MACATAWA WATERSHED MANAGEMENT PLAN

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Submitted by
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Acknowledgements

The ODC Network led the effort to update the Macatawa Watershed Management Plan, but the completion of this document was only possible with the contributions of the partners identified below.

- Ottawa Conservation District: Ben Jordan, Sarah Bowman, Natalie Bekins
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Land Acknowledgement Statement

The Macatawa Watershed is situated within the ancestral and traditional homelands of the Three Fires Confederacy of Bodewadmi (Potawatomi), Odawa (Ottawa), and Ojibwe (Chippewa) peoples. As partners in the conservation, restoration, and protection of the Macatawa Watershed, we want to recognize the sovereignty and resilience of all Indigenous caretakers who have survived and stewarded this land throughout the generations.

The Macatawa River, previously known as the Black River, was used for trapping furs and as an Indigenous settlement. In the mid-19th century, the Dutch settlers came into the Macatawa watershed area. The watershed is an interconnected, storied landscape that has been heavily modified since the Dutch settlers arrived.

In our efforts to restore the watershed to a healthy state, we acknowledge the effects of displacement that are entrenched in the land, water, ecologies, and cultures of this place. We want to offer this acknowledgement with positive intent to honor our living relationships with the People of the Three Fires. In this way, future generations can be better informed of their traditions and way of life.

LIST OF ACRONYMS

ACDC	Allegan County Drain Commission
ACHD	Allegan County Health Department
ACPF	Agricultural Conservation Planning Framework
ACRC	Allegan County Road Commission
ACD	Allegan Conservation District
ACS	American Community Survey
AFO	Animal Farm Operation
AUID	Assessment Unit Identification
AWRI	Annis Water Resources Institute at Grand Valley State University
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CDs	Conservation Districts
CDC	County Drain Commissioner
CFU	Colony Forming Unit
CMI	Clean Michigan Initiative
CNMP	Comprehensive Nutrient Management Plan
CW	Cold Water
CWA	Clean Water Act
DO	Dissolved Oxygen
DNR	Department of Natural Resources
DDT	Dichloro-diphenyl-trichlorethane
E. coli	Escherichia coli
EGLE	Michigan Department of Environment, Great Lakes, and Energy
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps
ft	foot or feet
GAAMPs	Generally Accepted Agricultural Management Practices
GIS	Geographic Information System
GLRI	Great Lakes Restoration Initiative
GPS	Global Positioning System
GSI	Green Stormwater Infrastructure
GVSU	Grand Valley State University
GWRI	Global Water Research Institute
HUC	Hydrologic Unit Code
I&E	Information and Education
lb.	pound
IDEP	Illicit Discharge Elimination Programs
IWR	Institute of Water Research
L	Liter

LiDAR	Light Detection and Ranging
LIAA	Land Information Access Association
LLFWA	Landscape Level Functional Wetland Assessment
I&E	Information and Education
m	Meters
MACC	Macatawa Area Coordinating Council
MAEAP	Michigan Agricultural Environmental Assurance Program
MDARD	Michigan Department of Agriculture and Rural Development
MDEQ	Michigan Department of Environmental Quality
MDPH	Michigan Department of Public Health
mg	Milligrams
mg/L	Milligrams per Liter
MiCorps	Michigan Clean Water Corps
mL	Milliliters
MRG	Macatawa River Greenway
MST	Microbial Source Tracking
MSU	Michigan State University
MSUE	Michigan State University - Extension
MS4	Municipal Separate Storm Sewer System
MWMP	Macatawa Watershed Management Plan
N	Nitrogen
NASS	National Agricultural Statistical Service
NH3-N	Ammonia
NOAA	National Oceanic and Atmospheric Association
NO3+NO2-N	Nitrate and Nitrite
NMP	Nutrient Management Plan
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NREPA	Natural Resources Environmental Protection Act
OCD	Ottawa Conservation District
OCDPH	Ottawa County Department of Public Health
OCRC	Ottawa County Road Commission
OCWRC	Ottawa County Water Resources Commissioner
P	Phosphorous
PBC	Partial Body Contact
PCB	Polychlorinated Biphenyls
PFOs	Perfluorooctanesulfonic acid
PDR	Purchase of Development Rights
QAPP	Quality Assurance Project Plan
RC	Road Commission
SESC	Soil Erosion and Sedimentation Control

SIDMA	Social Indicators Data Management and Analysis
SQS	Stream Quality Score
SRP	Soluble Reactive Phosphorus
STEPL	Spreadsheet Tool for Estimating Pollutant Loads
SWAT	Surface Water Assessment Tool
SWL	Static Water Levels
SWMP	Stormwater Management Program
TBC	Total Body Contact
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WASCOB	Water and Sediment Control Basin
WMP	Watershed Management Plan
WQC	Water Quality Criteria
WQS	Water Quality Standards
WRC	Water Resource Commissioner
WRP	Wetlands Reserve Program
WW	Warm Water
^{o}	Degrees
µ/L	Micrograms per liter, or parts per billion

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EXECUTIVE SUMMARY

The Macatawa Watershed is a watershed in Ottawa and Allegan Counties, Michigan, comprising eight (8) HUC-12 watersheds. The watershed is approximately 175 square miles in size, draining two (2) cities and parts of thirteen (13) townships. Lake Macatawa, hydrologically connected to Lake Michigan, is a drowned river mouth with the Macatawa River and several other tributaries flowing into it. Land use within the watershed consists of agricultural areas generally in the outer edges with urban and built-up land closer to the center and along Lake Macatawa.

The lake has a history of hypereutrophic conditions, leading to the development of a phosphorus total maximum daily load (TMDL) in 1999. The purpose of this Watershed Management Plan (WMP) is to collect and discuss contemporary data on ecological issues in the watershed and address water quality issues. This management plan includes the nine (9) elements required by the United States Environmental Protection Agency (USEPA) to received WMP approval. The Macatawa Area Coordinating Council (MACC) last updated the Macatawa WMP in 2012. Since that publication, the watershed was included in the statewide TMDL for *Escherichia coli* (*E. coli*). The ODC Network has worked with several project and research partners to conduct and update modelling and research examining the ecological issues in the watershed. The goal is to ensure a healthy lake and river system that is safe for all designated and desired uses.

Pollutants of concern in the Macatawa Watershed include nutrients (primarily phosphorus), sediment, altered hydrology, thermal pollution, *E. coli* and fecal indicator bacteria, and chloride. Sources of these pollutants are varied and widespread across the watershed, including cropland, livestock, human sources, developed areas, roads, streambanks, and wildlife. Chapter 4 describes in detail these pollutants, their sources, and causes, while Chapter 5 delves into priority areas.

Chapter 8 outlines a comprehensive action plan to address nonpoint source (NPS) pollution in the Macatawa Watershed, focusing on critical areas and broader watershed issues. It integrates data collected throughout the planning process to develop best management practices (BMPs) based on physical, policy, informational, and educational strategies to reduce pollutant loading and improve water quality and quantity. Key priorities include protecting and restoring wetlands, safeguarding groundwater, and addressing critical sites like agricultural lands, septic systems, livestock operations, and urban areas. The plan emphasizes the need for site-specific BMPs, considering factors such as cost, site conditions, and landowner preferences. It also calls for collaboration with local governments and technical partners, while identifying various funding sources, including federal, state, local, and private grants. These efforts aim to achieve pollutant reduction goals and ensure long-term water quality improvements across the watershed.

Educational opportunities will be essential to making sure any improvements to the watershed gained will not be lost after implementation or grant dollars run out. Chapter 7 discusses social survey data collected by Grand Valley State University (GVSU) and compared to data collected for the prior management plan. It also outlines educational goals and priority audiences for messaging, including but not limited to agricultural producers, government staff, and homeowners. In addition to education, ongoing monitoring is needed to track changes in pollutant levels, as well as the quality and variety of species within the watershed.

1.0 INTRODUCTION

The Macatawa Watershed is in southwestern Ottawa and northwestern Allegan County (Figure 1.1) and includes the cities of Holland and Zeeland. The watershed includes eight (8) HUCs as defined by the United States Geological Survey: 040500020401-04050020408. The Macatawa Watershed drains 175 square miles of land, approximately half of which is agricultural land use, within all or portions of 13 townships. The watershed includes Lake Macatawa, the Macatawa River and numerous tributaries to both the lake and river. County drains, roadside ditches and small private ditches also contribute to the main channels. The Macatawa River generally flows east to west into Lake Macatawa that connects to Lake Michigan via the Holland Channel.

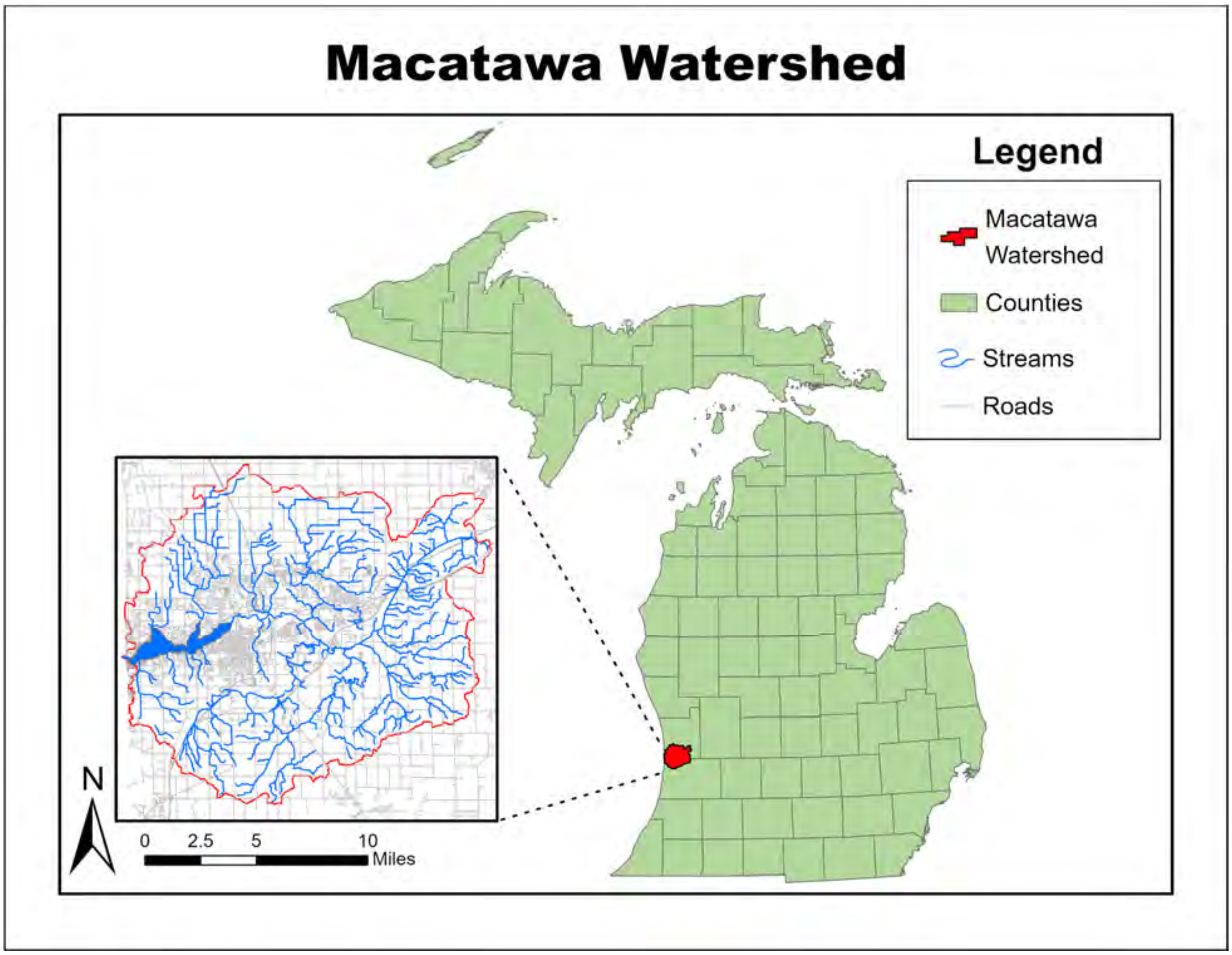

Figure 1.1 Macatawa Watershed location
Source: Michigan GIS Open Data
Date Prepared: December 2024

Approximately 128,000 people live in the watershed with higher population densities located near and along US-31, a major north-south corridor that traverses the watershed. The cities of Holland and Zeeland are in the center of the watershed with increasing agricultural land in the upstream headwater areas surrounding the cities.

A great amount of historical water quality data exists for the Macatawa Watershed due to state and local monitoring efforts extending back to the 1970s. The first plan developed for the watershed was a

Phosphorus Reduction Plan to address the phosphorus total maximum daily load (TMDL) approved by the USEPA in 2000. This plan was based solely on water quality monitoring collected by the then Michigan Department of Environmental Quality (MDEQ). In 2012, MDEQ approved the Macatawa Watershed Management Plan (MWMP) per the existing CMI and 319 criteria. This plan relied on not only state data, but also additional water quality monitoring data collected locally by Hope College. Since 2012, both Hope College and Grand Valley State University (GVSU) have collected extensive water quality data for both Lake Macatawa and the tributaries. In addition, the Macatawa Area Coordinating Council (MACC) and ODC Network have completed additional data collection including monitoring macroinvertebrates at seven stream locations, conducting road-stream crossing inventories, completing agricultural surveys, and other inventory and modeling to further characterize the watershed and aid in setting priorities for restoration and protection.

Representatives from the ODC Network authored this revised MWMP by with assistance from the Ottawa Conservation District (OCD) and Fishbeck. The ODC Network coordinated all efforts related to the planning process and overall WMP development including stakeholder engagement. Several community stakeholders were also important to the development of the revised MWMP including various Ottawa County departments, local units of government, the Holland Board of Public Works, Allegan Conservation District, GVSU, Hope College, and several community members.

1.1 Key Elements of Developing a Watershed Management Plan

Watershed planning and implementation is a process that includes building partnerships, characterizing the watershed, setting goals, and identifying solutions, designing an implementation program, implementing the watershed plan, and measuring progress and making adjustments (USEPA, 2008).

Watershed management plans (WMPs) are a resource used to prevent and improve water quality problems by understanding and addressing nonpoint source (NPS) pollution impacting a watershed. Nonpoint source pollution comes from diffuse sources and stormwater carries it across the land and effectively delivers it to lakes and stream. This is in contrast with point source pollution discharged from an identifiable point such as a pipe (USEPA, 2008). Watershed management plans document impaired areas for improvement or restoration and high-quality areas for long-term protection. A WMP outlines an action-oriented approach for improving and protecting water quality. The USEPA recommends developing a WMP by following their defined planning and implementation process, which includes the following nine elements:

1. Identification of the causes and sources or groups of similar sources that need to be controlled to achieve the load reductions estimated in the watershed-based plan.
2. Estimate the load reductions expected for the management measures described in element (3.) below.
3. Describe the NPS management measures that need to be implemented to achieve the load reductions estimated in element (2.) above and identify the critical areas in which those measures will be needed to implement the plan.
4. Estimate the amounts of technical, financial, and regulatory assistance needed; associated costs and/or the sources and authorities that will implement the plan.

5. Develop an information and education (I&E) component that will be used to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing the NPS management measures.

6. Develop a reasonably expeditious schedule for implementing the NPS management measures identified in the plan.

7. Develop a description of interim, measurable milestones for determining whether NPS management measures or other control actions implemented effectively.

8. Develop a set of evaluation criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining Water Quality Standards (WQS) and, if not, the criteria for determining whether the watershed-based plan needs to be revised.

9. Develop a monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element (8.) above.

1.2 Goals and Objectives

The purpose of this WMP is to assist the Macatawa Watershed community in ensuring the long-term protection and restoration of the Lake, River and surrounding lands focusing on restoring designated uses applicable to the watershed as mandated by state and federal water quality programs. This WMP provides, among other things, a shared strategy for uniting community stakeholders around a common vision for improving water quality.

The ODC Network and collaborating partners endeavored to develop a WMP that builds upon the previous plan approved in 2012 that is understandable and useful for local municipalities, organizations, and other interested stakeholders to work individually or collectively toward protecting and restoring the Macatawa Watershed. While all WMPs address NPS pollution impairments following USEPAs nine elements, every WMP's goals will differ depending on the identified pollutants and concerns in the watershed. The following goals for the Macatawa WMP are based on existing knowledge of the watershed and the information obtained, collected, analyzed, and described in the following chapters.

The goals of this WMP are to:

1. Restore water quality to meet state water quality standards and the Total Maximum Daily Loads established for Lake Macatawa, the Macatawa River and tributaries.
2. Protect natural areas for water quality improvement.
3. Enhance the watershed for desired uses that are of community importance:
    a. Recreation
    b. Public access
    c. Fish and wildlife
    d. Open space
    e. Groundwater protection and recharge

Objectives to achieve the above goals include:

1. Implement identified agricultural and urban best management practices in high priority areas of the watershed.

2. Deliver outreach and education to the watershed community to increase awareness and knowledge of water quality concerns and actions to protect water quality.

3. Work with local decision makers to institute policy changes that advance watershed protection and restoration.

4. Seek and secure funding to support plan implementation.

5. Conduct ongoing water quality monitoring to track progress toward meeting water quality standards and Total Maximum Daily Loads.

1.3 How to Use this WMP

Watershed management plans are a guidebook for individuals and organizations who are interested in protection, improvement and wise use of our lands and waters. These documents include a large amount of information to meet state and federal agency requirements for approval, and can become unmanageable to those interested in simple, straightforward implementation of the recommendations set forth. As such, this WMP was organized in a manner intended to clearly define the watershed's current conditions and recommendations needed for pollutant reduction. The WMP is divided into the following chapters:

Chapter 2.0 Description of the Macatawa Watershed provides a general overview of the Macatawa Watershed. This is background information that does not include specific recommendations for project implementation.

