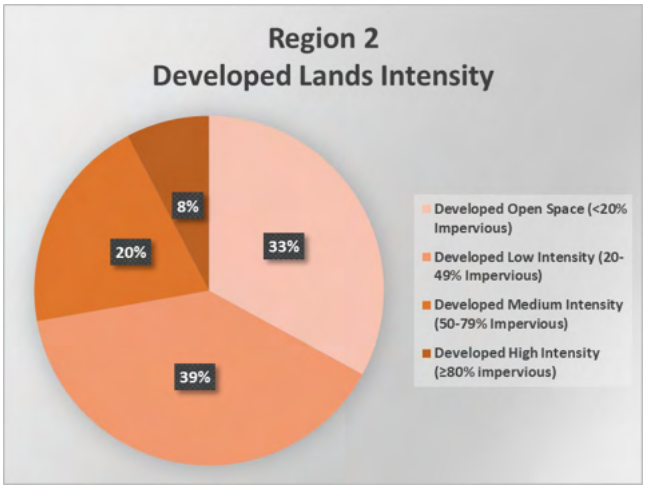
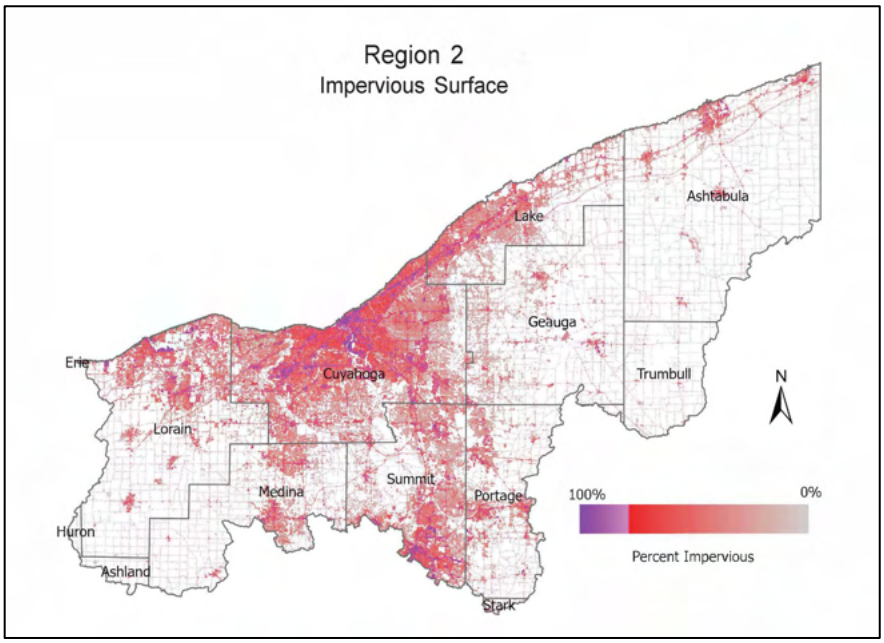


Figure 6. Detailed breakdown of developed areas within Region 2. (Dewitz & U.S. Geological Survey, 2021)

Developed land is often linked with high percentages of impervious surfaces such as roads and rooftops. Though these impermeable surfaces serve their practical purpose in city engineering, they disrupt the natural infiltration of stormwater during precipitation events.

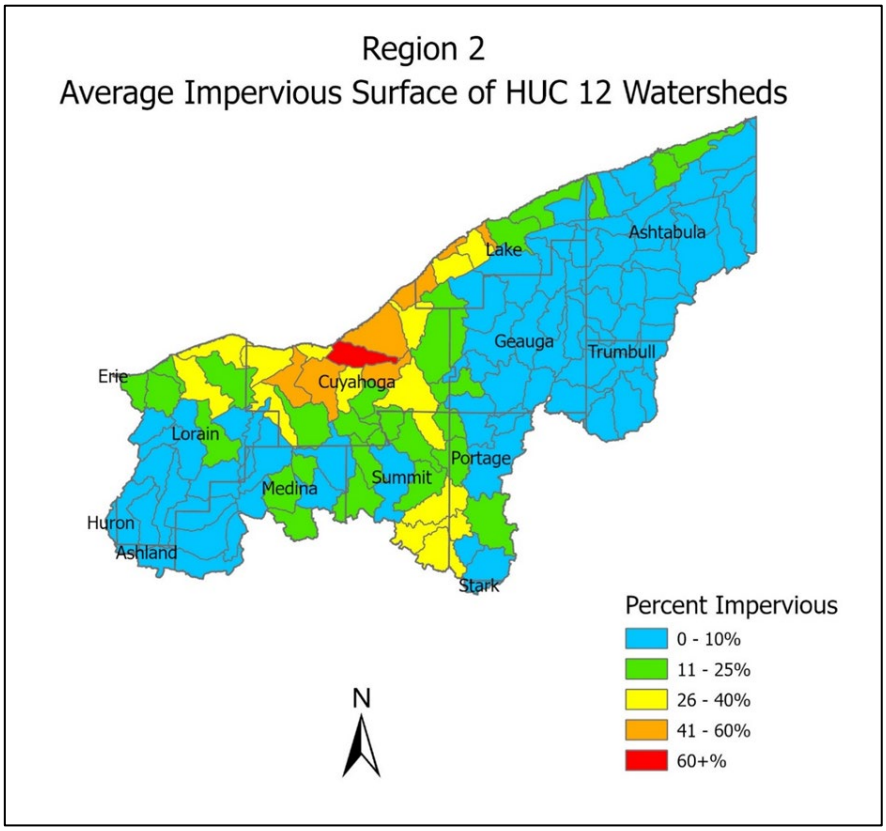
This can lead to negative impacts on water quality and habitat, including stream erosion, increased pollutants, sedimentation, and a rise in stream temperature. “Any stream's watershed having greater than 25% impervious is classified as non-supporting stream with characteristics such as eroding banks, poor biological diversity, and high bacterial levels.” (Kwon, Winer, & Schuele, 2022) and seen in Figure 7, a watershed is impacted by impervious surfaces at 10%, while large consecutive land areas are above

that threshold in Region 2. The spatial distribution of these areas can be seen in Map 16.



Map 16. Region 2 impervious surface. Source: MRLC 2019 Urban Imperviousness Database. (Dewitz & U.S. Geological Survey, 2021)

When considering potential impairment impacts of impervious surface, it is useful to consider coverage at the watershed scale. Map 17 shows the prevalence of impervious surface within HUC-12 watersheds of Region 2 based on thresholds delineated by the Center for Watershed Protection (Figure 7).



Map 17. Impervious surface shown as percentage of each HUC-12 watershed within Region 2. Source: Source: MRLC 2019 Urban Imperviousness Database. e: (Dewitz & U.S. Geological Survey, 2021).

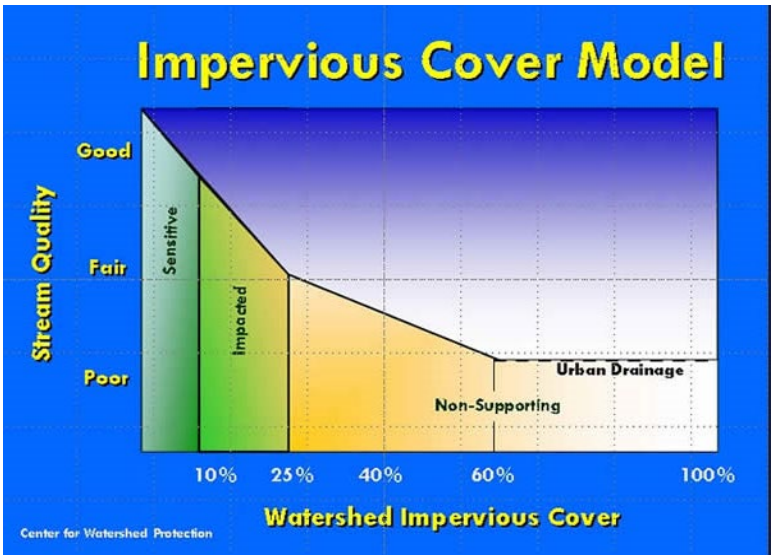


Figure 7. Center for Watershed Protection, Impervious Cover Model. Graphic representation of how impervious surfaces affect stream quality. (Center for Watershed Protection, 2003)

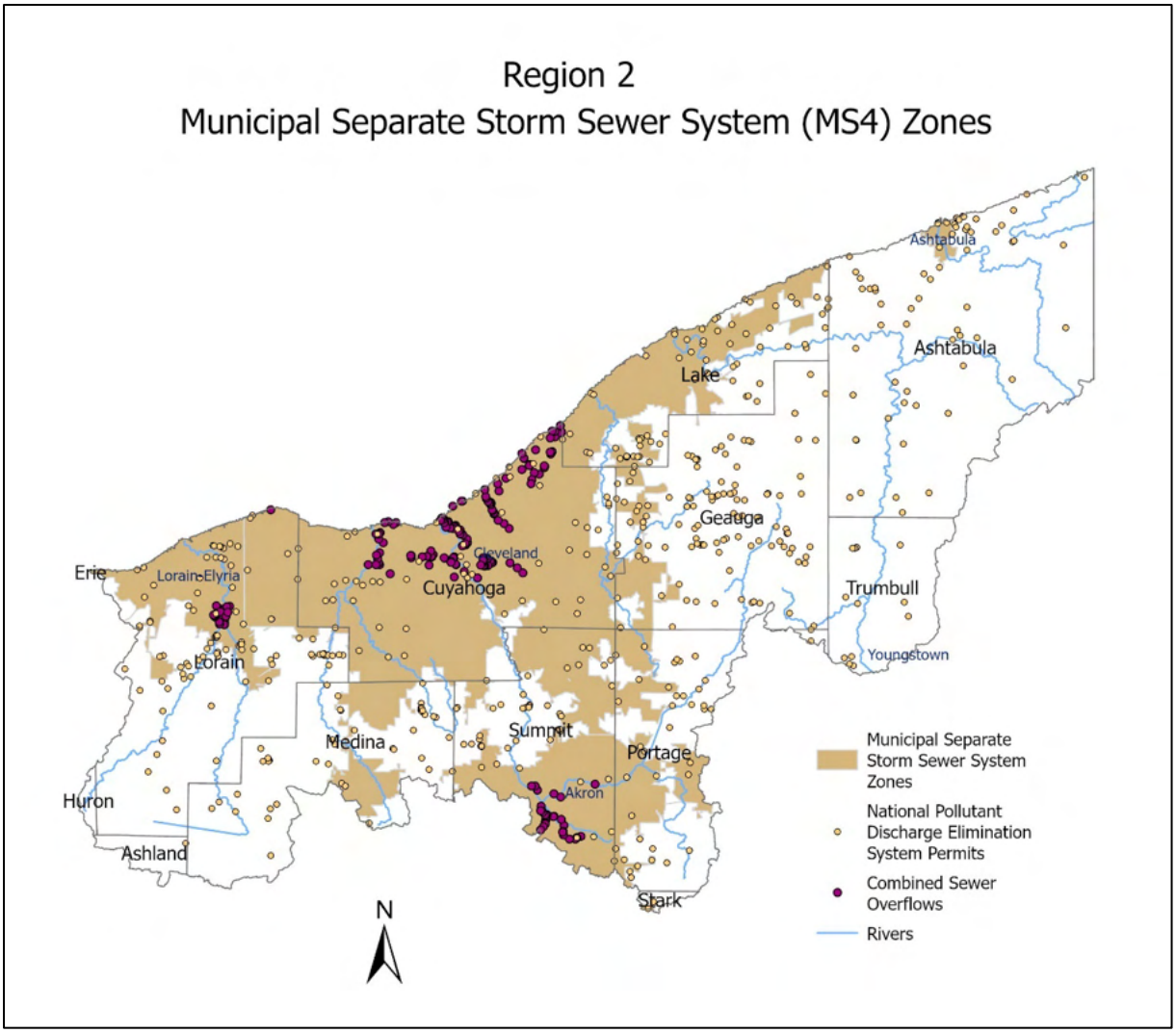
Number of HUC12s in each impervious category (2019)					
Region	**0-10%**	**11-25%**	**26-40%**	**41-60%**	**60+%**
1	299	18	5	5	0
2	67	24	12	5	1
3	238	38	16	1	0
4	204	12	8	5	0
5	277	19	6	0	0
6	100	12	3	0	0
7	157	6	0	0	0

Table 3. The number of HUC-12s per region that fall within each of the impervious surface thresholds. (Dewitz & U.S. Geological Survey, 2021)

Table 4 and Map 18 highlight the scope of the Municipal Separate Storm Sewer System (MS4) areas in Region 2 as required by the federal Clean Water Act (CWA), administered by U.S. EPA since 1972. Ohio EPA oversees the program in Ohio.

Region 2 Municipal Separate Storm Sewer System Communities and Acres Covered		
MS4 Name	Total Acres	Regional Acres
Akron	227,226	109,104
Ashtabula	5,060	5,060
Cleveland	512,179	505,491
Lorain-Elyria	71,488	66,868
Youngstown	149,724	140

Table 4. Region 2 MS4s and the acres they cover. (Ohio Environmental Protection Agency, Division of Surface Water)



Map 18. MS4s, Combined Sewer Overflows (CSOs), and National Pollutant Discharge Elimination Systems (NPDES) in Region 2. (Ohio Environmental Protection Agency, Division of Surface Water)

Ohio's infrastructure needs improvement, according to the 2021 Infrastructure Report Card from the American Society of Civil Engineers. The report grades infrastructure on an academic scale of A to F, and Ohio's stormwater and wastewater categories received grades of D+ and C- respectively. Aging and undersized stormwater infrastructure is a concern, given Ohio's extensive system. Additionally, wastewater rates have increased by almost 70% in the last 10 years and will likely continue given the need to reduce CSO and Sanitary Sewer Overflow (SSO) outfalls. Funding remains a hurdle for both storm and wastewater infrastructure in Ohio.

Construction and select industrial activities can have a negative impact on water quality, for which permits are required. Specifically, construction projects that disturb more than one acre, and certain industrial facilities based on their Standard Industrial Classifications, must obtain permits.

To dispose of sludge, a byproduct of wastewater treatment, wastewater operators must document the method and amount of disposal. The Ohio EPA Biosolids Program compiles this data into an Annual Sewage Sludge Report. In Ohio, approximately 40% of sludge is land applied, while the rest is either

incinerated or landfilled. The quality of the land-applied sludge must meet specific parameters outlined in Ohio Administrative Code (OAC) 3745-40-08, such as application restrictions for environmental conditions and proper rates.

Combined sewer overflow outlet.

Sludge is classified under two categories based on parameters outlined in OAC 3745-40-04 - Exceptional Quality or Class B. Currently, over 2400 sites are available in Ohio to receive biosolids, typically agricultural fields where nutrients can be used for crop production. Understanding these crucial wastewater treatment activities and regulations is essential for maintaining a healthy and sustainable urban environment.

In Region 2, highly developed areas have mostly or entirely culverted channels, known colloquially as ghost or zombie streams. Although often necessary for roadway crossings, disease prevention, development, and flood and erosion reduction (only to push the issues farther downstream), the urban environment loses connections to natural cycles and ecosystems when streams are buried underground. Though culverts transport water, sediment, and debris downstream like a natural channel, they are void of life. “Daylighting” a stream by removing the culvert and exposing the stream again to the environment can be an effective restoration practice.

Despite prevalent issues like hydromodification, flood plain disconnection, stormwater overflow, and high salinity in urban waters during winter, there has been a significant increase in the quality of urban water since the 1900s. The Cuyahoga river, which famously caught fire 14 times, prompted the creation of the CWA, and has since made considerable progress in meeting its goals between Akron and Cleveland. Although there are still challenges to overcome, it's important to recognize and celebrate the positive changes in urban water quality.

The impact of Household Sewage Treatment Systems (HSTS) on Region 2 in the Cuyahoga River is only quantitatively known, due to it being the only studied river in the Ohio EPA's nutrient Mass balance report. This being such a small portion of Region 2, it should be noted that the most common impairment associated with HSTS is E.coli and all HUC 12 watersheds other than 9 are impaired for e. Coli. In the Cuyahoga River HSTS accounts for 6% and 12% of total nitrogen and total phosphorous in Water Years (WYs) 13 through 19.

3.1.3 Forest

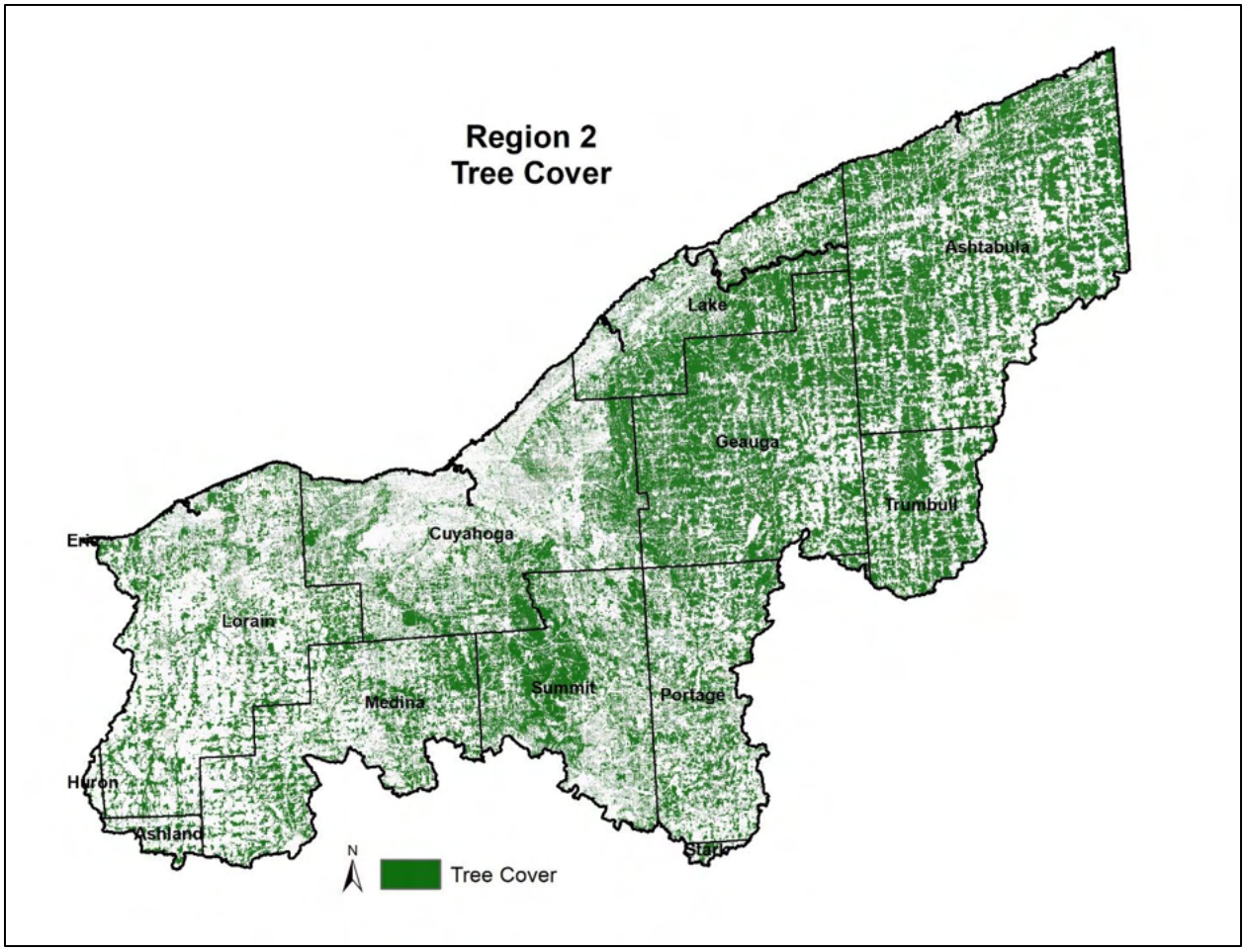
Once abundant with deciduous forests, Region 2 is now highly comprised of urban lands. However, even today forested area remains the second largest land use in the region, accounting for 33%, 30% of which is deciduous forest. While deforestation and poor logging practices may increase erosion and runoff, forested lands themselves are not significant contributors to water quality concerns.

Forests play a large role in water quality, with protected or active forested land. A forest’s canopy acts as a sponge to slow down precipitation, and eventually allowing it to reach the ground at a different time or

be lost through evaporation. The infiltration rate for forests is higher than suburban turf by approximately 3 times (Cotrone, 2022). Forest plants also remove nutrients from stormwater, keeping them from entering lakes and rivers. According to the Ohio Forest Action Plan, carbon pools, carbon sequestration, organic matter, and Mycorrhizae soil fungi are additional benefits of forested areas. Live trees and soil organic matter are two of the largest single pools of carbon. From 2004 to 2018 there was an increase in Ohio's total forest carbon. Note that mycorrhizae fungi are considered vectors for plant carbon to soil and take in nutrients and water from the soil.

Native Ohio plants.

The most effective BMP on forested lands is to prevent land use changes that reduce surface permeability. Trees and their networks of roots are like a sponge slowing down the flow of rain and melting snow to streams and groundwater. In Region 2, protecting forested areas near streams and rivers is a top priority for stakeholders. The presence of invasive species poses a challenge, as they harm native flora and fauna and disrupt ecosystems. However, numerous organizations are committed to preserving riparian corridors in areas like Grand, Chagrin, and Ashtabula rivers. See Map 19, which illustrates the scope of tree canopy in Region 2.



Map 19. Tree cover in Region 2 (2016 National Land Cover Database, MRLC consortium). (U.S. Department of Agriculture, Forest Service, 2016)

The ODNR has created the Ohio Forest Action Plan to address key forest-related concerns in the state. It highlights issues such as sustainable forest management, public benefits, biodiversity conservation, forest health threats, and fragmentation & loss of forest areas.

Reports from the USDA Forest Service's Forest Inventory and Analysis program show that forest cover in Ohio has remained at 30% since 1991, and private landowners play a key role in ensuring their continued health. While only a small percentage of landowners have management plans or received advice, improvement is seen from earlier reports. Large trees and sawtimber quality have shown improvement.

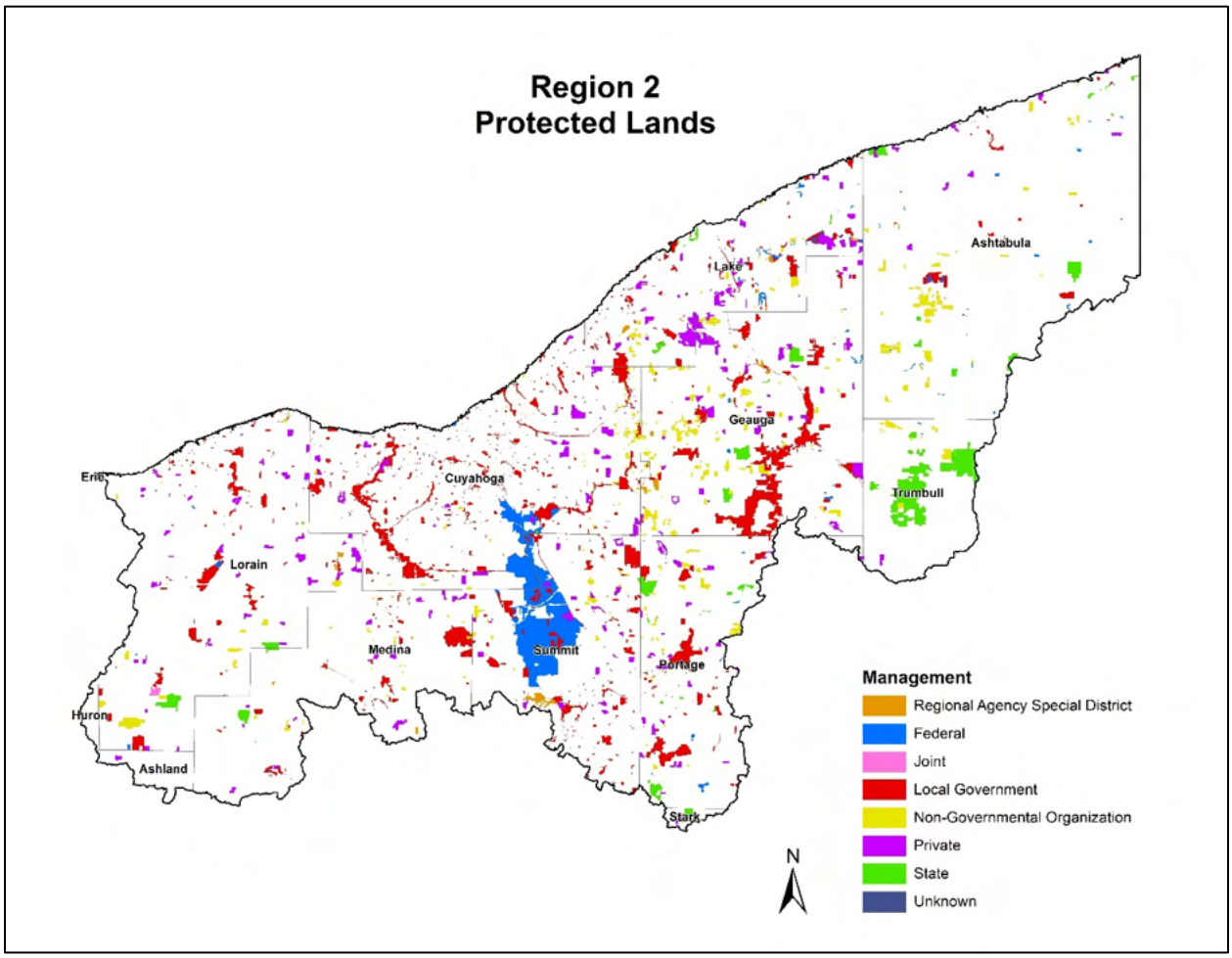
Ohio forests face several threats from insects, diseases, disturbances, invasive plants, parcellation, urbanization, and poor logging activities. Proper management and monitoring are needed to protect these natural areas and maintain their positive impact on water quality.

The Ohio Division of Forestry teams up with SWCDs to educate loggers, consulting foresters, and woodland landowners about erosion prevention and BMPs to protect surface water from soil sediment. Ohio Revised Code (ORC) defines Forestry Pollution as a failure to use management and conservation practices in silvicultural operations and provides legal authority to ODNR Division of Forestry and SWCDs to investigate alleged violations.

While Ohio does not mandate logging licenses, permits or erosion prevention plans, they offer voluntary programs such as the Ohio Voluntary Master logger program and the (THP) and notice of intent, which can be submitted for review by local SWCD.

3.1.4 Protected Lands

There are many types of protected lands, and varied purposes for protection. Land use maps capture much of the information pertinent to water quality. For example, a state forest should appear as "forested land" during land use analysis, and this allows decision-makers and planners to employ high-level determinations of water quality impact risk based on that general land use category, regardless of its protection status. However, delineating protected lands does allow analysis of sensitive areas that are threatened by changing land use, such as natural wetlands adjacent to urban expansion, or forests on soil deemed prime farmland, etc. It also helps determine which entities are the most appropriate partners and participants in water quality programs that may encourage expansion or enhancement of land protection practices. Protected lands in Region 2, shown on Map 20, total approximately 240,000 acres.



Map 20. Protected lands in Region 2, including state, federal, municipal, private, nonprofit and other entities. Data from the Geospatial Gateway, USDA-NRCS. (U.S. Department of Agriculture, 2018)

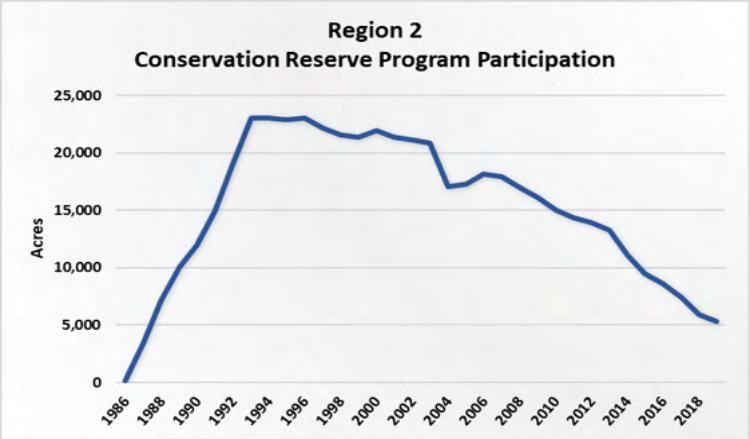
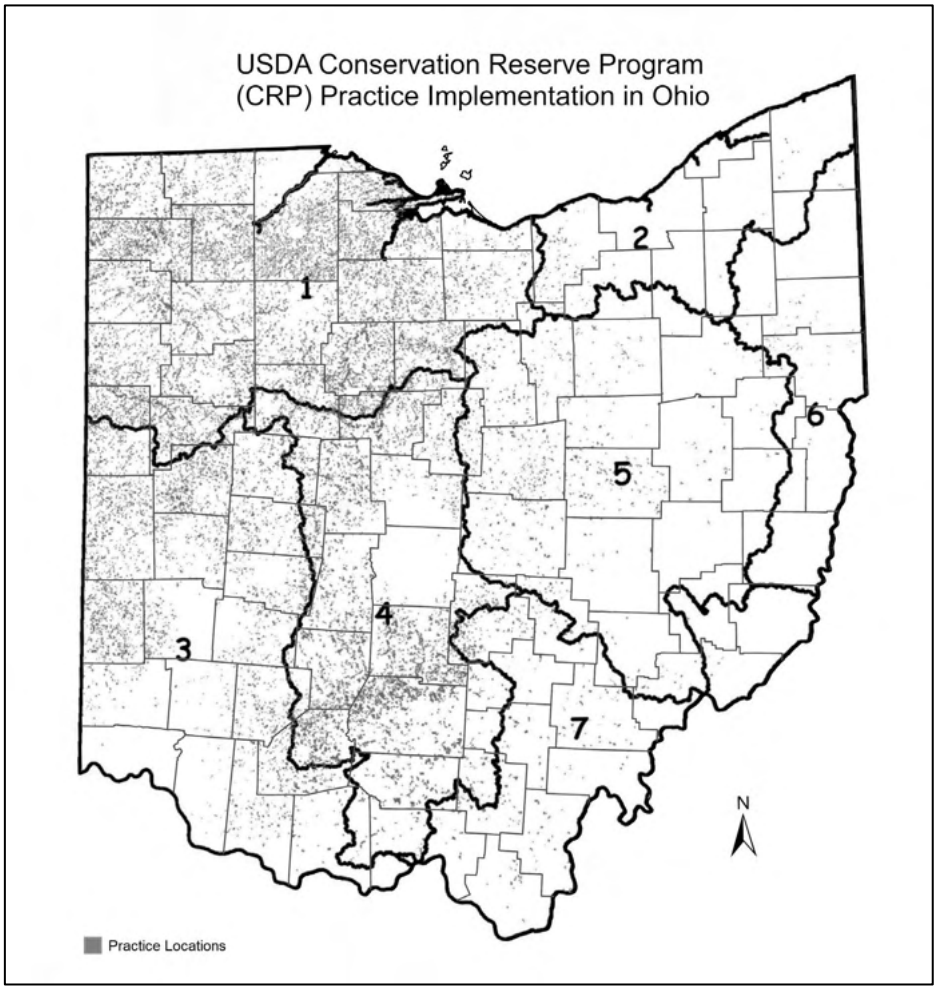


Figure 8. Farm Service Agency (FSA) Conservation Reserve Program (CRP) practices installed across the region (1986-2022). (U.S. Department of Agriculture, Farm Service Agency, 2022)

Several organizations collaborate in this region to safeguard Region 2's rare and distinctive landscapes, including the Cuyahoga Valley National Park, Cleveland Metroparks, Western Reserve Land Conservancy, West Creek Conservancy, Cleveland Museum of Natural History, Holden Arboretum, The Nature Conservancy, county parks, local land conservancies, and others.