Chapter 3.0 Summary of Water Quality in the Macatawa Watershed explains water quality standards (WQS) in the State of Michigan, the protected designated uses that surface water bodies must attain and an overview of the Macatawa Watershed water quality data used to develop this WMP. This includes summaries of historic data and reports, data collected since 2012, and new data collected during the WMP update process. This chapter is important to understanding the greater Macatawa Watershed Management Plan.

Chapter 4.0 Pollutants, Sources and Causes identifies and prioritizes all NPS pollutants currently impairing or threatening the designated and desired uses of the Macatawa Watershed based on data collected. Known, suspected, and potential sources and causes of pollutants are identified and described.

Chapter 5.0 Critical Areas and Sites for Restoration and Protection identifies primary critical areas and sites within the Macatawa Watershed that are contributing the most significant sources of NPS pollutants. These sites were identified during the watershed inventory process through critical areas models, which were developed for agricultural and urban areas that have been mapped and identified for specific types of pollutants.

Chapter 6.0 Policy Review and Recommendations summarizes any measures that local governments have in place that pertain to water quality, watershed protection, land use, stormwater management, best management practices, and tree planting guidelines. Based upon the existing policies and the information collected for this WMP, there are recommendations to update zoning ordinances, master plans, and other local government ordinances that can provide stronger protections for water quality within the Macatawa Watershed.

Chapter 7.0 Social Survey Analysis and Information and Education (I&E) Recommendations summarizes the results of a Social Indicators Data Management and Analysis (SIDMA) survey managed by GVSU in the watershed and identifies and recommends areas where I&E messaging could benefit water quality.

Chapter 8.0 Summary of Watershed Management Recommendations provides specific implementation recommendations for addressing NPS pollutants at critical sites and areas and larger, general issues the Macatawa Watershed is facing. Recommendations integrate data collected through the watershed management planning process to develop physical, policy based, information, and educational goals to serve as an action plan. This will provide clear direction for a strategic reduction in NPS pollution within the Macatawa Watershed.

Chapter 9.0 Evaluation and Monitoring Plan provides the information necessary for measuring the successfulness of implementing this watershed management plan.

Chapter 10.0 References includes all the studies and documents referenced in this watershed management plan.

2.0 DESCRIPTION OF THE MACATAWA WATERSHED

2.1 Geographic Scope

This WMP covers the Macatawa Watershed in western Lower Michigan that the United States Geological Survey identifies as eight HUCs: 04050020401-040500020408. The Macatawa Watershed covers an area of 175 square miles (approximately 112,000 acres) in southwestern Ottawa County and northwestern Allegan County that includes the cities of Holland and Zeeland and all or parts of thirteen townships: Port Sheldon, Olive, Blendon, Georgetown Charter, Park, Holland Charter, Zeeland Charter, Jamestown Charter, Laketown, Fillmore, Overisel, and Salem (Figure 2.1 and Table 2.1). The watershed includes Lake Macatawa (2.8 square miles), the Macatawa River (16 miles long) and numerous small tributaries (325.5 total stream miles). The watershed is similar to many other Lake Michigan coastal watersheds, such as the Pere Marquette, While, Black, and Paw Paw Rivers.

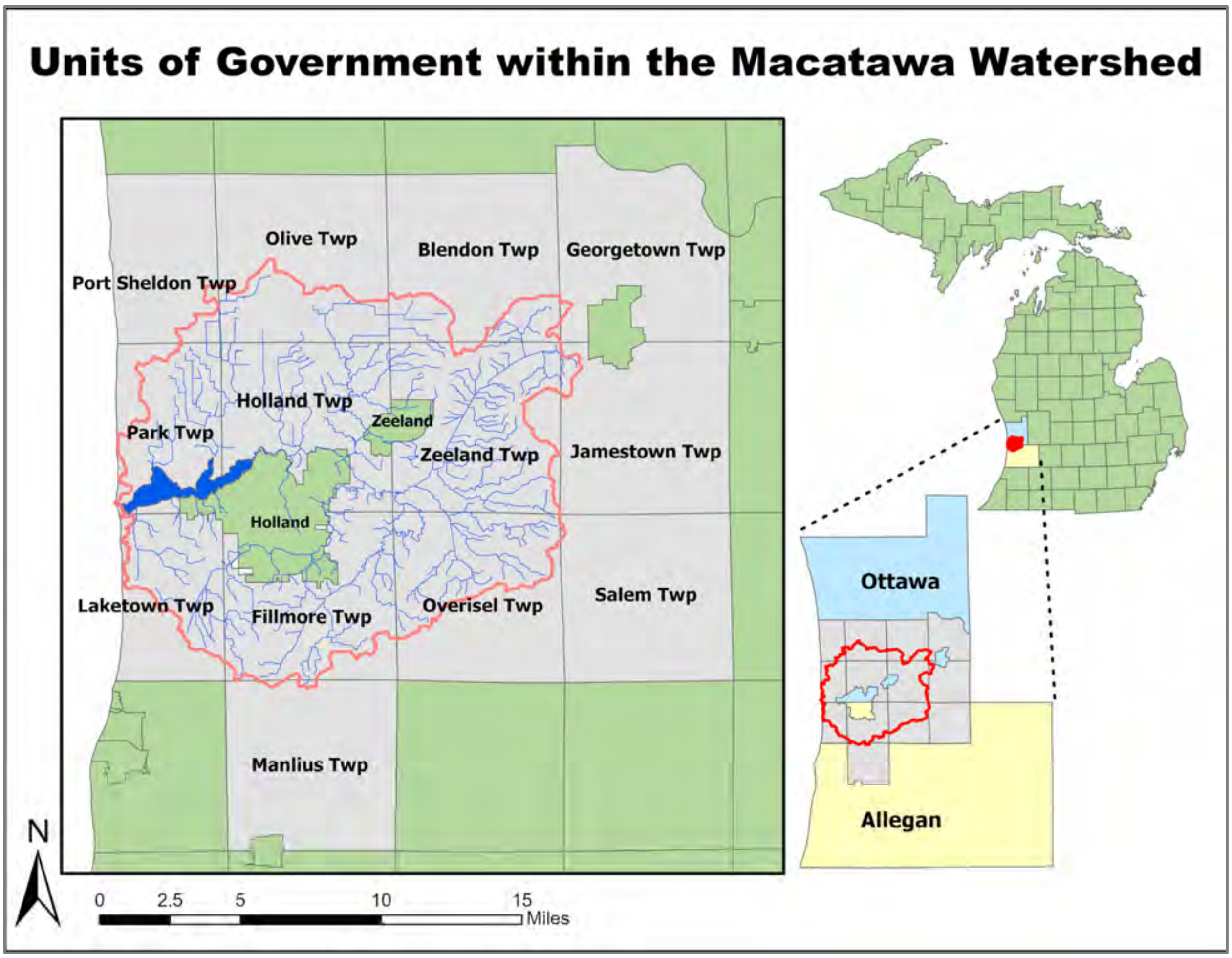

Figure 2.1 Governmental units in the Macatawa Watershed
Source: Michigan GIS Open Data
Date Prepared: December 2024

Table 2.1 Summary of land area and local units of government in the Macatawa Watershed

Local Unit of Government	Total land area (square miles)	% Land area within watershed boundary	Land area within the watershed (square miles)
Zeeland Charter Township	34.4	91.4	31.5
Holland Charter Township	27.5	100	27.5
Fillmore Township	28.4	88.4	25.2
Overisel Township	35.7	50.7	18.1
Park Township	21.3	81.4	17.3
City of Holland	17.3	100	17.3
Laketown Township	21.7	60.7	13.2
Olive Township	36.2	33.1	11.9
Blendon Township	36.4	18.7	6.8
City of Zeeland	3.0	100	3.0
Port Sheldon Township	22.6	6.7	1.5
Jamestown Charter Township	35.5	2.1	0.8
Manlius Township	35.9	0.74	0.27
Salem Township	36.0	0.19	0.07
Georgetown Charter Township	34.1	0.05	0.02
Total Square Miles	**425.97**		**174.4**

Source: Macatawa Watershed Management Plan, 2012
Date Prepared: June 2025

2.2 Geology

The geology and topography of the Macatawa Watershed is dominated by the actions of glaciation, which took place during the Quaternary Period approximately 100,000 to 14,000 years ago. The bedrock under the area of the watershed (Figure 2.2) is a part of the Marshall Sandstone Formation (known locally as Waverly Sandstone) from the Mississippian Period (355 to 320 million years ago), but almost all of it is covered by sand and glacial drift (Figure 2.3). The western one-third of the watershed is dominated by a flat, sandy outwash plain, while the eastern two-thirds is hillier due to moraine deposits.

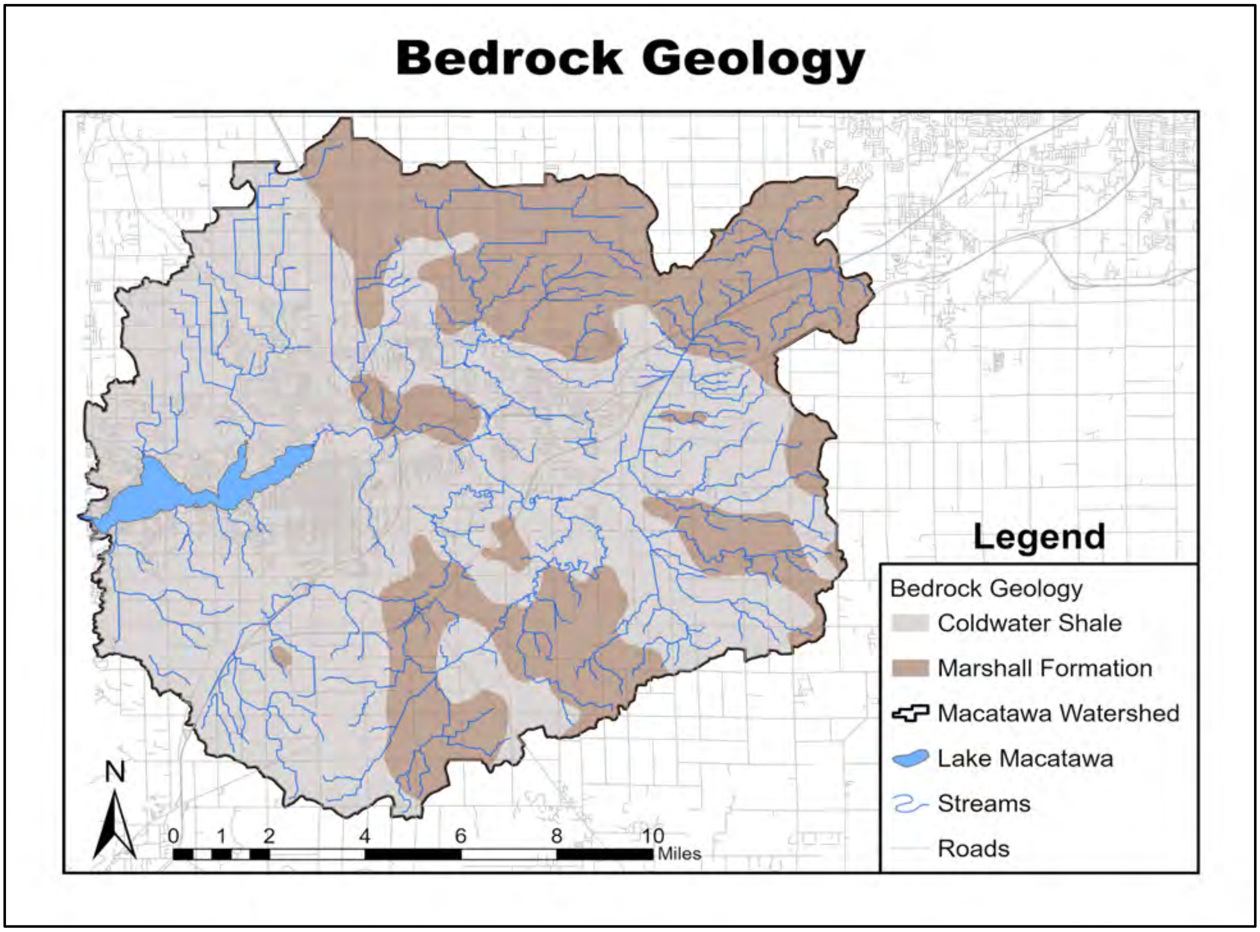

Figure 2.2 Bedrock geology in the Macatawa Watershed
Source: Michigan GIS Open Data
Date Prepared: December 2024

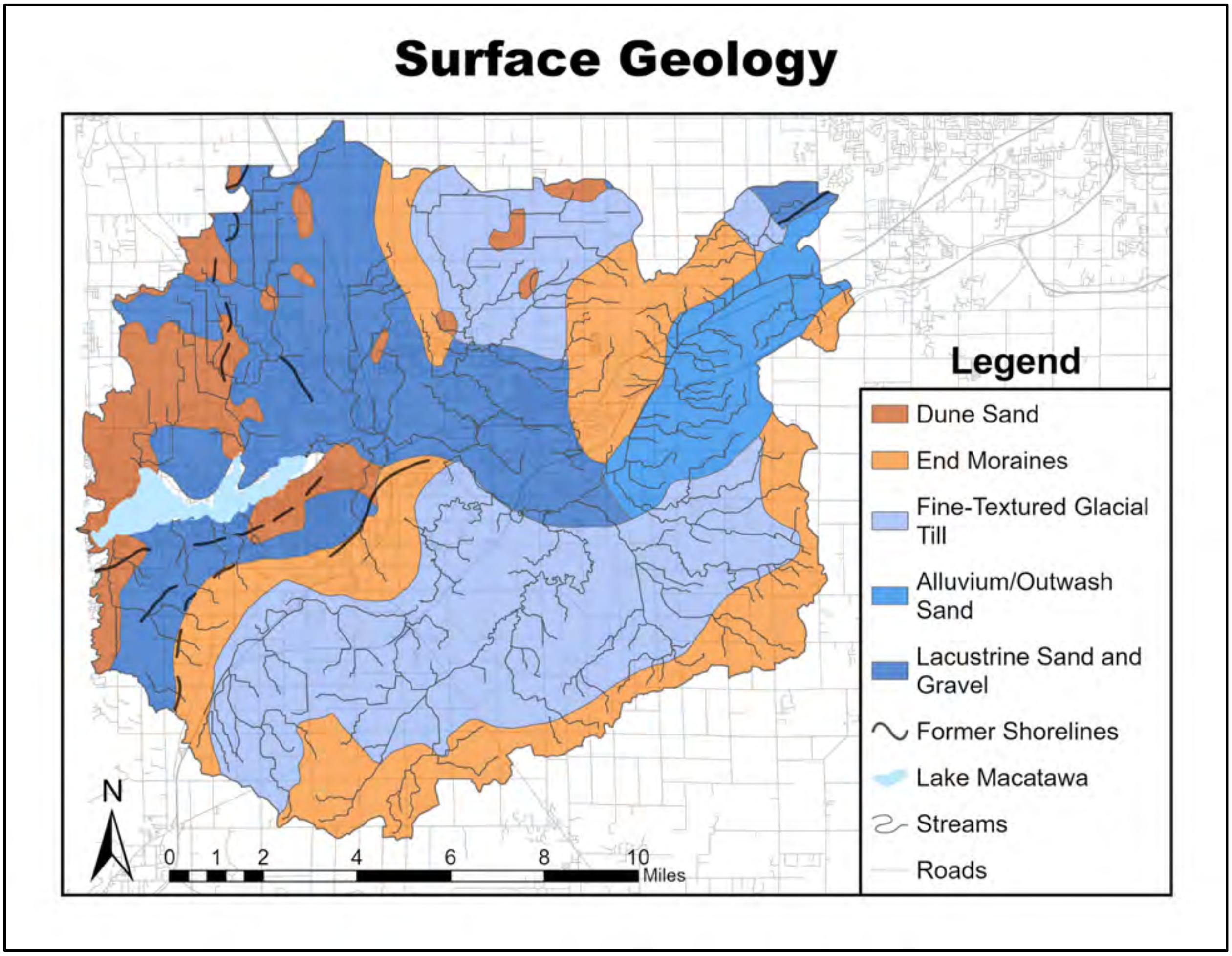

Figure 2.3 Surface geology in the Macatawa Watershed
Source: Michigan Natural Features Inventory and Dept of Natural Resources, Michigan GIS Open Source
Date Prepared: December 2024

2.3 Topography of the Macatawa Watershed

The Macatawa Watershed is roughly circular in shape, with the highest elevations, ranging from 700-800 feet above sea level, found in the eastern and southern portions of the watershed. The mouth of Lake Macatawa has the same elevation as Lake Michigan (approximately 580 feet above sea level), and is the lowest elevation point, along with the western third of the watershed (Figure 2.4). Cutting through the northeastern portion of the Macatawa Watershed is a low area along Chicago Drive, which, during the glacial retreat, was the outlet of the Grand River that now flows through Allendale to Grand Haven.

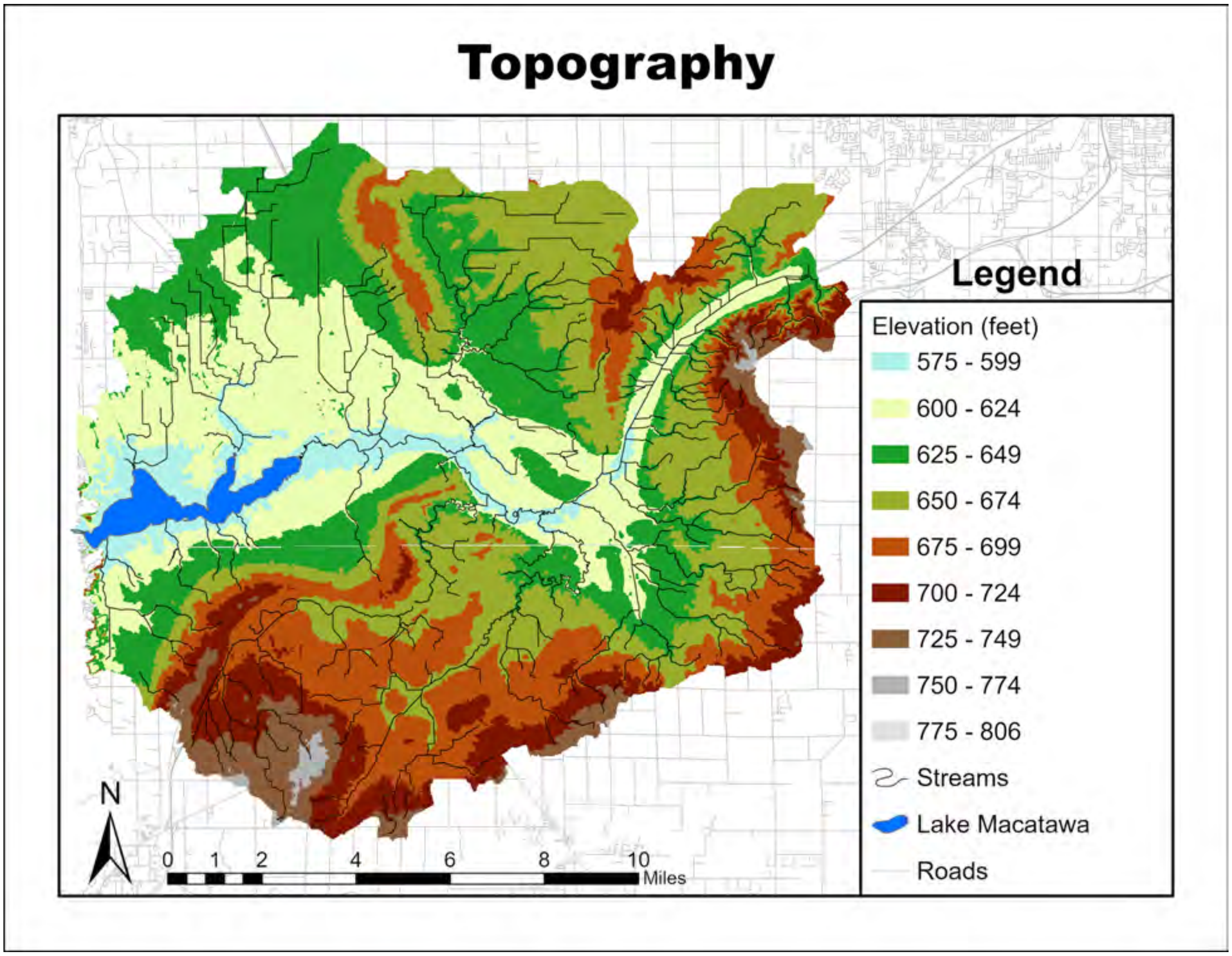

Figure 2.4 Topography of the Macatawa Watershed
Source: Michigan GIS Open Data
Date Prepared: December 2024

2.4 Soils of the Macatawa Watershed

The soil in the Macatawa Watershed consists of mixtures of varying degrees of sand, silt, and clays. The soils are known for being extremely fertile and directly reflect the geology of the area. The western one-third of the watershed consists of primarily sandy soils with good drainage while the eastern two-thirds of the watershed consists of heavier, clay mixtures that hold moisture very well and are rich in nutrients. Figure 2.5 shows the most common soil formations in the watershed.

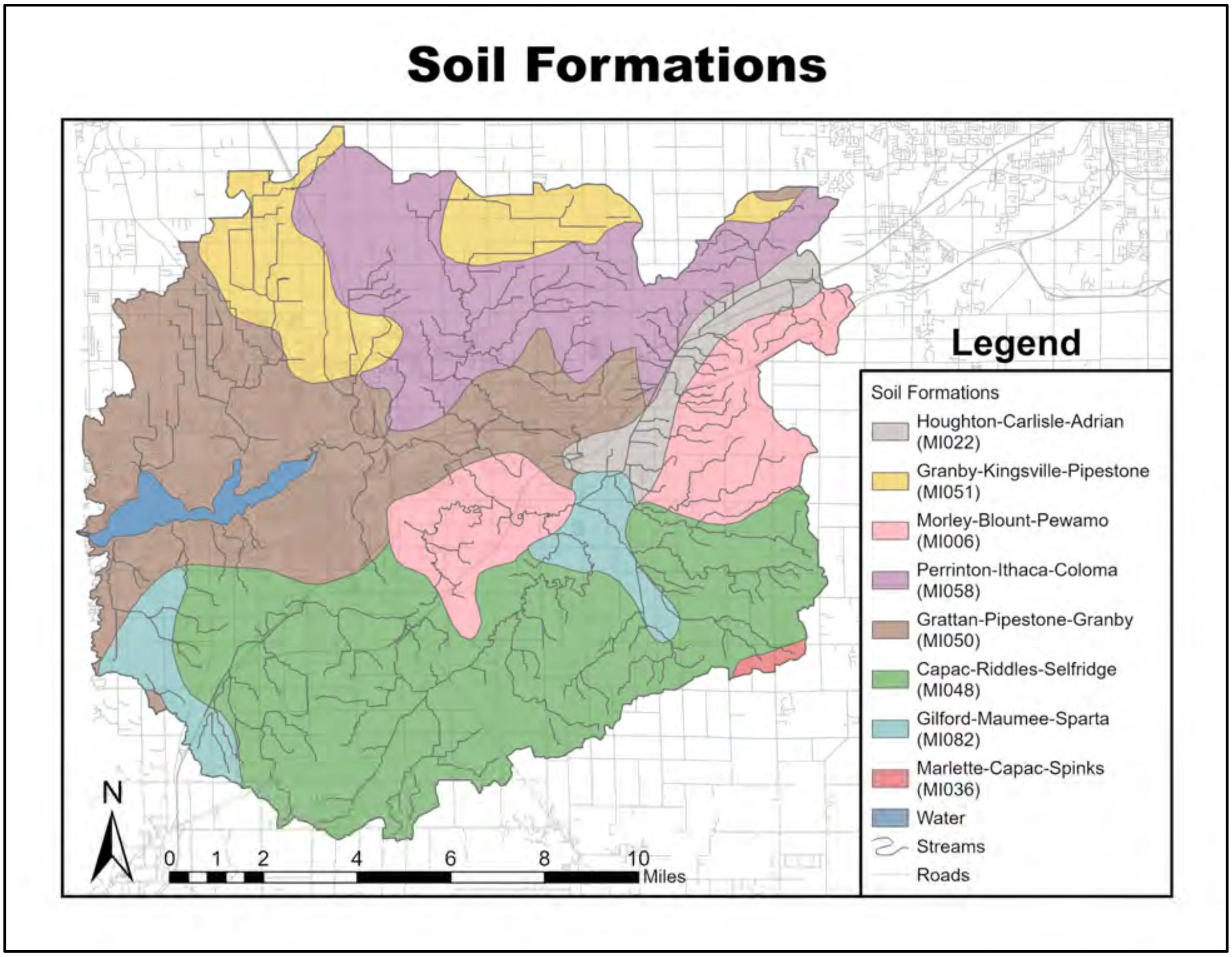

Figure 2.5 Major soil formations in the Macatawa Watershed
Source: The Digital General Soil Map of the United States: STATSGO2
Date Prepared: December 2024

The following are general descriptions of the soil formations summarized from information provided by the Natural Resources Conservation Service (NRCS) and do not include information specific to the Macatawa Watershed.

Morley-Blount-Pewamo (MBP): This combination of soils consists of very deep soils that range from very poorly drained to moderately well drained. The soils are formed in dense till or on moraines and lake plains. The potential for surface runoff is low to very high and saturated hydraulic conductivity is moderately low to moderately high. Permeability is moderately slow to very slow. Common crops are corn, soybeans, small grain, hay, and meadow. Some parts are permanent pasture or forest with native vegetation such as mixed deciduous hardwood forest, red maple, American elm, white ash, and American basswood.

Houghton-Carlisle-Adrian (HCA): This combination of soils is very deep, very poorly drained soils from herbaceous organic materials over sandy deposits on outwash plains, lake plains, lake terraces, flood plains, moraines, and till plains. The potential for surface runoff is low or negligible and saturated hydraulic conductivity is moderately high to high. Permeability is moderately slow to moderately rapid. Common crops are truck crops, onions, lettuce, potatoes, celery, radishes, carrots, mint, and some corn. Some areas are used for small grains, hay, and sod production, or used as pasture. Native vegetation includes marsh grasses including sedges, reeds, grasses (various species), buttonbush, and cattails, with some water-tolerant trees near the margins of the bogs, and shrubs such as willow, alder, and dogwood. Major tree species include American elm, white ash, red maple, willow, tamarack, quaking aspen, and alder.

Marlette-Capac-Spinks (MCS): This combination of soils is very deep, mostly well drained soils with some that are somewhat poorly drained. The potential for surface runoff is medium and hydraulic conductivity is moderately high. Permeability is moderately slow but sometimes rapid. The soil can be used to grow corn, beans, wheat, small grain, and soybeans.

Capac-Riddles-Selfridge (CRS): This combination of soils is a mix of very deep, mostly somewhat poorly drained soil and some well drained soils. The soil is described as having a saturated hydraulic conductivity that is moderately high. Permeability is moderately slow unless in the sandy material in which permeability is rapid making the potential for surface runoff as negligible to high. This combination of soil is mostly used to grow corn, small grains, and grass-legume hay. Other areas are forest or pasture.

Grattan-Pipestone-Granby (GPG): This combination of soils consists of very deep and poorly drained soils formed from outwash plains, beach ridges, and glaciolacustrine deposits. Potential for surface runoff is negligible and saturated hydraulic conductivity is high or very high. Permeability is rapid. Much of the soil has been cleared or cultivated. Crops include small fruit, vegetables, small grain, hay, and corn and these areas must be intensively managed. Native vegetation includes aspen, white pine, oak, hickory, white ash, maple, marsh grasses, reeds, sedges.

Granby-Kingsville-Pipestone (GKP): This combination of soils is very deep, poorly drained soils formed from outwash or glaciolacustrine deposits. Potential for surface runoff is negligible to very low. Ponding occurs on occasion, but permeability is mostly rapid. Saturated hydraulic conductivity is high. Some areas used to grow small fruits, vegetables, corn, soybeans, small grain, and hay. Native vegetation ranges from marsh grasses, reeds and swamp forest to elm, ash, oak, pine, reeds, and sedges.

Perrinton-Ithaca-Coloma (PIC): This combination of soils is very deep ranging from somewhat poorly drained to excessively drained. These soils formed till on ground moraines and end moraines or formed in sandy drift. The potential for surface runoff is medium to high and saturated hydraulic conductivity is moderately low to moderately high. Permeability is mostly slow but can be rapid in the Bw and E horizons. Most of the soil is cultivated, in pasture, or third growth timber. Most of the gently sloping areas are under cultivation to corn, soybeans, small grain, or hay. Native vegetation is sugar maple, American elm, American beech, white ash, American basswood, northern red oak, yellow birch, and pine oaks.

Gilford-Maumee-Sparta (GMS): This combination of soils consists of very deep poorly, very poorly, or excessively drained soils formed from outwash. The potential for surface runoff is negligible, and flooding occurs very rarely and for a very brief amount of time. Permeability is mostly rapid and moderately rapid in the upper part and saturated hydraulic conductivity is high in the upper part and very rapid in the lower part. These soils are used for growing corn, soybean, wheat, and oats. Native vegetation is mainly wetland, marsh grasses, reeds, sedges, and water-tolerant trees.

Soil texture, the percent of sand, silt and clay within each soil horizon, bulk density, and the weight of solids within a measured volume of soil, affect the rate and ability of water to infiltrate the soil. Low infiltration rates increase erosivity of soil. Soil properties ultimately affect how pollutants that are land applied or absorbed, such as manure, septage or fertilizers, are transmitted over or through the soil.

Soils are classified into hydrologic soil groups (A, B, C and D) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting (Table 2.2). The infiltration rate is the rate at which water enters the soil at the soil surface and is controlled by surface conditions. The hydrologic soil group also indicates the transmission rate, or the rate at which water moves within the soil. This rate is controlled by the soil profile.

Table 2.2 Hydrologic Soil Groups

Hydrologic Soil Group*	Definition
A	Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained, or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

**If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes. (NRCS, 2019)*
Source: NRCS, 2019
Date Prepared: June 2025

Land uses on different soil types will affect runoff, erosion, transmission, and ultimately, water quality of the receiving waters. Each of these different soil types also have different erosive properties. Certain soils have greater potential for overland flow and erosion, and other soils have greater potential for infiltration. Understanding how soils respond to precipitation is critical for watershed management, especially considering negative impacts resulting from erosion and eroded sediment on water quality of the receiving water bodies. Specifically, three types of erosion can be predicted: sheet, rill, and gully.

Figure 2.6 Types of overland erosion (left to right: sheet erosion, rill erosion, gully erosion)
Image Credit: ODC Network, NRCS Photo Gallery

Sheet erosion (as seen in the left photo of Figure 2.6) occurs when rainfall hits the ground and runs off the land uniformly across a large area with little to no water infiltration while carrying away loose soil particles. Rill erosion (as seen in the middle photo of Figure 2.6) occurs when runoff cuts small drainage pathways into the surface of the land, giving water little time to infiltrate. Gully erosion (as seen in the right photo of Figure 2.6) occurs when rills become much larger. The depth of erosion defines the difference between rills and gullies. Generally, rills are easily repaired/removed by normal tillage practices whereas gullies are not.

Soil type affects the functionality of septic systems, also known as on-site disposal systems, which are dependent on the ability of the soil to allow water to percolate. Unsuitable soil for septic systems includes soil that is poorly to very poorly drained with a seasonal high-water table of less than one foot below the ground surface or soil that is highly impermeable.

Soil properties also impact farming conditions. The United States Department of Agriculture (USDA) NRCS defines prime farmland as land with the best combination of physical and chemical characteristics for producing crops. This land must be available for agricultural use to receive a prime farmland designation. Prime farmland has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming practices. Prime farmland soils may include those that are productive if artificially drained or managed to prevent flooding. Approximately 45% of the land in the Macatawa Watershed is under agricultural use and 69% of it designated as prime farmland (Figure 2.7).

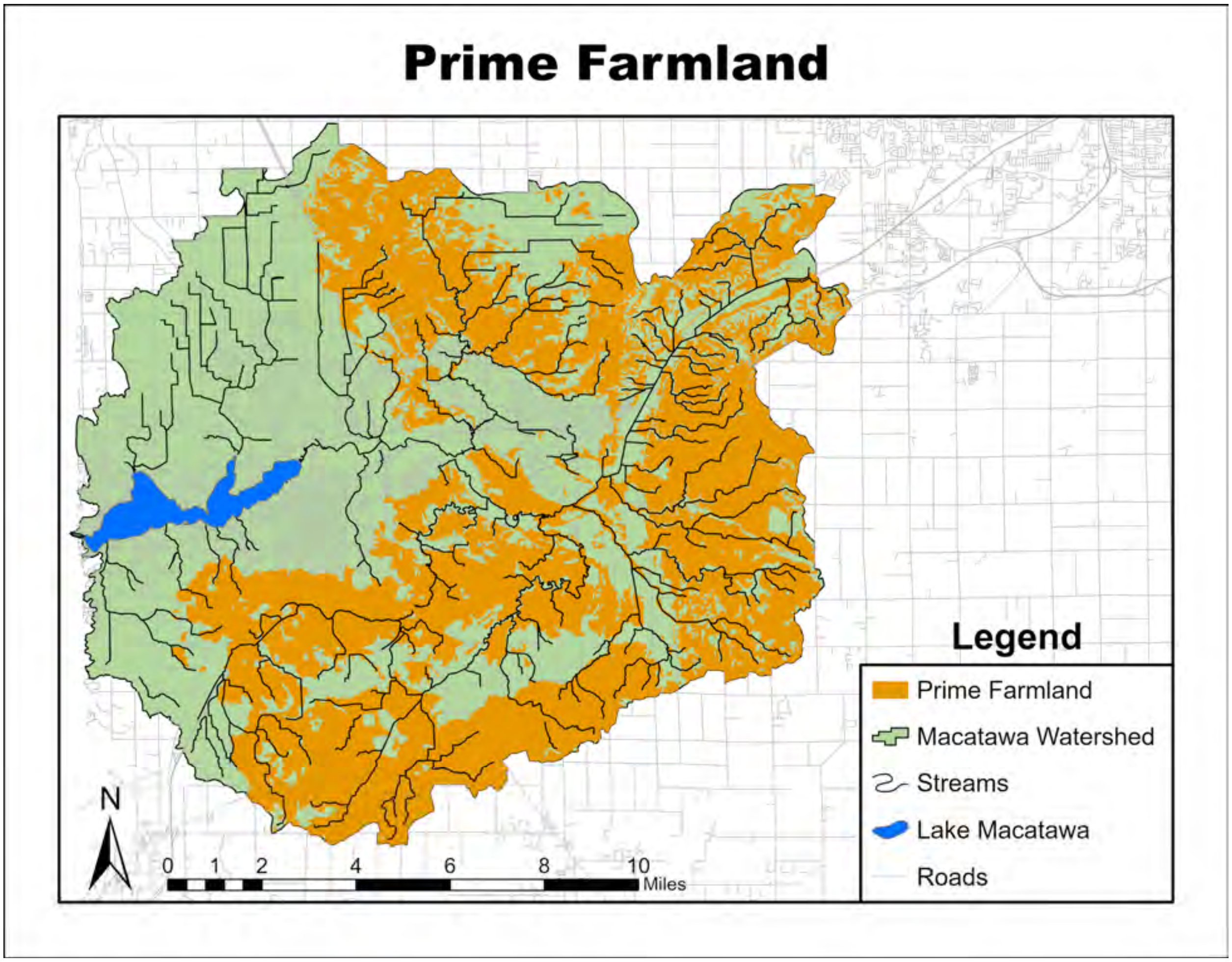

Figure 2.7 Prime farmland in the Macatawa Watershed
Source: Ottawa and Allegan County Soil Survey
Date Prepared: December 2024

Over 44,000 acres of the watershed (41%) is composed of hydrologic soil groups C and D (Table 2.3 and Figure 2.8) meaning that much of the watershed has a high potential for runoff and associated erosion. The soils around the outer rim are composed primarily of clay with occasional boulders and deposits of mixed size spread throughout. These clay soils are comparatively impermeable, which makes them very susceptible to runoff. From the northeast corner of the watershed down to Lake Macatawa (the former site of the Glacial Grand River), there are low elevation deposits of organic muck and sand. The northern and northwestern portion of the watershed is composed primarily of flat sand and former sand dunes from the Nipissing Period approximately 4000-6000 years ago.