The Farm Service Agency (FSA) in Ohio holds significant easements through the Conservation Reserve Program (CRP), with Region 2 participation illustrated in Figure 8 and Map 21.

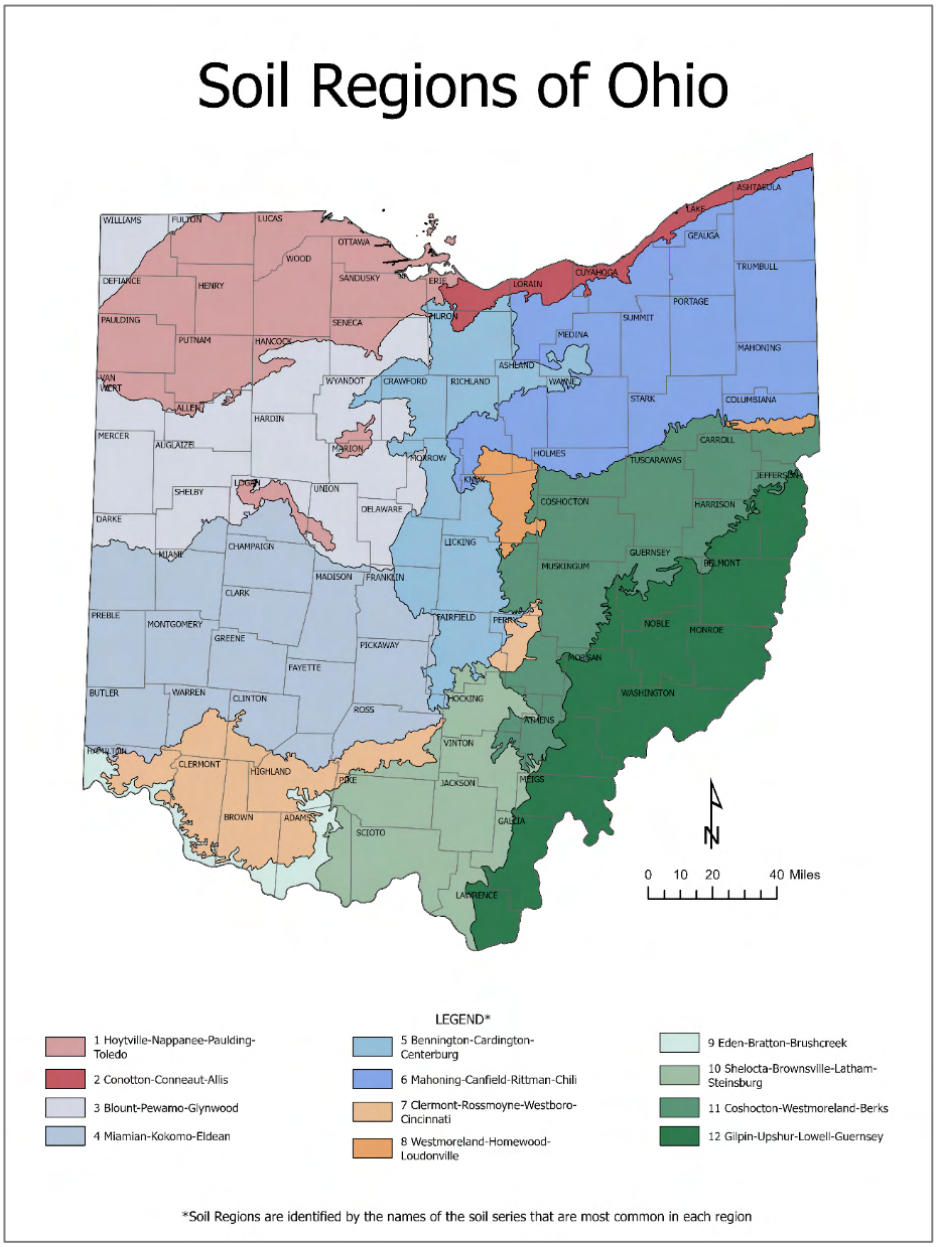


Map 21. Map of farm Service Agency (FSA) Conservation Reserve Program (CRP) practices installed across the state. (U.S. Department of Agriculture, Natural Resources Conservation Service - Ohio State Office, 2022)

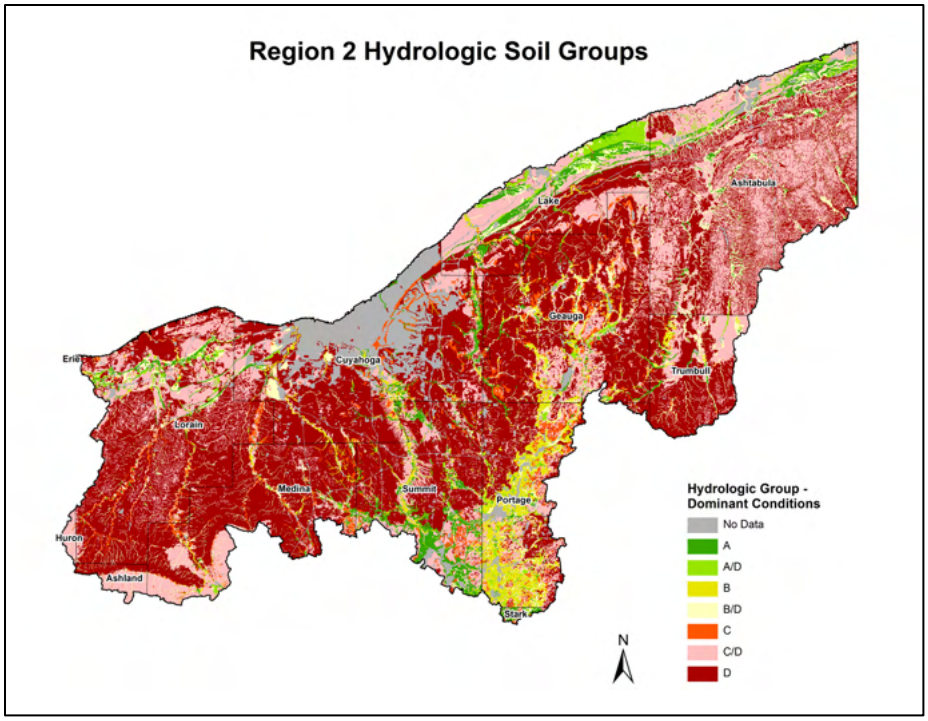
A significant effort to maintain and increase participation in CRP is the Conservation Reserve Enhancement Program (CREP). This initiative provides additional incentives, coupled with contributions from the participating state, to boost participation in the most locally relevant CRP practices. The Lake Erie CREP (available in 27 counties) has been renewed under a new agreement with USDA-FSA in 2023.

3.1.5 Soils

Corresponding to its diverse topography and land uses, the soils of Region 2 are similarly varied. Soil regions of the state can be seen in Map 22. Two commonly used metrics for characterizing agricultural soils are drainage class and hydrologic soil group, which are related concepts that reflect the dominant hydrologic characteristics of a soil. Hydrologic soil groups are used to determine the rate of water infiltration in soils and the risk of runoff in specific conditions. Instead of being used to assess crop growth conditions, the main purpose of these groups is to estimate runoff potential from precipitation. The highest infiltration rate is found in Class A, while the lowest is found in Class D. Categories with two letters indicate the infiltration rate with or without subsurface drainage (Map 23).

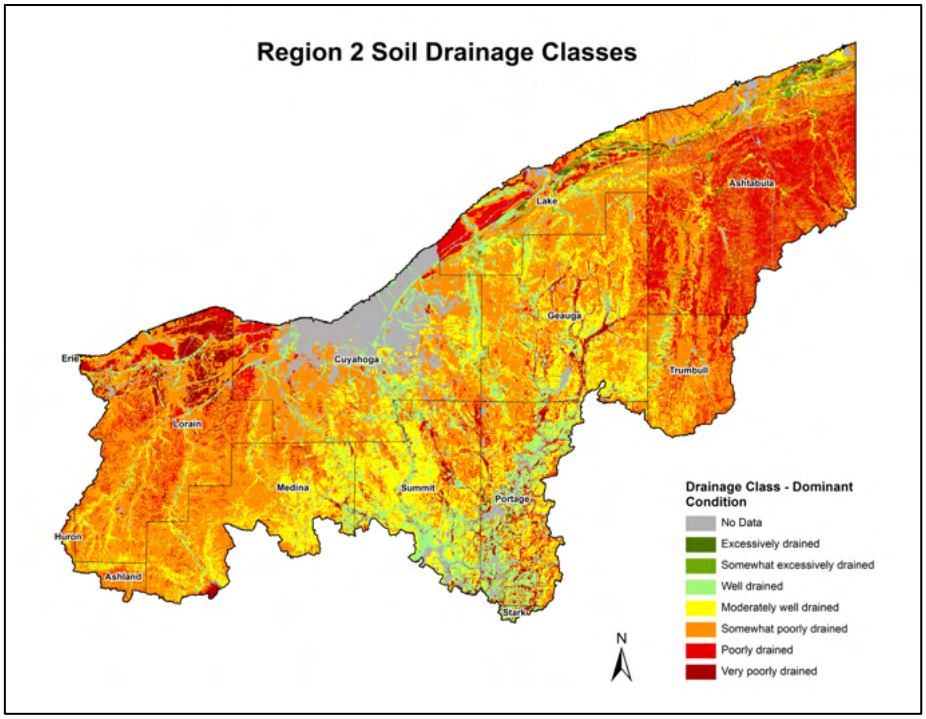


Map 22. Soil Regions across Ohio. (Ohio Department of Agriculture, Division of Soil and Water Conservation)



Map 23. Hydrologic soil groups of Region 2. (U.S. Department of Agriculture, Natural Resources Conservation Service, 2021)

Soils in Region 2 exhibit a moderate to poor level of drainage, with some areas classified as very poorly drained due to the prevalence of impervious surfaces in urban settings. The hydrologic soil group dominating the region is D, indicating that natural infiltration occurs at a slow or very slow rate. This is crucial information for understanding the hydrological dynamics of the region and designing effective water management strategies.



Map 24. Drainage classes by soil map units. Data from the Gridded Soil Survey Geographic Database (gSSURGO) database, USDA-NRCS. (U.S. Department of Agriculture, Natural Resources Conservation Service, 2021)

The distribution of soil drainage classes within Region 2 can be seen in Map 24.

Soil characteristics are important factors that affect water quality. Among them, the most common are slope, organic matter, clay content, depth to water table, and depth to bedrock. The steeper the slope, the higher the risk of soil erosion. Soils with more organic matter in the top 10 inches are more fertile and stable. Higher clay content reduces soil permeability and increases the likelihood of compaction and surface runoff. Depth to the seasonal high-water table and bedrock also affect a soil's potential use for land. More information about Ohio soils can be found at the ODA website.

More information about Ohio soils can be found at the Ohio Department of Agriculture's website.

Ohio water resources are largely a legacy of the state's interesting geologic history. The land we now call Ohio once existed south of the equator and was engulfed by a salty inland sea. While moving towards its current location, it carried sediment from the sea floor, which formed bedrock consisting of layers of limestone, dolomite, shale, and sandstone. It's also responsible for large deposits of salt mined from under Lake Erie. Ohio's current landscape was then influenced by several glaciations creating Lake Erie and other distinctive landforms of Region 2.

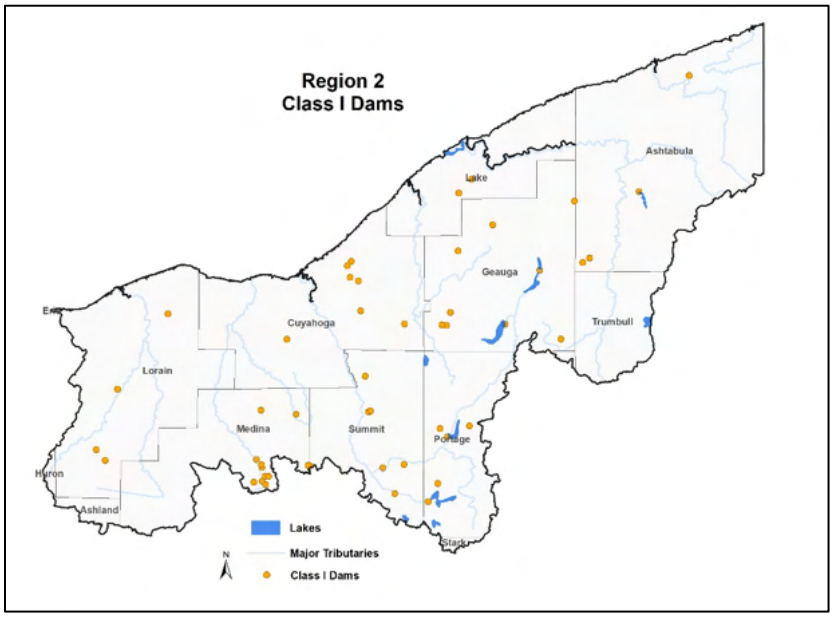
Ohio consists of 3 physiographic regions, or large geographic areas. Two of those regions are in the CLEB, the Central Lowlands and the Appalachian Plateau. The Central Lowlands are glacial influence landscapes underlain by limestone and dolomite bedrock with some shale. The movement of the glaciers smoothed the bedrock and the material left behind was sand, clay, peat, gravel and boulders. The Appalachian Plateau, the eastern portion of Region 2, has high elevation bedrock hills. The glaciated portion of this region in Medina, Summit, Portage, Geauga, Trumbull, and Ashtabula counties we resistant to the movement of the ice. This broadened the valleys for post glacial drainage (Ohio Department of Natural Resources, 2020).

3.1.6 Dams/Impoundments

In Region 2, a total of 937 dams are present, of which 48 fall into class I, 76 in class II, 95 in class III, and 163 in class IV. While dams are critical in supplying water to urban areas, they also impact riverine ecosystems. Dams disrupt river ecology, migratory patterns of organisms, biotic connectivity, and deplete nutrient-rich sediments needed for plant growth downstream. Dam removal is an active restoration method used in Region 2, which has proved successful in restoring significant stretches of river and stream habitat. Map 25 shows class I dams in Region 2.

Region 2 Dam Inventory	
Class	**Count**
Exempt	528
I	48
II	76
III	81
III-EXE	14
IV	163
N/A	5
Unclass	19
Inspexe	3

Table 5. Inventory of dams in Region 2. (Ohio Department of Natural resources, Division of Water Resources, 2021)



Map 25. Class I dams in Region 2. (Ohio Department of Natural resources, Division of Water Resources, 2021)

Low head dam removal.

3.1.7 Water Use

Ohio's groundwater, rivers, and lakes provide abundant sources of water for the people and businesses of this state when managed well. One of the most effective and accessible ways of preserving our water resources is through water conservation. On average, Ohio's residents, cities, farms, industries, and powerplants withdraw over 13 billion gallons of water each day (USGS, 2015).

Great Lakes water is subject to restrictions under the Great Lakes Water Resources Compact, which mandates its use only within the basin. This agreement includes Canadian premiers from Great Lakes provinces. ORC section 1521.16 requires large water withdrawal facilities to register with the ODNR.

In 2020, the total amount of water withdrawn within Region 2 amounted to 56.4 billion gallons. Out of this, public use accounted for a third of the total withdrawals, at 33.2%. The industrial sector emerged as the largest user at 46.9%, with miscellaneous uses, mineral extraction, agriculture, and golf courses using the remaining amount. Detailed information regarding this data can be found in Figure 9 and Figure 10. This information by county and by HUC-8 watershed is available through Ohio DNR's Water Withdrawal Atlas.

In 1986, after the Water Resources Development Act was passed, the City of Akron received consent to extract water from Lake Erie for public drinking water. However, it was granted on the condition that the water drawn would be returned back to the Great Lakes Basin in the same amount, ensuring no net loss of resources. This arrangement remains in effect even today in Portage Lakes.

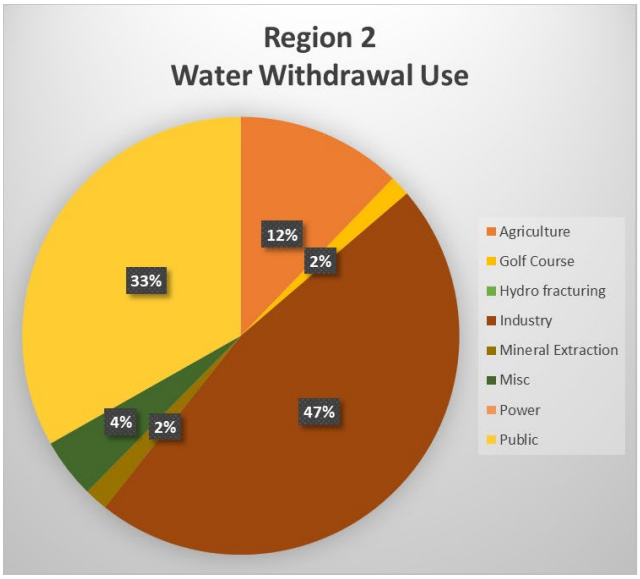


Figure 9. Water withdrawal use in Region 2 (Ohio Department of Natural Resources, Division of Water Resources, 2020)

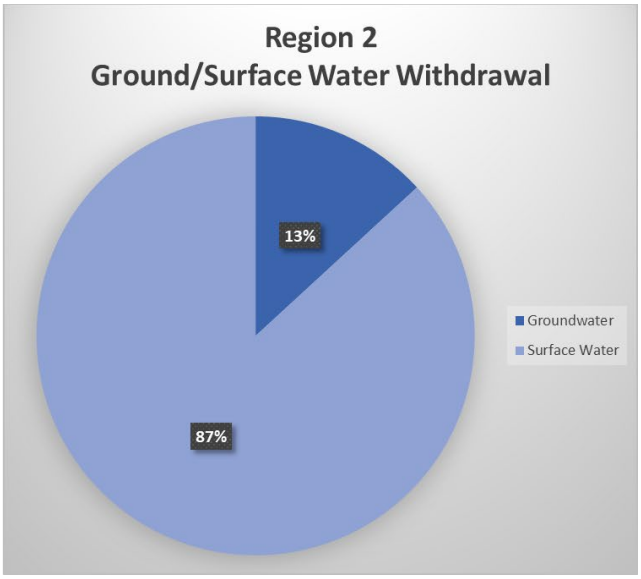
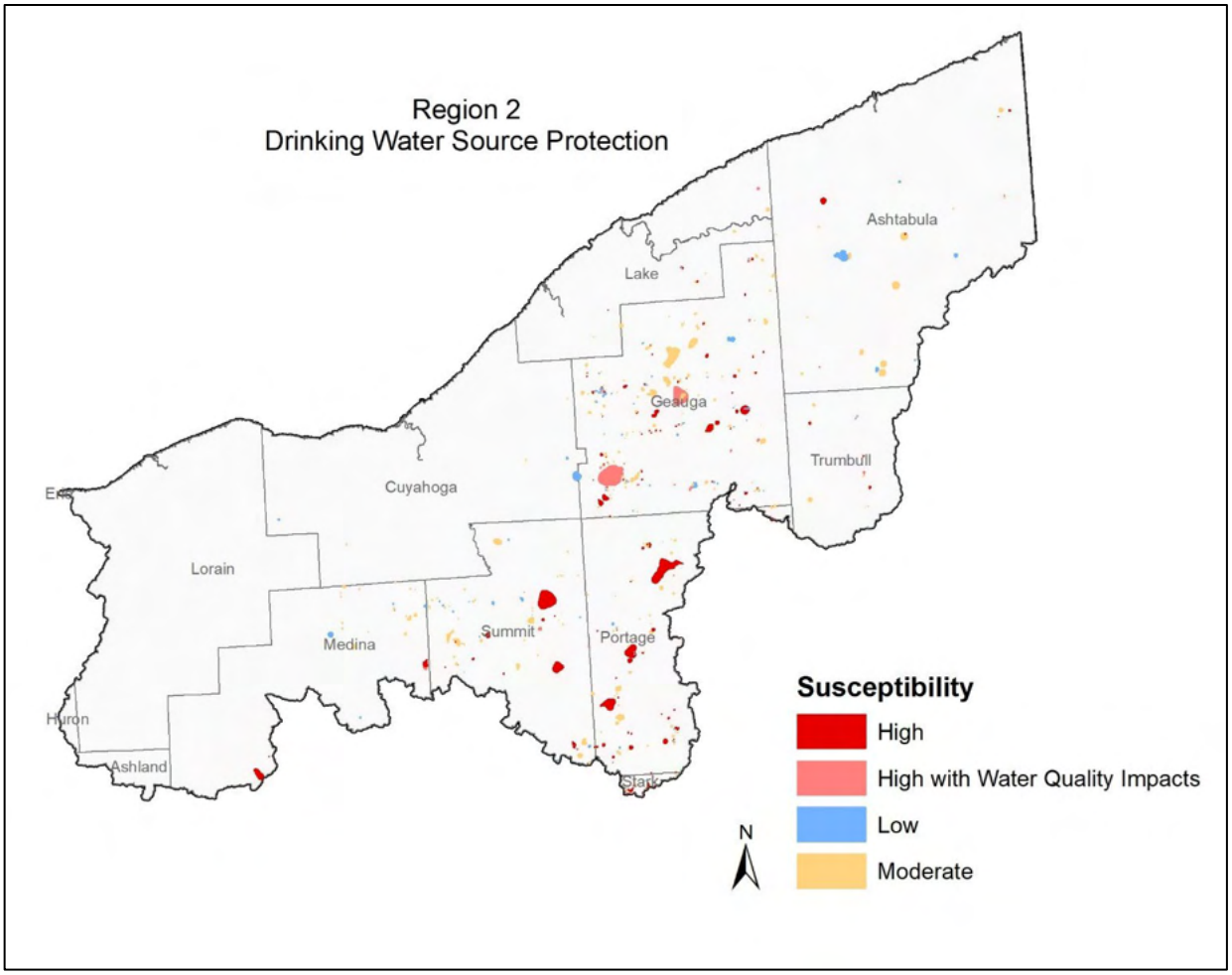


Figure 10. Ground/Surface water withdrawal in Region 2. (Ohio Department of Natural Resources, Division of Water Resources, 2020)

In Region 2, most water withdrawals are from surface water, contributing to 86.8% of the total volume. The major end-uses are industries and public drinking water, constituting 53.6% and 26.8%, respectively. Groundwater sources comprise the rest of the water usage, with drinking water being the primary use at 74.6%. Notably, registered facilities' water withdrawal has continuously declined, with Ohio's Water Conservation and Efficiency Program's introduction in 2008 playing a significant role in this trend.

3.1.7.1 Source Water

Source water pertains to water sources that serve as public drinking water or are utilized for private wells. These water sources may include rivers, lakes, groundwater, reservoirs, and springs. Maintaining and safeguarding these areas is crucial in preventing drinking water and public health concerns. Activities aimed at protecting these areas include riparian zone restoration, stream bank stabilization, land preservation, and the implementation of BMPs by land managers. Proper protection of these areas is essential to guarantee a clean and reliable source of drinking water for communities. Groundwater source protection areas and their susceptibility to contamination can be seen in Map 26.

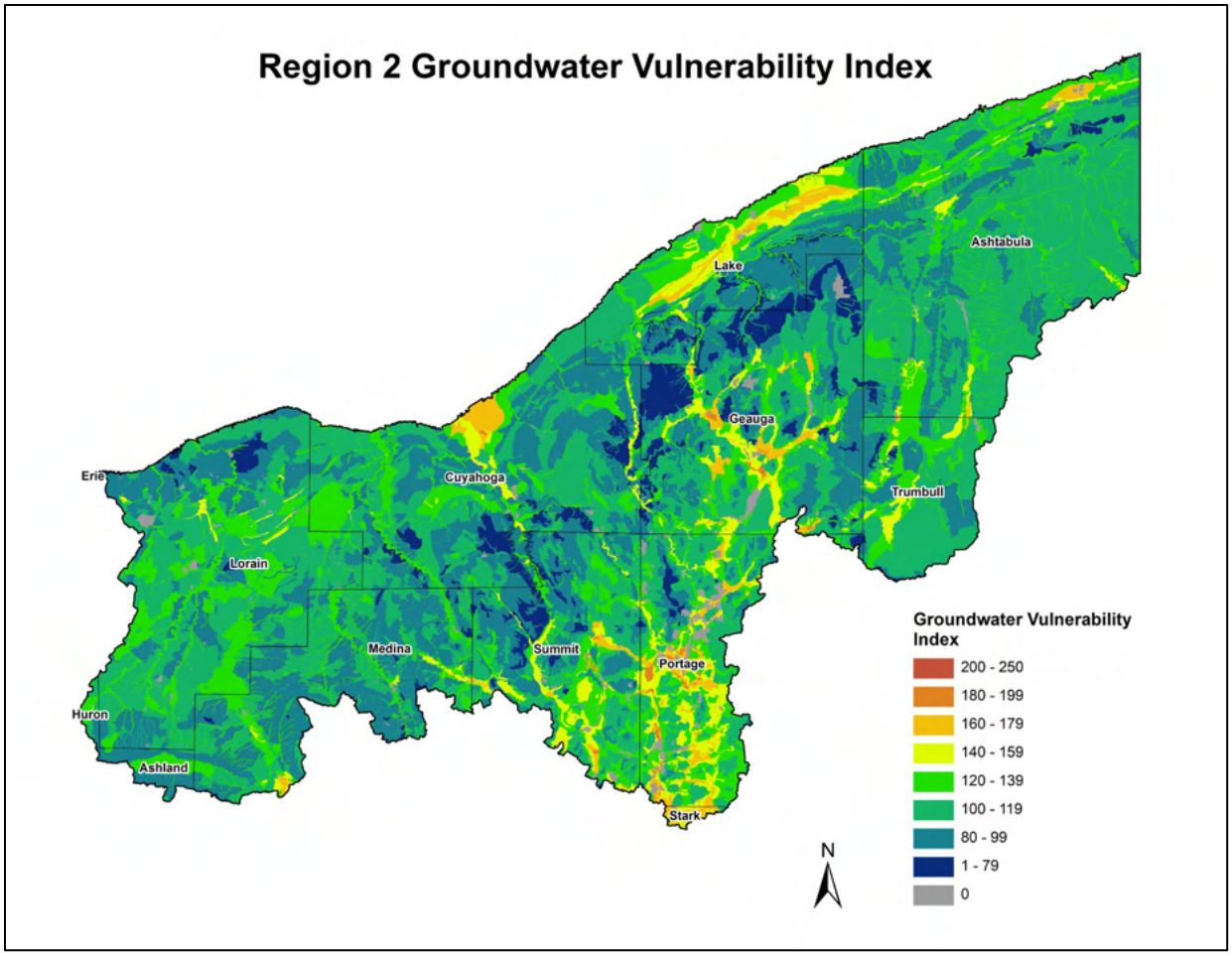


Map 26. Public drinking water systems using groundwater as their source in Region 2. Colored areas are source water protection areas, and the colors correlate to susceptibility to contamination. (Ohio Environmental Protection Agency, Division of Drinking and Ground Waters, 2022)

In 2020, a major portion of groundwater was utilized for public drinking water, with the Cuyahoga HUC 8 watershed emerging as the top extractor, drawing approximately five billion gallons of drinking water that year.