Table 2.3 Summary of Hydrologic Soil Groups in the Macatawa Watershed

Hydrologic Group	Total Acres	% of Watershed Area
A	13,153	12
A/D*	12,241	11
B	24,781	22
B/D*	10,004	9
C	40,590	37
C/D*	1,855	2
D	2,170	2
Not rated	4,704	4

**first letter is if soil is drained, second letter is if soil is not drained*
Source: NRCS, 2019
Date Prepared: June 2025

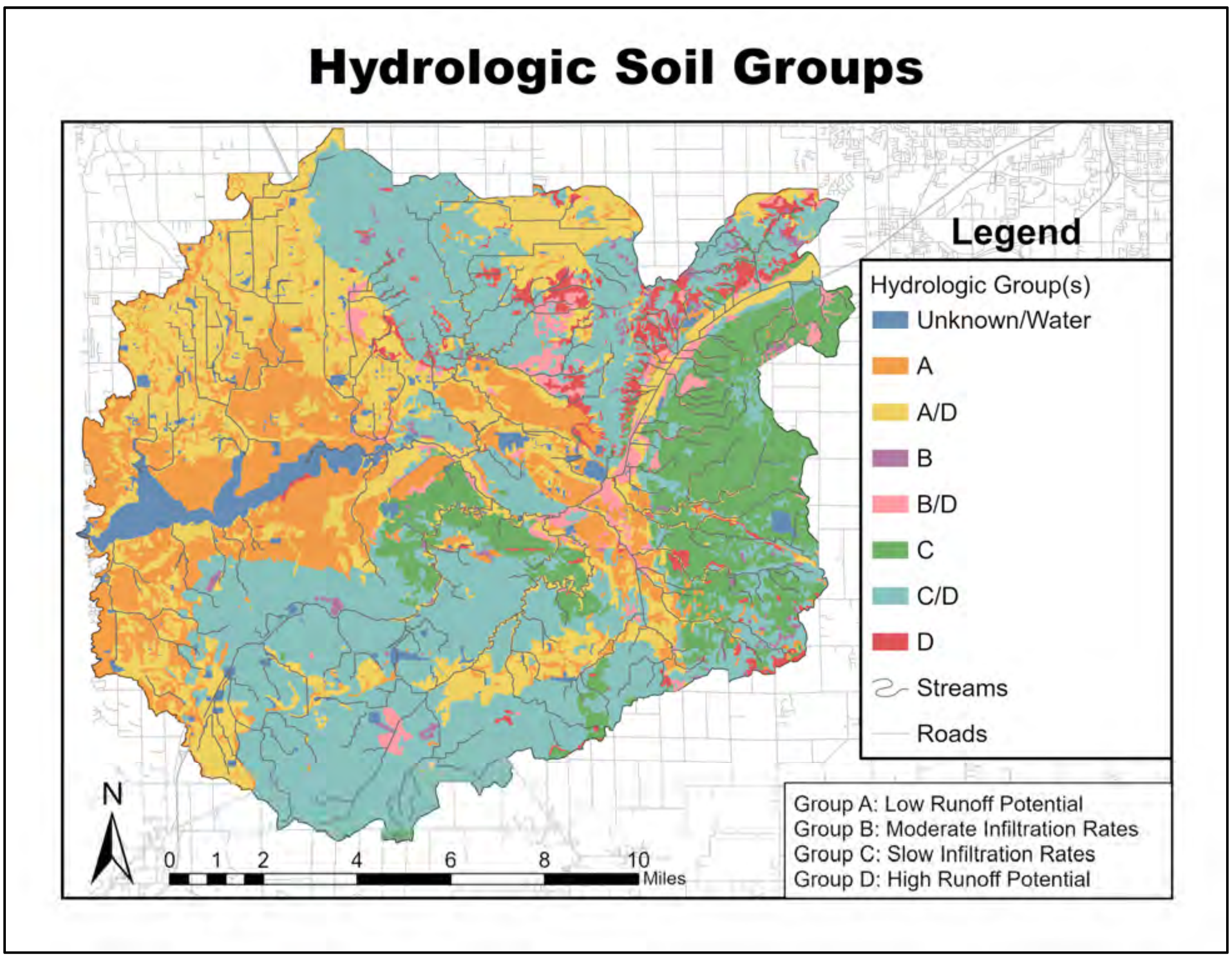

Figure 2.8 Hydrologic Soil Groups in the Macatawa Watershed
Source: Michigan GIS Open Data
Date Prepared: December 2024

2.5 Climate

The Macatawa Watershed has a modified continental climate. The prevailing westerly winds that cross Lake Michigan pick up warm, moist air in the winter and cool, moist air in the summer. The result is milder winters and cooler summers than regions located west of Lake Michigan. According to the National Oceanic and Atmospheric Administration (NOAA), the average high and low temperatures in Holland, Michigan, for January, historically the coldest month in Ottawa County, are 32 degrees (°) Fahrenheit (F) and 20°F, respectively. In July, historically the warmest month, the average high and low temperatures are 82°F and 62°F, respectively. Like temperature, precipitation is seasonally variable with February, historically the driest month, receiving an average of 1.77 inches of precipitation and May, historically the wettest month, receiving an average of 3.76 inches. Average annual precipitation is 33.62 inches. The dominant precipitation in the months of December through February is snowfall, with an annual average snowfall of 70 inches and the largest average snowfall occurring in January (25 inches) (NOAA, 2024).

The Michigan Climate Assessment conducted a study in 2019 to look at the projected change in temperature around the Great Lakes. The study found that in the next 50 years the average temperature in Ottawa County is expected to increase up to 5°F. This average rise in temperature has a strong correlation to rising lake temperatures that will move the Macatawa Watershed toward a more humid climate in the coming decades (Kovacs and Barrett, 2020).

Due to observed and predicted outcomes of climate change, the ODC Network completed a climate resilience plan in the summer of 2022 (Appendix A). This plan highlights areas in the Macatawa Watershed that will be most vulnerable to the effects of climate change and the optimal mitigation strategies to those vulnerabilities. Since wetland once dominated the watershed prior to European settlement, one of the greatest risks associated with climate change in the watershed is severe flooding and the negative effects it has on the landscape. More than 86% of the original wetlands in the watershed were drained and many river channels have been straightened leading to a much greater risk posed by increasing rainfall to cause damage to buildings and infrastructure in low-elevation areas.

2.6 Land Use

2.6.1 Pre-settlement Ecology

The pre-settlement ecology of the Macatawa Watershed is very much like many other areas in Michigan. Wetland dominated in the central portion of the watershed (Figure 2.9). Lake Macatawa was originally named Black Lake due to its appearance, which, like many inland lakes in Michigan, was a result of clear water filled with a mat of leaves, tannins from the trees, and aquatic vegetation on the bottom. As a drowned river mouth, water travels through Lake Macatawa at a relatively slow rate. Deciduous trees, such as maples, oaks, and beeches, heavily forested the surrounding area around the lake. Reports from before the Dutch settlers arrived in 1847 describe the area being the forest so dense that the sun's rays could not penetrate it. The trees that made up this forest were on average two centuries old, a hundred feet high and more than six feet in diameter. In his notes from 1832, surveyor C. Britain states that the area was "gently rolling with the primary trees being beech, sugar maple, and hemlock". The most frequent species identified by the surveyor during the period of 1820-1830 for Ottawa County were: American beech (*Fagus grandifolia),* eastern hemlock (*Tsuga canadensis),* sugar maple (*Acer saccharum)* pine (*Pinus ssp.),* oaks (*Quercus ssp.),* soft maples (*Acer ssp.)* black ash (*Fraxinus nigra),* and white ash (*Fraxinus americana).*

The marsh areas consisted of blue sagittaria (*Sagittaria ssp.*) and wild rice (*Zizania aquatica)*. While there are more than just these types of plants in the marshes, these are the only ones recorded in historical accounts. Native species of trees that could also be found in the area included birch (*Betula ssp.),* tulip tree (*Liriodendron tulipifera),* shellbark hickory (*Carya laciniosa),* and ironwood (*Ostrya virginiana).* Walnut (*Juglans ssp.),* black cherry (*Prunus serotina),* and American chestnut (*Castanea dentana)*, which all made good lumber, were also found within the area. Soil type present in certain locations within the watershed often determined the types of trees. Hardwoods, such as oak, were more prevalent in the clay soil areas of the watershed. Trees used to more arid sandy soil, such as pine, could be found in western portions of the watershed close to Lake Michigan. In the wetlands, other species of trees, such as cedar, dominated the wetland ecology of the area.

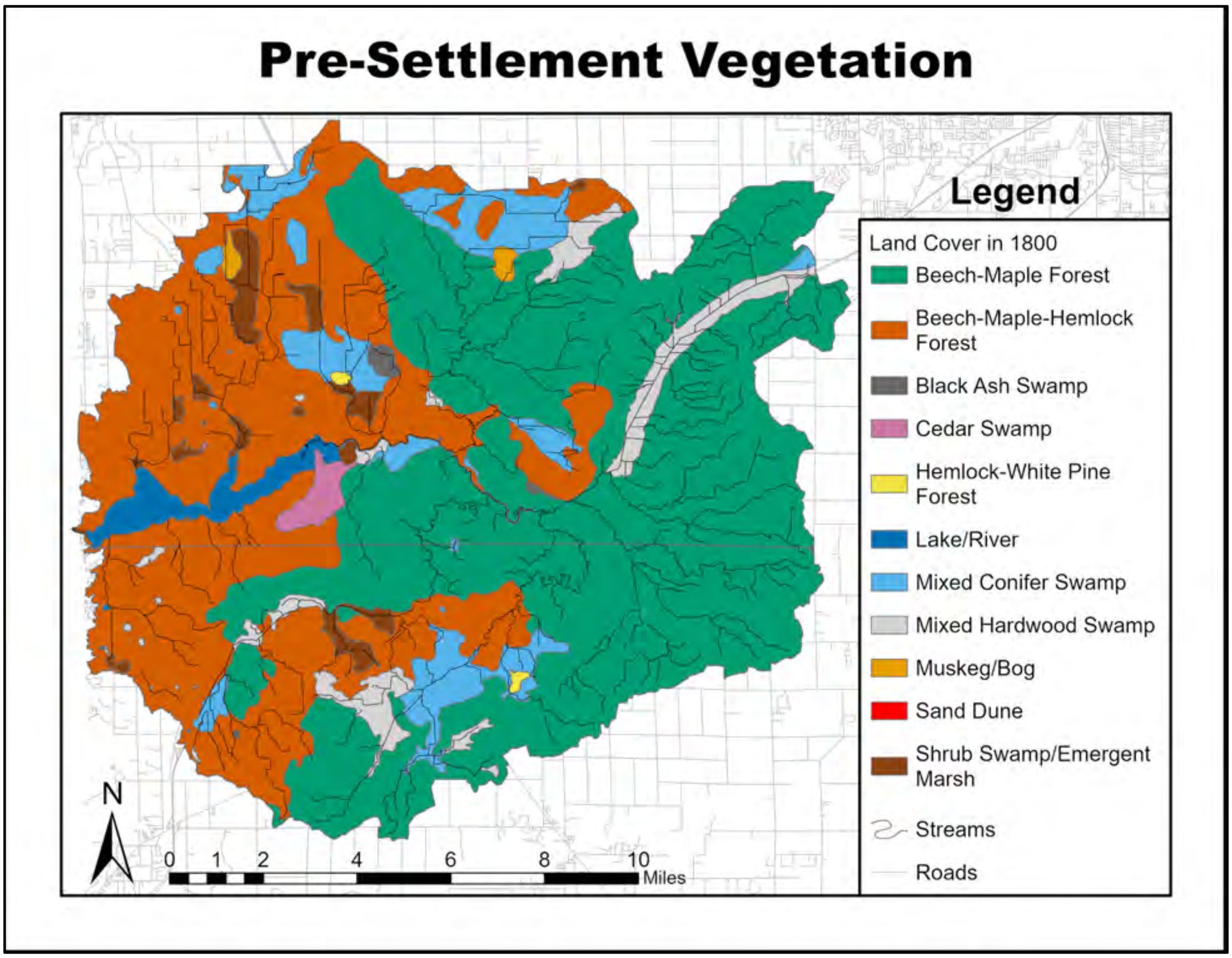

Figure 2.9 Pre-settlement vegetation in the Macatawa Watershed
Source: Michigan GIS Open Data
Date Prepared: December 2024

In the 1832 survey, before Dutch settlers arrived, huge tracts of wetlands covered the Macatawa Watershed. In Michigan, there are three basic types of wetlands: bogs, marshes, and swamps. All three of which were present in the watershed before the arrival of the Dutch. Today, it is common to see only marshes and swamps, with most of the bogs reduced or filled in. Evidence of historic bogs in the Macatawa Watershed comes from the Michigan Natural Features Inventories. They were found in the northernmost part of the watershed, one in Park Township and the other in Holland Township. Two large tracts of marshes also existed before the Dutch settlement, one located at present-day Windmill Island and the other was located just north of the city near present day US-31 and James St. The marsh at Windmill Island is about half of the size it used to be and the other marsh near US-31 no longer exists. In many historical accounts of Zeeland, there are references to a hardwood and cedar swamp that lay south of town. This area was virtually untouched until 1870 when the settlers dug a ditch through the center to drain the swamp. A very large hardwood swamp lay to the east of present-day Zeeland, while some of the present-day city of Holland sits on the former cedar swamp.

2.6.2 Cultural History

Although there is no written record of Native American populations in Lower Michigan prior to the arrival of the Ojibwe (Chippewa), Bodewadmi (Potawatomi), and Odawa (Ottawa) peoples, archaeologists have found evidence of other civilizations existing in the Macatawa Watershed from as far back as 9,000 years before present. The Ojibwe, Bodewadmi, and Odawa, known today as Anishinaabe, are descendants of the Algonquins. The Algonquins settled in the northeastern United States, but were forced to leave the area between 800 and 1600 CE due to the increasingly hostile tribes of the Iroquois nation. Given a sign to “find the land where food grows on water” the Anishinaabe migrated west to the Great Lakes region where they eventually found wild rice (*mnoomin*) that grew on slow moving rivers and inland lakes (Figure 2.10). The Ojibwe people settled the Upper Peninsula and portions of the Lower Peninsula. The Bodewadmi settled the lands south of the Kalamazoo River. The Odawa settled the Kalamazoo, Grand, and Macatawa River watersheds. Ottawa County now carried the anglicized pronunciation of the Ottawa or Odawa peoples.

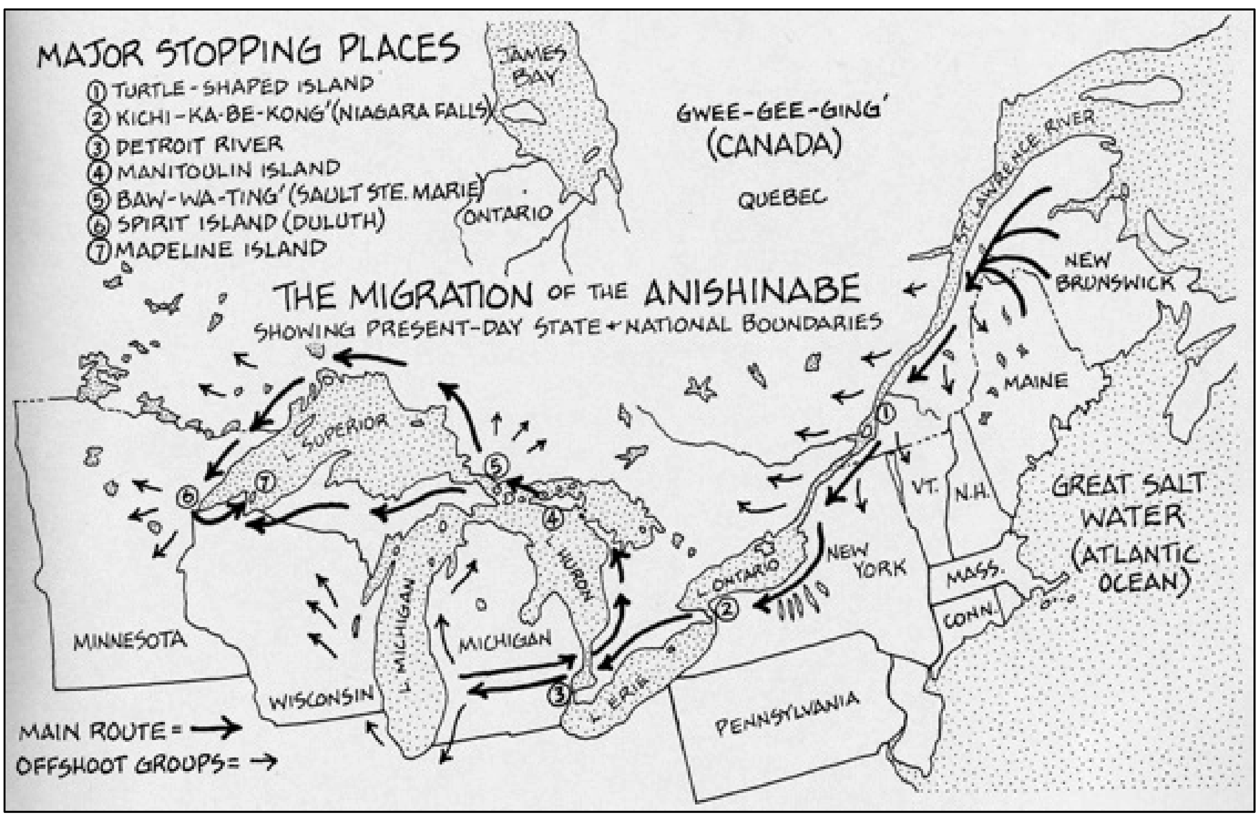

Figure 2.10 Map depicting the migration of the Anishinaabe
Source: The Mishomis Book (Benton-Banai, 1988)

The first written records of people utilizing the resources in the Macatawa Watershed were the Odawa. They were a transient people at the time of European settlement, traveling between Lake Macatawa region and Middle Village, which is near current day Traverse Bay. The Odawa used the Macatawa as their winter hunting grounds and had two major camps within the watershed: one located on the south shore of Lake Macatawa, located near the current day Heinz Pickle Factory on 16th St. in Holland, MI, and the other located in Allegan County on 40th St. near a tributary of the Macatawa River. For the summers, they traveled north to the Traverse Bay area to hunt, fish, and gather resources. The word "Odawa" means "trade" in Anishinaabemowin, the language of the Ojibwe, Odawa, and Bodewadmi peoples. They were, by accounts of the Dutch, a peaceful people. The men hunted and fished, while the women grew crops, maintained the wigwam, and cared for the children. Benefitting from the mild climate and fertile soils of the area, they often produced surpluses of corn, cranberries, and maple sugar, which, as their name implies, they would trade with other tribes for additional resources. Unlike the modern farming methods of today, most crops the Odawa farmed were grown in small open patches of ground or around tree stumps causing little man-made changes to the landscape and ecology. Hunger did not appear to be an area of concern for the Odawa, gathering and trading for all that they needed. Upon the arrival of the Europeans, the Odawa engaged with trading for furs, or pelts, from the French Fur Traders that began in the early 1600s.

Accounts from 1847-1848 by the early Dutch settlers indicate that most of the furbearers were still plentiful within the watershed. Fur traders frequented the area, but they were not as influential in the cultural history of the area as other entities. Land prospectors surveyed Holland and Lake Macatawa for the possibility of establishing it as a "paper town" or towns that dedicated to accommodating the emerging logging industry. Prospectors would buy large parcels of land, map them out, and attend to sell the plots to potential settlers. Dots appeared on local maps near Black Lake (otherwise known as Lake Macatawa), but no one ever claimed a plot of land or house and the names disappeared quickly from maps.

In 1847, the first Dutch settlers entered the Macatawa Watershed. They would have encountered the woods and swamps of West Michigan, but as it was the winter of 1846-1847, they encountered solely trees, snow, and ice. Led by a Dutch minister, Albertus Van Raalte, the group discovered the area of the Black Lake was covered with an average of two feet of snow. The Black Lake would provide ample water resources and a good harbor, giving the area potential for a successful commerce center. Though there was no way of knowing what the soil was like, Van Raalte determined with the dense forest there must be good soil underneath the snow. As early as February 1847, the Dutch settlers started arriving on the shores of Lake Macatawa, unaware of the hardships ahead of them with the change needed for the vegetation and hydrology of the region to accommodate their large colony. Prior to the arrival of the Dutch settlers, it is estimated that about 300 Odawa led by Chief Waukazoo (Wakazoo) lived in the Macatawa Watershed. The Odawa taught the Dutch the art of maple sugaring, how to cook corn in the kernel, and were paid to help clear the land around the watershed for agricultural purposes. Despite this working relationship, there was a "bitter animosity," as a Dutch settler wrote in their journal, between the Dutch and the Odawa. By 1855, the Odawa were effectively driven out of the Macatawa Watershed, heading north to their summer grounds near Traverse Bay.

Since European settlement beginning in 1847, the ecology of the Macatawa Watershed has undergone a dramatic transformation due to human land use. The settlers felt it was their duty to clear the land and to farm it, increasing its production and not wasting the resources that were so bountiful on the landscape. In the first few years of settlement, more than 3,000 acres had been cleared for farming, one acre of tillable soil for each person. Over a period of around ten years, settlers had cleared most of the trees to open farmland, especially in the higher elevation areas with the clay soils. Most of the rich top soil began to erode, causing waterways to become shallower and warmer as they filled with sediment.

The Odawa people were driven from the area, and Holland became a center of industry and tourism. In addition, most of the original wetlands were drained (Figure 2.11 and Table 2.4) to build commercial and residential properties. By using knowledge of canals from the Netherlands, the Dutch settlers were able to alter the landscape to use the wetlands as agricultural fields since they were less dense with vegetation and had rich soils. To make the area suitable for human habitation, most of the top predators were hunted and eliminated from the area, and domestic animals became the dominant species. The settler's desire to get rid of these "nuisance animals" was not just out of fear, but stemmed from their desire to see the land put to good use, and animals competed with this desire. To drain the wetlands, many of the natural river channels were straightened artificially, making some areas of the watershed more susceptible to flash flooding.

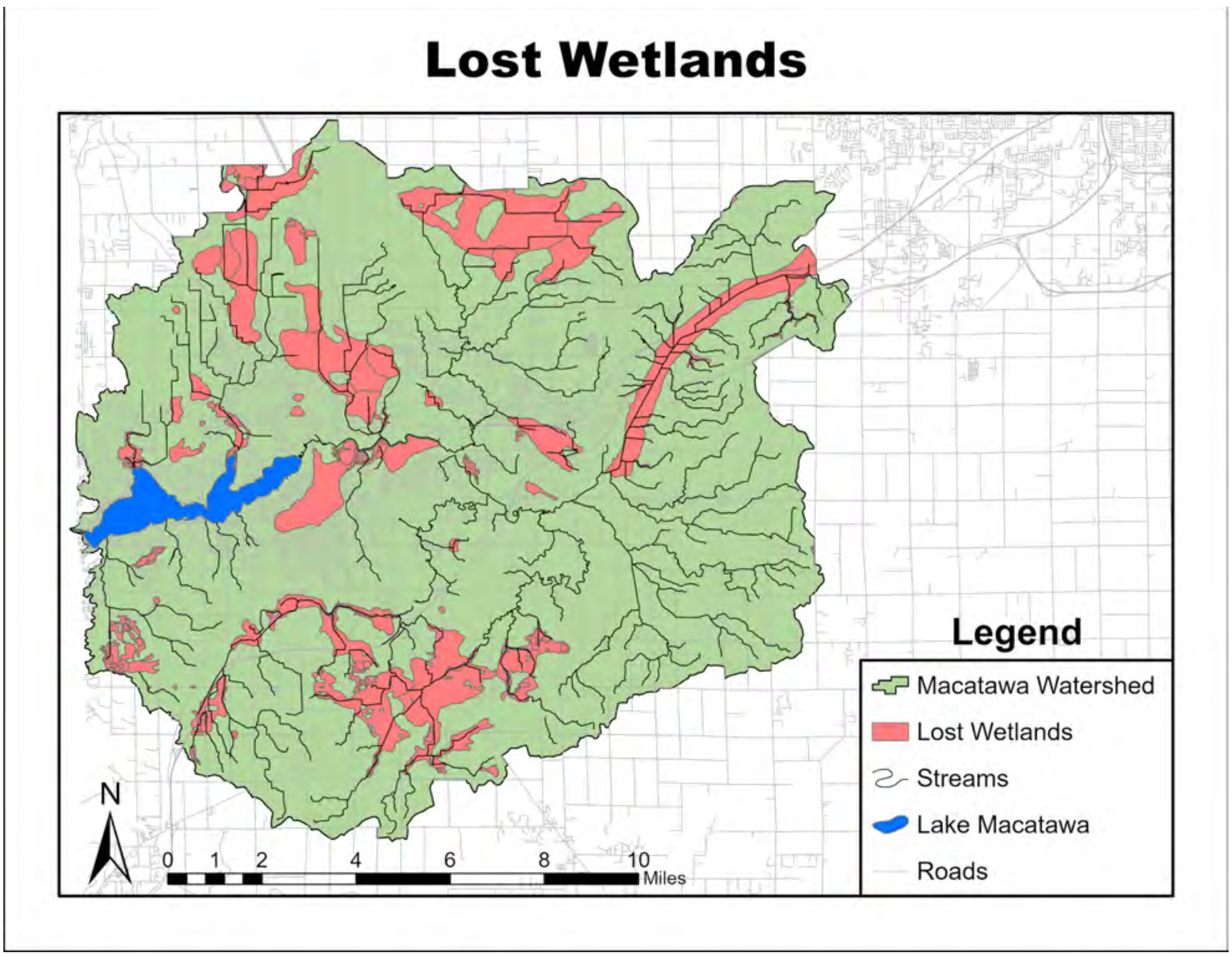

Figure 2.11 Historic wetland loss in the Macatawa Watershed
Source: Michigan GIS Open Data, MDEQ, 2010
Date Prepared: December 2024

Table 2.4 Wetland loss by subwatershed*

Wetland Loss	Upper Macatawa	South Branch	North Branch	Noordeloos Creek	Lower Macatawa	Pine Creek	Lake Macatawa Direct Drainage	Totals
Total Wetland Loss (acres)	2,121	3,104	1,498	3,315	2,119	2,672	1,749	16,578
% of total wetland loss	12.80%	18.7%	9%	20%	12.8%	16.1%	10.60%	100%

**Excludes Peters Creek since there was no wetland loss in this subwatershed*
Source: Macatawa Watershed Management Plan, 2012
Date Prepared: June 2025

Note: all information contained in this section summarized from Van Faasen, et.al, 2008.

2.6.3 Current Land Use

Due to the soil types present, land use in the Macatawa Watershed fits a noticeable pattern (Figure 2.12 and Table 2.5). Most of the higher elevation, clay soil areas are dominated by agriculture and a lack of urbanized areas. The urban areas (Cities of Holland and Zeeland and Holland Township) tend to be in the lower elevation areas dominated by the former wetlands and areas of sandy soil. According to the latest U.S. Census Bureau data, Ottawa County is the fastest growing county in Michigan, with a 12.3% change in total population from the 2010 Census to 2020 Census (U.S. Census Bureau, 2020). It can be anticipated that the percentage of land area dedicated to agriculture will continue to decrease over time with the increase in population and impervious surfaces.

Table 2.5 Land use in the Macatawa Watershed (2018)

Land Cover Type (2018)	Area (acres)	Area (%)
Agriculture	50,217	44.97
Forest	13,388	11.99
Open Land	5,136	4.60
Urban/Built Up	37,081	33.21
Water	3,067	2.75
Wetlands	2,738	2.45
Barren	42	0.04
Total Area	**111,669**	**100**

Source: Grand Valley State University, Annis Water Resources Institute
Date Prepared: June 2025

Even though runoff from agricultural land is a source of pollution in the Macatawa Watershed, sustainably managed and protected agricultural land has the potential to have the greatest positive impact on water quality. A study in *Applied Geography* found that the adverse impact of land use changes on water quality was much more substantial in less-urbanized suburban areas than in highly urbanized central cities (Tu, 2011). As of 2018, approximately 45% of the land cover in the Macatawa Watershed was farmland. The preservation of effectively managed farmland, or less-urbanized areas within the watershed, is critical to avoid compromising stream integrity and preserving pervious landscapes.

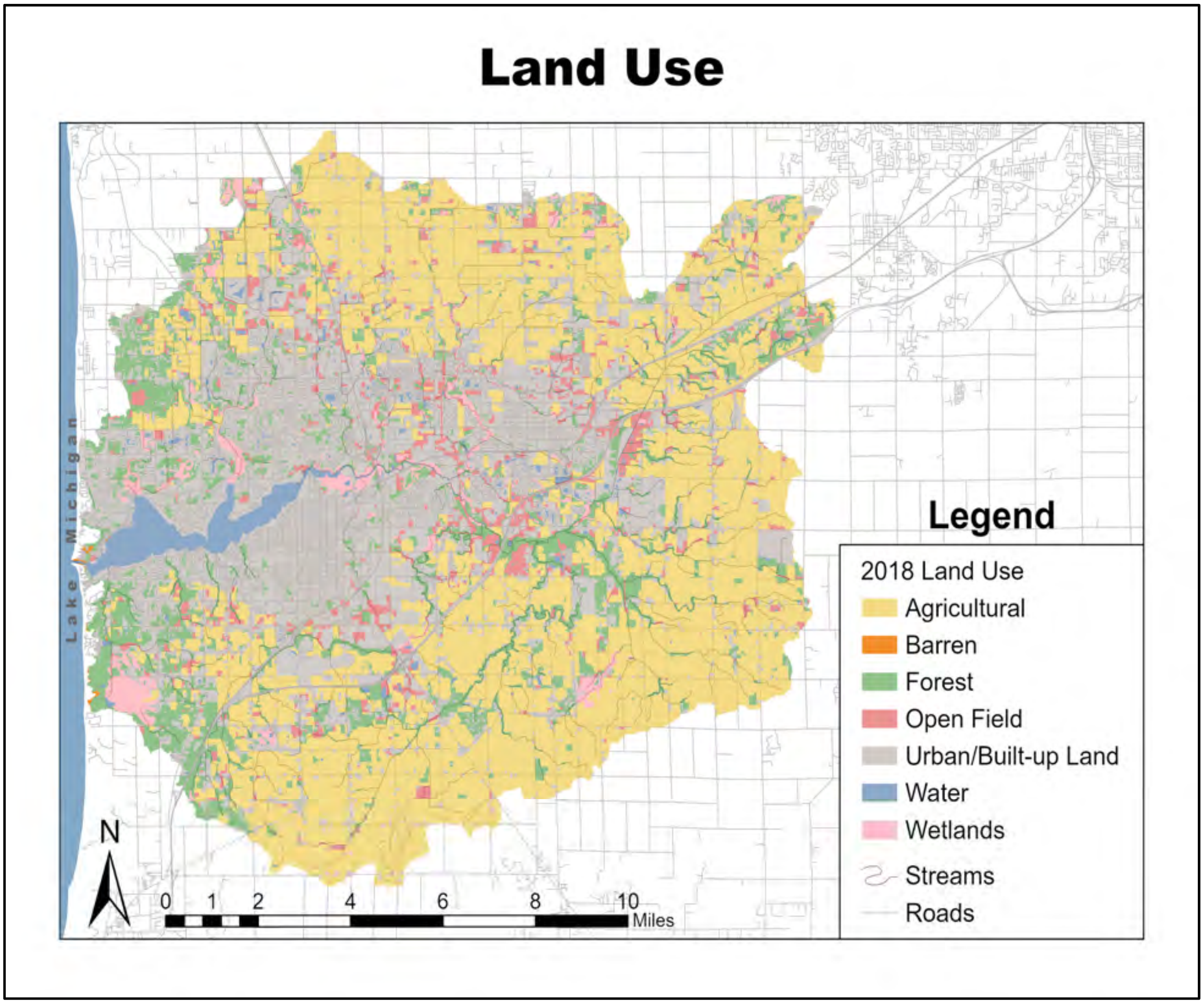

Figure 2.12 Current land use in the Macatawa Watershed (2018)
Source: Grand Valley State University, Annis Water Resources Institute
Date Prepared: December 2024

With more than 33% of the watershed in urban land use, this has a significant impact on the amount of runoff that flows directly into Lake Macatawa. What is more concerning is the urbanized area within the Macatawa Watershed only increased by 648 acres, which is 0.5% of the total acreage of the watershed. This data, along with the 13% increase in population over the past decade, gives valuable insight into where the new populations are settling: not in the urbanized area. Educational outreach and BMPs need to be focused within the suburban and agricultural areas where population growth will have more of an impact in the future.

The land within the Macatawa Watershed has changed significantly since pre-settlement times (Figure 2.13). Two overriding trends have made the largest impact on water quality; the first is the removal of forested areas in favor of farmland by early settlers, and the second is the expansion of built-up areas at the expense of that farmland. These changes negatively impacted the hydrology of the watershed which correlates to the degradation of water conditions. While there has been some expansion and restoration of wetlands and forested areas in recent years, minimizing the amount of impervious surface going forward will be a key land use goal for keeping, maintaining, and improving water quality.