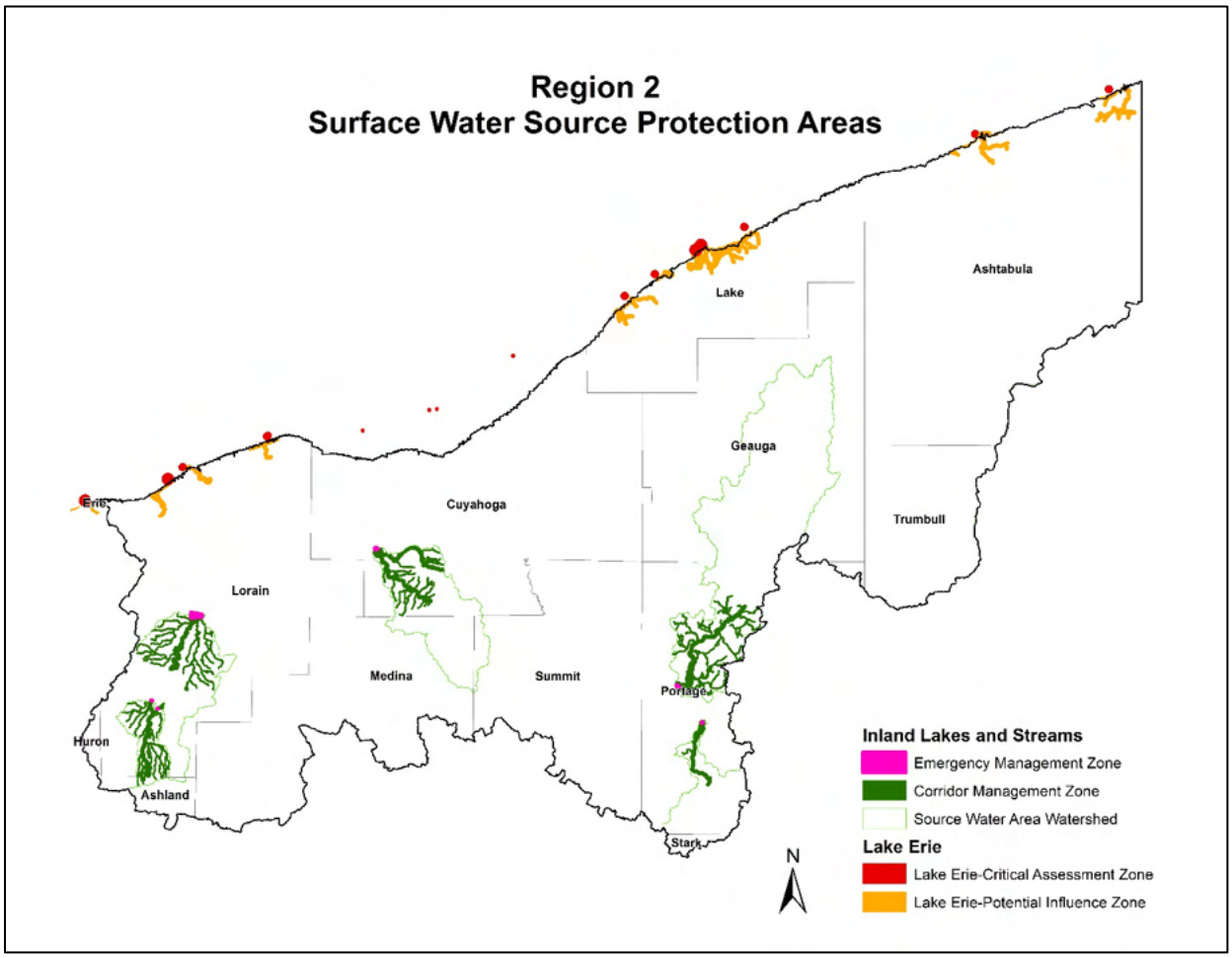
Groundwater is the primary source of drinking water for 42% of Ohioans, making it essential to understand its pollution risk. To aid in this understanding, the ODNR has developed a weighted scoring system that assesses the vulnerability of groundwater to contamination based on various landscape characteristics, such as hydrogeology, topography, and soil media (Nelson, 2022).

The department has indexed the vulnerability of groundwater across Ohio, and the relative vulnerabilities are indicated in Map 27. This scoring system can assist communities and organizations in better protecting their water supplies. You can find more information regarding Ohio's groundwater resources and vulnerability map on the ODNR website.



Map 27. Groundwater vulnerability index map for Region 2. (Ohio Department of Natural Resources, Division of Geologic Survey, 2022)

Apart from groundwater, the region's numerous streams and reservoirs supply the remainder of source water. Map 28 shows surface water source protection areas in Region 2. These are zones where water contamination carries increased risk to public health due to the presence of surface water intakes for public drinking water use.



Map 28. Source water protection areas for public drinking water systems that use surface water sources. Inland lakes, rivers, reservoirs, and Lake Erie sources are displayed. Data source: Ohio Environmental Protection Agency. (Ohio Environmental Protection Agency, Division of Drinking and Ground Waters, 2022)

In Ohio, both municipal and non-municipal public water systems are required to have a plan in place that identifies and addresses potential sources of contamination that could affect their source of water. Municipal systems create a written plan while non-municipal systems complete a tailored checklist. These protection plans and checklists must be submitted to the Ohio EPA for review and endorsement.

Issues begin to arise when withdrawals are occurring from smaller tributaries and during low flow periods. Small streams and tributaries within the region are subject to increasing amounts of water withdrawal to feed to oil and gas industry needs. These companies may have multiple withdrawal points on a stream which during low flow times of year could drastically impact the biological integrity of the stream through increases in water temperature, lower levels of assimilation, and lower water quantity and velocity.

3.1.8 Industrial Use

Region 2 is a hub for industrial activity, which necessitates effective environmental regulation. In compliance with Ohio EPA rules, any facility that discharges into state waterways must have a national Pollutant Discharge Elimination System (NPDES) permit and submit continuous monitoring reports. The region has a total of 537 individual permits, 118 industrial permits, and 419 public permits. Besides, industries that extract water must file an annual report with the Ohio DNR.

In 2020 according the Ohio DNR Water Withdraw Registry, Region 2 witnessed significant water withdrawals from two primary sectors- Industry and Public Drinking Water- totaling 26.5 billion and 18.7 billion gallons, respectively. Among the HUC 8s in the region, the Cuyahoga River Basin extracted more surface and groundwater due to the high industrial presence between Cleveland and Akron.

3.1.8.1 Large-Scale Developments

Industrial development results in land use changes, affecting water movement and consumption. Additionally, changes in technology can introduce new types of contaminants which may impact water quality. The conversion of agricultural land to solar farms is a recent development in Ohio. These developments place solar panels across large acres of land and connect them to the power grid. They have been developed across the state, and although they tap into a renewable resource, they can be controversial due to the land use conversion, and potential for degradation during the development process. These solar farms often remain active for decades, and grading, compaction, and erosion that can occur during development or use may affect whether the land can be reverted back to agricultural use. The Ohio Department of Agriculture has been involved in developing guidance to preserve the integrity of land being converted to solar farms.

Large-scale industrial projects can also raise concerns for water quality. The construction of new manufacturing plants in central Ohio has brough funding and the promise of jobs. However, the conversion of land to industrial use and water-intensive manufacturing have raised questions about the impact of such developments on water quality.

3.1.8.2 Pervasive Issues

Polyfluoroalkyl substances (PFAS) have emerged as a widespread concern for water quality, especially as it relates to drinking water. According to the Ohio EPA, “Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals applied to many consumer goods to make them waterproof, stain resistant, or nonstick. PFAS are also used in products like cosmetics, fast food packaging, and a type of firefighting foam called aqueous film forming foam (AFFF) which are used mainly on large spills of flammable liquids, such as jet fuel. PFAS are classified as contaminants of emerging concern, meaning that research into the harm they may cause to human health is still ongoing.

PFAS can enter drinking water at sites where they are made, used, disposed of, or spilled. PFAS can be found in the air near manufacturing facilities and can enter rainwater. PFAS are very mobile and can be transported through rainwater run-off and enter surface water (lakes, ponds, etc.) or seep through the soil and migrate into ground water (underground sources of drinking water). Because PFAS are very long-lasting and are not easily broken down by sunlight or other natural processes, they may remain in the environment for many years. If a public water system or your private well gets its water from a surface or ground water source that is contaminated with PFAS, and the water is not properly treated to remove the PFAS, the chemicals may be in your drinking water and can pass into your body when you ingest (drink or eat food cooked in) them.” (Ohio EPA)

3.2 Water Quality

Assessing water quality requires various methods, parameters, and benchmarks depending on the location, environment, and purpose of the evaluation. The Ohio EPA follows this principle and employs biological indicators and chemical analyses to examine water bodies in Ohio. In this chapter, we'll highlight the recent assessment findings from Ohio EPA's work in Region 2 and explore the known causes and sources of nonpoint pollution.

Point source pollution is described by U.S. EPA as a discernible, confined, and discrete conveyance of pollutants. Nonpoint sources (NPS) are simply considered anything not defined as a point source. Commonly referred to “contaminated runoff,” NPS also include channelization and habitat modification. It’s important to note for the following conversation that some NPS of pollution are regulated through permitting processes and are thus often grouped in with point sources because they have the potential to be readily quantified. For purposes of this document, emphasis is given to describing the impacts of actual NPS of pollution, regardless of permitting status, with the understanding that programmatic priorities are targeted to voluntary efforts not required by regulatory measures. Additionally, where point sources are known, they are given limited discussion below, to show a more holistic context.

The Ohio EPA conducts periodic water quality sampling throughout the state, with results consolidated in the biennial Ohio Integrated Water Quality Monitoring and Assessment Report (Integrated Report). This report examines 12-digit hydrologic unit areas, or Watershed Assessment Units (WAUs), to highlight any impairments to the watershed. Four primary beneficial uses are considered when assessing water quality - aquatic life, recreation, public drinking water supply, and human health. The impairment status is determined by analyzing chemical and biological factors that impact these uses. If a waterway does show signs of impairment, a Total Maximum Daily Load report may be generated. This report follows the guidelines set forth by the CWA, assessing current conditions in the watershed, identifying necessary pollutant reductions, and recommending actions to bring the watershed back into compliance with Ohio water quality standards.

3.2.1 Primary Causes and Sources of Impairment

Habitat alteration is the most common cause of biological impairment across Region 2. This includes stream modifications and changes in flow patterns that degrade the habitat quality. Other significant impairments include nutrient pollution, organic enrichment, and sedimentation. Natural limitations, such as limited flow volume, are also a contributing factor. Maps 22 (A-E) show the geographic distribution of these impairments across HUC-12 watersheds in the region.

The federal CWA describes a process for listing impaired waters, or those that do not meet criteria necessary to be effectively used for intended purposes. More detailed information about this program can be found on the Ohio EPA’s Integrated Report web page.

The intended purposes of water use, or “beneficial uses,” of surface waters in Ohio include recreation, aquatic life, public drinking water and human health (fish consumption). To evaluate these uses, specific spatial units are utilized. In Region 2, the assessment units (AUs) include HUC 12 WAUs, Large River Assessment Units, and Lake Erie Assessment Units .

However, this report focuses only on WAUs for numeric, summary data. By analyzing Integrated Report data, trends can be easily spotted, which helps to pinpoint areas of major concern for surface waters in

the region. One approach to analyzing impairments is to examine the "attainment status" of each WAU for its designated uses. This information is presented in Figures 11-16.

Aquatic life in Ohio is divided into specific categories based on the characteristics of the watershed and expected ecological community. Warmwater Habitat is the most common category, where a typical warmwater species grouping is expected to reside. Meanwhile, Exceptional Warmwater Habitat (EWH) is given to waters with a unique or rare population of species, possibly consisting of threatened or endangered animals. Coldwater Habitat is the category designated for waterbodies that should contain cold water organisms. Modified Warmwater Habitat is given to rivers and streams that have been legally altered, which makes them unlikely to support warm water inhabitants. Finally, Limited Resource Waters (LRW) are substantially degraded waters with little potential for recovery.

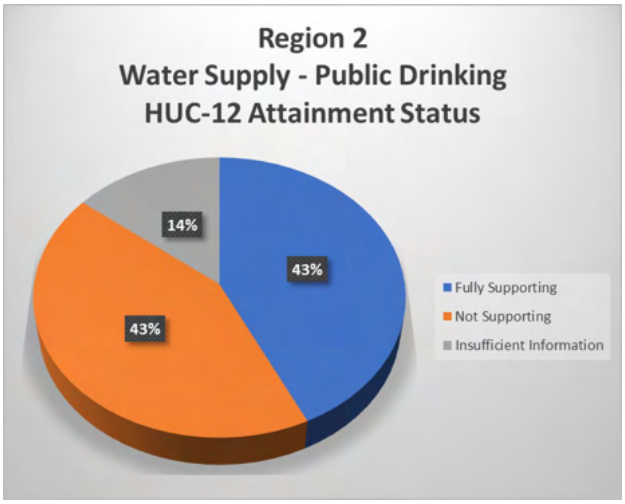


Figure 11. Attainment status of assessment units that are used for public drinking water in Region 2. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

In Region 2, seven HUC12 AUs have met the criteria for providing safe public drinking water. A visual representation of the status of each unit can be found in Figure 10. Here, you can see the percentage of AUs that are "Fully Supporting", "Not Supporting", or have "Insufficient Information" to be designated as such. These findings only pertain to untreated surface water and do not reflect the suitability of finished drinking water. A single HUC12 AU is currently in "not supporting" status, with nitrates being the main parameter responsible for the impairment.

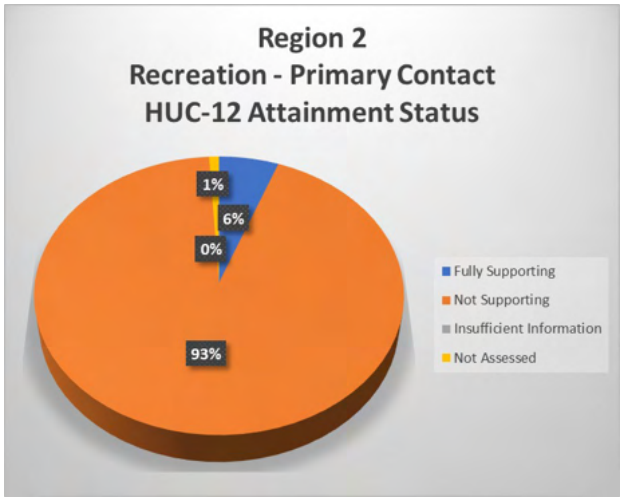


Figure 12. Status of Region 2 assessment units for their designated recreational uses. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

Widespread Recreational Use impairments are evident within Region 2 and throughout Ohio. Merely 6% of the 105 HUC12 watershed units evaluated for "Recreation - Primary Contact" met full compliance criteria. Escherichia coli (E. Coli) is the primary factor causing impairment in watersheds that do not meet recreational use criteria. Figure 11 highlights the attainment status and AUs percentages for recreational use in Region 2.

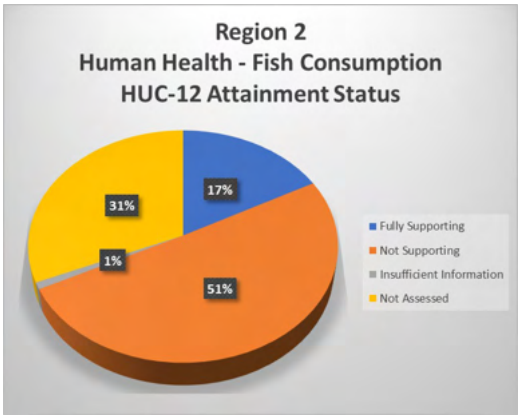


Figure 13. Human Health - Fish Consumption HUC-12 Attainment Status. (Ohio Environmental Protection Agency, Division of Surface Water,

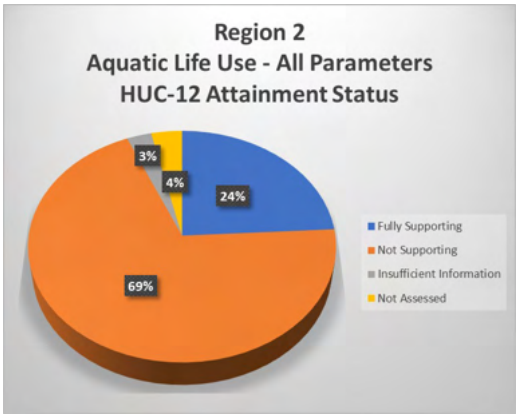


Figure 14. Aquatic Life Use - All Parameters HUC-12 Attainment Status. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

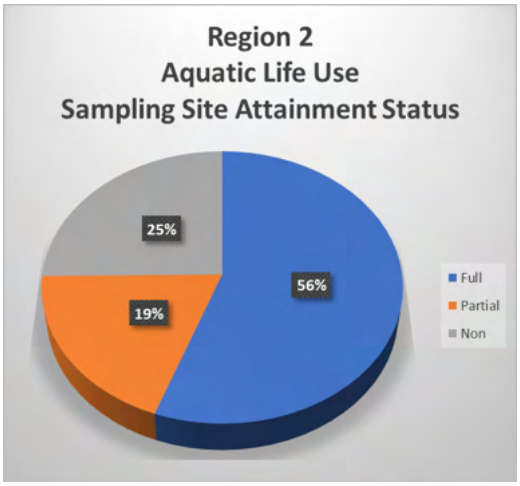


Figure 15. Aquatic life beneficial use attainment by sampling site. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

The safety of fish for human consumption in a watershed is determined by the Human Health Beneficial Use criterion. Out of the 105 watersheds in Region 2 that allow fish consumption, their attainment status is depicted in Figure 12. A major cause of contamination in fish tissue is due to polychlorinated biphenyls (PCBs), a harmful byproduct from manufacturing. This contaminant can adversely affect the attainment status of these watersheds. In addition to PCBs, unknown causes of impairment are also frequently cited for affecting the safety of fish consumption.

Water quality monitoring aims to maintain surface waters that can support aquatic life. To assess the communities of aquatic life, biological indices are employed with multiple criteria levels based on habitat quality across various ecoregions in the state. The ALU attainment status in Region 2 can be visualized in Figure 13. Out of the HUC12 AUs, only 24% have achieved full attainment status, while the vast majority of almost 70% do not meet attainment for aquatic life use. This highlights the importance of water quality monitoring efforts to ensure a suitable environment for aquatic organisms to thrive.

Figure 14 displays the attainment status of individual sampling sites within a Water Assessment Unit (WAU). While WAUs are typically scored based on multiple sites, this breakdown shows that assessing individual sites offers a more accurate reflection of regional water health. The results reveal that 60% of the sites fully support aquatic life. This demonstrates that just because a WAU is considered impaired, it does not mean that all river miles within it are similarly affected. In some instances, a weak score from one site can obscure an otherwise positive assessment.

ALU in Region 2 is significantly influenced by certain parameters, as depicted in Figure 16. This list only comprises causes linked to NPS pollution pertaining to aquatic life use. Causes that were attributed to unknown causes or natural limits were not included in this data set.

The spatial distribution of parameters causing impairment is important to effectively target improvement efforts. Maps 29-33 show the spatial distribution of the top 5 parameters causing impairment in Region 2.

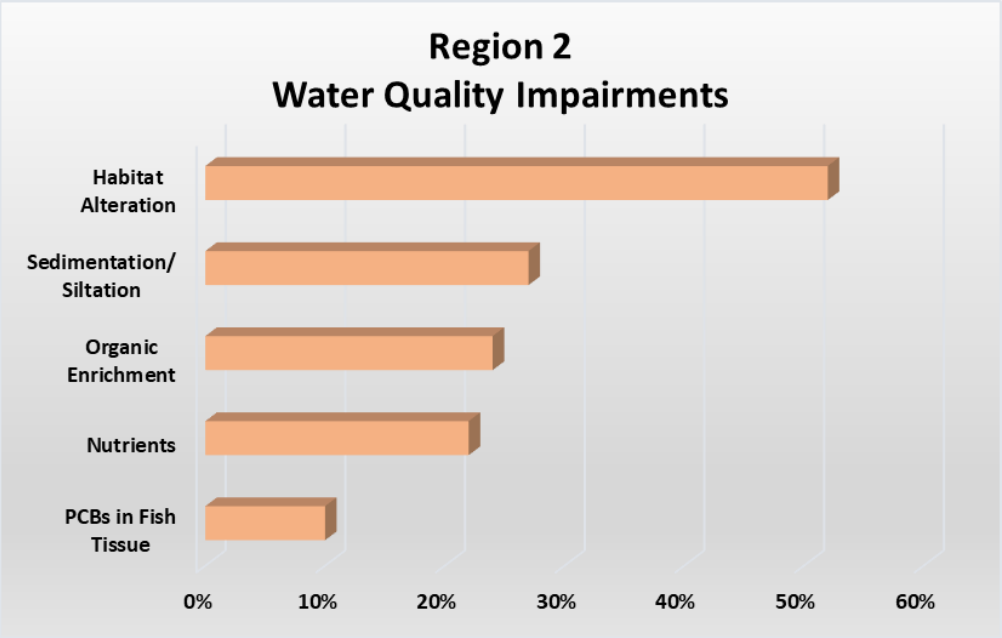
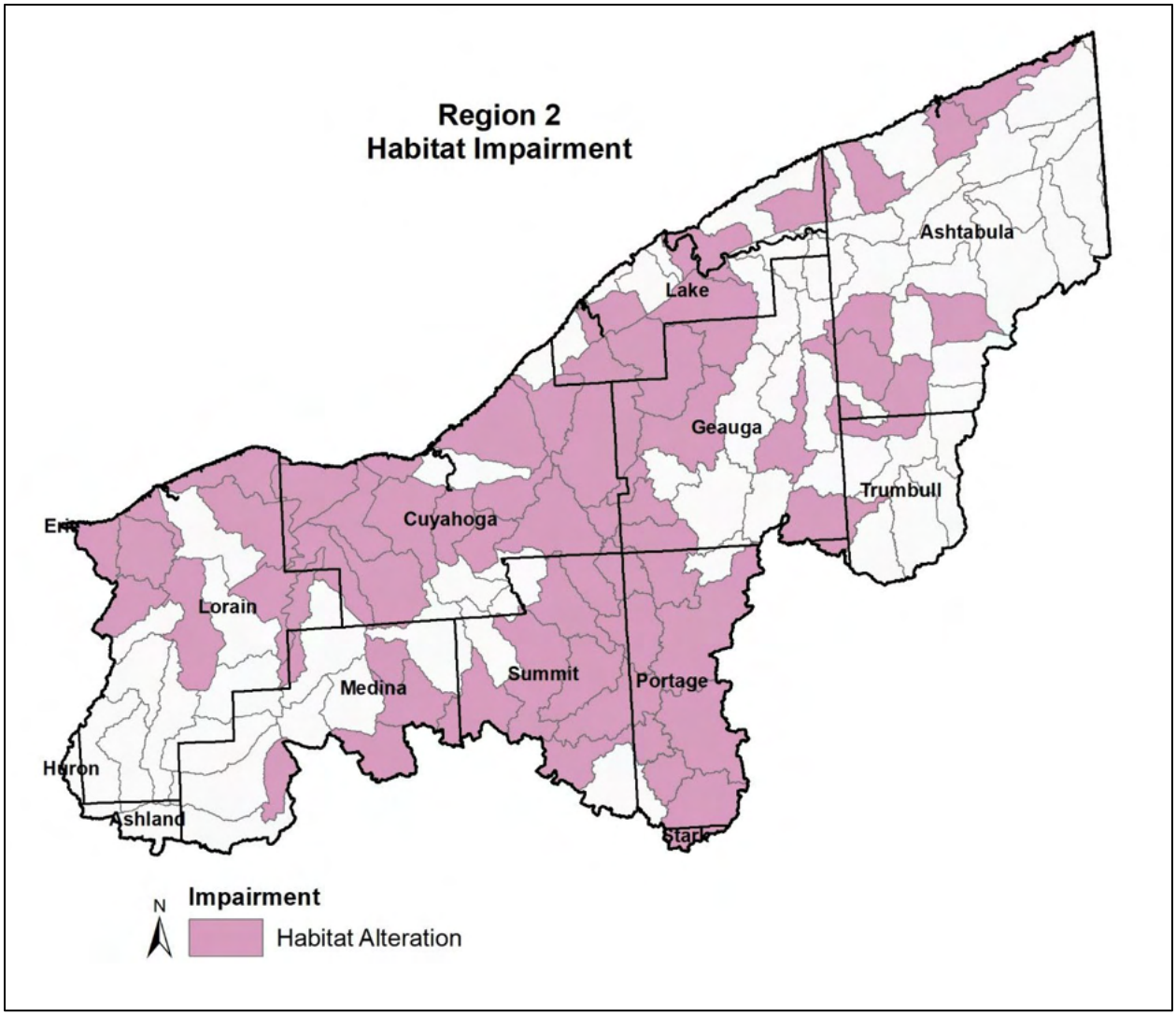
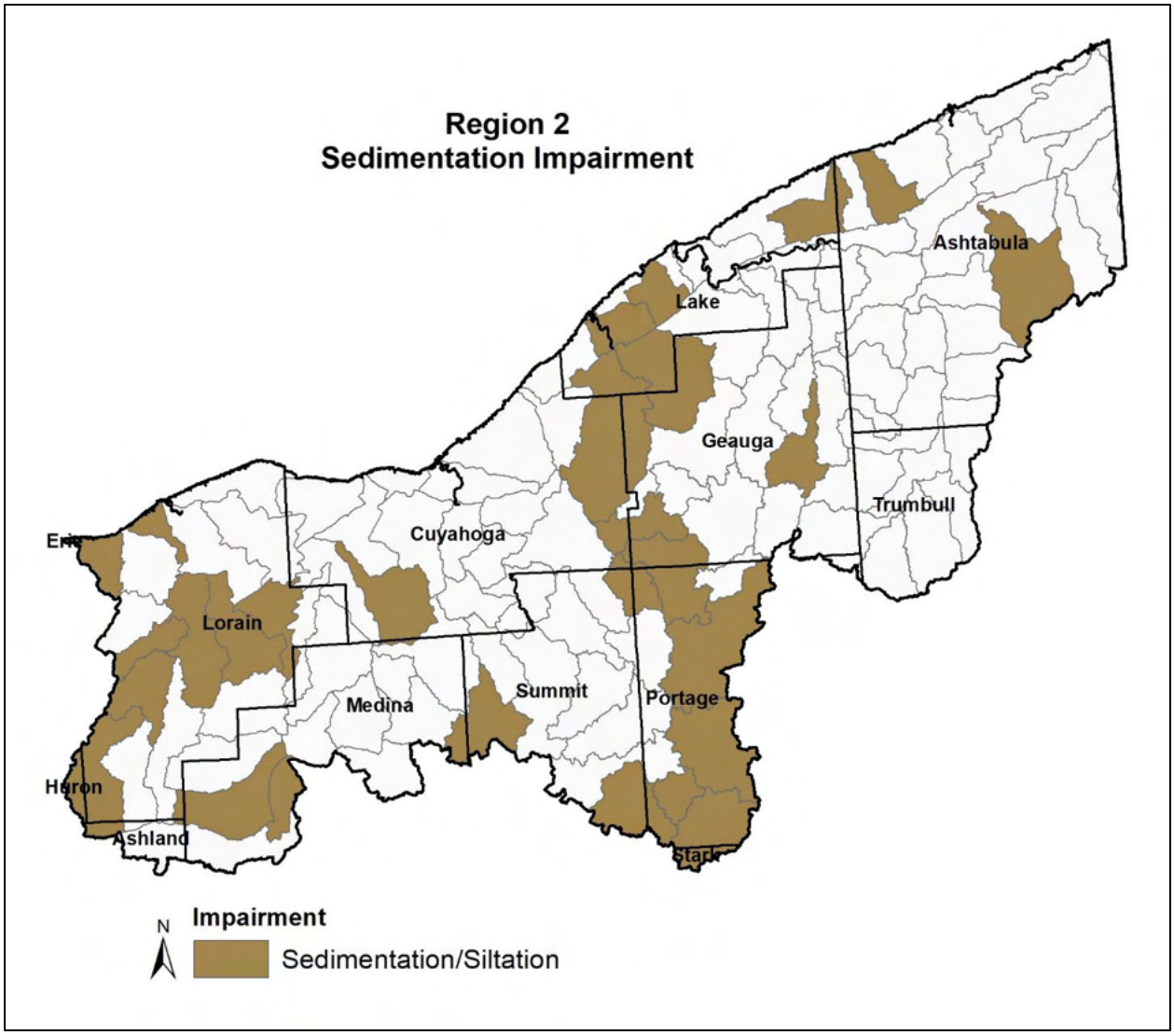