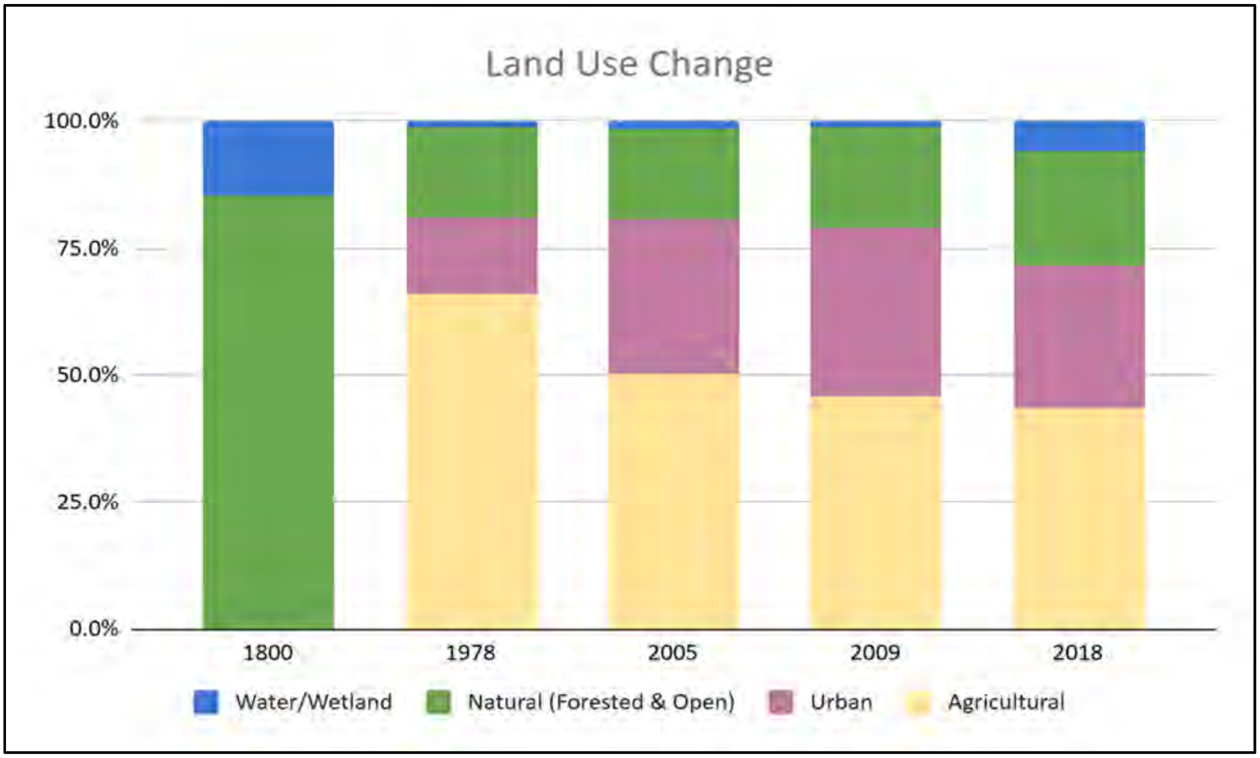

Figure 2.13 Land use change in the Macatawa Watershed over time
Sources: Macatawa Watershed Management Plan (2012) and Grand Valley State University, Annis Water Resources Institute
Date Prepared: December 2024

2.6.4 Demographics of the Macatawa Watershed

Overall, the watershed area has a population of approximately 128,000 people according to the latest US Census Bureau data (2020, Figure 2.14). The City of Holland lies completely within the Macatawa Watershed, bordering Lake Macatawa, and contains approximately 27% of the watershed's population (about 34,000 people) while occupying only 10% of the total land area (population density 1,994 persons per square mile).

While most watershed residents identify themselves as "white," about 16.5% identify themselves as Hispanic or Latino and 5.4% are of Asian descent. However, the Hispanic community centers in the urban areas, so a better characterization of the minority population is best displayed through examining

City of Holland's demographics. See the Social Survey Analysis and Information and Education (I&E) Recommendations for a more complete description of community demographics.

The 2020 Census Data (City of Holland statistics) indicate that of the total population:

- 6.9% are foreign born (51.4% of which are not a U.S. Citizen)
- 23.4% are Hispanic or Latino origin, 4.2% are African American, 2.8% are Asian, 11.5% claim two or more races
- 14.7% speak a language other than English in the home,
- 10.6% are below the poverty level, median household income is $58,796
- 9.7% of those 25 years and older have not attained a high school diploma

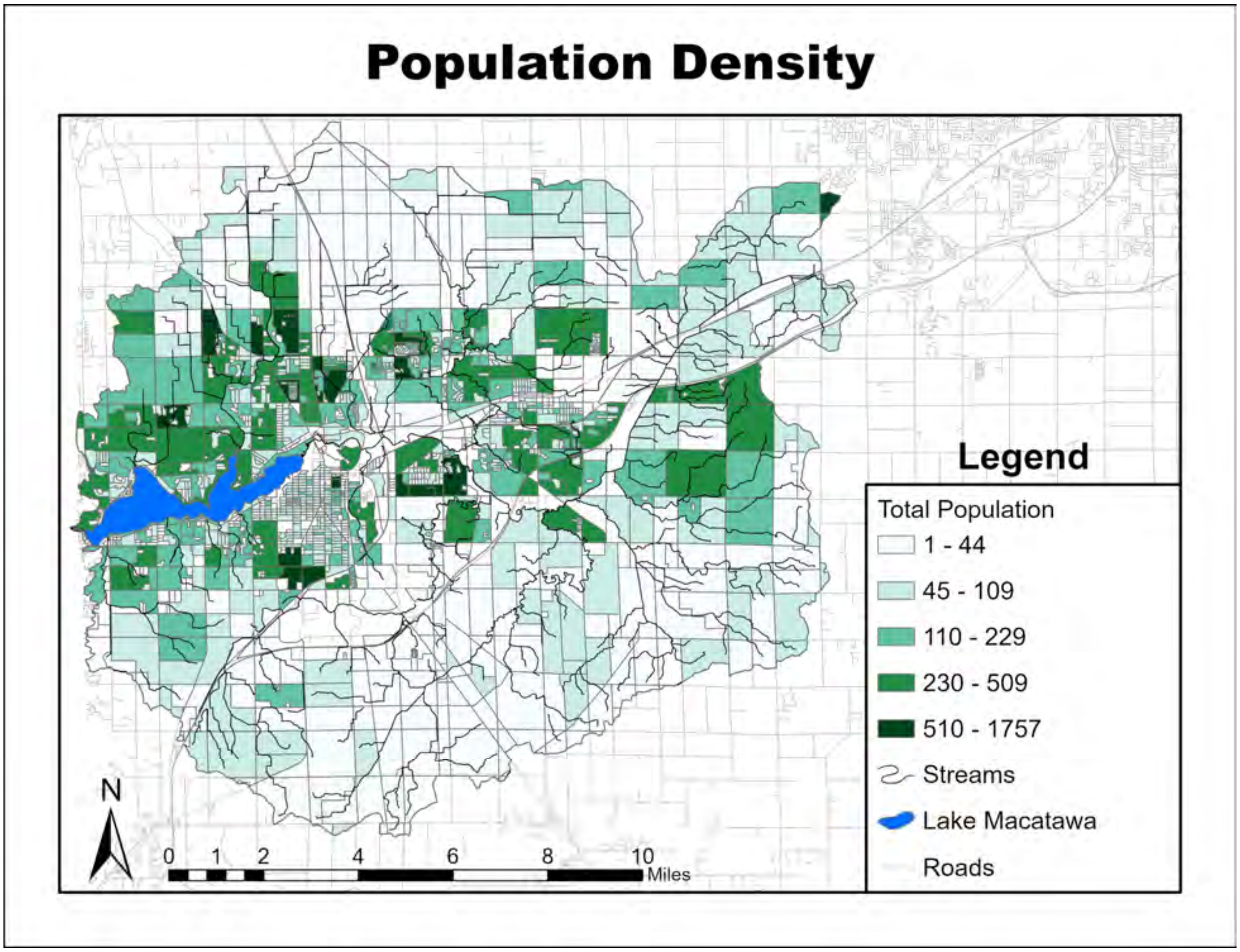

Figure 2.14 Population density in the Macatawa Watershed
Source: US Census Bureau
Date Prepared: December 2024

2.7 Hydrology of the Macatawa Watershed

2.7.1 Surface Hydrology

Lake Macatawa, in southern Ottawa County, Michigan, is an 1800-acre (2.75 mi^2) drowned river mouth that empties into Lake Michigan (Figure 2.15). On its west end, Lake Macatawa narrows and is connected to Lake Michigan by a man-made channel built by the Dutch settlers around the time of the Civil War, and later maintained and improved by the United States Army Corps of Engineers (USACE). USACE dredges the channel almost every year to a depth of twenty-three (23) feet, allowing large commercial vessels to move freely between the lakes. This connection also keeps the surface elevation of Lake Macatawa the same as that of Lake Michigan, around 580 feet above sea level.

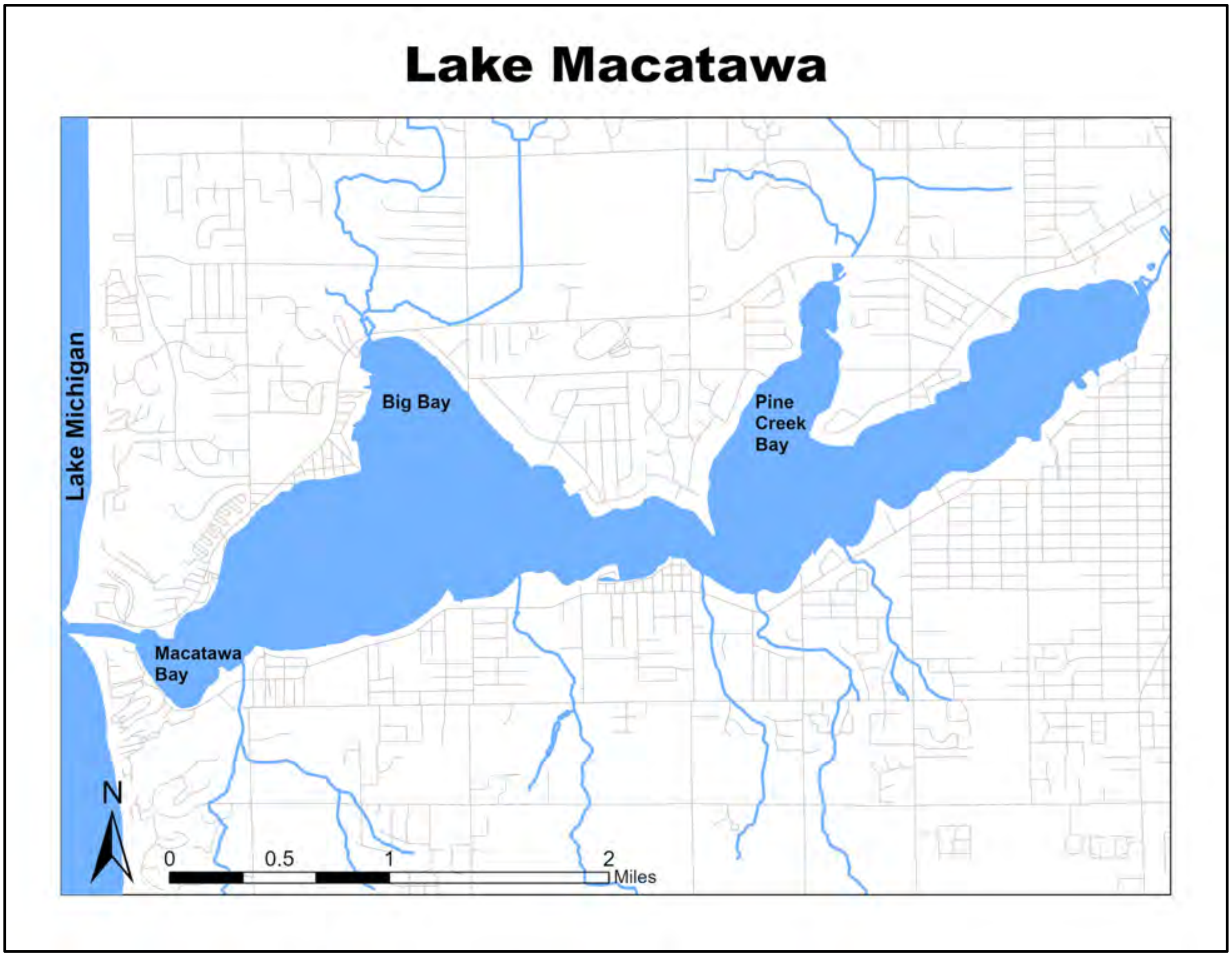

Figure 2.15 Lake Macatawa
Source: Michigan GIS Open Data
Date Prepared: December 2024

Surrounding and flowing into Lake Macatawa is a series of small rivers and creeks (Figure 2.16). The Macatawa River is the most prominent of these, flowing into the east end of Lake Macatawa with almost 90 percent of the total water volume that enters the lake. Many smaller rivers, creeks, and drains empty into the Macatawa River as well, dividing the watershed into seven (7) major subbasins and 55 minor subwatersheds (Figure 2.17 and Table 2.6). Pine Creek is the second largest tributary, flowing through the northern portion of the watershed and emptying into Pine Creek Bay. The Macatawa Watershed is one of many watersheds found around Lake Michigan. All the watersheds of Michigan are part of the Great Lakes Drainage Basin, which empties through the Saint Lawrence River into the Atlantic Ocean.

According to a hydrology study of the Macatawa Watershed conducted in 2009 by MDEQ, the Macatawa Watershed's profile is typical, although the main branch (Macatawa River) is flatter than its tributaries. (Fongers, 2009, Figure 2.18). In all cases, however, the rivers and tributaries found in the watershed are significantly straighter in course than the original pre-settlement paths due to human modification. As a result, surface water moves more quickly through the watershed, making many low-elevation areas more susceptible to flash floods.

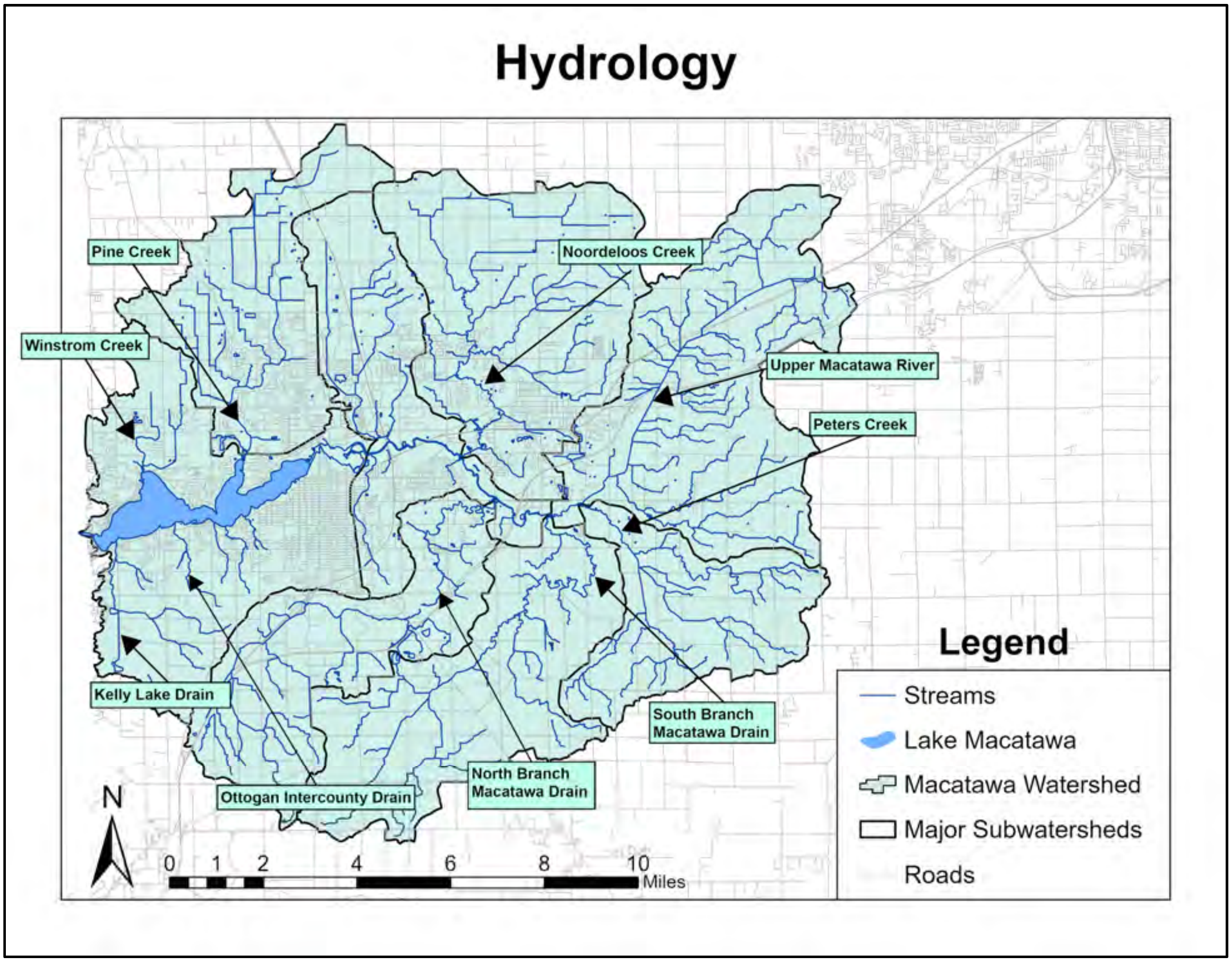

Figure 2.16 Macatawa Watershed surface hydrology
Source: Michigan GIS Open Data
Date Prepared: December 2024

Lake Macatawa has an approximate surface area of 1,800 acres (2.75 mi^2) and is a drowned river-mouth lake. The average depth of Lake Macatawa is about twelve (12) feet, which is quite shallow in comparison with many other West Michigan lakes. The maximum depth is 38 feet in Big Bay. The shape of the lake is long and slender with two bays on the north side: Big Bay and Pine Creek Bay. It is approximately four and a half miles long, and varies in width from 870 feet at its narrowest (Superior

Point) to 6,035 feet at its widest (Big Bay). Lake Macatawa contains approximately seven (7) billion gallons of water or almost thirty (30) million tons of water at a time.

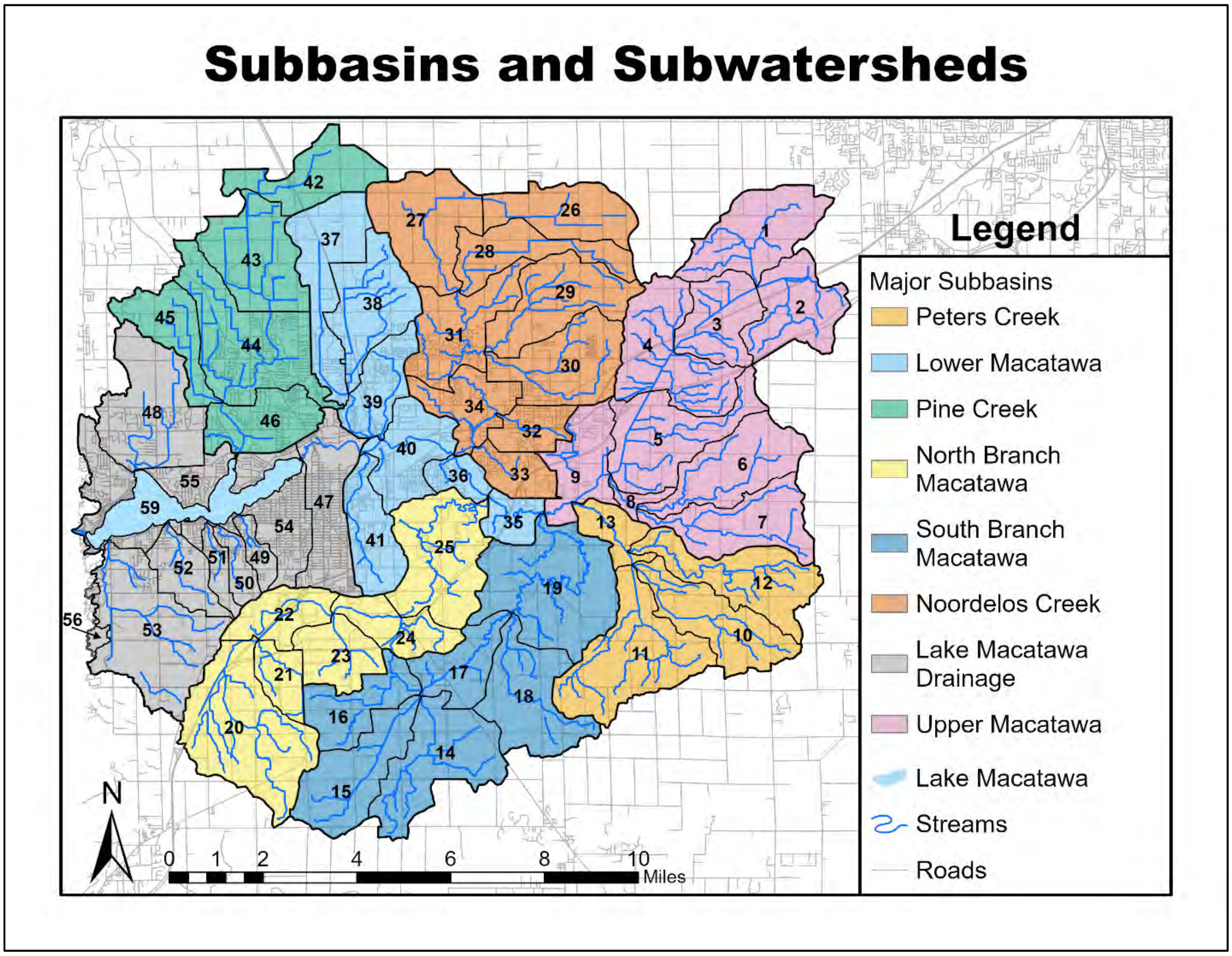

Figure 2.17 Macatawa major subbasins and minor subwatersheds
Source: EGLE
Date Prepared: December 2024

Table 2.6 Land area of the subbasins and subwatersheds of the Macatawa Watershed

Subwatershed	Name	Subwatershed Area (acres)	Major Subbasin	Subbasin Area (acres)
1	Beaver Dam Drain to Macatawa River	2492.77	Upper Macatawa River	18,528
2	Macatawa River to Beaver Dam Drain	2045.74		
3	Macatawa River at 72nd Avenue	1712.63		
4	Macatawa River at I-196 Overpass	2901.59		
5	Macatawa River at Hunderman Creek	2697.68		
6	Big Creek to Hunderman Creek	2406.82		
7	Hunderman Creek to Big Creek	2297.51		
8	Hunderman Creek to Macatawa River	255.43		
9	Macatawa River to the South Branch	1717.95		
10	Unnamed tributary to Peters Drain	2326.06	Peters Creek	9,102
11	Peters Drain	3428.88		
12	Unnamed tributary to Peters Creek	2502.78		
13	Peters Creek to Macatawa River	844.35		

Subwatershed	Name	Subwatershed Area (acres)	Major Subbasin	Subbasin Area (acres)
14	Kleinheksel Drain to South Branch	2868.34	South Branch Macatawa River	14,993
15	Jaarda Drain to South Branch	2412.79		
16	South Branch Macatawa River to Jaarda Drain	1652.09		
17	South Branch Macatawa River to Unnamed Tributary near 146th	1441.12		
18	East Fillmore Drain (including Eskes Drain)	2605.11		
19	South Branch Macatawa River to Macatawa River	4013.93		
20	Uppermost North Branch Macatawa River	4072.93	North Branch Macatawa River	11,989
21	Vanderbie Drain and Rotman Drain	847.72		
22	North Branch Macatawa River to Den Bleyker Drain	1290.41		
23	Den Bleyker Drain	1415.37		
24	North Branch Macatawa River at M-40	1314.07		
25	North Branch Macatawa River to Macatawa River	3048.36		
26	Bosch and Hulst Drain at 104th Avenue	1976.51	Noordeloos Creek	17,006
27	Bosch and Hulst Drain to Noordeloos Creek	2727.12		
28	Tributary to Bosch and Hulst Drain	1754.11		
29	Hunters Creek to Brower Drain	2470.37		
30	Brower Drain to Hunters Creek	2498.77		
31	Noordeloos Creek to Drain #52	2227.08		
32	Cedar Drain to Noordeloos Creek	931.89		
33	Drain #4 and #43 to Noordeloos Creek	942.69		
34	Noordeloos Creek to Macatawa River	1477.23		
35	Macatawa River to the North Branch	732.14	Lower Macatawa River	10,992
36	Macatawa River to Noordeloos Creek	639.38		
37	North Holland Creek to Drain #40	2476.62		
38	Drain #15 and #17 to Drain #40	2308.86		
39	Drain #40 to Macatawa River	1406.12		
40	Macatawa River to Windmill Island	1825.43		
41	Maplewood Intercounty Drain to Macatawa River	1602.84		
42	Troost and Boven Dam Drains to Harlem Drain	1876.83	Pine Creek	11,136
43	Harlem Drain at Quincy St	2534.92		
44	Pine Creek to Drain #37	3516.6		
45	Drain #37 to Pine Creek	1507.96		
46	Pine Creek to Lake Macatawa	1700.04		
47	Macatawa River marsh	2283.27	Lake Macatawa Tributaries	15,966
48	Winstrom Creek and Drains #20A, #23, #53 to Lake Macatawa	3171.52		
49	Old Lela Drain	445.91		
50	Weller Drain	527.52		
51	Arbor Creek	457.66		
52	Ottogan Intercounty Drain	1135.4		
53	Kelly Lake Drain	3922.8		
54	East Lake Macatawa Direct Drainage	1968.48		
55	West Lake Macatawa Direct Drainage	2054.05		
Totals		**109,712**		**109,712**

Source: Macatawa Watershed Management Plan, 2012
Date Prepared: June 2025

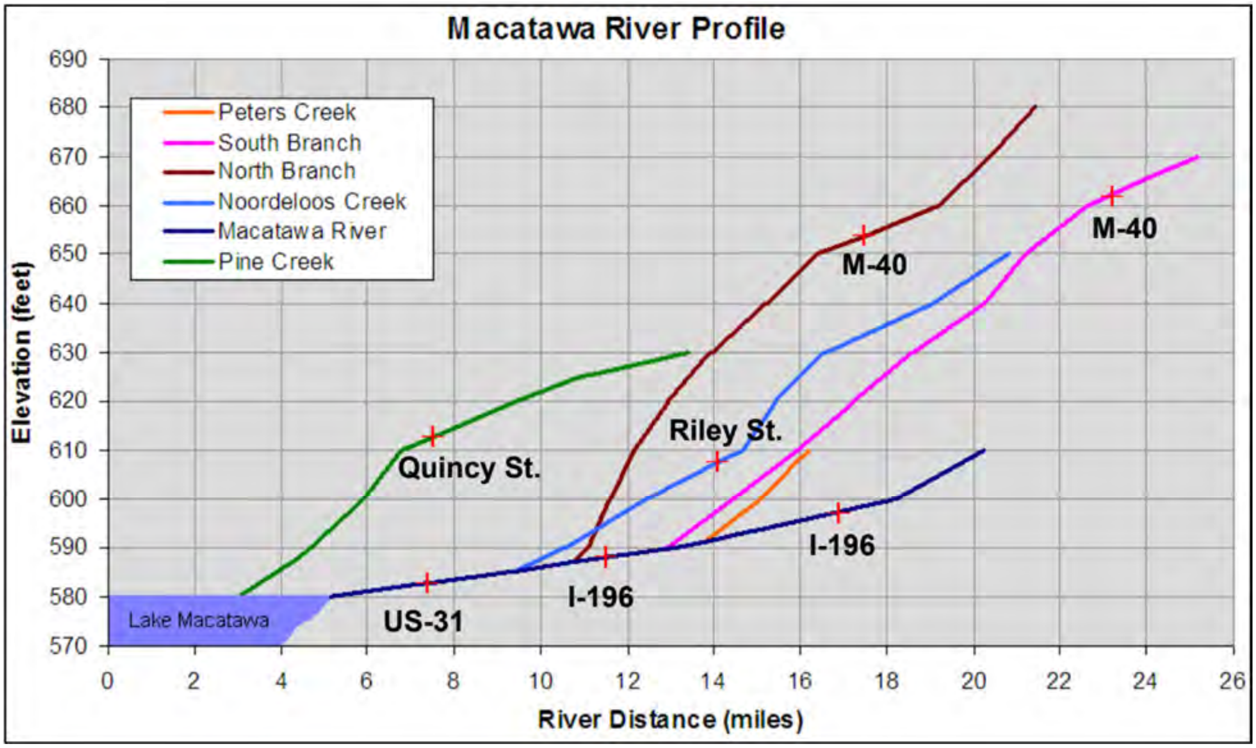

Figure 2.18 Cross-sectional profile of the Macatawa River and major tributaries
Source: Fongers, 2009
Date Prepared: original image in Fongers, 2009

2.7.2 Stormwater Management

Along with the natural rivers and other forms of drainage, there is a significant amount of stormwater infrastructure in the urbanized areas of the watershed. As a result, management of stormwater runoff is a significant concern in the watershed. The stormwater drainage system in the Macatawa Watershed is a municipal separate storm sewer system (MS4) owned and operated by a variety of public entities (Table 2.7). These entities must operate their MS4 systems in accordance with the MS4 permit issued by EGLE. The permit requires the following minimum measures:

- **Authorized Discharges** that include maintaining an inventory of all permittee owned outfalls and points of discharge. There are approximately 1,086 outfalls and points of discharge located in the Macatawa Watershed.
- **Stormwater Management Program** (SWMP) that includes the following elements:
  - **Enforcement Response Procedure** that outlines procedures related to compelling compliance with the permittee's related ordinances to prevent stormwater pollution.
  - **Public Participation Program** to encourage involvement of the public in implementation and periodic review of the SWMP.
  - **Public Education Program** that requires a plan to address ten (10) stormwater related topics (See Chapter 7 for further details).

- **Illicit Discharge Elimination Program** that outlines a procedure to detect and eliminate illicit discharges and connections to the permittee's MS4. This includes periodic required screening of outfalls and points of discharge during dry weather and employee training on how to carry out screenings and related procedures.

- **Construction Stormwater Runoff Control Program** to address runoff from construction sites. Permittees manage this through the Part 91 Soil Erosion and Sedimentation Control program within each municipality.

- **Post-Construction Stormwater Runoff Program** to enforce management of stormwater after new construction is complete. This includes requirements to comply with channel protection and water quality treatment performance standards set by the state as well as enforcing maintenance and proper operation of private stormwater systems in perpetuity.

- **Pollution Prevention and Good Housekeeping Activities for Municipal Operations** to prevent or reduce pollutant runoff from municipal facilities and operations. This includes implementing best practices to prevent stormwater pollution as well as inspecting and maintaining stormwater infrastructure. Employee training is required to ensure that everyone is implementing best practices and completing inspections appropriately.

- **Total Maximum Daily Load (TMDL) Implementation Plan** to reduce the discharge of TMDL pollutants from the permittees MS45 to make progress toward meeting water quality standards. This includes implementing BMPs specific to the TMDL and conducting periodic water quality monitoring.

Table 2.7 MS4 permittees in the Macatawa Watershed as of 2025

Municipality Name	Permit Number
City of Holland	MI0060217
City of Zeeland	MI0060218
Allegan County	MI0059970
Allegan County Road Commission	MI0059965
Ottawa County	MI0059969
Ottawa County Road Commission	MI0059962

Source: MiEnviro
Date Prepared: June 2025

Because the Macatawa Watershed contains all or portions of two cities and nine townships, and townships are not currently required to have MS4 permit coverage, there is a lack of continuity in ordinance language regarding stormwater management and other types of water quality and environmental protections. In the summer of 2022, the ODC Network completed an ordinance review as a part of developing a climate resilience plan that compared language used by local municipalities (Appendix A, see Chapter 6 for full ordinance review). The goal of this effort is to encourage all municipalities to adopt language that is uniform, and ensure the protection of the natural and built environment from flood damage. Additional policy changes or adoption may also be needed at the county level to further support stormwater management to protect water quality and manage quantity.

Certain areas in the Macatawa Watershed are more prone to flooding than others, and the Federal Emergency Management Agency (FEMA) has analyzed these areas and created flood risk (FIRM) maps (https://msc.fema.gov/portal/home).This is a useful tool for communities and landowners to help assess flood risk, and determine mitigation strategies. In addition, flood risk areas also serve as good targets for mitigated wetlands. Over the past decade, Project Clarity has been able to restore some land closer to its pre-settlement state. Due to their ability to catch and slow some runoff, the susceptibility of some areas to flash flooding should be reduced by these efforts.

2.7.3 Wetlands

As mentioned above in Section 2.6.2, settlers drained much of the original wetlands that existed in the Macatawa Watershed. Wetlands are a critical part of the water cycle, providing flood control, groundwater recharge, and erosion control. The loss of wetlands, along with human straightening of water channels allows rainfall and snowmelt to move more quickly through the system, thus increasing the risk of flash flooding and streambank erosion.

Historic wetlands in the Macatawa Watershed were largely swamps with varying plant communities, including ash, cedar, and assorted hardwoods. There were smaller areas of emergent wetlands and marshes closer to the lake and its major bays. Today, many of the remaining wetlands are close to the river corridors along with the extensive marsh at the east end of the lake (Figure 2.19). Many of these are in locations and on topography that were inaccessible for settlers to drain.

Since the turn of the 21st century, there has been a concerted effort to replace some of these lost wetlands to regain some of the historic floodplain capacity and wetland habitats. Projects undertaken by Ottawa County Parks and the ODC Network involved securing large tracts of low-lying land and restoring wetlands. Projects include the Upper Macatawa Natural Area (former row crops), Paw Paw Park East (golf course), Middle Macatawa (pasture), and the Macatawa Mitigation Bank (row crops). Smaller restoration projects have been constructed on properties owned by Zeeland Public Schools, the Holland Board of Public Works, Gentex Corporation, the Outdoor Discovery Center, and other private landowners. These projects help provide some of the lost habitat and flood capacity, but still pale in comparison to what was once in the watershed. Historic human activity negatively impacted significant portions of the remaining wetlands in the watershed, which are often dominated by plant monocultures that are either non-native (reed canary grass, hybrid narrowleaf cattail) or species not readily eaten by livestock (hawthorn).

Approximately 86% percent of pre-settlement wetlands in the Macatawa Watershed have been lost (See Figure 2.11, MDEQ, 2010). This represents a significant change in the landscape and has had negative impacts to watershed hydrology. Although Project Clarity has made efforts to reclaim wetlands and stabilize stream banks through land acquisition and restoration, the current amount of wetland land use is a small percentage of what it used to be (Figure 2.19).