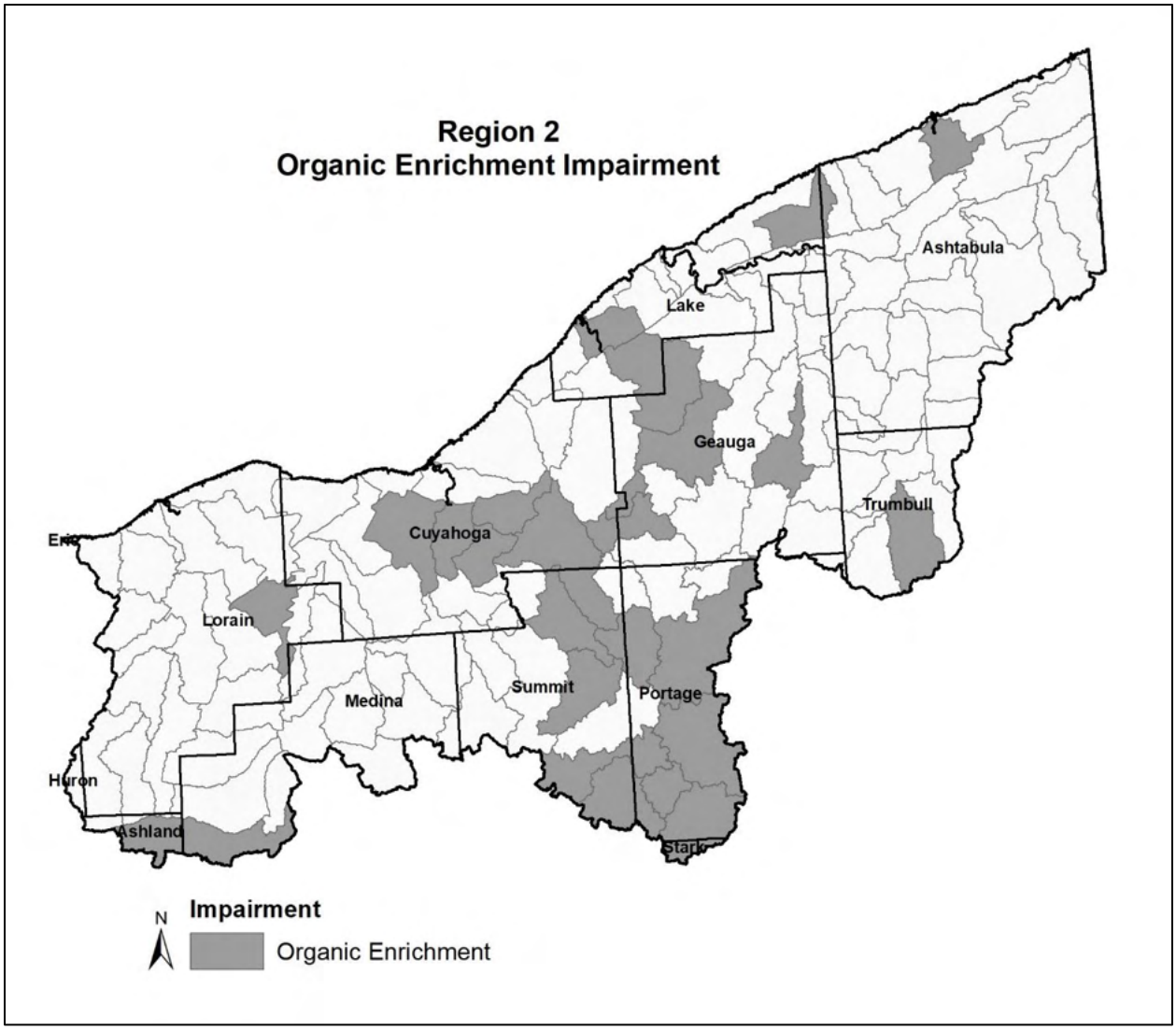
Figure 16. The top five parameters causing impairment across Region 2. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)



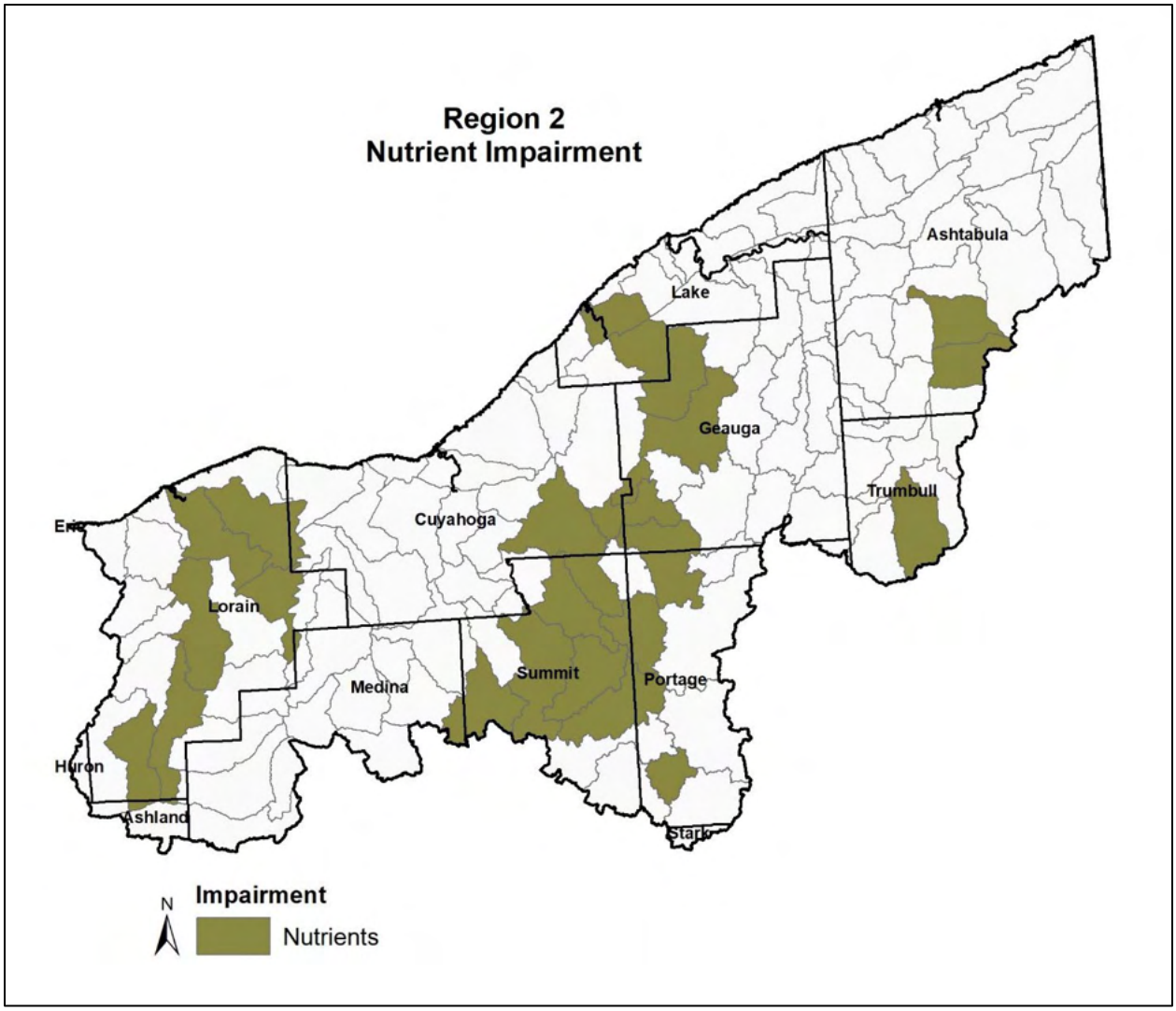
Map 29. Region 2 HUC-12s with Habitat Alteration impairments. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)



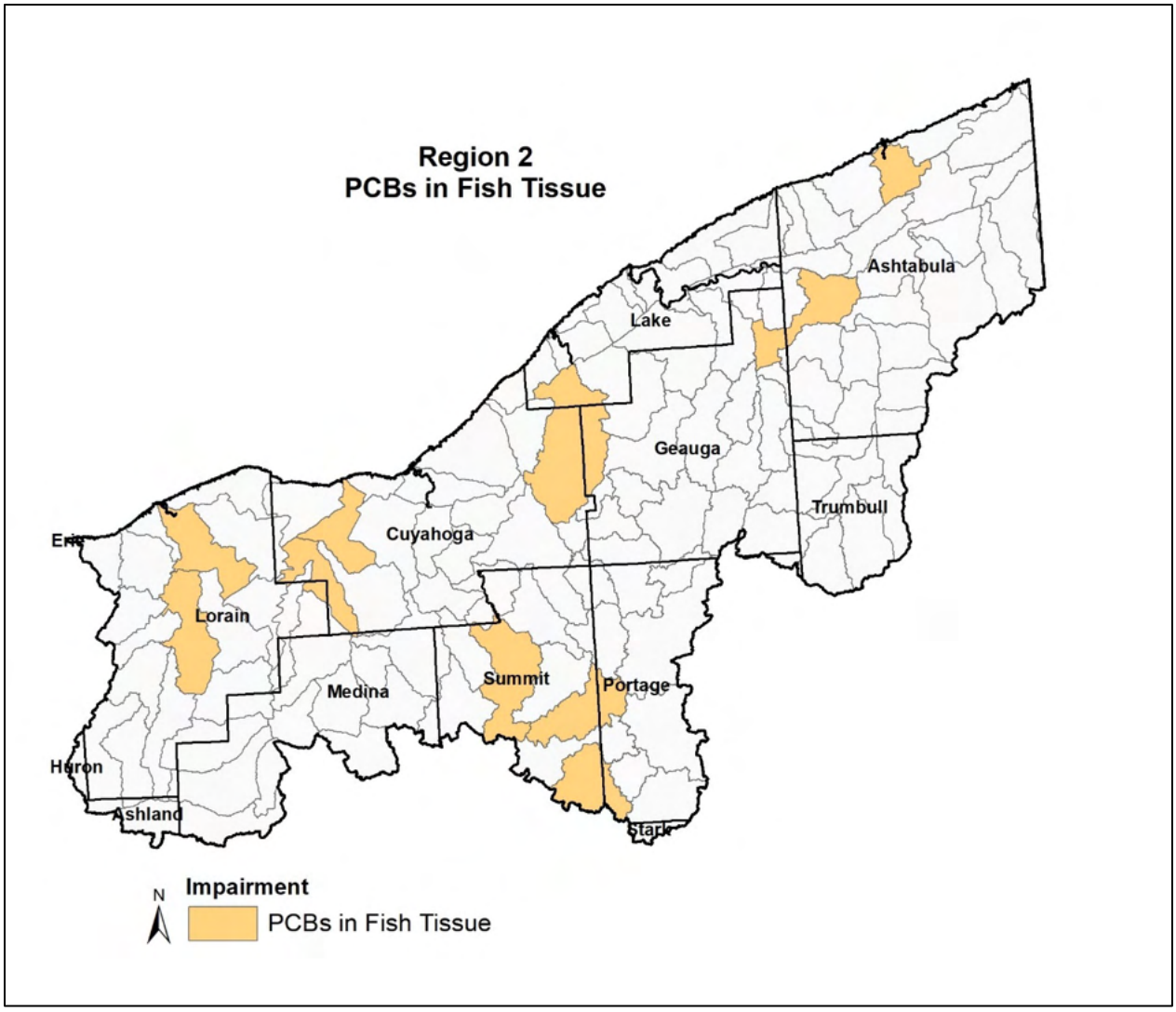
Map 30. Region 2 HUC-12s with Sedimentation/Siltation impairments (Ohio Environmental Protection Agency, Division of Surface Water, 2022)



Map 31. Region 2 HUC-12s with Organic Enrichment impairments (Ohio Environmental Protection Agency, Division of Surface Water, 2022)



Map 32. Region 2 HUC-12s with Nutrient impairments (Ohio Environmental Protection Agency, Division of Surface Water, 2022)



Map 33. Region 2 HUC-12s with PCBs in fish impairments (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

Ohio EPA's Master List reveals that there are 57 lakes in Region 2, encompassing both natural and man-made lakes. To be part of the list, lakes must have a surface area of over 5 acres. Although inland lakes are typically components of WAUs, Ohio EPA includes specific sampling results and attainment of beneficial uses for some inland lakes when applicable and available. Ohio EPA's Inland Lakes Program continues to expand its sampling and monitoring activities for Ohio's lakes, assessing them for all beneficial uses except aquatic life, which does not have an approved assessment method yet.

The latest Integrated Report released in 2022 states that none of the lakes in Region 2 are officially listed as impaired for human health. Two lakes, Lake Rockwell, and Springfield Lake reported bacteria sampling data, and several are impaired as a source of public drinking water supply due to nitrates and/or algae. However, Harmful Algal Blooms (HABs) continue to be a growing concern for both recreational and drinking water uses of the water bodies. The watershed land use significantly impacts inland lakes, and in Region 2, many reservoirs are fed by streams that come from agricultural landscapes.

Ohio DNR maintains Ohio's public beaches in state parks to ensure they meet safe levels of bacteria during the recreation season. The Integrated report tracks the frequency of exceedances and beach advisories, with only Monroe Falls, Punderson, and Silver Creek reported in Region 2. Additionally, Region 2 has 23 public beaches along Lake Erie, with their frequency of exceeding beach action values (BAVs) documented in the Ohio Integrated Report.

Frequency of Beach Action Value Exceedance at public beaches located at 50 Ohio inland lakes (2017-2021)									
Region	**Park**	**Beach**	**County**	**2017[1]**	**2018[1]**	**2019[1]**	**2020[1]**	**2021[1]**	**Total[1]**
2	Monroe Falls		Summit	--	0/5	0/6	--	--	0/11
2	Punderson		Geauga	1/8	1/9	0/8	0/8	0/8	2/41
[1] Indicates the number of BAV exceedances, based on a measured E. coli density exceeding 235 cfu/100 mL, followed by the number of samples									

Table 6. Beach Action Value (BAV) Exceedance at public beaches located at Ohio inland lakes (2017-2021). The percentage shown is the percentage of samples exceeded the BAV from the total number of samples taken. Number of samples varies depending on location. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

3.2.2 General Habitat Quality

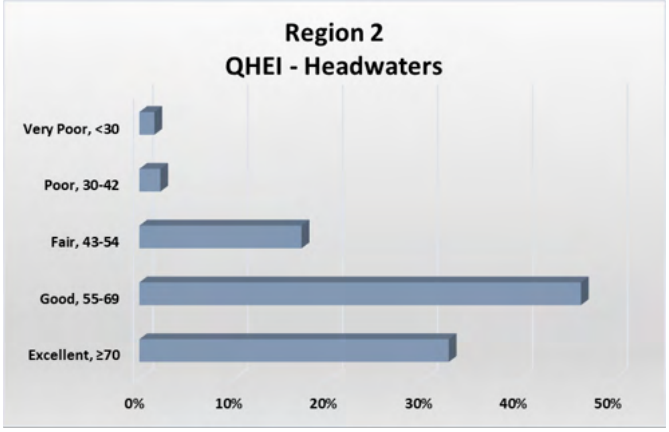
3.2.2.1 ALU Impairment: Habitat Alteration

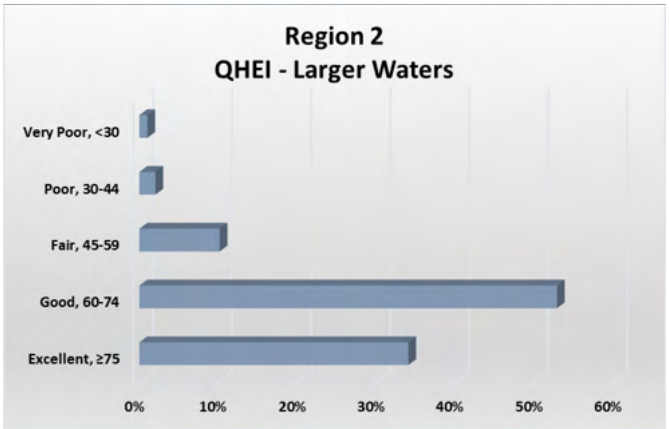
Habitat modification is the straightening, widening or deepening of a stream's natural channel. Habitat modification can also include the degrading or complete removal of vegetation from stream banks; such vegetation is essential to a healthy stream. These activities can effectively transform a stream from a functioning ecosystem to a simple drainage conveyance. Some aquatic life will not be protected from predators and stressful flows and temperatures. The stream also often loses its ability to naturally process water pollutants.

Region 2's urbanized land use has significantly altered the natural habitat. To make room for development, streams have been redirected to flow alongside infrastructure, floodplain and riparian buffers have been eliminated, and waterways have been sent underground through culverts to expedite drainage. Such alterations have profound ecological impacts and reduce environmental services.

The habitat in Region 2 has been significantly altered, especially in headwater regions where it has been drained for agriculture. There has been a channelization of streams and creation of artificial ditches, which has modified both the habitat and hydrology of the area. Some stream miles may not have existed without human intervention, which complicates ecosystem expectations. The rivers in the region are now discharging more water than before due to human-directed drainage modifications and increased precipitation. Tile drainage has contributed to high peak flows and "flashiness" with low base-flow regimes in Ohio. (Miller & Lyon, 2021)

Channelized stream in area with altered habitat.





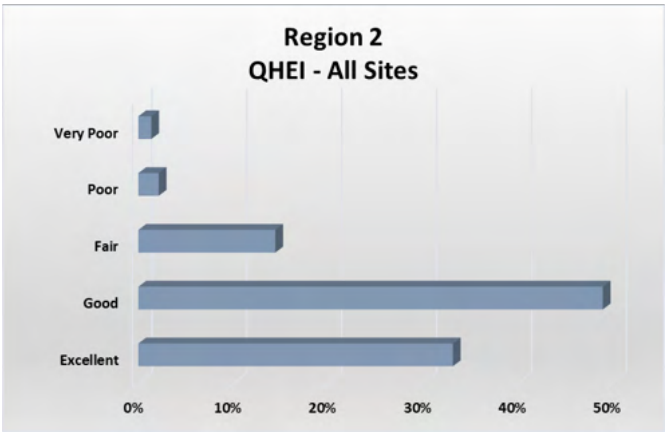


Figure 17. QHEI scores at Ohio EPA sampling points. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

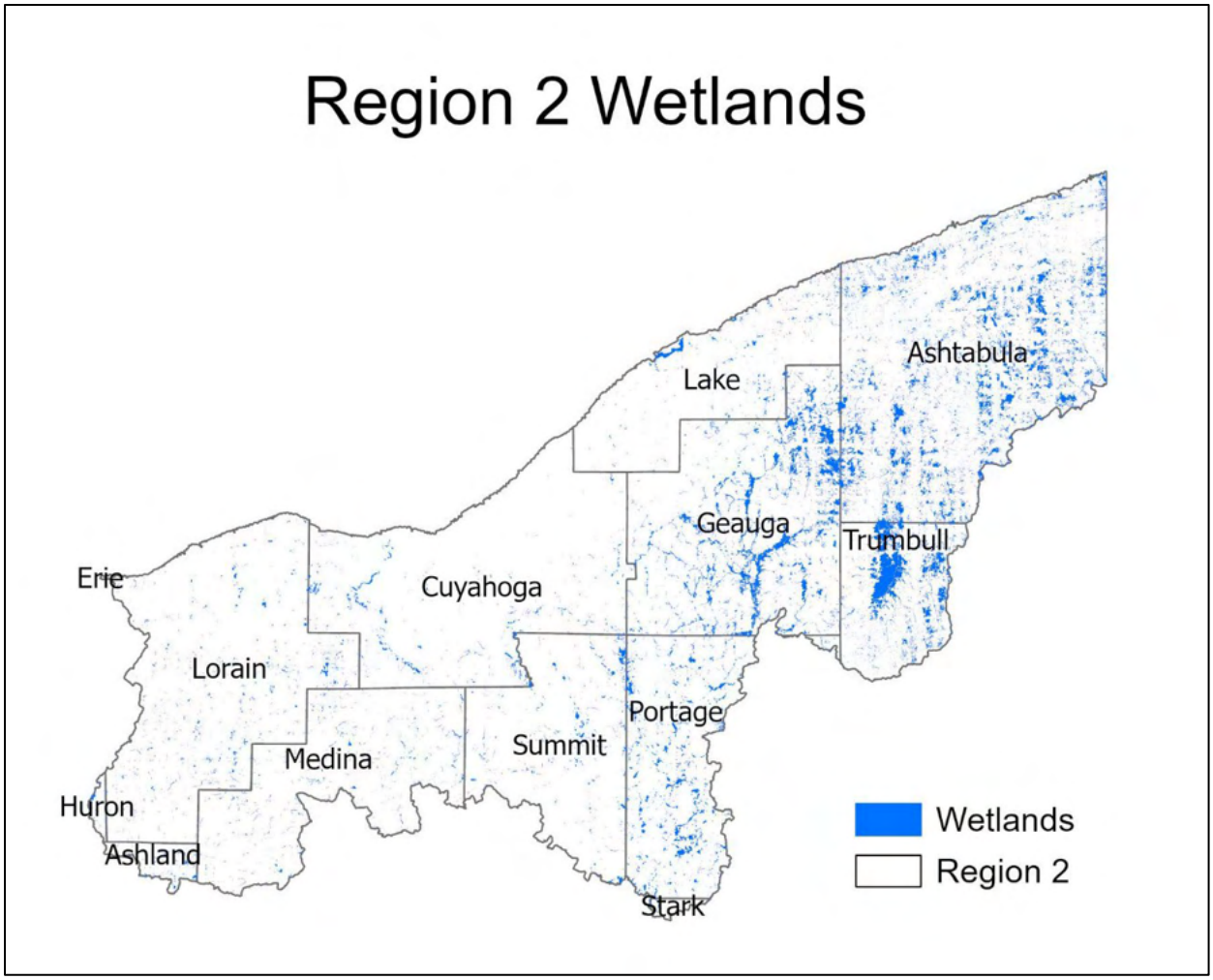
Ohio EPA uses the Qualitative Habitat Evaluation Index (QHEI) to assess stream habitat quality, specifically in supporting aquatic macroinvertebrate and fish life. By evaluating several key metrics such as substrate, instream cover, and channel morphology, among others, the QHEI assigns an overall score out of a maximum of 100 points. This allows for a comprehensive evaluation of stream health that considers the many factors that contribute to a healthy aquatic ecosystem.

Region 2 QHEI scores range from Very Poor to Excellent with headwaters sites and larger water sites producing slightly different ranges. Figure 16 illustrates the distribution of QHEI scores for sampling sites in this region. Impressively, 82% of sampled sites demonstrate Good or Excellent aquatic habitat, while the average QHEI of 64.8 earns Region 2 the Good rating for both headwaters and larger streams.

According to the Ohio DNR, wetlands are highly effective and cost-efficient in improving water quality by preventing excess nutrients from flowing into waterways and lakes, which fuel algal blooms. Wetlands also provide important habitat for a diverse range of wildlife. Through slowing the flow of water, wetlands filter and process water by removing nutrients and other contaminants, thereby absorbing, and storing them on the landscape, preventing their movement further downstream.

ODNR's H2Ohio initiative is dedicated to the creation, restoration, and improvement of wetlands across Ohio. Currently, as of March 2023, 19 wetland projects are underway or have been completed in Region 2.

Furthermore, based on the region's land use, roughly 6.5% of acres are defined as either herbaceous or woody wetlands, with one acre of wetland capable of storing 1-1.5 million gallons of water, helping to mitigate flooding. Map 34 shows wetlands across Region 2.



Map 34. Wetlands in the Region U.S. Fish & Wildlife Service. (U.S. Fish and Wildlife Service, 2023)

3.2.2.2 ALU Impairment: Nutrients

Nutrient enrichment is the term used for the overabundance of nitrogen and phosphorus in waterways. High nutrient levels may lead to an increase in algae growth and adversely affect the physical, chemical, and biological health of aquatic systems.

The water quality in Region 2 and Ohio's water resources are impacted by an excessive amount of nutrients. This issue is a significant cause for concern for local watersheds and is specifically highlighted in Section 3.2.1. Multiple parameters related to nutrient impairments including Ammonia, Nutrients, Nutrient eutrophication/biological indicators, Nitrate/nitrite (nitrite + nitrate as N), Nitrogen, Nitrate, and Total Phosphorus, were combined to summarize the top regional impairments. Analysis of HUC12 impairment maps and land use data reveals that both urban and agricultural areas are major contributors.

The Ohio EPA's Nutrient Mass Balance report is a biennial assessment of phosphorus and nitrogen loading for selected watersheds in the state. Three source categories are used to estimate loading based on sampling data: NPDES (point source), HSTS, and NPS. The Cuyahoga River watershed is the only HUC 8 of Region 2 included.

The report reveals that nonpoint nutrient loading, as shown in Figures 18 and 19, is the largest contributing source of nutrients. However, within the Cuyahoga River HUC 8, 46% of total phosphorus and 83% of total nitrogen are from point sources, which include industrial facilities, sewage treatment facilities, package plants, and similar sources. This is consistent with the watershed's large industrial footprint, but NPS also plays a significant role. NPS is comprised of agricultural and urban runoff, as well as natural sources. Urban areas can be significant contributors to phosphorus loading through activities like construction site erosion and the use of fertilizers in lawns and gardens. Agricultural sources stem from runoff of both commercial and manure-based fertilizers, and erosion of fields and channels bound with phosphorus. Grazing livestock with access to streams adds nutrients from manure directly and accelerates bank erosion.

The NPDES program mandates permittees to report flow data and nutrient concentrations to the Ohio EPA via Discharge Monitoring Reports to regulate point source discharges. Urban areas in this report have instances of CSO and SSO, which are contributing factors to nutrient loading within the region. While other rivers in Region 2 also have point source impacts, they have not yet undergone analysis by the Ohio EPA.

HSTS can potentially pose a threat to waterways by releasing nutrients from human waste, especially in cases of system failure. While they only account for a small portion of total nutrient loading, HSTS are often identified as a source of concern when it comes to nutrient pollution. In the period spanning 2017 to 2021, HSTS were responsible for contributing to 12% of total phosphorus loading and 6% of total nitrogen loading in the Cuyahoga River watershed. Refer to section 3.2.3.c of this report for a more in-depth analysis on HSTS, including their potential failure and how this can impact water quality.

The agricultural industry is facing a complex challenge as soil test values and phosphorous balances continue to decline. While advances in tillage practices have reduced sedimentation in waterways and led to aquatic recoveries in the region, certain changes in agricultural practices have also inadvertently caused stratification of nutrients in the upper soil horizons. These changes include simplification of crop rotations, with a shift away from winter wheat and perennial forages to summer annual row crops. This shift has resulted in more soil erosion during fall and winter months, with more inputs such as commercial fertilizers being applied simultaneously during the most influential period of nutrient loading to Lake Erie (March-July) when summer annual crops are planted. Triplett & Dick (2008) have reported that this is a known result of conservation tillage. It is important for the agricultural industry to find a balance that supports the environment and the industry itself. Figures 18 and 19 show the phosphorus balance trend and statistical trends of County-level soil test phosphorus median values for 1993-2015.

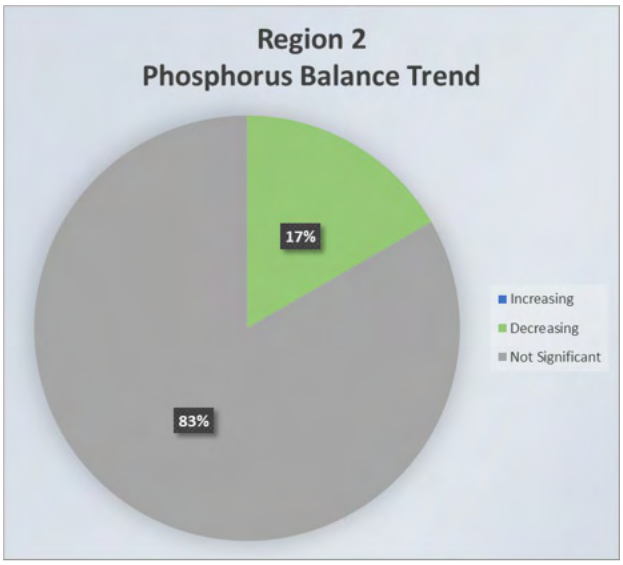


Figure 18. County-based Phosphorus Balance Trend in Region 2. (Dayton, et al., 2019)

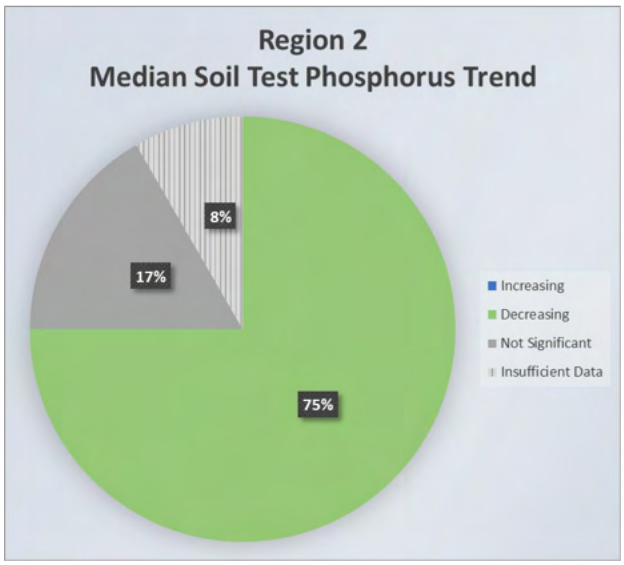


Figure 19. County-based Median Soil Test Phosphorus Trend in Region 2. (Dayton, et al., 2019)

The western portion of Region 2 has seen an increase in subsurface drainage intensity alongside practices favoring nutrient stratification. Although the area has had a high proportion of drained land through "tiling," recent trends show a shift towards systematic, whole-field systems. Subsurface pathways now result in more nutrient loss at the field scale than surface pathways due to the higher volume of water exported. However, surface runoff events still have higher nutrient concentrations, which could worsen due to the increased intensity of precipitation events and nutrient stratification. Both pathways and their interactions are crucial factors when choosing management practices.

Livestock operations are required to follow regulations similar to other industrial operations and cannot discharge any wastewater or stormwater directly into a waterway without a permit. Land application of manure also comes with environmental risks as soil moisture, proximity to sensitive areas, and precipitation forecast must be considered before all applications. The NRCS 590 Standard provides guidelines on manure applications to mitigate environmental risks.

Based on Ohio EPA's 2020 Nutrient Mass Balance Study, summarized data from WYs 2013-2019 and aggregated to the Cuyahoga River HUC8 in Figure 20 and Figure 21. Nonpoint nutrient loading was identified as the largest contributor of nutrients to the Cuyahoga River watershed by monitoring data and literature. (Ohio EPA, 2020)

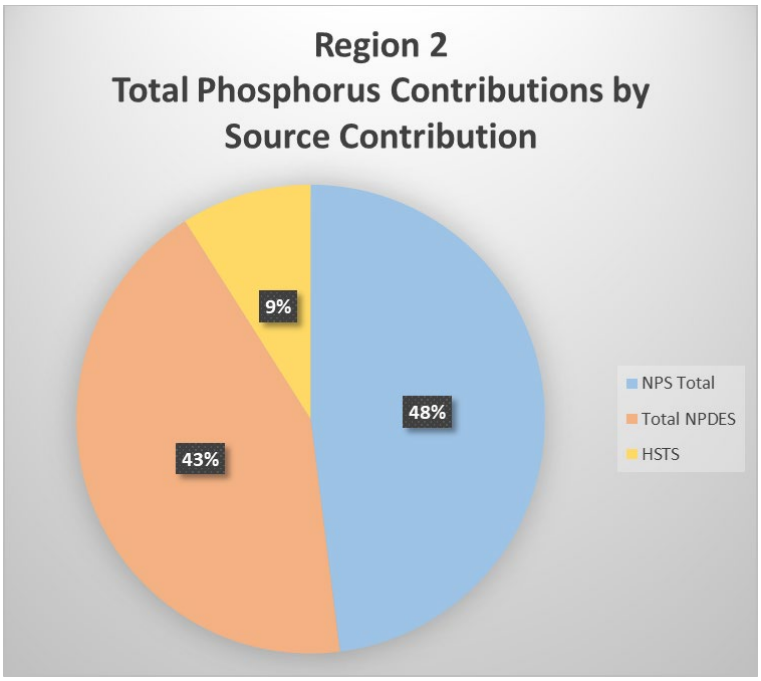


Figure 20. Average proportions of total phosphorus from categorical sources for WY13-WY19 for WLEB (040001) primary watersheds: Data from 2020 Nutrient Mass Balance Report, OHIO EPA. (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

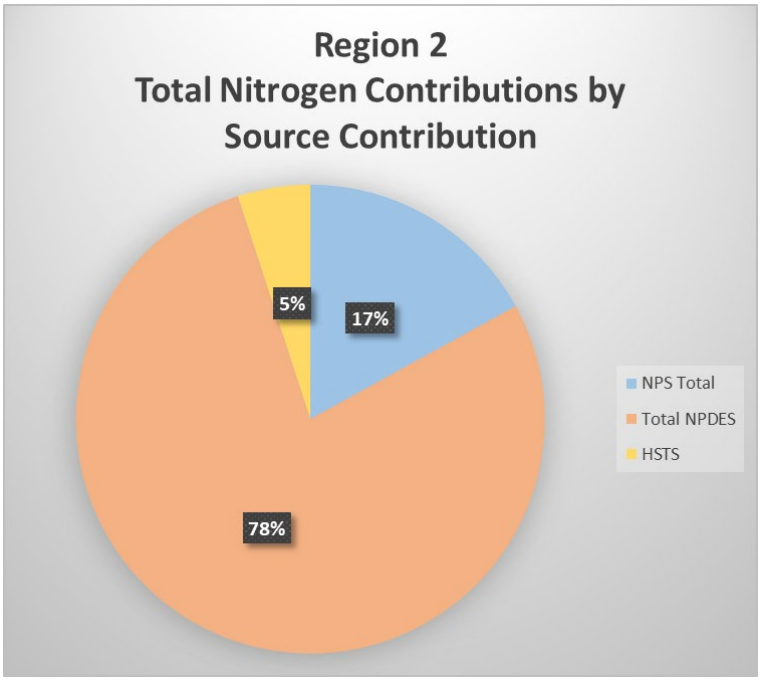


Figure 21. Average proportions of total nitrogen from categorical sources for WY13-WY19 for WLEB (040001) primary watersheds: Data from 2020 Nutrient Mass Balance Report, OHIO EPA . (Ohio Environmental Protection Agency, Division of Surface Water, 2022)

While agriculture plays a major role in nutrient enrichment of the region, it is not solely the responsibility of agriculture. Residential and urban areas also contribute to this issue through factors such as failing HSTS, aging wastewater infrastructure, stormwater runoff, and CSOs.

Stormwater runoff can carry residential lawn fertilizer just as easily as agricultural fertilizer. In urban areas, underground storm sewers can transport these nutrients into streams or rivers at an accelerated pace. Unfortunately, developments with channelized waterways, impervious surfaces and stormwater outlets can also increase erosion and flow velocity, leading to a greater loss of soil-bound nutrients into the environment.

3.2.2.3 ALU Impairment: Sedimentation/Siltation

When soil particles are suspended in streams and rivers, it's called sedimentation or siltation. This happens after heavy rainfalls that wash soil from the land or stream channels. Unfortunately, it affects biodiversity in aquatic habitats and can carry other pollutants, including nutrients. Nutrients become available to aquatic life after undergoing desorption processes and potentially overload the system beyond its capacity.

Suspended sediment concentrations can harm aquatic life in four ways. The sediment can obstruct filter feeding, reduce light penetration, abrade fish gills or exposed surfaces, and increase water temperatures. Deposited and bedded sediments alter benthic habitats, reduce interstitial flows, and decrease substrate size, leading to diminished diversity and stability.

Bank erosion is a natural occurrence that happens when environmental conditions change, but human modifications can induce it. Modifications to stream morphology and intensive watershed drainage affect peak flow and stream channel stability. Agricultural practices like tillage and reduction of ground cover also contribute to erosion and soil loss.

Even pastured livestock operations can affect the waterway through livestock movements and overgrazing. However, Region 2 seems not to be at high risk of impairment from this source as most livestock is in confined feeding operations.

Example of stream cutting and erosion.

Finally, urban and residential construction, re-development and channel modifications can pose a risk of erosion, however, many of these activities fall under general permits with requirements for mitigation practices.

Recent research conducted by The Ohio State University reveals a concerning trend of increased rainfall in Ohio, ranging from 5-15% since the early 1900s. This, coupled with excessive impervious surfaces in the watershed, has led to accelerated runoff and high-intensity water flow through streams and rivers. To further exacerbate water management issues, channelization has taken place in many areas to accommodate development and maximize land use. Channelized streams tend to facilitate higher velocities during peak flow periods, increasing the risk of bank erosion or unstable banks. This, in turn, results in the loss of floodplains and reduces sediment deposition and filtration. As banks erode, sediment enters the water system, further aggravating the issue.

3.2.2.4 ALU Impairment: Organic Enrichment/Dissolved Oxygen

Organic enrichment and dissolved oxygen levels are the third and fifth most common water quality impairments in the region, respectively. Organic enrichment is the accumulation of carbon-based materials from living organisms beyond natural amounts, which can deplete oxygen levels and harm aquatic life. The dissolved oxygen levels in a body of water are critical for the survival of fish and other organisms as well as the prevention of unpleasant odors caused by decomposition.

Temperature and the amount of decomposing organic material are the primary factors that affect dissolved oxygen levels, with excessive decomposition causing oxygen depletion. In streams where riffles and structure have been removed, the aquatic organisms may face high amounts of stress due to low oxygen levels in daylight.

Human waste is a common source of organic enrichment that can bypass solid treatment, including through illegal SSOs. Other sources in residential areas may include grass clippings, leaves, and other organic materials lost directly or through storm sewer systems.

Organic enrichment in agriculture can come from sources such as livestock manures and crop residues. It's important to note that discharging animal waste into waterbodies is against the law. In Region 2, the main concern is inadvertent losses during the land application of manure due to environmental factors like heavy rainfall, dry soils with fissures, and poor application methods or equipment. Another issue is the loss of crop residues from fields, especially when high residue crops like corn are grown using reduced tillage methods. Residues that remain on the soil surface can easily move with erosive forces, such as during heavy rainfall, and potentially enter waterways.

Organic material may also accumulate in ponds or impoundments, affecting water quality and downstream areas as the system cycles.

3.2.3 Other Nonpoint Source Concerns

Stakeholders throughout Region 2 have noted numerous concerns relating to NPS water pollution. Many of these concerns are reflected in the available data, including nutrient loading relating to agricultural use of fertilizer and manure, streambank erosion, and HABs. Stakeholders have also called attention to issues that affect highly populated and urbanized areas disproportionately, including water quality impairments due to CSOs, road salt runoff, and lawn treatments. In the less developed or rural areas a main concern for NPS loading is from failing HSTS.

3.2.3.1 Urban

Urban land use is associated with specific nonpoint pollution challenges, such as impervious surfaces, consolidated stormwater conveyance, and wastewater treatment. Of these, impervious surfaces have

the most significant impact on water quality, exacerbating existing problems such as decreased infiltration capacity, increased velocity of water, and high volumes of fast-moving runoff. This can increase the volume of flow, erode streams, impact aquatic life, increase sedimentation, and overwhelm wastewater systems.

Impervious surfaces also contribute to thermal pollution of waterways, resulting in decreased dissolved oxygen levels and stress for aquatic organisms. Wastewater also poses a risk due to its potential for organic materials, nutrients, bacteria, viruses, and other contaminants.

Centralized wastewater treatment is crucial in mitigating these concerns. Upgrades targeted at addressing nutrient concerns have been implemented in the past few decades to meet phosphorous level requirements in discharge effluent. Large wastewater treatment plants are generally required to have concentrations at or below 1mg/L total phosphorus in the WLEB.

Developed areas' stormwater discharge has the potential to trigger multiple water quality concerns, with contaminants such as nutrients, oils, trash, road salt, and sediment carrying from impervious surfaces to receiving streams or water bodies. When the water is discharged, excessive erosion and sediment loss may occur, leading to a diminished habitat and water quality.

The Ohio Department of Transportation maintains and implements a Stormwater Management Plan for activities under its jurisdiction to minimize impacts to water quality.

3.2.3.2 Household Sewage Treatment Systems

HSTS pose a risk to water quality in Region 2 and throughout Ohio. These systems are relied upon by households in areas without access to sewered wastewater treatment systems. Their failures lead to nutrient loading and E. coli contamination. While HSTS sources make up only a small portion of nutrient pollution, they can cause significant bacterial issues that pose a severe threat to human health. Although several factors contribute to the failure of HSTS systems, existing system age, site, soil, and drainage limitations are the main causes. The slope of the site and insufficient maintenance also lead to system failure.

In 2012, the Ohio Department of Health conducted a study on the status of HSTS throughout the state, which revealed concerning statistics. In the Northeast District, which closely matches the area of Region 2, 38% of the estimated 236,386 systems were failing at the time. This failure rate is larger than the statewide average of 31%, indicating that the region's HSTS systems pose a higher risk to water quality than other areas in the state.

Household Sewage Treatment System Failures						
District	**Central**	**Northeast**	**Northwest**	**Southeast**	**Southwest**	**Total**
Existing Systems Reported	54,813	236,386	117,819	87,943	131,532	628,493
Failing Systems Reported	20,512	90,380	45,560	13,267	24,269	193,988
Failure Rate (calculated)	37%	38%	39%	15%	18%	31%

Table 7. Home Sewage Treatment Systems Failures by OHIO EPA District. (Ohio Department of Health, 2012)

3.2.3.3 Harmful Algal Blooms

Freshwater HABs are a growing concern in the United States and worldwide. They are a well-known issue in the state of Ohio due to their occurrence within the WLEB. What is less known is their occurrence throughout the state's inland waters. HABs are caused by blooms of cyanobacteria. “Cyanobacterial blooms can be harmful to the environment, animals, and human health. The bloom decay consumes oxygen, creating hypoxic conditions which result in plant and animal die-off. Under favorable conditions of light and nutrients, some species of cyanobacteria produce toxic secondary metabolites, known as cyanotoxins” (US Environmental Protection Agency, 2019).

“Conditions that enhance growth of cyanobacterial HABs Factors that promote cyanobacterial bloom formation and persistence include:

- Extended periods of direct sunlight
- Elevated nutrient availability (especially phosphorus and nitrogen)
- Elevated water temperature
- pH changes
- An increase in precipitation events
- Calm or stagnant water flow, and water column stability/lack of vertical mixing. (US Environmental Protection Agency, 2019)

Nutrient loads and environmental factors, are responsible for HABs, as is most notable in western Lake Erie. The eutrophic status of Western Lake Erie Is the most complex and prominent issue associated with nutrient loading. Lake Erie saw similar but distinct eutrophication issues in the past, and the nutrient loading data correlating to current eutrophication reflect these apparent differences. Phosphorous is noted as the limiting factor for nutrient growth in most freshwater bodies and has been agreed upon as the leading correlative factor in current eutrophication. Total phosphorous loading to the lake has not increased significantly in several decades, but rather, the proportion of phosphorous that has been reaching the lake in a bioavailable form (commonly reported as Dissolved Reactive Phosphorous) has significantly increased as a proportion of this total loading.

Negative impacts from HABs on water quality, human and animal health and the economy can be significant. According the U.S. EPA’s HAB and Drinking water Factsheet, some HABs can produce toxins that are harmful to humans and animals. These toxins can pose challenges to drinking water supplies. Given this risk, many drinking water systems are taking actions to manage cyanotoxins in drinking water and notify the public if toxin levels become a possible health concern. Reducing nutrient pollution, such as excess nitrogen and phosphorus, in drinking water sources is important for the long-term management of the risks HABs pose to public health and water quality.

3.2.4 High Quality Areas

In Region 2’s waterways, warmwater aquatic habitat predominates. Watersheds that exhibit high levels of diversity among aquatic life species can be designated as EWH, reflecting their superior ecological value. Definitions of each ALU can be found within OAC.

Region 2 also features a number of waterways that have been given special status to denote their exceptional quality with respect to biological, aesthetic, or recreational value. These include several Outstanding State Waters as defined in Ohio code, including The Aurora Branch of the Chagrin River, East Branch of the Chagrin River, Chagrin River, Conneaut Creek, Cuyahoga River, Grand River, and an

unnamed tributary to the Black River East Branch. Outstanding State Waters are noted for exceptional ecological value. Region 2's superior waters are the Ashtabula River, Baughman Creek, Furnace Run, North Fork of Yellow Creek, Yellow Creek, and an unnamed tributary to the East Branch of the Black River.

Despite the presence of water quality impairments throughout Region 2, there are still plenty of superb bodies of water that sustain an exceptional array of biodiversity, habitats, and human utilization. Consequently, the preservation of these exceptional locations constitutes a key objective in ODA's regional watershed planning initiatives. Tables 9 and 10 outline the Superior and Outstanding waters of Region 2 designated by the Ohio EPA. According to the ORC, there are four categories of High Quality Waters: General High Quality Waters, Superior Waters, Outstanding State Waters, and Outstanding National Resource Waters.

General High Quality Waters are wetlands categorized as Category 2 or 3 in accordance with OAC 3745-1-54 of the Administrative Code and other surface waters that are not specifically categorized as limited quality waters, superior high quality waters, outstanding state waters, or outstanding national resource waters.

Map 35. Scenic Rivers across the state. (Ohio Department of Natural Resources, Division of Natural Areas and Preserves, 2022)

Superior High Quality Waters are surface waters that have exceptional ecological values. Ecological values are assessed based on the presence of threatened or endangered species and a high level of biological integrity.

Outstanding State Waters have special significance for the state due to their exceptional ecological or recreational values. To qualify based on ecological values, they must meet the qualifications for Superior High Quality waters and be among the best waters in the state from an ecological perspective. To qualify based on recreational values, they must provide unique opportunities for recreational boating, fishing, or personal enjoyment.

Outstanding National Resource Waters are surface waters that have national ecological or recreational significance. National ecological significance may include providing habitat for populations of endangered or threatened species or displaying unique biological characteristics. The Ohio Scenic Rivers program is managed by ODNR's Division of Natural Areas and Preserves. The mission of the program is to work cooperatively with local governments, businesses, landowners, non-profit organizations, and other state and federal agencies to protect the aquatic resources and terrestrial communities dependent on healthy riparian habitats. Scenic Rivers are noted for their relatively undeveloped, high-quality shorelines and riparian areas. Information about the protections provided to Scenic River lands can be found in OAC 1501:47-4.

Ohio currently has 15 designated Wild, Scenic and/or Recreational rivers comprising 27 stream segments. They can be seen in Map 35. More than 830 river miles are protected in the Ohio scenic river system. Three state-designated streams - the Little Miami River, Big and Little Darby Creeks, and Little Beaver Creek - are also designated as National Scenic Rivers. The Chagrin River, Cuyahoga River, Grand River, Ashtabula River, and Conneaut Creek are also recognized as Scenic Rivers through Ohio DNR. Scenic Rivers are noted for their relatively undeveloped, high-quality shorelines and riparian areas. Tables 8 and 9 show Ohio EPA designated Superior and Outstanding waters across the Region.

Region 2 – Superior Waters		
Waterbody Name	**Flows into**	**Drainage Basin**
Ashtabula river - confluence of East and West fork (RM 27.54) to adjacent East 23rd street (RM 2.00)	Lake Erie	Ashtabula
Baughman creek	Grand river	Grand
Furnace run	Cuyahoga river	Cuyahoga
North Fork Yellow creek	Yellow creek	Cuyahoga
Unnamed tributary to East Branch Black river at RM 41.41	East Branch Black river	Black
Yellow creek	Cuyahoga river	Cuyahoga

Table 8. Ohio EPA designated "Superior Waters" across Region 2.

Region 2 – Outstanding Waters		
Waterbody Name	**Flows into**	**Drainage Basin**
Aurora branch - state route 82 (RM 17.08) to the mouth	Chagrin river	Chagrin
Chagrin river - Woodiebrook road (RM 49.14) to state route 6 (RM 11.1)	Lake Erie	Chagrin
Conneaut creek - state line (RM 23.83) to the mouth	Lake Erie	Ashtabula
Cuyahoga river - Troy-Burton township line (RM 83.9) to U.S. route 14 (RM 60.75)	Lake Erie	Cuyahoga
East Branch Chagrin river - Heath road (RM 14.49) to the mouth	Chagrin river	Chagrin
Grand river - state route 322 (RM 67.08) to U.S. route 20 (RM 5.67)	Lake Erie	Grand
Unnamed tributary to East Branch Black river at RM 39.06	East Branch Black river	Black

Table 9. Ohio EPA designated "Outstanding Waters" across the Region. (Ohio EPA, Division of Surface Water, 2022)

3.3 Other Watershed Planning

The major water quality focused watershed planning efforts are shown in Table 10. This list includes active plans that are not less than basin geographic scope. Many additional planning efforts exists at smaller scales than those identified here.

Watershed Planning Efforts (no less than basin geographic scope)	
Plan	**Organization**
Great Lakes Water Quality Agreement	IJC
Ohio Domestic Action Plan	OLEC
Ohio Nutrient Reduction Strategy	Ohio EPA
H2Ohio	ODA, ODNR, Ohio EPA
Great Lakes Restoration Initiative (Action Plan III)	ODA
Binational Phosphorous Reduction Strategy	U.S. EPA
Ohio Coastal Nonpoint Source Pollution Control Plan	ODNR Coastal Office
Lake Erie Protection and Restoration Plan/ORC	OLEC/State of Ohio
Lake-wide Action Management Plan for Lake Erie	U.S. EPA

Table 10. State-wide and regional watershed planning efforts (no less that basin geographic scope).

3.3.1 Nine Element Nonpoint Source Implementation Strategies

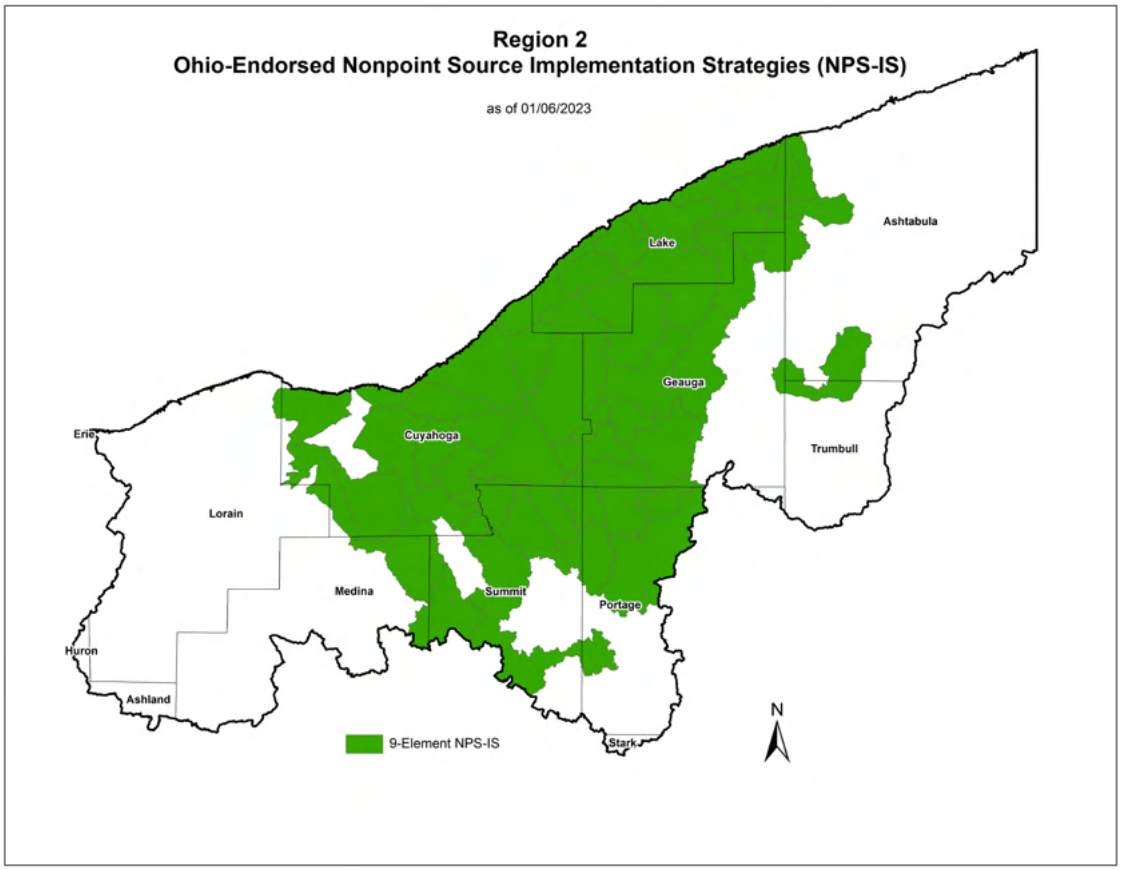
A 9-Element Nonpoint Source Implementation Strategy (NPS-IS) is a local watershed-based plan written according to a framework developed by Ohio EPA and ODA. A state-endorsed NPS-IS assures granting institutions that implementation projects contained within satisfy 9 Essential Elements referenced in U.S. EPA guidance. Such projects are rooted in the best science available; located to address the most significant problems; and will be supported with the administrative, evaluation, and educational components needed to achieve the greatest long-term, water quality benefits. Ohio EPA leads the NPS-IS program and provides more information and NPS-IS development tools. The region's subwatersheds (HUC-12) with state-endorsed NPS-IS are listed and highlighted in Table 11 Map 36 below.

Region 2 Ohio endorsed Nonpoint Source Implementation Strategies (NPS-IS)		
HUC-12	**HUC-12 Name**	**NPS-IS Version and Approval Date**
041100010108	Baker Creek—West Branch Rocky River	Version 1.0, Dec. 27, 2019
041100010201	Headwaters East Branch Rocky River	Version 1.0, June 22, 2017
041100010202	Baldwin Creek-East Branch Rocky River	Version 1.0, June 27, 2019
	Version 1.1	Version 1.1, May 12, 2020
	Version 1.2	Version 1.2, Feb. 23, 2021
041100010204	Cahoon Creek-Frontal Lake Erie	Version 1.0, May 14, 2019
	Version 1.1	Version 1.1, Jan. 13, 2020
041100020102	West Branch Cuyahoga River	Version 1.0, Jan. 9, 2020

041100020104	LaDue Reservoir—Bridge Creek	Version 1.0, Dec. 30, 2019
041100020105	Black Brook	Version 1.0, Jan. 3, 2020
041100020203	Lake Rockwell-Cuyahoga River	Version 1.0, April 6, 2017
041100020304	City of Akron - Cuyahoga River	Version 1.0, March 13, 2020
041100020402	Yellow Creek-Summit Co.	Version 1.0, Jan. 26, 2021
041100020404	Brandywine Creek	Version 1.0, Jan. 17, 2020
041100020405	Boston Run	Version 1.0, Feb. 21, 2020
041100020501	Pond Brook	Version 1.0, July 5, 2017
041100020502	Headwaters Tinkers Creek	Version 1.0, July 6, 2017
	Version 1.1	Version 1.1, Oct. 20, 2021
041100020503	Headwaters Chippewa Creek	Version 1.0, May 21, 2020
041100020504	Town of Twinsburg-Tinkers Creek	Version 1.0, Aug. 8, 2017
041100020505	Willow Lake - Cuyahoga River	Version 1.0, May 7, 2020
041100020601	Mill Creek—Cuyahoga River	Version 1.0, July 17, 2017
	Version 1.1	Version 1.1, May 3, 2018
	Version 1.2	Version 1.2, April 1, 2020
	Version 1.4	Version 1.4, Nov. 1, 2022
041100020602	Village of Independence-Cuyahoga River	Version 1.0, May 21, 2020
041100020603	Big Creek	Version 1.0, June 9, 2017
	Version 1.1	Version 1.1, April 14, 2020
041100020604	Cuyahoga Heights-Cuyahoga River (West Creek)	Version 1.0, June 9, 2017
	Version 1.1	Version 1.1, May 26, 2020
	Version 1.2	Version 1.2, Jan. 19, 2021
	Version 1.3	Version 1.3, Oct. 20, 2021
041100020605	City of Cleveland-Cuyahoga River	Version 1.0, March 24, 2020
041100030203	Arcola Creek	Version 1.0, June 27, 2019
041100030204	McKinley Creek-Frontal Lake Erie	Version 1.0, May 22, 2017
041100030301	Silver Creek	Version 1.0, June 19, 2017
041100030302	Headwaters Aurora Branch	Version 1.0, May 12, 2017
	Version 1.2	Version 1.2, Nov. 10, 2022
041100030303	McFarland Creek-Aurora Branch	Version 1.0, April 13, 2017
	Version 1.1	Version 1.1, July 6, 2018
	Version 1.2	Version 1.2, Aug. 14, 2019
041100030304	Beaver Creek-Chagrin River	Version 1.0, March 1, 2017
	Version 1.1	Version 1.1, Aug. 14, 2019
	Version 1.2	Version 1.2, Feb. 25, 2020
	Version 1.3	Version 1.3, Nov. 23, 2020
	Version 1.4	Version 1.4, Oct. 12, 2021
041100030401	East Branch Chagrin River	Version 1.0, May 10, 2017
	Version 1.2	Version 1.2, Aug. 14, 2019
	Version 1.3	Version 1.3, Oct. 15, 2021
041100030402	Griswold Creek-Chagrin River	Version 1.0, March 9, 2017
	Version 1.1	Version 1.1, Nov. 27, 2017
	Version 1.2	Version 1.2, May 3, 2018
	Version 1.3	Version 1.3, Aug. 14, 2019
041100030403	Town of Willoughby—Chagrin River	Version 1.0, Jan. 15, 2020
	Version 1.1	Version 1.1, Dec. 2, 2020

041100030501	Marsh Creek-Frontal Lake Erie	Version 1.0, May 10, 2017
	Version 1.1	Version 1.1, July 16, 2018
041100030502	City of Euclid—Frontal Lake Erie	Version 1.0, April 24, 2020
041100030503	Euclid Creek	Version 1.0, June 7, 2017
	Version 1.1	Version 1.1, July 13, 2018
	Version 1.2	Version 1.2, Jan. 29, 2020
041100030504	Doan Brook	Version 1.0, Feb. 26, 2019
041100040303	Mill Creek—Grand River	Version 1.0, Dec. 17, 2019
041100040603	Community of Mechanicsville—Grand River	Version 1.0, Dec. 17, 2019
041100040604	Paine Creek—Grand River	Version 1.0, Dec. 17, 2019
041100040605	Talcott Creek—Grand River	Version 1.0, Dec. 17, 2019
041100040606	Big Creek—Lower Grand	Version 1.0, July 27, 2017
041100040607	Red Creek-Grand River	Version 1.0, May 8, 2017
041100020502	Headwaters Tinkers Creek	Version 1.0, July 6, 2017
	Version 1.1	Version 1.1, Oct. 20, 2021
041100020503	Headwaters Chippewa Creek	Version 1.0, May 21, 2020
041100020504	Town of Twinsburg-Tinkers Creek	Version 1.0, Aug. 8, 2017

Table 11. Region 2 Ohio endorsed Nonpoint Source Implementation Strategies (NPS-IS).



Map 36. Ohio endorsed Nonpoint Source Implementation Strategies (NPS-IS) plans in Region 2.

3.3.2 Watershed Action Plans

State-endorsed Watershed Action Plans (WAP) were produced between 2001 and 2015 according to A Guide to Developing Local Watershed Action Plans in Ohio, (Ohio EPA, 1997). These plans were also developed according to U.S. EPA 9-Essential Elements. Whereas NPS-IS are developed at the consistent geographic scope of HUC-12 subwatersheds, the geographic scope of WAPs varied from HUC-12 up to HUC-8 watersheds. The content scope was also more comprehensive and exhaustive, however, WAPs do not include priority implementation project detail as is the focus of NPS-IS. Although WAPs are no longer regarded as adequate to support project funding, they continue to serve as valuable reference material for NPS-IS development and education. WAPs developed within the region are listed in Table 12.

Ohio Environmental Protection Agency Endorsed Watershed Action Plans	
Plan Name	**Endorsement Date**
Arcola Creek	4/1/2013
Black River	4/10/2012
Chagrin River	12/24/2003
Doan Brook	5/8/2013
Euclid Creek	4/27/2006
Lower Grand River	12/27/2005
Mentor Marsh	7/25/2006
Middle Cuyahoga River	1/11/2013
Rocky River	7/26/2006
Tinkers Creek	8/12/2010
Upper Grand River	1/11/2013
West Creek	2/17/2009

Table 12. Ohio Environmental Protection Agency endorsed Watershed Action Plans in Region 2.

4. Water Quality Goals

The following summary highlights statewide and regional water quality goals and their associated planning efforts, supporting organizations, and grants (Table 13).

State and Regional Water Quality Goals and Associated Plans				
Water Quality Impairment	**Goal**	**Plan (no less than basin geographic scope)**	**Organization**	**Grants**
All NPS	Implement NPS, Altered Stream Habitat, High Quality Waters Protection, Urban Sediment and Nutrient Reduction strategies, goals and milestones.	Ohio Nonpoint Source Management Plan Update	Ohio EPA	Clean Water Act Section 319
	Implement Coastal NPS Management Measures	Ohio Coastal Nonpoint Pollution Control Program Plan	ODNR Coastal Office NOAA U.S. EPA - Region V	Coastal Management Assistance Grants
Nutrient Reduction	Minimize the extent of hypoxic zones in the Waters of the Great Lakes associated with excessive phosphorus loading, with particular emphasis on Lake Erie	GLWQA - Annex 4 Nutrients	NOAA	
	Maintain algal species consistent with healthy aquatic ecosystems in the nearshore Waters of the Great Lakes	Ohio DAP	U.S. EPA - Region V & Great Lakes National Program Office	
	Maintain cyanobacteria biomass at levels that do not produce concentrations of toxins that pose a threat to human or ecosystem health in the Waters of the Great Lakes	Ohio Nutrient Reduction Strategy	Ohio EPA	GLSNRP
Sediment & Erosion Control	No open lake disposal of dredge material.	Lake Erie Protection and Restoration Plan/ORC	OLEC/State of Ohio	

Habitat Protection & Restoration	Support the protection, creation, enhancement, and restoration of coastal and riparian wetland habitats. This includes the development of in-water wetlands within nearshore and bay areas where feasible. Objective: Maintain and enhance habitat diversity for signature Lake Erie habitats (coastal wetlands, riparian corridors, swamp forests, fish spawning and nursery areas, wildlife areas).	Lake Erie Protection and Restoration Plan	OLEC	
	Promote on-farm habitat restoration around streams, wetlands and woodlots through farmer-developed and famer-implemented environmental farm plans.	Lake-wide Action Management Plan for Lake Erie	U.S. EPA	
	Restore/enhance 110 acres of coastal wetland within the Western Lake Erie/Lake St. Clair Focus Area (Great Lakes Coastal Program 5-year Target).			
E. coli Reduction	Reducing Bacteria Loads: Continue to oversee and monitor the development and implementation of long-term control plans to reduce combined sewer overflows (CSOs) and associated discharge of bacteria loads to Lake Erie.	Lake-wide Action Management Plan for Lake Erie	U.S. EPA	
Land Use Change and Development	Develop and implement local, watershed-based Balanced Growth Strategies and Best Local Land Use Practices	Ohio Balanced Growth Strategy	Ohio Lake Erie Commission	State Incentives

Table 13. Water quality goals and their associated planning efforts, supporting organizations, and grants.

Many of the planning efforts outlined in Tables 10 and 13 provide funding opportunities for implementation through grants. Current grant funding opportunities and selected details are summarized in Table 14.

Implementation Resource Opportunities			
Grant	**Organization**	**Summary**	**Link**
Great Lakes Restoration Initiative	U.S. EPA	• Funding objective – Implementation of programs and projects to improve the Great Lakes in 5 key focus areas: Toxic Substances and Areas of Concern, Invasive Species, Nonpoint Source Pollution Impacts, Habitats and Species, Foundations for Future Restoration Actions	Great Lakes Restoration Initiative
		• Funds availability – Various/ongoing; $3.8 billion allocated between FY2010-FY2021; $30 million currently available for Great Lakes Environmental Justice Grant Programs opportunity for the period January 2024-January 2030	
		• Key dates – Variable; August 11, 2023 application deadline for current Great Lakes Environmental Justice Grant Programs opportunity	
		• Eligibility – State agencies, interstate agencies, tribes, local governments, universities, and NGOs	
		• Requirements – Variable; collaboration with federal agencies	
Coastal Management Assistance Grants	ODNR	• Funding objective – Water quality improvement, coastal planning, education programs, land acquisition, research, public access, habitat restoration, and other purposes	Coastal Management Assistance Grants
		• Funds availability – Approximately $400,000 available annually, $50,000-150,000 per application	
		• Key dates – Pre-proposals due in September/October; applications for accepted proposals due in December	

		• Eligibility – local government (municipalities, townships, counties, school districts, park districts, port authorities, etc.), state agencies, academic institutions, and 501(c)(3) non-profit corporations	
		• Requirements – Minimum 1:1 match of non-federal funds	
H2Ohio Ohio Wetland Grant Program	ODNR	• Funding objective – Wetland creation, hydrologic restoration of wetlands on hydric soils, hydrologic enhancement of existing wetlands, floodplains, and riparian corridors, stream, conservation channel design and floodplain restoration, Acid Mine Drainage (AMD) Abatement projects, dam removal and associated restoration, property acquisition if associated with water quality restoration, stormwater retention and/or green infrastructure projects	H2Ohio Statewide Wetland Grant Program
		• Funds availability – Minimum of $50,000 application	
		• Eligibility – City, Village, County, Park district, 501-C3, Conservancy District, Township, SWCD	

Table 14. Current grant funding opportunities associated with major watershed planning efforts.

5. Management Measures

5.1 Available Management Measures/Best Management Practices

A variety of management measures have been assembled through the work of numerous agencies and organizations. These documents describe management measures and specific BMPs to address resource concerns related to water quality impairment across Ohio.

These include:

- USDA-ARS Best Management Practices To Minimize Agricultural Phosphorus Impacts on Water Quality
- USDA Field Office Technical Guide
- Ohio State University Extension – Agricultural BMPs
- Tri-State Fertilizer Recommendations
- Midwest Cover Crops Field Guide
- P-Filter Guidance
- H2Ohio BMP Guidelines
- ODA – APAP guidance
- U.S. EPA Urban Runoff: National Management Measures
- Ohio EPA Ohio Nonpoint Source Management Plan
- Ohio EPA Rainwater and Land Development Manual
- ODNR – Coastal Nonpoint Source Pollution Control Management Measures
- ODNR – Acid Mine Drainage
- ODNR – Division of Mineral Resources Management
- ODNR Division of Forestry – BMPs for Erosion Control for Logging and Forestry Practices in Ohio
- ODNR & OSU Extension - Clean Marina and Clean Boater guides and tools
- OLEC – Ohio Balanced Growth Best Land Use Practices
- USDA National Best Management Practices for Water Quality Management on National Forest System Lands
- Stormwater Best Management Practices for Local Roadways

The referenced guidance documents contain numerous BMPs that can address various concerns and situations. However, when planning at a regional level, it's necessary to refine the BMPs to those that are most appropriate and applicable to the region's priorities and issues. In this section, instead of suggesting a limited set of practices, we aim to identify widely applicable BMPs and groups that can address the water quality impairments in the region. By identifying such opportunities, both local and regional planning can benefit and positively impact the region's goals.

5.2 Regional Applicability and Alignment

Region 2 is made up of approximately 1.97 million acres. Broadly categorized these lands are made up of Agricultural, Urban/Developed, and Forested land.

The land area for each of these categories is show below on Table 15.

In the following sections BMPs for each major land use will be assessed and those most applicable, and with the greatest potential impacts towards water quality improvement will be identified.

Region 2 Land Cover	
NLCD Land Cover Class	**% Area**
Open Water	1.0
Developed Open Space	11.2
Developed Low Intensity	13.4
Developed Medium Intensity	6.8
Developed High Intensity	2.6
Barren Land	0.2
Deciduous Forest	30.1
Evergreen Forest	0.3
Mixed Forest	2.3
Shrub/Scrub	0.3
Herbaceous	0.8
Hay/Pasture	14.3
Cultivated Crops	10.3
Woody Wetlands	6.0
Emergent Herbaceous Wetlands	0.4

Table 15. Region 2 Land Use Area. (Dewitz & U.S. Geological Survey, 2021)

5.3 Agriculture

In section 3.1 of this plan, we discuss the use of USDA MLRAs to group together land areas within the state. MLRAs are classifications developed by the Natural Resources Conservation Service, a division of the USDA. They are geographically associated land areas that represent regions with similar geology, soils, climate, and land use patterns. MLRAs are similar in scope and purpose to U.S. EPA Ecoregions, but with a focus on soil-related resource concerns. MLRAs are useful for analyzing regional water quality needs, especially for agricultural production.

Region 2 is primarily comprised of the LEGP, which is a gently to strongly rolling, glaciated highland in the northwest portion of the Allegheny Plateau. The area has a narrow band of flat plains adjacent to Lake Erie. Its stream valleys are generally narrow and not deeply incised, yet the valley walls are steep. Interfluves are broad in some areas, and almost flat.

Nearly 75% of the LEGP is utilized for farming purposes, with feed grains (corn, soybeans, winter wheat, and oats) and forage (grass-legume hay, tall fescue pasture, and alfalfa hay) mainly being grown in the west. Similarly, these crops are also cultivated in the east, where there are a large number of part-time farms and rural residences. Cow-calf operations are also maintained in this area, along with some areas designated for potatoes or small fruit crops. A significant portion of the milk produced in this region is utilized for cheese production. The available MLRA hardwood forest areas are found mostly in farm woodlots, where sawlogs for rough construction, firewood, and some high-quality sawlogs for specialty purposes are harvested.

5.3.1 State/Regional Priorities

As described in section 4, there are several notable state and regional priorities important to consider. With regards to the scope of this plan these are:

- Great Lakes Water Quality Agreement (GLWQA) of 2012, 40% reduction of total phosphorus in the WLEB from 2008 loading levels
- Great Lake Water Quality Agreement-U.S. Action Plan for Lake Erie
- Great Lake Water Quality Agreement-Ohio Domestic Action Plan
- Lake Erie Area of Concern Remedial Action Plan for the Cuyahoga and Black Rivers
- Northeast Ohio Regional Sewer District (NEORSD) Master Plans
- House Bill 7, which initiated the Watershed Program, calls for a focus on nutrients, specifically mentioning phosphorus and nitrogen

The process of identifying BMPs for Region 2 included a focus on nutrient related impairments. This focus is in line with the legislative directive and the goals laid out in the GLWQA. Nutrient-reduction BMPs will help to address near-field impairments in the watershed as well as the regional goals for Lake Erie.

5.3.2 Water Quality Impairments/Stressors

In addition to state and regional priorities, the primary water quality impairments and stressors highlighted in section 3.2 provide insight in where management efforts should be focused. In Region 2 the top impairments include:

- Habitat alteration
- Erosion/Sedimentation
- Organic enrichment
- Nutrients
- PCBs in fish

In this section the focus is on nutrients, erosion/sedimentation, and habitat alteration, as these encompass the primary impairments related to agriculture.

Other impairments less directly relevant to agriculture will be discussed in more detail in later sections.

5.3.3 Applicable Agricultural Best Management Practices

Effective watershed management involves aligning technical solutions with water quality goals. To achieve this, we conducted a detailed analysis of agricultural BMPs and their relationship to primary water quality impairments in Region 2.

We utilized the Conservation Practice Physical Effect (CPPE) matrix, a USDA planning tool that evaluates the impact of conservation practices on natural resources (Table 16). The matrix encompasses 167 agricultural management practices and 47 resource concerns, each with an effects rating. By analyzing the data, we identified the most effective BMPs for improving water quality related to the region's major resource concerns (Table 17).

United States Department of Agriculture (USDA) Conservation Practice Physical Effects (CPPE) Scoring Matrix	
Effects Quantification	**Score**
Substantial Improvement	5
Moderate to Substantial Improvement	4
Moderate Improvement	3
Slight to Moderate Improvement	2
Slight Improvement	1
Not Applicable	0
Neutral	0
Slight Worsening	-1
Slight to Moderate Worsening	-2
Moderate Worsening	-3
Moderate to Substantial Worsening	-4
Substantial Worsening	-5

Table 16. Conservation Practice Physical Effect Scoring Matrix (U.S. Department of Agriculture, Natural Resources Conservation Service, FY23)

Water Quality Impairments and Resource Concerns	
Water Quality Impairment	**Resource Concern**
Nutrients	Nutrients Transported to Surface Water
	Nutrients Transported to Groundwater
	Inadequate Livestock Shelter
	Inadequate Livestock Water Quantity, Quality and Distribution
Erosion/Sedimentation	Sheet and Rill Erosion
	Wind Erosion
	Ephemeral Gully Erosion
	Classic Gully Erosion
	Bank Erosion from Streams, Shorelines or Water Conveyance Channels
	Sediment Transported to Surface Water
	Inadequate Livestock Shelter
	Inadequate Livestock Water Quantity, Quality and Distribution
Habitat Alteration	Aquatic Habitat for Fish and other Organisms

Table 17. The three primary impairment categories and the associated resource concerns as defined in the Conservation Practice Physical Effect matrix. (U.S. Department of Agriculture, Natural Resources Conservation Service, FY23)

Cover crop.

To aid conservation planners in making informed decisions, a comprehensive list of 167 land management practices were screened and sorted based on their relevance to the Region's land use and agricultural characteristics. The remaining practices were grouped into categories and marked for their applicability to cropland or hay/pasture/livestock areas, and their potential impact on each water quality impairment was noted based on their CPPE score. Only practices with a positive impact rating were included in the compilation of BMPs in Table 18, where the data was presented in a clear and informative manner. By connecting the BMPs to specific water quality impairments, conservation planners are given strategic guidance on selecting and implementing the most effective practices.

Region 2 - Best Management Practices								
Best Management Practices	**BMP Suite**	**Hay / Pasture / Livestock**	**Cropland**	**Nutrients**	**Erosion**	**Habitat**	**Regional Applicability**	**Current Adoption**
386 - Field Border	Buffers						25%	21%
390 - Riparian Herbaceous Cover							13%	
391 - Riparian Forest Buffer								
393 - Filter Strip								
601 - Vegetative Barrier								
327 - Conservation Cover	Conservation Cover						10%	*Limited Data*
328 - Conservation Crop Rotation							25%	
340 - Cover Crop							10%	12%
484 - Mulching								*Limited Data*
511 - Forage Harvest Management							25%	
512 - Pasture and Hay Planting								
311 - Alley Cropping	Cropping System						10%	
330 - Contour Farming								
395 - Stream Habitat Improvement and Management	Habitat Restoration						13%	
396 - Aquatic Organism Passage								
580 - Streambank and Shoreline Protection								
382 - Fence	Livestock / Grazing						14%	
472 - Access Control								
516 - Livestock Pipeline								

528 - Prescribed Grazing								
561 - Heavy Use Area Protection								
574 - Spring Development								
578 - Stream Crossing								
614 - Watering Facility								
Grazing Management Plan								
313 - Waste Storage Facility	Livestock / Headquarters							
316 - Animal Mortality Facility								
317 - Composting Facility								
359 - Waste Treatment Lagoon								
367 - Roofs and Covers								
368 - Emergency Animal Mortality Management								
558 - Roof Runoff Structure								
560 - Access Road								
576 - Livestock Shelter Structure								
634 - Waste Transfer								
590 - Nutrient Management Planning	Nutrient Mgmt						25%	38%
Comprehensive Nutrient Management Plan								17%
Manure Incorporation							10%	21%
Subsurface Placement								29%
332 - Contour Buffer Strips	Sediment Control							*Limited Data*
350 - Sediment Basin								
380 - Windbreak/Shelterbelt Establishment and Renovation							25%	
410 - Grade Stabilization Structure							10%	
412 - Grassed Waterway								
585 - Strip-cropping								
329 - Residue and Tillage Management, No Till	Tillage Mgmt							

345 - Residue and Tillage Management, Reduced Till								
314 - Brush Management	Vegetation						25%	
315 - Herbaceous Weed Treatment								
342 - Critical Area Planting								
422 - Hedgerow Planting								
612 - Tree/Shrub Establishment								
635 - Vegetated Treatment Area								
362 - Diversion	Water Mgmt							
436 - Irrigation Reservoir								
447 - Irrigation and Drainage Tailwater Recovery								
554 - Drainage Water Management							6%	
587 - Structure for Water Control								
604 - Saturated Buffer								
605 - Denitrifying Bioreactor								
Phosphorus filter								
606 - Subsurface Drain								
Two-stage ditch							25%	
Over-wide channel								
638 - Water and Sediment Control Basin								
656 - Constructed Wetland	Wetlands						20%	
657 - Wetland Restoration								
658 - Wetland Creation								
659 - Wetland Enhancement								

Table 18. Summary of Best Management Practices.

5.3.4 Challenges to Implementation

To successfully promote conservation practices, one must not only be aware of relevant and fitting practices but also mindful of challenges and obstacles. The adoption of solutions can be impeded by cultural, physical, or technological factors. Table 19 contains a compilation of commonly observed challenges associated with BMP groups. Although certain challenges are common throughout the state, many are exclusive to specific regions and circumstances.

Region 2 Common Challenges to Adoption of Best Management Practices												
BMP Group	**Buffers**	**Conservation Cover**	**Cropping System**	**Habitat Restoration**	**Livestock / Grazing**	**Livestock / Headquarters**	**Nutrient Mgmt**	**Sediment Control**	**Tillage Mgmt**	**Vegetation**	**Water Mgmt**	**Wetlands**
Challenges												
Management intensity	✓	✓			✓		✓			✓	✓	
Cost-share availability				✓	✓	✓	✓				✓	✓
SWCD familiarity							✓				✓	
Producer familiarity				✓			✓		✓	✓	✓	
Physical constraints (e.g., steep slope)			✓			✓		✓	✓		✓	✓
Program requirements	✓	✓	✓			✓	✓	✓	✓			✓
Equipment/technology requirements			✓				✓		✓			
Weather		✓					✓		✓			
Removal of ground from production	✓	✓						✓		✓	✓	✓
Commodity Market	✓	✓	✓				✓	✓				
Engineering Resources											✓	
Institutional Distrust	✓	✓			✓	✓	✓		✓	✓		✓

Table 19. Challenges to adoption and associated BMP groups.

Management intensity

Certain BMPs may present challenges for producers due to required maintenance and management requirements. For instance, vegetation or buffer practices necessitate species management, while grazing practices require extra time and labor. Additionally, drainage structures demand ongoing maintenance. Such considerations may pose difficulties for some producers.

Cost-share availability

Implementing BMPs often requires upfront and continued investment. Unfortunately, without cost-sharing funding, this investment can prove to be insurmountable. While there is funding accessible for certain practices, those that require a significant initial investment, such as constructing wetlands, maintaining livestock facilities, and restoring streambanks, often face a shortage of funding to meet demand.

SWCD familiarity/Producer familiarity

Unfamiliarity with effective BMPs can hinder their implementation amongst producers and local conservation personnel. Such cases include techniques addressing nutrient management, water conservation, and tillage methods, all of which require a certain level of technical expertise and familiarity to ensure successful practice integration.

Physical constraints

Several practices may have restricted use due to topography, soil types, climate, and other local factors. These may include sediment control or water management practices and structures, and location-specific practices such as wetlands.

Program requirements

Producers may face challenges complying with implementation requirements of programs administered by USDA, ODA, or other organizations. Conflicting time constraints, management practices, and other issues may hinder their ability to participate.

Equipment/technology requirements

Challenges to the adoption of BMPs, such as reduced tillage and nutrient management practices, can arise from the need for specialized equipment. Variable rate application technology and no-till capable planters are often required, causing concerns for some producers who lack access to such equipment.

Weather

The timing and nature of tillage, planting, crop rotations, and nutrient applications in agriculture hinge significantly on the weather.

Removal of ground from production/Commodity Market

Financial pressure on farmers may create a disincentive towards practices that could potentially take land out of agricultural production. This poses a barrier to implementing edge-of-field practices like grass buffers, wetlands, and other habitat improvement practices.

Constructed BMPs necessitate engineering expertise. Though local conservation staff are typically competent, they may not be able to design practices as efficiently due to time or resource constraints. This may especially be the case with complex BMPs, particularly those involving intricate drainage structures.

Institutional Distrust

Large-scale conservation cost-share programs are typically carried out by public agencies, and individual producers may feel hesitant or skeptical about participating in government programs due to negative experience, expectations or perception.

5.3.5 Existing Implementation

The general applicability of a BMP can be assessed based on land use and physical characteristics. However, effective conservation planning requires an understanding of current levels of practice implementation as this can help inform program managers about the likelihood of voluntary adoption and how to strategically engage agricultural producers given their level of familiarity. As described by USDA-

"Behavioral factors, such as risk attitudes, environmental attitudes, and social networks interact with economic and technical feasibility factors in the adoption of any innovation. Individual adoption and widespread diffusion of an innovation are context dependent. The relationship between different influences depends on the innovation in question, broader social, policy, regulatory, and market conditions, and the adopter him or herself."

Figure 22 shows the adoption innovation lifecycle, showing the progression of adoption led by early innovators and early adopters, and shifting to the majority and later adopters as the practice becomes widespread. Understanding the stage of adoption for a given practice allows planners to develop strategic outreach and support to increase adoption.

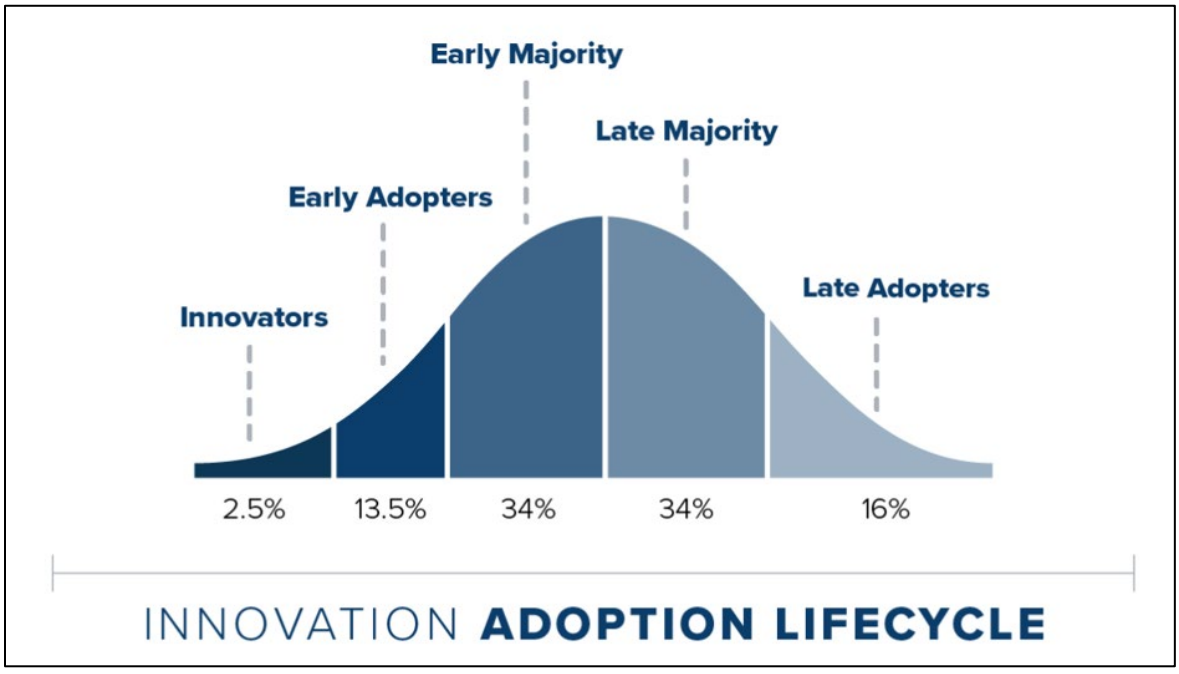


Figure 22. Innovation Adoption Lifecycle. (Recchia, 2022)

The Ohio Agricultural Conservation Initiative (OACI) is currently conducting assessments of conservation practice adoption across the state, which is expected to provide a valuable baseline of implementation once complete. It is anticipated that data from OACI and other sources will be incorporated in future revisions of the watershed plan as available.

Since no statewide baseline of conservation practice adoption was available, a survey of SWCDs was conducted to provide an estimate of practice implementation across the state. The survey consisted of 33 questions and was distributed to all 88 SWCDs in the state. The goal was to obtain a preliminary baseline of existing conservation to inform planning efforts. This baseline is particularly helpful in situations where existing data is limited. Table 20 contains summary responses pertinent to the adoption of BMPs in Region 2.

Overall, the SWCD survey results provide a helpful perspective from conservation planners and implementers who know the locale and landscape of their respective counties. Many of the answers provide affirmation of data that is already estimated through other sources, including USDA census data, scientific studies, and other estimation efforts. Answers regarding average farm size, subsurface tile installation, average slope, tillage practices, livestock practices, and crop rotations all support existing knowledge about Region 2's character, and this helps to inform and focus efforts at increasing adoption of beneficial BMPs.

SWCD Survey Results Estimated Adoption of Best Management Practices in Region 2	
Practice	**Estimated Adoption**
Buffer/Filter strips present along water bodies	21%
Operations with NMP or Following Tri-State Soil Test Recommendations	38%
Cover Crops	12%
Variable Rate Fertilizer Application	21%
Manure Incorporated within 24 hours	21%
Subsurface fertilizer application (non-manure)	29%
Livestock Operations with current Comprehensive Nutrient Management Plan	17%

Table 20. Selected results from the survey of Soil and Water Conservation Districts (Ohio Department of Agriculture, Division of Soil and Water Conservation, 2022)

In Region 2 and throughout Ohio, nutrient loading has emerged as a major concern for water quality. Despite the growing implementation of agricultural BMPs optimized for reducing nutrient loading, SWCD personnel reveal significant scope for improvement. According to estimates, only 38% of agricultural fields follow NMPs and/or adhere to Tri-State guidelines for nutrient application. As Ohio's nutrient reduction strategy focuses on nutrient management planning, this figure is a reasonably promising starting point for adoption.

Similarly, the use of variable rate fertilizer application, subsurface fertilizer application frequency, manure incorporation rate post-application, and adoption of Comprehensive Nutrient Management Plans (CNMPs) in livestock production all exhibit potential for growth. Wider adoption of these BMPs will help us move closer to attaining our state and regional nutrient reduction targets.

Other commonly promoted practices in Region 2 include cover cropping and planting of buffers or filter

Grassed waterway.

strips along waterways, both of which can mitigate against nutrient and sediment-related issues. SWCD personnel estimate 38% adoption of cover crops and 21% coverage by buffers along water courses.

The Natural Resources Conservation Service (NRCS) is responsible for numerous programs aimed at mitigating resource challenges. A comprehensive list of the top practices implemented within Region 2 over the past decade is presented in Table 21. A primary focus in this region is on in-field practices, including conservation crop rotation, tillage methods, nutrient management, and cover cropping.

Region 2 Top NRCS Practices		
	Practice Code	**Practice Name**
Cropland	328	Conservation Crop Rotation
	340	Cover Crop
	590	Nutrient Management
	345	Residue and Tillage Management, Reduced Till
	E328136Z	Leave standing grain crops unharvested to benefit wildlife food sources
Livestock	382	Fence
	516	Livestock Pipeline
	606	Subsurface Drain
	568	Trails and Walkways

Table 21. Top NRCS practices by category. (U.S. Department of Agriculture, Natural Resources Conservation Service - Ohio State Office, 2022)

To gain deeper insights into current implementation efforts, we turn to specific USDA programs that offer funding support for a range of practices, including those implemented by NRCS (as reflected in Table 22) and FSA. Table 20 highlights that within Region 2, there are 1,300 acres of CRP practices, comprising habitat planting for wildlife, grassed waterways, filter strips, and grass and tree plantings. These practices are often placed in areas most susceptible to environmental damage, particularly in proximity to stream corridors.

Conservation Reserve Program (CRP) Practices Across Region 2	
Practice Type	**Acres**
CP1-Establishment of Permanent Introduced Grasses & Legumes	208
CP10-Vegetative Cover-grass, already established	9
CP12-Wildlife Food Plot	9
CP2-Establishment of Permanent Native Grasses	84
CP21Filter Strip	154
CP22-Riparian Buffers	67
CP23-Wetland Restoration On Floodplains	31
CP23A-Wetland Restoration, Non-Floodplain	21
CP25-Rare And Declining Habitat	223
CP29-Marginal Pastureland Wildlife Buffer	24
CP3-Tree Planting	13
CP33-Habitat Buffers for Upland Birds	5
CP38E-4D-SAFE - Grass	22
CP3A-Tree Planting	118
CP42-Pollinator Habitat	55
CP4B-Permanent Wildlife Habitat (Corridors)	16
CP4D-Permanent Wildlife Habitat	163
CP5A-Field Windbreak Establishment	8
CP8A-Grass Waterway	49
CP9-Shallow Water Areas for Wildlife	1

Table 22. Conservation Reserve Program practices across Region 2. (U.S. Department of Agriculture, Natural Resources Conservation Service - Ohio State Office, 2022)

Implementation of BMPs is also occurring voluntarily across the entire watershed. The SWCD survey helped establish a baseline of applicable practices that are currently being executed and have tremendous potential for further implementation.

5.3.6 Management Measures Summary

The summary table shows a wide variety of BMPs applicable and relevant to the water quality concerns of the region. Our objective was to identify the most effective practices and provide additional information to conservation planners to help guide local implementation strategies. Together with our discussion on the causes and sources of water pollution in Section 3.2, we outline which BMPs and groups are needed to address these issues. By considering applicability and current implementation levels, we help identify where to expand practices for maximum benefit. Designed to highlight

challenges and barriers, our insights give conservation planners the knowledge they need to overcome adoption hurdles.

At 25% agricultural land makes up a smaller portion of Region 2, but still presents opportunities for adoption of conservation practices. The western portion of the region is primarily row crop agriculture, with characteristics similar to the WLEB. In these areas practices such as nutrient management planning, placement or incorporation of fertilizer and manure, and conservation cover will be beneficial. There is opportunity to increasing edge-of-field practices like wetlands, buffers, vegetation, and two-stage ditches. Drainage water management is also important on the western edge of the region due to the flat landscape and poorly drained soils. Across the southern and eastern portion of the region there are opportunities to implement practices related to hay and pastured livestock. Animal operations provide opportunity for livestock and manure management practices. Education and development of NMPs are an important area of need and opportunity in this region.

5.3.7 H2Ohio

ODA's Watershed Program and ODA H2Ohio teams are closely linked, with both initiatives sharing similar objectives. While the Watershed Program has a broader mandate, it aims to serve as groundwork for the potential expansion of H2Ohio beyond the current WLEB project area. By identifying regional priorities and concerns, the Watershed Program provides insight for H2Ohio and other large-scale conservation initiatives to focus their efforts efficiently. Currently, several Watershed Program staff members participate in H2Ohio activities, and this collaboration is expected to increase as H2Ohio expands across the state. H2Ohio aims to address crucial water quality concerns while connecting with its region and aligning with regional priorities.

5.4 Forestry

5.4.1 Education: Scope and activities of ODNR forestry programs

Ohio benefits from plentiful forest land, both private and public. This section explores the role forestry plays in nonpoint source (NPS) pollution, the measures required to minimize its impact on Ohio's water, and the resources available to achieve this goal. It will discuss planning efforts required to minimize NPS pollution via best management practices (BMPs) ensuring soil erosion during timbering is controlled, as well as measures to manage forests and develop water quality. Technical professional help and resources will be provided for woodland management.

The Ohio Department of Natural Resources (ODNR) Division of Forestry is the principal agency responsible for forestry-related issues and management. ODNR manages 24 state forests, approximately 200,000 acres, and is dedicated to the mission of promoting and implementing management practices that promote sustainable use and protection of both private and public forest lands. This section will focus on the Division of Forestry's resources and information, primarily focused on their efforts to provide technical assistance and large-scale planning through the Ohio Forest Action Plan.

5.4.1.1 Timber Harvest Plans

Forestry Pollution Prevention Plans, referred to as FP3s, are voluntary erosion control plans landowners, forestry companies, and consulting foresters may submit to their local Soil and Water Conservation District (SWCD). These plans aim to ensure sustainable logging and silviculture by listing the best management practices (BMPs) to be installed on the property.

Having an approved Forestry Pollution Prevention Plan provides legal protection for the parties following it, as it is an affirmative defense in private civil action for nuisances involving forestry pollution. The Ohio Administrative Code 1501:3-12-05 also recognizes the importance of the plan in ensuring that the person responsible for silvicultural operations is operating under and in substantial compliance with an approved Timber Harvest Plan. As of May 2023, the Timber Harvest Plan has been renamed "Forestry Pollution Prevention Plan" or "FP3" to reflect its essential purpose better.

In Ohio, Timber Harvest Plans are commonly initiated by consulting and industry foresters. More loggers are participating in the pre-planning program due to promotion and training, resulting in increased submission of plans for private sales among counties. Some SWCDs receive up to 15 plans per year while others get 3 or fewer. For more information on Forestry Pollution Prevention Plans, visit the ODNR website.

5.4.1.2 Logger Certifications

The ODNR Division of Forestry and The Ohio State University Extension collaborate closely with the Ohio Forestry Association (OFA) to support OFA's Ohio Voluntary Master Logging Company Program which provides training and certification for logging contractors and their employees in Ohio. OFA's Master Logging Program maintains a robust safety training and certification program covering chainsaw safety, best management practices for soil and water protection, and first aid and CPR. Periodic re-certification ensures that each logger remains up-to-date on new developments and emerging industry concerns. Membership in a local logger's chapter is mandatory. These chapters are regional organizations of loggers and representatives in Ohio that work together to develop programs and projects that promote the welfare of loggers through information, education, and legislative advocacy.

5.4.2 Management Measures and Pollution Complaints

5.4.2.1 Best Management Practices for Erosion Control for Logging and Forestry

The ODNR Division of Forestry published a book entitled BMPs for Erosion Control for Logging and Forestry Practices in Ohio. The most recent edition was published in April of 2023. The book outlines erosion control practices that need to be installed to meet the standards of Ohio's Forestry Pollution Abatement Law (formerly known as the Ohio Agricultural and Silvicultural Pollution Abatement Law of 1991) follow the link for more information on ORC 1501:3-12.

The Ohio Division of Forestry collaborates with OSU Extension, OFA, county SWCD's, log and lumber yards, wood product manufacturers, and other local and regional entities to conduct Logging BMP trainings as needed. This training ensures that loggers are equipped with the latest and most effective practices to prevent and minimize erosion at timber harvest sites.

ODNR Division of Forestry delineates logging erosion control best management practices as follows:

Prevent soil detachment

- Minimizing skid trail numbers and widths
- Minimizing log landing size and disturbance
- Phasing the logging job to minimize the amount of bare soil at any given time
- Armoring high traffic areas such as haul roads with stone or wood mud mats
- Seeding to revegetate bare soil
- Straw mulch or brush cover

Interrupt sediment runoff from water erosion

- Water bars
- Broad-based Dips
- Rolling Dips
- Brushed-in trails to slow runoff

Control sediment deposition

- Silt fence
- Straw bale barriers
- Filter sock barriers

Minimize streamside management zone impacts

- Portable bridges
- Maintaining filter strips
- Properly constructed and armored stream fords
- Removing tops and logging slash from streams to prevent blockage and bank erosion

BMPs to cross headwater streams:

- Culverts
- Pole crossings
- Crane mat bridges

BMPs to protect wetlands or saturated soils:

- Use temporary wood mud mats to support logging equipment
- Using specialized equipment such as tracked forwarders that minimize compaction and rutting

5.4.3 Timber Harvest Plans and Silviculture Pollution Complaints

5.4.3.1 Silviculture Pollution

Forest ecosystems are vital for maintaining clean water quality. However, when silvicultural activities like logging are performed without appropriate Best Management Practices (BMPs), soil disturbance can result, leading to sedimentation and watershed impairment. This is considered forestry pollution under OAC 1501:3-12-01, which defines it as the failure to use appropriate measures to prevent soil erosion and degradation of state waters due to silvicultural activities. To address forestry pollution, complaints can be made orally or in writing to the ODNR Division of Forestry or the SWCD in the county where the logging is taking place, as outlined in OAC 1501:3-12-06. It is important to include specific information when making a complaint:

1. Location and description of the property and/or waters of the state allegedly being damaged
2. The nature and extent of the damage
3. The alleged source of pollution
4. Any efforts made to obtain voluntary cooperation to eliminate the problem

If the Division of Forestry or SWCD spots or receives a report of a possible violation of the Forestry Pollution Abatement Rules, they will investigate to determine if a violation is taking place. If one is discovered, they will collaborate with the responsible individuals to create a plan to bring the site back into compliance with state water quality standards. This involves identifying necessary Best Management Practices and setting deadlines for implementation.

Should the SWCD or Division's deadlines not be met, a legal order may be issued (Chief's Order). Failure to comply with a Chief's Order counts as a misdemeanor of the first degree and each day of violation is a distinct offense.

To date, the ODNR and SWCDs have worked alongside forest industry personnel and landowners to proactively and cooperatively address forestry pollution matters and avoid legal repercussions. If a forestry pollution complaint is brought to an SWCD, the Ohio Division of Forestry's Forestry Pollution Abatement Program Manager should be notified immediately to coordinate resolution efforts.

5.4.3.2 Best Management Practice Implementation

When the program was initially introduced, loggers were not aware of their legal obligation to install BMPs. As a result, several complaints were raised in the late 90s and early 2000s, with many sites lacking adequate closeout measures. During this period, logger training was delivered on site and in the field. On-the-job training aimed to communicate the benefits of BMPs, installation procedures, as well as the legal mandate to install them.

In 2016, the Ohio Division of Forestry conducted a research project to evaluate compliance with silviculture pollution program rules. Their findings revealed that 78% of the sites visited met the requirements, while the remaining sites had at least one resource concern that required further Best Management Practices (BMPs). Compliance rates were highest in northwestern and northeastern Ohio, whereas southeastern Ohio had the lowest compliance rate, mainly due to steep topography and numerous stream crossings. (Mulligan, 2023)

The Ohio Division of Forestry aims for all logging sites to comply with the current state BMP standards, ideally without the intervention of the SWCD's or the Division of Forestry. In the last three years, the Division of Forestry received 116 complaints of inconsistent logging practices on private lands. Inconsistent practices refer to logging without appropriate BMPs for silviculture, as defined by the Sustainable Forestry Initiative. (Sustainable Forestry Initiative, 2023) The new BMPs for Erosion Control for Logging and Forestry Practices in Ohio book sets a clear timeline for the installation of close-out BMPs, which must be deployed within seven days following the completion of the harvest. In case of temporary shutdown due to inclement weather or other factors, temporary water bars or other suitable measures must be implemented. (Mulligan, 2023)

5.4.4 Major Land Resource Areas, Other Best Management Practices, and the Ohio Forest Action Plan

5.4.4.1 Ohio's Major Land Resource Areas and Forestry Descriptions

MLRAs are geographically associated land resource units (LRUs). Identification of these large areas is important in statewide agricultural planning and has value in interstate, regional, and national planning.

LEGP- The areas of hardwood forest are mainly in farm woodlots. Saw logs for rough construction, firewood, and some high-quality saw logs for specialty uses are harvested from the numerous farm woodlots. Some large holdings are used for watershed protection.

5.4.4.2 Other Best Management Practices for Forestry

The NRCS has identified specific practices related to forest management that have a positive impact when implemented correctly (Table 23). Definitions of practice and standards are available on the USDA-NRCS Field Office Technical Guide.

To create an effect on the landscape its recommended that these practices be integrated into forestry management plans (FMP's) developed or signed off on by a certified professional forester. These can be implemented singularly or in combination with other BMPs to improve overall forest health, wildlife habitat, and water quality.

Forestry Best Management Practices (BMPs)

Practice Code	NRCS Practice
391	Riparian Forest Buffer
342	Critical Area Planting
612	Tree/Shrub Establishment
327	Conservation Cover
654	Road/Trail/Landing Closure and Treatment
381	Silvopasture
379	Forest Farming
390	Riparian Herbaceous Cover
666	Forest Stand Improvement
645	Upland Wildlife Habitat Management
380	Windbreak/Shelterbelt Establishment and Renovation
340	Cover Crop
395	Stream Habitat Improvement and Management
338	Prescribed Burning
393	Filter Strip
484	Mulching
314	Brush Management
420	Wildlife Habitat Planting
580	Streambank and Shoreline Protection
660	Tree/Shrub Pruning
649	Structures for Wildlife
647	Early Successional Habitat Development/Mgt.
562	Recreation Area Improvement
566	Recreation Land Improvement and Protection
384	Woody Residue Treatment

Table 23. NRCS Forestry Practices (U.S. Department of Agriculture, Natural Resources Conservation Service, FY23)

5.4.4.3 Finding a Forester

The ODNR Division of Forestry has 22 professional foresters known as Service Foresters, who are dedicated to helping Ohioans manage their woodlands for a range of benefits. They offer expert technical guidance on topics like forest management, insect and disease control, tree planting, habitat development, and recreational opportunities. Furthermore, they provide information on managing timber sales and work closely with private foresters and Master Loggers. They also offer support with the Ohio Forest Tax Law and cost-share incentive programs by inspecting privately-owned forest land to determine eligibility. Contact these Service Foresters today to learn how they can help you make the most of your woodland investment.

In Ohio, there are currently no legal requirements for an individual to be licensed or registered as a professional forester. To ensure you are working with a qualified forester, it is recommended to look for membership in professional forestry organizations. Two prominent organizations in Ohio are the Ohio Society of American Foresters (Ohio SAF) and the Association of Consulting Foresters (ACF).

The SAF is a comprehensive organization that includes consulting foresters, state, regional, and federally employed foresters, forestry students, and those in academia. Members of SAF must have a degree from an accredited college or university, and student members must be attending an accredited program. Foresters in good standing are eligible to take a challenging exam and become Certified Foresters through SAF. (Downie, 2023)

Locally, Ohio SAF has forty listed foresters on their Forester Directory. Each forester is in good standing with both national and Ohio SAF and has paid a small fee to be on this list. Some of these foresters have the Certified Forester accreditation, while others do not. When seeking a professional forester in Ohio, consider looking for membership in Ohio SAF or ACF as evidence of their expertise. (Downie, 2023)

Use the following online resources for more information: Society of American Foresters

Additionally, Ohio has about twenty foresters who are full or candidate members of the ACF. To be a full or candidate member of this organization, you must be a degreed forester, have past years in professional consulting, and meet specific criteria. (Downie, 2023)

Ohio Society of American Forester's Forester Directory

Ohio ACF and National ACF. This is according to the Ohio Society of American Foresters. (Downie, 2023)

5.4.4.4 The Ohio Forest Action Plan

The Statewide Forest Action Plan serve as a strategic guide for the management and conservation of forests across the nation. Mandated by the 2008 and 2014 Farm Bills, states must have an approved plan to qualify for funding under the Cooperative Forestry Assistance Act. Specifically, the Ohio Forest Action Plan encompasses all types of forests in Ohio, including rural, urban, public, and private areas. It comprises two important documents that offer critical insights into the current and future state of Ohio's forests. The Forest Resource Assessment is an extensive analysis that identifies key issues and priorities, whereas the Forest Resource Strategy outlines actionable objectives and strategies to tackle the identified concerns. The six key issues affecting Ohio's forests include:

1. Sustainable forest management on all forest lands
2. Public benefits from Ohio’s forests
3. Conservation of soil and water resources
4. Conservation of biological diversity
5. Threats to forest health
6. Forest fragmentation, parcelization, and loss” (Ohio Department of Natural Resources Division of Forestry, 2020)

Forested areas have a significant impact on maintaining high water quality in streams. This is due to their ability to act as natural filters, absorbing pollutants and retaining nutrients in the humus layer. By doing so, they prevent these potential contaminants from reaching our waterways. Additionally, forests help to minimize runoff during storm events, allowing time for precipitation to infiltrate the soil and recharge vital aquifers. Trees within the riparian area further benefit the ecosystem by preventing soil erosion and shading streams, keeping water temperatures stable. The Ohio Forest Action Plan outlines the importance of forested riparian areas, the rate of change in these regions, and forest land area in watersheds. To learn more about forested lands and their impact on water quality in Ohio, read the Ohio Forest Action Plan Indicator 9 – Area of forest land adjacent to surface water and forest land by watershed. (Ohio Department of Natural Resources Division of Forestry, 2020)

5.4.5 Summary

Forestry and water quality are interconnected. Forests are essential for healthy watersheds and can improve water quality if managed correctly. By implementing effective conservation planning, we can strive towards this goal. According to a survey conducted by the Ohio Division of Forestry, 78% of sites with BMPs were compliant with program rules, indicating that programmatic incentives and outreach efforts can increase implementation numbers to improve water quality issues such as sedimentation. (Mulligan, 2023)

However, the Ohio Forest Action Plan reveals that 85% of private landowners with over 10 acres of forest land do not have a forest management plan for their property. To address this, various training and guidance programs are available to private forest landowners, including the Master Logger Program and the THP Program. (Ohio Department of Natural Resources Division of Forestry, 2020)

Proper planning is essential for improving water quality, but the key lies in follow-through and implementation. Section 4.1 outlined specific planning and incentivizing practices, paired with increasing the number of landowners with FMPs and FP3s prescribed by professionals, to improve water quality across the state.

5.5 Urban

5.5.1 Available Management Measures/Best Management Practices

In Ohio, practices for maintaining urban water quality are not directly monitored by the ODA. However, there are state and local guidelines in place. The Rainwater and Land Development Manual, developed by the ODNR, outlines standards and specifications for stormwater practices that affect land development from an engineering perspective. Additionally, local statutes, along with Stormwater Management Plans associated with MS4s, provide additional mitigation guidelines. Stormwater Master Plans, if applicable, are plans for stormwater needs for a given watershed that inventory existing assets, stormwater modeling of the watershed, and identify problem areas and plans to address them. The State of Ohio actively implements multiple Areawide Waste Management Plans linked to section 208 of the CWA.

5.5.2 Regional Applicability and Alignment

Urban areas are susceptible to NPS pollution from various sources, with stormwater being the primary contributor. Impervious surfaces in urban spaces exacerbate the problem by increasing surface runoff, leading to erosion of streams, flow velocity, contamination of stormwater with chemicals and nutrients, and flooding due to inadequate floodplain.

5.5.2.1 Existing Implementation

Urban water quality challenges are being proactively tackled by a range of organizations including local government, SWCD, planning commissions, nonprofit organizations, and many others. To help mitigate stormwater pollution, these organizations have implemented various methods such as green infrastructure, wetlands, and pervious pavement, which have been proven to "slow the flow" of water. This allows for natural features to process materials through ecosystems. Urban water quality is also improved through the restoration and protection of stream ecosystems and other critical watershed habitats including wetlands and floodplain forests.

Urban centers may host agencies dedicated to managing and processing stormwater, such as the NEORSD. The District oversees the collection and treatment of stormwater for the majority of Cuyahoga

County as well as portions of Lorain, Medina, Lake, and Summit Counties, in addition to handling sanitary wastewater in the region. Active initiatives aimed at mitigating the impacts of stormwater in these vicinities are also underway. Notably, NEORSD offers a stormwater program with funding options that match other financing sources. The sewer district also offers stormwater fee reductions and credits to encourage green infrastructure and stormwater management.

Employing natural channel design techniques to restore modified streams is a promising solution to reduce erosion and improve habitats. It involves mimicking undisturbed streams by reintroducing natural features such as sinuosity and riffles that reduce velocity and erosive force of the flowing water. In addition, bends in streams create buffer zones that improve the quality of the water. See Table 20 for current Nonpoint Source Implementation Strategy (NPS-IS) projects that aim to restore streams with natural channel design.

5.5.2.2 Water Quality Impairments/Stressors

Water quality impairments to ALU and Recreation beneficial uses are common in urban areas, as identified by the Ohio EPA. They are summarized as follows:

- Habitat modification resulting from changes in stream flow, removal of flood plains, and hydrological changes caused by dams, among others.
- Nutrient transport from impervious surfaces during precipitation events, leading to high loading events in streams.
- Increased erosion and sedimentation caused by impervious surfaces, culverts, and channelized streams.
- Bacteria transport to recreational areas during large stormwater flows, particularly in areas that experience CSO events.

Unfortunately, many of the most heavily degraded waterways in urban areas offer very little opportunity for natural environmental processes and services. The impacts are reflected in the ALU designation of "LRWs" which are found almost exclusively in urban settings.

5.5.2.3 Urban Needs

In urban areas, addressing issues requires different practices of varying scope and size. To tackle small scale needs in areas with high percentages of impervious surfaces, adoption of flow-reducing practices like onsite rainwater storage (rain barrels and rain gardens) is highly recommended to increase infiltration and reduce runoff flashiness, especially in headwaters. However, implementation of these practices can be challenging owing to the high number of private properties in urban areas and the financial constraints of many residents. Fortunately, some grants are available for implementing green urban structure enhancements like living walls and roofs, and pervious pavers. Additionally, landowners willing to install these practices may benefit from stormwater fee reduction. While the scale of implementation needed to reduce stormwater flow sufficient to

Urban rain garden.

maintain stable streams and protect water quality remains unclear, a study by the Cleveland Metroparks found that a pilot street in Parma, Ohio was able to cut stormwater flows by 45%, even with only 10% public participation in rain gardens.

One of the challenges specific to heavily urbanized watersheds is the scarcity of available wetland mitigation options. This becomes problematic when there are plans to remove wetlands within the watershed for other purposes, like development, but there are limited opportunities for creating new wetlands. In such scenarios, the required wetland mitigation credits or projects might need to be purchased from locations outside the watershed where the development is taking place, resulting in a discrepancy in the original plan to offset environmental concerns.

With the current threat of climate change, urban environments will be affected severely. Increased temperature, wave height and intensity on shorelines, and rainfall are already hindering the urban environment and are estimated to increase in the future. Utilizing climate resilient practices, such as resilient coast lines or tree canopy expansions can lessen the impact of climate change. This is particularly important in disadvantaged neighborhoods where tree canopy and green infrastructure are scarce. Funding for these neighborhoods is important in creating a more resilient urban landscape for the future climate.

Urban Best Management Practices	
Category	**Practice**
Reducing Stormwater Runoff	Filter Strips and Areas
	Grass Swales
	Infiltration Basins
	Permeable Pavers and Concrete
	Bioretention
	Disconnect Impervious surfaces
	Green Roofs
	Rain Barrels
	Urban Canopy Expansion and Preservation
	Dam Removal
	Daylighting streams
	Sediment Basins and Traps
Passive Stormwater Treatment	Wetlands
	Rain Gardens
	Riparian Buffers
	Low Impact Development
	Vernal Pools, Baffles, Riffles
	Flood Plain Reconnection

Table 24. Applicable Urban Best Management Practices.

The region has a pressing need to reduce impervious surfaces and restore environmental services offered by riparian and aquatic habitats. However, a significant obstacle to such initiatives is the lack of adequate funding options. Removing existing pavement to facilitate urban canopy expansion projects, for instance, proves difficult due to insufficient resources. In addition, stream restoration projects that don't require easements or land acquisition face funding challenges. Though conservation easements are useful in ensuring that implemented practices are maintained and functional, they limit private landowner adoption. Similarly, the cooperation required to achieve the greater needs of a watershed may be difficult to attain, especially upstream of acute impacts, where invasive pests and plant species may be a bigger issue. In such situations, education and public involvement are imperative. Many urban streams are highly or completely culverted. The effort to "daylight" or uncover these streams is an intensive process and does not guarantee success for recovering aquatic life. Nevertheless, this is an important step in urban recovery of environmental services.

5.5.2.4 Municipal Separate Storm Sewer System Program

The MS4 program, overseen by the U.S. EPA, is a permit-based system enforced at the state level by the Ohio EPA. It focuses on controlling sediment runoff from active and completed construction sites in urban areas through six Minimum Control Measures (MCM): public education, public involvement, illicit discharge detection, construction site stormwater runoff control, post-construction management, and good housekeeping.

Many SWCDs have taken on a significant role in ensuring the success of the MS4 program. Districts can assume responsibility for some or all of the MCMs for both county and individual municipality MS4s. The SWCD Urban Networking Committee conducted a survey of all 88 districts in Ohio in 2022 to gather valuable information about their involvement in the MS4 program. Figures 23-26 below are selected findings from the survey.

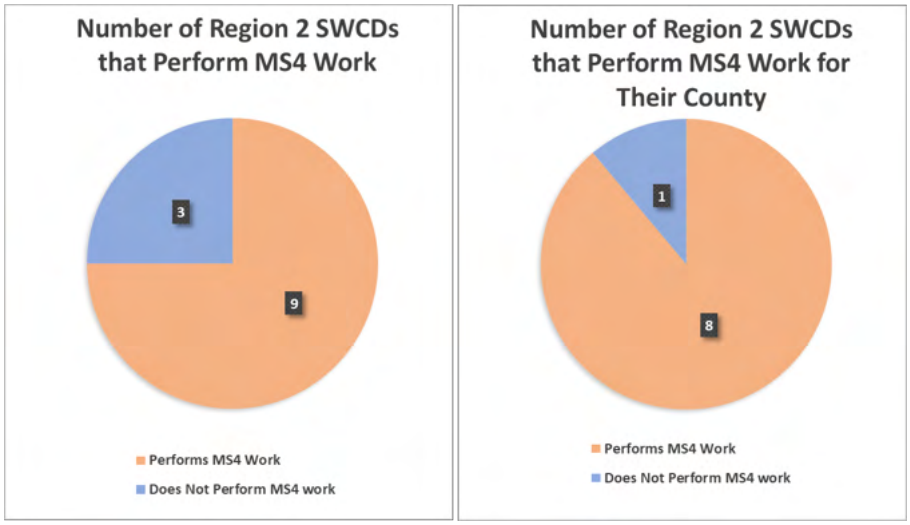


Figure 23. SWCD engagement with MS4 program work. (Ohio Federation of Soil and Water Conservation Districts, Urban Networking Committee, 2023)

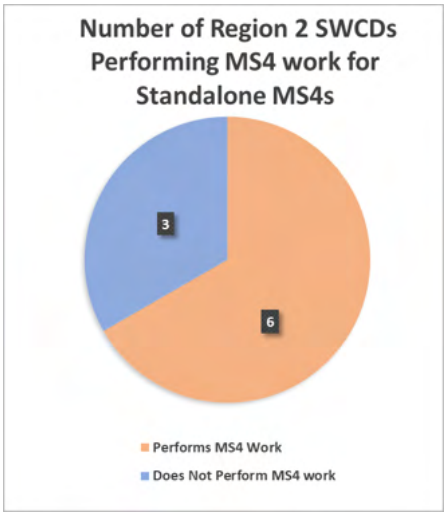


Figure 24. Percent of Region 2 SWCDs performing MS4 work for standalone MS4s. (Ohio Federation of Soil and Water Conservation Districts, Urban Networking Committee, 2023)

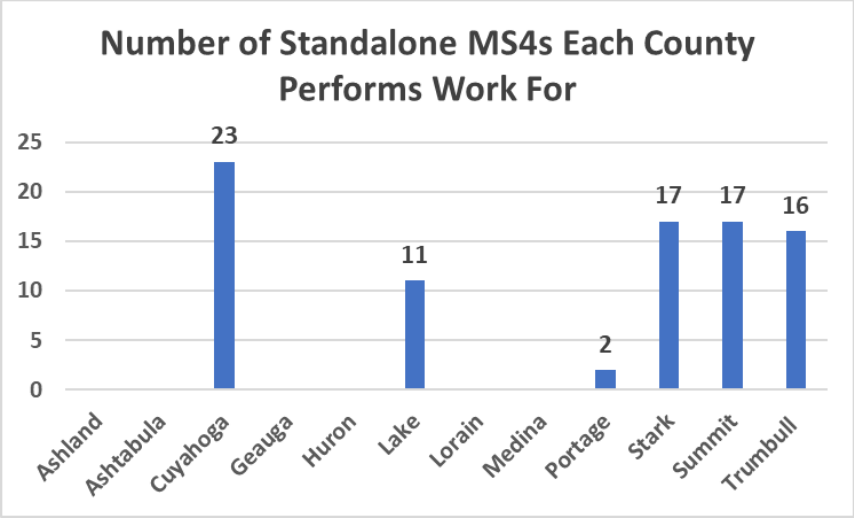


Figure 25. Number of standalone MS4s each county performs work for. (Ohio Federation of Soil and Water Conservation Districts, Urban Networking Committee, 2023)

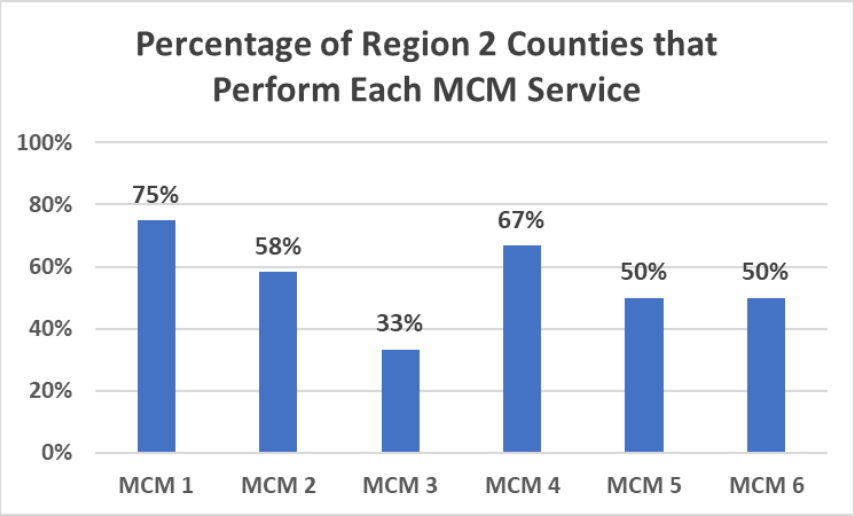


Figure 26. Percentage of Region 2 counties that perform each MCM service. (Ohio Federation of Soil and Water Conservation Districts, Urban Networking Committee, 2023)

5.5.2.5 Goals and High-Level Priorities

The challenges faced in urban watersheds are varied and numerous, spanning from inadequate funding to limited space for project implementation. While stakeholder objectives may vary, commonalities do exist. Across different scales, land acquisition remains a pressing concern.

Securing funding for extensive wetlands or stream restoration initiatives is challenging, as many landowners are unwilling to grant easements on their property or are willing and lack technical support. Moreover, funding sources do not typically cover the cost of buying the required land. On a smaller scale, private landowners are hesitant to adopt stormwater retention measures like rain barrels and rain gardens due to maintenance needs and lack of motivation. Cost sharing programs have been suggested to encourage landowners to implement and maintain these methods, allowing them to retain ownership

of the land. Such programs may serve as “foot-in-the-door” allowing landowners to participate while helping to evaluate the maintenance and impact of the practices.

Wetland mitigation projects may be compulsory under state and federal law; however, finding a suitable location for these projects in highly developed watersheds poses a challenge. Although wetland mitigation is an effective method of preserving water retention and treatment, relocating such projects to other watersheds, rather than the one where the wetlands were disturbed, accelerates the degradation of the initial watershed's stormwater retention capabilities. To address this issue, local organizations in such watersheds wish to mitigate degraded wetlands by implementing stormwater retrofits or practices as surrogates. Stakeholders suggest development of financial assistance programs for such projects would bring significant benefits, increase the range solutions, and provide flexibility for problem solving in Ohio’s highly complex urban watersheds.

Bioretention cell.

6. Implementation and Outreach

The following outline highlights the efforts of the ODA Watershed Team to coordinate and organize education and outreach regionally and statewide.

6.1 Plan Dissemination & Use

The ODA watershed team will undertake strategic outreach with key partners to provide information on how to utilize regional watershed plans. These include:

- Regional watershed plan overview for SWCD boards/other partner leadership
    - Review of plan contents – characterization/priority BMPs
    - How to use the plan for NPS-IS grant proposals, project development and implementation
- Regional watershed plan overview at conferences and regular meetings
- Develop companion web resources to provide and maintain up-to-date information

6.1.1 Ongoing Education & Coordination

ODA strategically structured this planning process to engage a cohort of partners, experts, and stakeholders, not only to ensure the robustness of content, but to facilitate a larger mutual understanding of a complex and unique watershed. A strong network of people and institutions is a valued asset as the ODA Watershed Team advances with regional program development, implementation, and local assistance.

Watershed Managers will coordinate outreach and education through existing regional networks (SWCDs, TATs, and other stakeholders). Areas of focus will include messaging related to top regional ALU impairments, and highlighting resources available to implement regionally applicable management measures. Such resources will largely consist of USDA programs, U.S. EPA 319 Clean Water Act grants, H2Ohio, and other regional opportunities.

6.1.2 Project/Grant Development, NPS-IS Planning

Watershed staff will assist SWCD staff and other local entities to support project implementation. This includes providing assistance in the development of NPS-IS plans, as well as identifying and applying for available funding opportunities.

- NPS-IS development and related topics through cohort facilitation.

  Watershed managers will invite SWCD and partner staff to work sequentially through the NPS-IS planning process as a group. Much like the regional planning process, this group process will reinforce common learning, group cohesion, mutual support all while efficiently producing several state-endorsed NPS-IS throughout Ohio each cycle.

  This network of local planners assisted by the ODA watershed management team will also serve as an effective network for communicating aligned project implementation funding opportunities.

  A facilitated group learning approach will also provide opportunities for statewide skill development with new watershed management tools and models, e.g., Agricultural Conservation Planning Framework and Pollutant Load Estimation Tool.

- Integration of local watershed planning training into existing education programs.

  Technical Development Program: The ODA Technical Development Program (TDP) has been satisfying the technical training needs for a dynamic community of Ohio conservation professionals since 2003. TDP provides hands-on instruction of engineering fundamentals and conservation practice design in accordance with the policies and procedures of the Ohio USDA-NRCS on a statewide basis.

  ODA watershed managers will coordinate internally with technical staff to develop new training modules and videos as an outgrowth of the NPS-IS development facilitated group process described above and input from SWCDs and partners.

6.1.3 Topical Training Needs

In addition to training related to regional and local planning and program development, the ODA Watershed Team will develop and provide trainings on topics related to general nonpoint source pollution reduction methods, tools, and resources. Training opportunities will initially be provided to

SWCDS and partners on a quarterly basis with each watershed manager providing training opportunities every six months and statewide trainings developed by the full team in alternating quarters.

Such trainings may be offered in conjunction with annual conferences and similar events sponsored by public agencies, NGOs, academic institutions, and others. These include but are not limited to:

Appalachian Ohio Watershed Coalition regular meetings
Central Lake Erie Basin Collaborative regular meetings
Conservation Tillage and Technology Conference
Ohio Federation of Soil and Water Conservation Districts Conservation Annual Partnership Meeting and Summer Supervisor School
Ohio Stormwater Conference
Ohio Watershed Academy and Network
Ohio Watershed Leaders Conference
Water Management Association of Ohio Annual Meeting and Symposium

The ODA watershed managers will also develop web resources to share topical information and trainings offered by SWCDs and other regional partners. In addition, regular coordination with partners and stakeholders will in part focus on team building and aggregation of regional training needs.

6.1.4 Development of New Regional Programs

In addition to providing assistance to develop and implement existing projects, watershed staff will seek to identify strategic opportunities for new regional-scale conservation programming. Areas of opportunity aligned with regional water quality priorities, and not currently being addressed through Federal, State or local programs will be highlighted, and efforts will be made to develop programming to meet the needs. This may be done in collaboration with other Federal, State, or local partners as appropriate.

7. Appendices

Appendix A. Soil and Water Conservation District and Technical Assistance Team Members

Region 2 Soil and Water Conservation District and Technical Assistance Team Members		
Name	**Organization**	**Group (SWCD/TAT)**
Alan Atkins	NRCS	TAT
Amy Holtshouse	The Nature Conservancy	TAT
Bill Zawiski	Ohio EPA	TAT
Derek Schafer	West Creek Conservancy	TAT
Scott Hardy	Ohio Sea Grant	TAT
Heather Elmer	Chagrin River Watershed Partners & Central Lake Erie Basin Collaborative	TAT
Jeff Hayes	ODNR	TAT
Jennifer Grieser	Cleveland Metroparks	TAT
John Kehn	ODNR	TAT
John Kaiser	ODNR	TAT
Josh Griffin	Ohio EPA	TAT
Keith McClintock	NEORSD	TAT
Kim Brewster-Sheffleton	Chagrin River Watershed Partners & Central Lake Erie Basin Collaborative	TAT
Mark Smith	NRCS	TAT
Pam Davis	NOACA	TAT
Sandra Kosek Sills	Ohio Lake Erie Commission	TAT
Steve Holland	ODNR	TAT
Tori Mills	Doan Brook Partnership	TAT
Tanja Williamson	USGS	TAT
Abby Costilow	Medina	SWCD
Anthony Lerch	Portage	SWCD
Nate Paskey	Ashtabula	SWCD
Suzanne Westlake	Ashtabula	SWCD
Stephanie Deibel	Summit	SWCD
Dan Donaldson	Lake	SWCD
Eric Hange	Medina	SWCD
Jared Bartley	Cuyahoga	SWCD
Kairsten Nitsch	Cuyahoga	SWCD
Kate Chapel	Cuyahoga	SWCD
Lynn Vogel	Portage	SWCD
Meg Hennessey	Cuyahoga	SWCD
Maurine Orndorff	Lake	SWCD
Nichole Lopez	Summit	SWCD
Caitlin Ormsby	Lake	SWCD
Brian Prunty	Summit	SWCD

Appendix B. 2017 Animal Units by County

2017 Statewide, County-level Animal Population by Animal Units										
County	Total Cattle minus Dairy	Dairy	Hogs	Broilers	Layers	Pullets	Turkeys	Equine	Sheep & Goats	Total Animal Units
Adams	25,288	2,527	398	7	40	1	1	2,090	220	30,573
Allen	5,809	293	71,512	2	4,936	5	D	1,018	158	83,733
Ashland	19,806	9,911	9,797	3,983	4,232	1,894	2	3,482	409	53,516
Ashtabula	7,581	5,744	270	7	69	4	1	3,784	189	17,649
Athens	9,638	458	128	5	34	3	2	2,146	400	12,813
Auglaize	20,435	8,596	44,054	0	3,869	3,041	D	478	121	80,594
Belmont	18,535	1,077	38	27	40	3	1	1,646	279	21,646
Brown	14,310	844	168	3	43	2	1	2,112	101	17,583
Butler	10,370	466	5,706	8	44	4	37	3,206	201	20,041
Carroll	13,295	4,320	84	1,320	33	D	1	2,212	267	21,534
Champaign	7,515	1,581	10,285	22	52	3	1	1,590	176	21,225
Clark	10,107	6,020	7,304	9	1,286	1	2	1,678	132	26,539
Clermont	4,843	24	115	3	89	14	2	4,024	174	9,286
Clinton	4,618	77	6,367	6	24	4	D	1,508	234	12,839
Columbiana	20,555	12,236	2,240	6,056	295	D	2	3,290	232	44,904
Coshocton	18,176	4,532	28,231	7,198	923	5	2	3,688	483	63,238
Crawford	6,780	2,393	51,508	1	514	D	0	554	67	61,816
Cuyahoga	18	X	10	X	6	1	X	2,100	2	2,137
Darke	32,187	12,006	96,078	105	122,303	49,616	13,325	1,592	175	327,388
Defiance	4,829	6,546	5,575	2	48,945	D	0	472	97	66,467
Delaware	2,383	447	1,461	D	33	7	2	2,704	221	7,258
Erie	3,896	305	34	D	11	D	D	910	54	5,209
Fairfield	11,062	1,102	7,841	5	56	6	4	2,380	278	22,735
Fayette	2,719	4,159	2,304	5	13	1	0	1,222	203	10,626
Franklin	773	X	499	4	33	1	D	1,328	148	2,786
Fulton	25,955	4,108	6,078	3	22	1	1	952	122	37,243
Gallia	18,141	164	267	3	200	2	1	2,418	307	21,502
Geauga	7,476	4,533	540	23	98	8	11	7,730	213	20,630
Greene	4,812	1,043	13,407	10	52	7	3	1,934	162	21,429
Guernsey	18,304	727	2,802	5	29	2	1	2,120	227	24,216
Hamilton	671	442	19	D	14	4	D	2,446	49	3,645
Hancock	2,151	1,425	17,842	4	280	1	1	1,352	188	23,244
Hardin	8,711	13,223	27,590	6	34,012	15,075	1	1,084	89	99,791
Harrison	12,717	368	158	2,623	24	1	1	1,494	272	17,659
Henry	5,522	2,712	4,155	0	7	0	2	490	35	12,923
Highland	22,054	2,762	6,166	4	86	3	1	2,678	469	34,223
Hocking	2,189	18	52	2	29	4	1	668	70	3,033
Holmes	32,295	24,245	1,784	24,445	4,512	1,269	4	15,852	801	105,207
Huron	12,129	4,152	5,128	7,546	2,344	3	1	1,516	306	33,126
Jackson	10,529	395	70	0	15	D	D	1,318	57	12,383
Jefferson	8,231	371	116	D	29	1	0	2,086	111	10,946
Knox	18,540	4,785	13,762	13,556	336	2,261	4	4,504	947	58,695
Lake	523	171	29	D	20	D	D	808	22	1,573

Lawrence	5,443	95	55	1	22	1	0	914	98	6,629
Licking	16,426	6,555	9,831	29	121,320	23,244	6	4,628	490	182,528
Logan	8,658	4,773	6,765	9	21,410	3,760	4	2,262	383	48,023
Lorain	5,491	2,391	4,466	7	48	3	1	3,188	147	15,742
Lucas	269	X	3,573	4	20	5	2	1,024	49	#VALUE!
Madison	2,413	10,028	9,495	8	19	2	0	1,612	98	23,675
Mahoning	5,360	10,655	219	9,131	59	8	8	2,928	142	28,511
Marion	2,525	6,580	35,400	5	20	2	D	564	170	45,265
Medina	5,592	2,871	321	28	96	11	12	5,152	207	14,291
Meigs	9,228	736	227	2	87	1	1	1,018	75	11,374
Mercer	60,317	24,486	126,816	D	119,537	15,464	33,947	664	173	381,403
Miami	4,864	1,868	5,328	28	57	3	D	1,260	265	13,672
Monroe	11,998	1,001	87	D	31	3	3	1,768	387	15,279
Montgomery	7,315	370	2,494	7	69	2	28	2,064	68	12,416
Morgan	12,879	1,390	1,972	1	36	4	1	786	131	17,199
Morrow	7,170	2,208	6,480	8	51	D	3	2,636	448	19,003
Muskingum	25,704	1,474	6,445	12,050	597	4	3	4,052	427	50,757
Noble	10,257	62	27	2	20	3	1	1,408	326	12,105
Ottawa	5,824	X	1,920	X	13	X	X	604	27	8,388
Paulding	X	18,406	24,507	D	11	D	D	318	89	43,331
Perry	10,058	213	6,413	7	39	8	3	868	194	17,802
Pickaway	9,000	4,018	3,187	5	17	1	3	1,360	155	17,746
Pike	6,686	525	1,613	4	23	4	1	1,156	89	10,101
Portage	5,981	1,949	236	53	85	8	16	5,270	221	13,819
Preble	19,114	1,567	13,499	3	1,066	2	1	1,596	272	37,120
Putnam	16,142	6,975	47,604	1	1,242	D	D	312	207	72,483
Richland	16,615	11,676	31,453	2,818	4,530	247	2	3,178	199	70,718
Ross	13,422	2,173	191	6	296	3	1	1,780	198	18,070
Sandusky	4,006	1,442	2,196	2	20	3	1	748	94	8,511
Scioto	8,291	430	111	26	5,490	2	1	1,954	73	16,377
Seneca	6,157	507	16,252	10	53	2	D	554	324	23,859
Shelby	26,986	10,802	29,264	18	1,312	1	D	526	95	69,004
Stark	14,802	10,655	1,320	2,891	3,285	931	8	3,418	272	37,581
Summit	464	304	41	3	67	3	12	1,624	58	2,576
Trumbull	7,405	3,850	157	1,200	66	3	4	3,010	88	15,782
Tuscarawas	24,119	12,747	2,485	14,261	70	D	2	4,402	355	58,441
Union	9,562	2,722	12,798	2	32,348	2,752	1	2,252	247	62,683
Van Wert	10,196	7,466	30,567	3	32,387	D	648	458	80	81,804
Vinton	2,981	80	31	0	5	D	0	676	19	3,793
Warren	4,121	17	1,653	13	108	4	4	4,370	123	10,412
Washington	18,952	3,048	917	1	38	3	1	2,732	223	25,915
Wayne	55,571	47,281	31,186	21,109	4,362	D	2	9,772	999	170,283
Williams	10,340	8,820	7,077	D	20	2	D	830	183	27,272
Wood	3,132	6,944	389	3	15,326	D	1	1,194	131	27,121
Wyandot	3,182	2,652	21,623	1	28,581	1	D	582	140	56,761

Appendix C. 2017 Livestock Numbers by County

2017 Statewide, county-level animal populations.									
County	**Total Cattle minus Dairy**	**Dairy**	**Hogs**	**Broilers**	**Layers**	**Pullets**	**Turkeys**	**Equine**	**Sheep and Goats**
Adams	25288	1805	996	914	3265	169	57	1045	2203
Allen	5809	209	178781	236	404616	572	(D)	509	1584
Ashland	19806	7079	24493	497912	346862	236737	118	1741	4090
Ashtabula	7581	4103	676	843	5615	500	57	1892	1888
Athens	9638	327	319	599	2761	385	88	1073	4000
Auglaize	20435	6140	110134	42	317151	380090	(D)	239	1214
Belmont	18,535	769	95	3437	3319	317	44	823	2,786
Brown	14,310	603	419	392	3,515	191	40	1,056	1,005
Butler	10,370	333	14,264	943	3,642	458	2,072	1,603	2,006
Carroll	13,295	3,086	211	165000	2703	(D)	76	1,106	2,674
Champaign	7,515	1,129	25,712	2770	4298	402	45	795	1,764
Clark	10,107	4,300	18,259	1128	105398	137	107	839	1,324
Clermont	4,843	17	288	318	7,262	1,697	109	2,012	1,736
Clinton	4,618	55	15,918	761	1994	492	(D)	754	2,342
Columbiana	20555	8,740	5,599	756959	24143	(D)	90	1645	2318
Coshocton	18176	3,237	70,578	899730	75661	580	130	1844	4828
Crawford	6780	1,709	128,770	104	42114	(D)	8	277	668
Cuyahoga	18	X	24	X	519	176	X	1050	15
Darke	32,187	8,576	240,196	13,173	10,024,862	6,201,944	740,259	796	1,748
Defiance	4829	4676	13938	200	4,011,864	(D)	12	236	974
Delaware	2,383	319	3,652	(D)	2714	840	134	1,352	2,211
Erie	3,896	218	85	(D)	877	(D)	(D)	455	535
Fairfield	11062	787	19,603	662	4610	735	241	1190	2780
Fayette	2719	2971	5760	610	1067	120	16	611	2025
Franklin	773	X	1247	476	2722	111	(D)	664	1481
Fulton	25955	2934	15196	435	1812	120	42	476	1222
Gallia	18141	117	668	313	16355	262	41	1209	3070
Geauga	7476	3238	1349	2849	7994	951	589	3865	2127
Greene	4812	745	33517	1193	4291	833	164	967	1618
Guernsey	18304	519	7,005	570	2351	298	43	1060	2272
Hamilton	671	316	48	(D)	1145	446	(D)	1223	489
Hancock	2151	1018	44604	537	22957	92	31	676	1884
Hardin	8711	9445	68974	702	2787878	1884400	64	542	892
Harrison	12717	263	396	327896	1,954	178	44	747	2719
Henry	5522	1937	10387	30	592	38	112	245	346
Highland	22054	1973	15415	471	7037	350	33	1339	4693
Hocking	2189	13	130	266	2351	456	75	334	700
Holmes	32,295	17,318	4,461	3055593	369,844	158,595	247	7,926	8,006
Huron	12129	2966	12821	943273	192160	413	35	758	3062
Jackson	10529	282	174	16	1207	(D)	X	659	567
Jefferson	8231	265	291	(D)	2366	124	25	1043	1108
Knox	18540	3,418	34,406	1,694,442	27,530	282,569	197	2,252	9,474
Lake	523	122	72	(D)	1666	(D)	(D)	404	218
Lawrence	5443	68	138	76	1838	78	7	457	980

Licking	16426	4,682	24,578	3606	9944243	2905464	350	2314	4895
Logan	8,658	3,409	16,913	1,130	1,754,910	470,000	200	1,131	3,825
Lorain	5,491	1,708	11,166	855	3,905	388	36	1,594	1,467
Lucas	269	X	8,932	536	1,652	625	130	512	485
Madison	2,413	7,163	23,737	1,043	1,522	308	12	806	975
Mahoning	5,360	7,611	548	1,141,410	4,838	996	472	1,464	1,415
Marion	2,525	4,700	88,499	673	1,614	210	(D)	282	1,695
Medina	5,592	2,051	802	3,496	7,875	1,409	654	2,576	2,074
Meigs	9,228	526	567	240	7,125	136	36	509	745
Mercer	60,317	17,490	317,040	(D)	9,798,085	1,932,967	1,885,956	332	1,726
Miami	4,864	1,334	13,320	3,552	4,656	325	(D)	630	2,646
Monroe	11998	715	217	(D)	2563	407	169	884	3873
Montgomery	7,315	264	6,234	875	5,658	239	1,536	1,032	681
Morgan	12879	993	4,930	111	2956	455	34	393	1307
Morrow	7170	1,577	16,200	951	4151	D	148	1318	4484
Muskingum	25704	1,053	16,113	1,506,304	48,962	493	170	2,026	4,270
Noble	10257	44	67	262	1635	324	38	704	3262
Ottawa	5824	X	4800	X	1030	X	X	302	274
Paulding	X	13147	61268	(D)	921	(D)	(D)	159	886
Perry	10058	152	16,032	830	3179	948	186	434	1939
Pickaway	9000	2870	7968	610	1397	140	141	680	1551
Pike	6686	375	4032	506	1890	468	79	578	887
Portage	5,981	1,392	591	6635	6980	1044	876	2635	2205
Preble	19,114	1,119	33,747	377	87,397	282	33	798	2,724
Putnam	16142	4982	119011	120	101768	(D)	(D)	156	2072
Richland	16615	8,340	78,633	352236	371292	30840	102	1589	1993
Ross	13422	1552	478	705	24271	416	46	890	1978
Sandusky	4006	1030	5489	300	1619	342	35	374	941
Scioto	8291	307	278	3273	450000	223	41	977	725
Seneca	6157	362	40630	1275	4328	297	(D)	277	3240
Shelby	26986	7716	73160	2260	107563	83	(D)	263	947
Stark	14,802	7,611	3,300	361,324	269,243	116,320	426	1,709	2,721
Summit	464	217	102	430	5,492	337	692	812	580
Trumbull	7,405	2,750	393	150,000	5,371	382	198	1,505	878
Tuscarawas	24,119	9,105	6,212	1,782,568	5,758	(D)	113	2,201	3,554
Union	9562	1944	31995	206	2,651,500	344,000	29	1126	2470
Van Wert	10,196	5,333	76417	322	2,654,648	(D)	36000	229	795
Vinton	2,981	57	78	62	439	(D)	24	338	188
Warren	4,121	12	4,133	1,663	8,819	449	219	2,185	1,226
Washington	18,952	2,177	2,293	133	3,116	360	57	1,366	2,232
Wayne	55,571	33,772	77,965	2,638,660	357,563	D	119	4,886	9,992
Williams	10340	6300	17693	(D)	1627	271	(D)	415	1830
Wood	3132	4960	973	409	1256191	(D)	79	597	1314
Wyandot	3182	1894	54058	70	2342683	68	(D)	291	1400

Appendix D. Livestock Calculation Methodology

Livestock Estimate Methodology

I. For species whose NASS data is "all or nothing" (i.e. no "number of farms" and associated animal "inventory ranges")(this category includes: ***pullets, broilers, turkeys, horses and ponies, sheep and goats***):
   a. If NASS data is present, and DLEP data is absent → use NASS data
      (EXAMPLE: ALLEN_SWINE = 178,781)
   b. If NASS data is present, and DLEP data is present:
      i. NASS # > DLEP # → use NASS
      (EXAMPLE: ASHLAND SWINE = 24,493.... [DLEP REPORTS 3986])
      ii. NASS # < DLEP # → use DLEP
      (EXAMPLE: PAULDING SWINE = 78,969... [NASS REPORTS 61,268])
   c. If NASS data is withheld, and DLEP data is absent → use "X"
      (EXAMPLE: ALLEN TURKEYS = X)
   d. If NASS data is withheld, and DLEP data is present → Use DLEP data
      (EXAMPLE: PUTNAM TURKEYS = 74,000)

II. *For species whose NASS data is broken out by "number of operations" and associated animal inventory ranges (this includes ***"cattle including calves", "milk cows", "hogs", "layers"***):
   a. If NASS "Total Inventory" data is present, and DLEP data is absent → use NASS data
      (EXAMPLE: HENRY SWINE = 10,387)
   b. If NASS "Total Inventory" data is present and DLEP data is present:
      i. if NASS # > DLEP # → use NASS
      (EXAMPLE: CRAWFORD SWINE = 128,770... [DLEP REPORTS 20522])
      ii. if NASS # < DLEP # → use DLEP
      (*EXAMPLE: DEFIANCE SWINE = 21,825..... [NASS REPORTS 13,938]*)
   c. If NASS "Total Inventory" data is withheld, and DLEP data is absent → Use "maximum value estimations", by summing each inventory range row, i.e. : sum = [(number of operations) x (maximum value in range), for each range, and then sum all ranges to get inventory for this species]. If an inventory range row does report actual inventory (not just "number of operations"), use that number for the row.
      EXAMPLE ALLEN 'Milk Cows' = [(10 'milk cows' reported for operations with 1 to 9 cows each) + (1 operation reported with 100-199 cows each) so in total our estimate is: [10 + 1(199)] = 209 'Milk Cows'
   d. If NASS "Total Inventory" data is withheld, and DLEP data is present → use DLEP

*In the ODA Report, *"Dairy"* = the NASS category *"Milk cows"*. However, *"Total Cattle Minus Dairy"* is a calculated category used in this ODA-DSWC Report that does not directly correlate to any one NASS category. It is based on the following function: *'Total Cattle minus $dairy_{ODA\text{-}DSWC}$" = 'Total Cattle, Incl. $Calves_{NASS}$' – 'Milk $cows_{NASS}$'*... Order of operations requires *'Milk Cows'* number to be determined before calculating *'Total Cattle Minus $Dairy_{ODA\text{-}DSWC}$"*. If NASS *'Milk cows'* data falls into category "II.c.", or "II.d." above, the *"NASS max estimate"* or "DLEP data", respectively, must be used as the final "*$Dairy_{ODA\text{-}DSWC}$*" number, and also to calculate *"Total Cattle Minus $Dairy_{ODA\text{-}DSWC}$"*.

Appendix E. SWCD Survey Instrument

Survey of Agricultural Conservation Practice Implementation

As part of Regional Watershed Plan development, the ODA Watershed Program would like to establish a baseline estimate of conservation practice implementation in your county based on your expert opinion. This estimate is for all agricultural producers, not only those formally participating in conservation programs. Please keep this in mind as you fill out the survey. If a question is not applicable for your county use the N/A where available.

1. Which county do you work in?
2. What is the most common farm size in your county? (acres)
3. Describe the main topography of farms within your county.
    a. Slope 0-2%
    b. Slope 2-6%
    c. Slope 6-12%
    d. Slope 12-18%
    e. Other
4. What percentage of fields in your county are believed to contain any artificial tile?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A
5. What percentage of floodplain land is utilized for row crop agriculture?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A
6. What percentage of floodplain land is utilized for pastured agriculture?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Most Fields >75%
    e. N/A
7. Which size farm would be the most important for future program outreach?
    a. Small/Hobby Farms
    b. Medium Sized Farms
    c. Large commodity Production Farms

7a. Why is the farm size selected in question 7 most important to future program outreach?

8. Are resources available to write voluntary nutrient management plans in your county?
    a. Yes
    b. No

8a. If yes, explain what resources are available.

9. What percentage of fields in your county utilize continuous no-till farming?
    a. Few to none
    b. Approximately 25%

c. Approximately 50%
d. Approximately 75%
e. Most Fields >75%
f. N/A

10. What percentage of fields in your county utilize conventional tillage farming (plowing or intensive "numerous" tillage trips)?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A
11. What is the most common crop rotation? (Include hay)
12. What percentage of fields in your county have buffers or filter strips (minimum width of 30 feet of permanent vegetation) along water bodies.
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A
13. What percentage of fields are believed to be following a Nutrient Management Plan or Soil Test Recommendations that meet Tri-State Guidelines?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A
14. What percentage of fields utilize cover crops?
    a. Few to none
    b. Approximately 10%
    c. Approximately 20%
    d. Approximately 30%
    e. Most Fields 40%
    f. 50% or more
    g. N/A
15. What percentage of fields utilize variable rate fertilizer technology (VRT)?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A

15b. If the percentage of fields which utilize VRT in question 15 is 25% or below: Are there resources available to implement VRT in your county (including access to new technologies and equipment and service providers)?

16. What percentage of fields receiving manure have the manure incorporated within 24 hours?

a. Few to none
b. Approximately 25%
c. Approximately 50%
d. Approximately 75%
e. Most Fields >75%
f. N/A

17. What percentage of fields utilize subsurface nutrient application of non-manure fertilizer?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A
18. What percentage of cropping operations have a combination of livestock as well?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most Fields >75%
    f. N/A
19. What is the most common number of pasture-based livestock per farm in your county? a. 1-9
    b. 10-19
    c. 20-49
    d. 50-99
    e. 100-199
    f. 200-499
    g. 500+
    h. N/A
20. What percentage of livestock operations have an up-to-date comprehensive nutrient management plan (CNMP)?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most operations >75%
    f. N/A
21. What percentage of livestock operations have a grazing management plan?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most operations >75%
    f. N/A
22. What percentage of pastures have up to date soil tests?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%

   d. Approximately 75%
   e. Most Pastures >75%
   f. N/A
23. What percentage of pastures are fertilized as needed?
   a. Few to none
   b. Approximately 25%
   c. Approximately 50%
   d. Approximately 75%
   e. Most Pastures >75%
   f. N/A
24. What is the most common way in which winter feeding is managed?
   a. Barn
   b. Heavy Use Pad
   c. Sacrifice Area
   d. Stockpile Grazing
   e. N/A
25. What is the main type of watering system being used in your county?
   a. Open Stream Access
   b. Protected Stream Access
   c. Pressurized Waterers
   d. Spring Development
   e. N/A
   f. Other
26. What is the average frequency of rotation through paddocks and pastures?
   a. <24 Hours
   b. 1-3 days
   c. 4-7 days
   d. Continuous
   e. N/A
27. On average, what are the months which livestock are grazed?
28. What percentage of livestock operations have livestock excluded from waterways?
   a. Few to none
   b. Approximately 25%
   c. Approximately 50%
   d. Approximately 75%
   e. Most Operations >75%
   f. N/A
29. What percentage of livestock in the county is confined and NOT grazed on a pasture?
   a. Few to none
   b. Approximately 25%
   c. Approximately 50%
   d. Approximately 75%
   e. Most livestock >75%
   f. N/A
30. What are the main types of confined/feedlot livestock species?
31. Does the standard confined/feedlot-based operation have enough manure storage to comply with winter spreading recommendations?

a. Yes
b. No
c. Maybe
d. N/A

32. What percentage of feedlots are covered?
    a. Few to none
    b. Approximately 25%
    c. Approximately 50%
    d. Approximately 75%
    e. Most feedlots >75%
    f. N/A
33. If silage is stored on the farm are leachate prevention measures taken or installed?
    a. Yes
    b. No
    c. N/A

Appendix F. Grouped Impairments from Ohio EPA Integrated Report

Parameter Causing Impairment (Code as listed in IR)	Parameter Causing Impairment (Code as listed in Regional Watershed Plan after Consolidations)
ALTERATION IN STREAM-SIDE OR LITTORAL VEGETATIVE COVERS	HABITAT ALTERATION
FLOW REGIME MODIFICATION	
HABITAT ALTERATIONS	
AMMONIA	NUTRIENTS
NITRATE	
NITRATE/NITRITE (NITRITE + NITRATE AS N)	
NITROGEN, NITRATE	
NUTRIENT/EUTROPHICATION BIOLOGICAL INDICATORS	
NUTRIENTS	
PHOSPHORUS, TOTAL	
ORGANIC ENRICHMENT	ORGANIC ENRICHMENT
ORGANICS	
SEDIMENTATION/SILTATION	SEDIMENTATION
SILTATION	

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