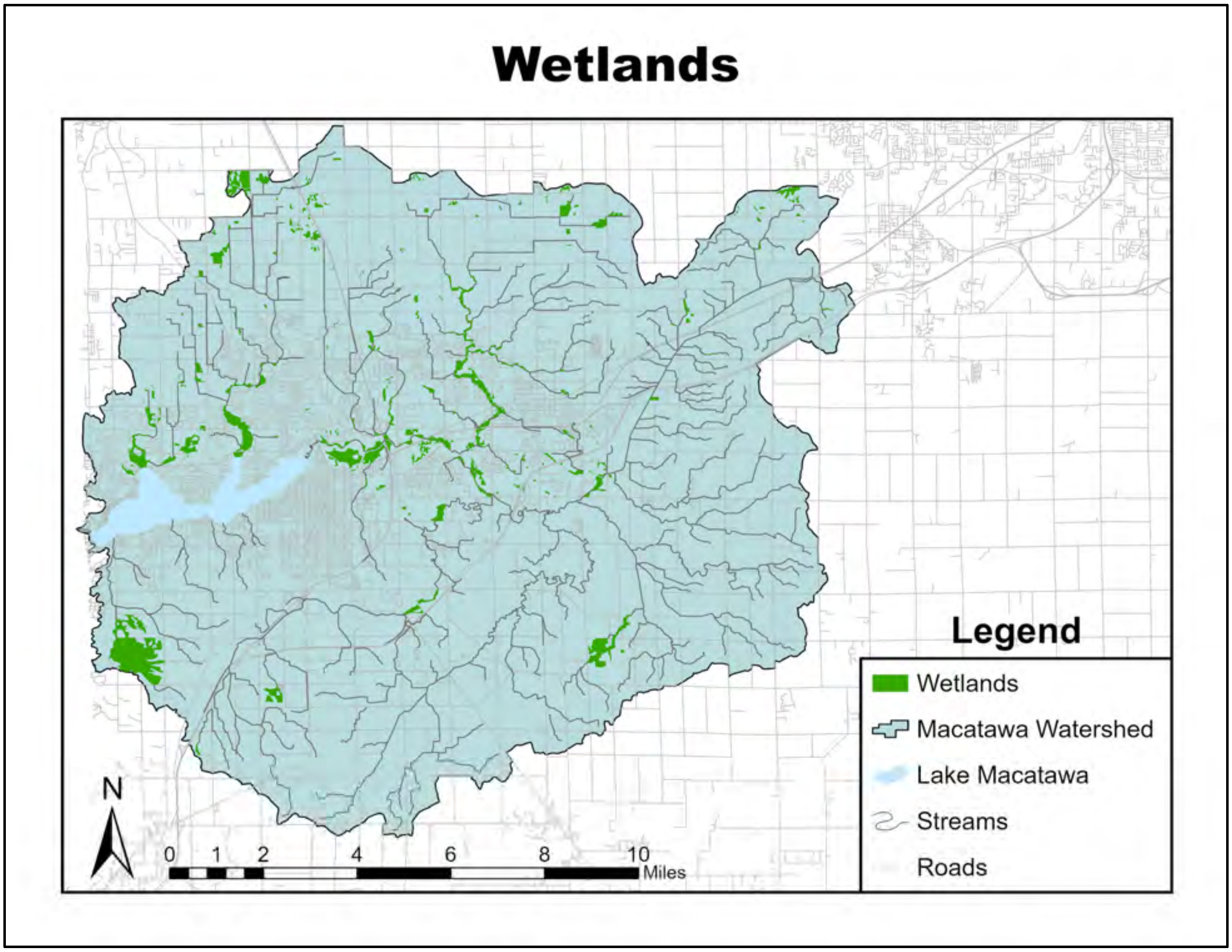

Figure 2.19 Current wetlands (2018) in the Macatawa Watershed
Source: Grand Valley State University, Annis Water Resources Institute
Date Prepared: December 2024

2.7.4 Groundwater

Ottawa County

Groundwater is a vital part of the Lake Macatawa watershed and serves as a primary source of drinking water for communities in Michigan. While this WMP primarily addresses surface water issues and NPS pollution, the association of groundwater and surface water makes groundwater an important focus due to their mutual influence.

In recent years, residents, agricultural operations, and businesses around Ottawa County have increasingly reported groundwater problems, such as reduced availability and rising sodium chloride levels in certain wells. In response, the Ottawa County Board of Commissioners engaged the Michigan State University (MSU) Institute of Water Research (IWR) to conduct a two-part investigation. The goal was to develop a comprehensive understanding of the county's groundwater status and offer preliminary decision-making tools for local officials (MSU, 2013 and Curtis et al., 2018).

This research revealed that homes and farms not connected to municipal water systems depend on two different groundwater sources. The first source, shallow aquifers, consists of small pockets of groundwater located at depths ranging from 5 to 75 feet. Surface water inputs, such as rain and runoff, frequently replenish these aquifers are. However, in many areas of the watershed, shallow aquifers are either absent or insufficiently productive.

The second source is the deep bedrock aquifer, commonly known as the Marshall Formation, which lies between 100 and 300 feet below the surface. While the deep bedrock aquifer has long been utilized, it faces a major limitation due to the presence of a unique clay barrier that restricts its natural recharge from surface water. As a result, this aquifer is not sustainably replenished. Increased groundwater extraction has caused a steady decline in water levels, forcing well users to drill deeper (Figure 2.20). Unfortunately, deeper drilling leads to proximity with the salt-brine deposits found at the bottom of the aquifer, causing the brine to mix with the pumped water.

The MSU study identified specific areas at risk of significant aquifer drawdowns and high chloride concentrations (Figure 2.21). The observed reductions in groundwater quantity and quality are likely caused by natural brines within the Marshall Formation, which have been drawn upward due to increased pumping from both bedrock and glacial aquifers since 1999. This has contributed to declining Static Water Levels (SWLs) in wells and has exacerbated groundwater quality issues in the region.

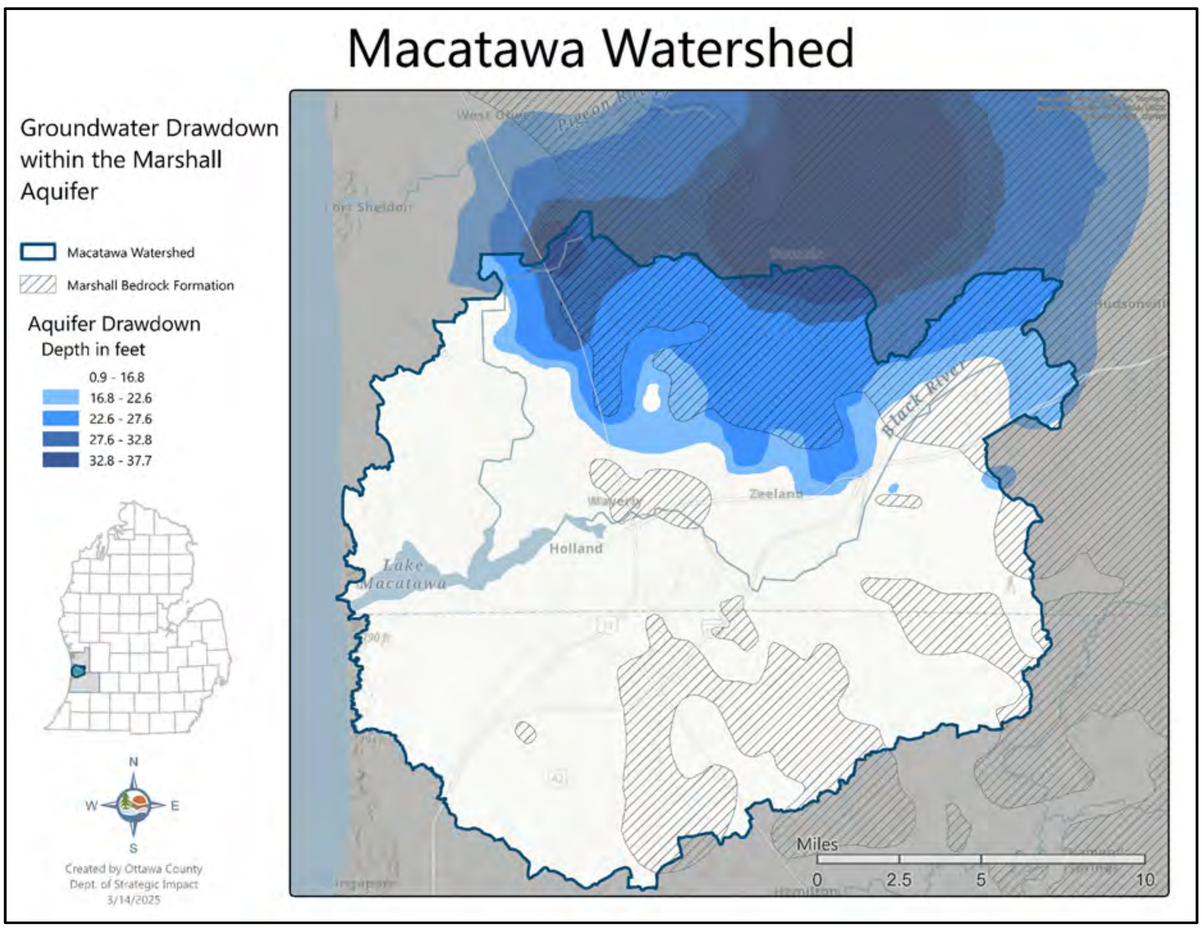

Figure 2.20 Marshall Aquifer drawdown in the Macatawa Watershed
Source: Ottawa County Department of Strategic Impact
Date Prepared: February 2025

As groundwater levels continue to drop and mineral concentrations, particularly chloride, increase, more regions around Lake Macatawa will experience deteriorating water quality. This may result in dry wells, crop losses, plumbing damage, and potential health risks. The MSU study also noted that a significant portion of groundwater recharge in Ottawa County comes from outside its borders.

To mitigate these concerns, the county has initiated the Groundwater Sustainability Initiative, which promotes responsible water use and conservation measures. More information is available at [Ottawa County Groundwater Sustainability](#).

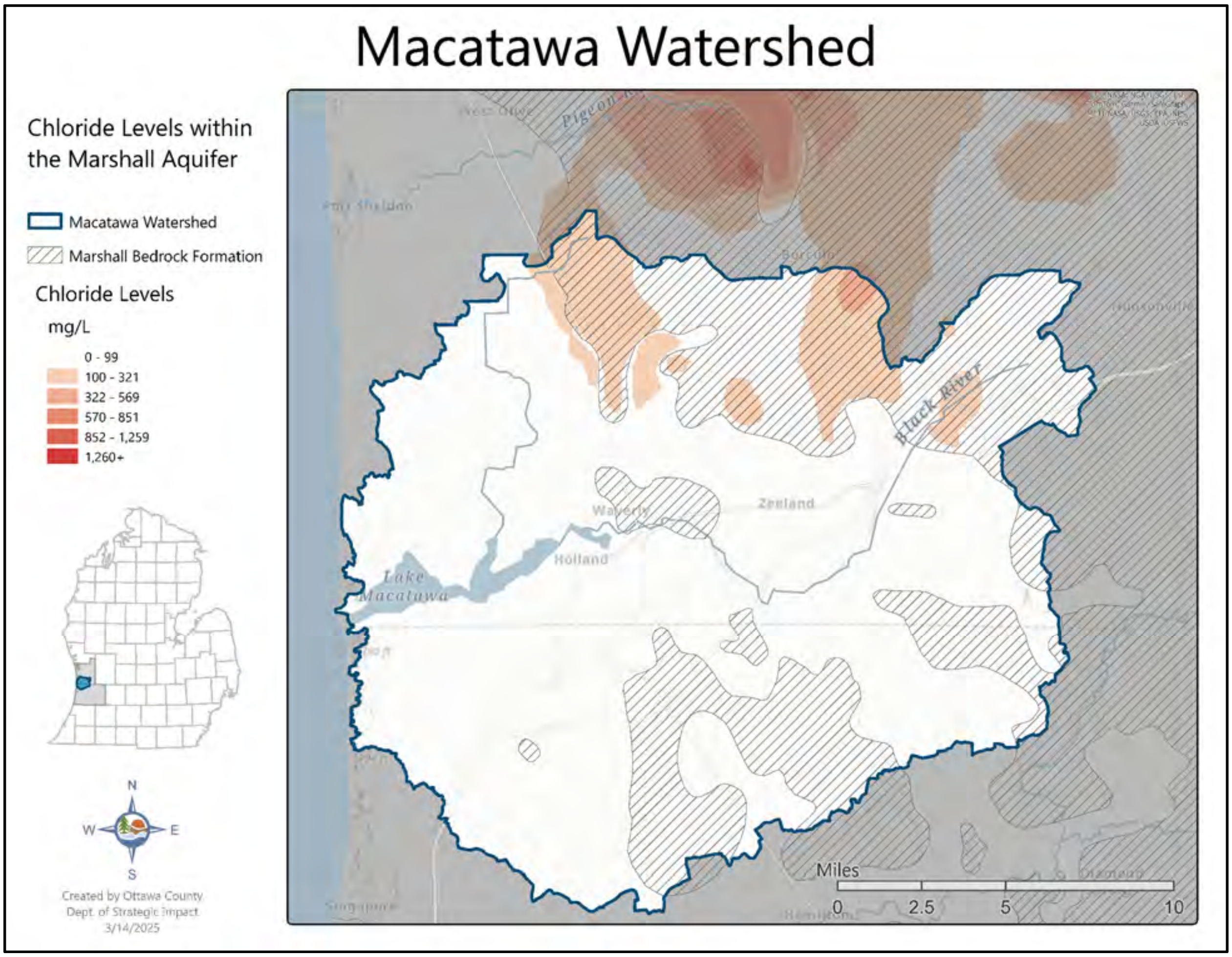

Figure 2.21 Chloride levels in the Macatawa Watershed, Ottawa County
Source: Ottawa County Department of Strategic Impact
Date Prepared: February 2025

Allegan County

A comprehensive review of available information, including the Allegan County Water Resources Study conducted by Hydrosimulatics, Inc., reveals a need for sustainable groundwater management in Allegan County. The study, a collaborative workgroup of experts with both big picture and local approaches, highlights a significant rise in groundwater use driven by expanding agricultural activities and population growth (Allegan County, 2021). As an ad-hoc workgroup, Allegan County formed the team in December 2019 to conduct an Allegan County Groundwater Survey. They completed the survey in

December 2020, and the findings provided valuable insights into the current state of groundwater resources in the county.

The study found that 100% of respondents considered a safe and sufficient water supply to be crucial. However, 71% expressed uncertainty about the availability of water in the future, indicating a growing concern about the sustainability of groundwater resources. Additionally, 66% of respondents were unfamiliar with the concept of wellhead protection areas, highlighting a lack of understanding about the importance of protecting groundwater sources from contamination (Allegan County, 2024).

The study's finding highlights a growing demand for water resources in the Allegan region, specifically Wayland, Plainwell, Hopkins, and Laketown townships. Only 5% of planned developments intended to use municipal water, while 7% are in these areas. This suggests a potential shortage of supply if not addressed. Given the low percentage of planned developments intending to use municipal water, it is important to consider safe alternative water sources or implement measures to expand municipal water infrastructure. Recharge of the aquifer is generally largest in the central portions of the county, north and south-southeast of Lake Allegan, and along the upper and middle reaches of the Kalamazoo River (Figure 2.22). Recharge is generally low in the upland areas of Fillmore and Overisel Townships and in the portions of Casco and Ganges Townships (and Saugatuck Township, to lesser degree).

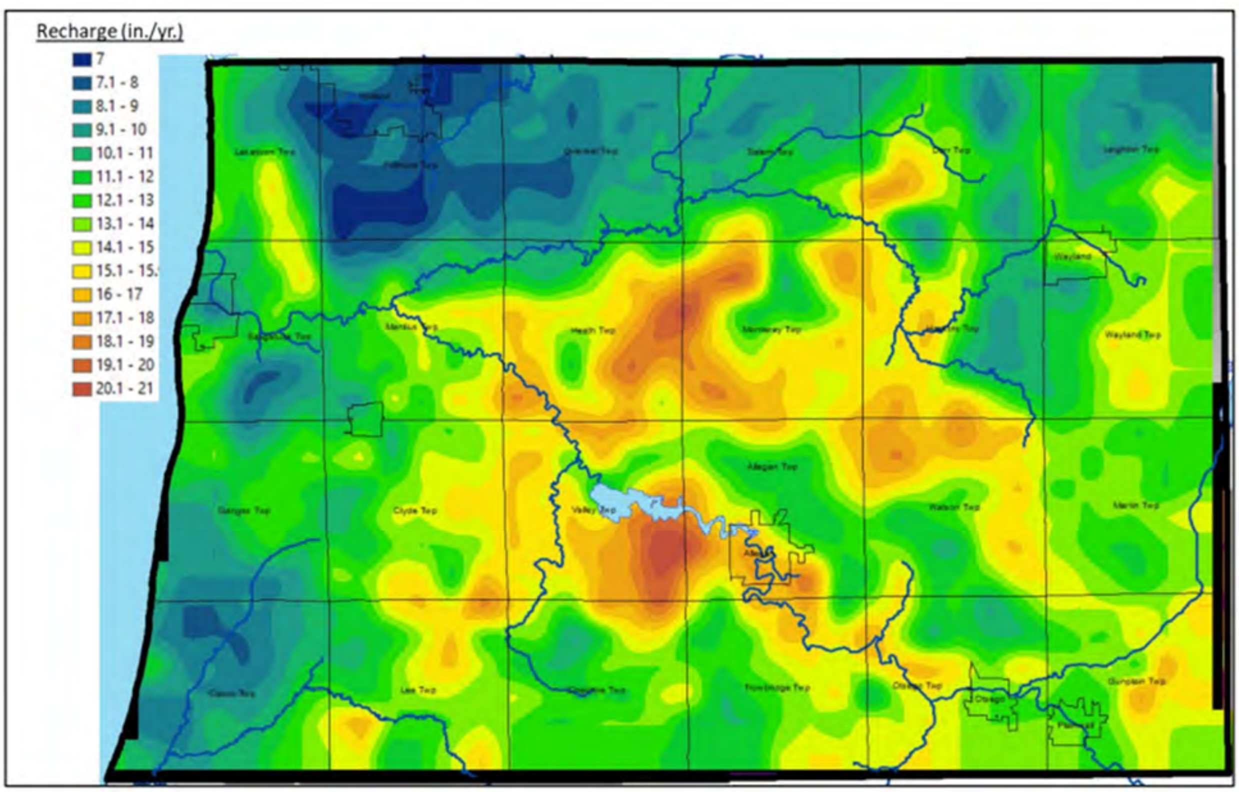

Figure 2.22 Estimates of long-term mean recharge rate, Allegan County
Source: Allegan County Health Department (Allegan County, 2021)

The workgroup also emphasizes the importance of education and awareness regarding groundwater resources, contamination areas, wellhead protection areas, and the need for continued investigation of contaminated sites by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). Additionally, the workgroup suggests expanding municipal water systems to accommodate future development, particularly in areas with high groundwater demand. These findings underscore the need for effective groundwater management strategies to address public concerns and ensure the long-term sustainability of Allegan County's water resources. The water table is generally higher in the majority of the watershed with some areas of drawdown in southwest Fillmore and Overisel Townships (Figure 2.23).

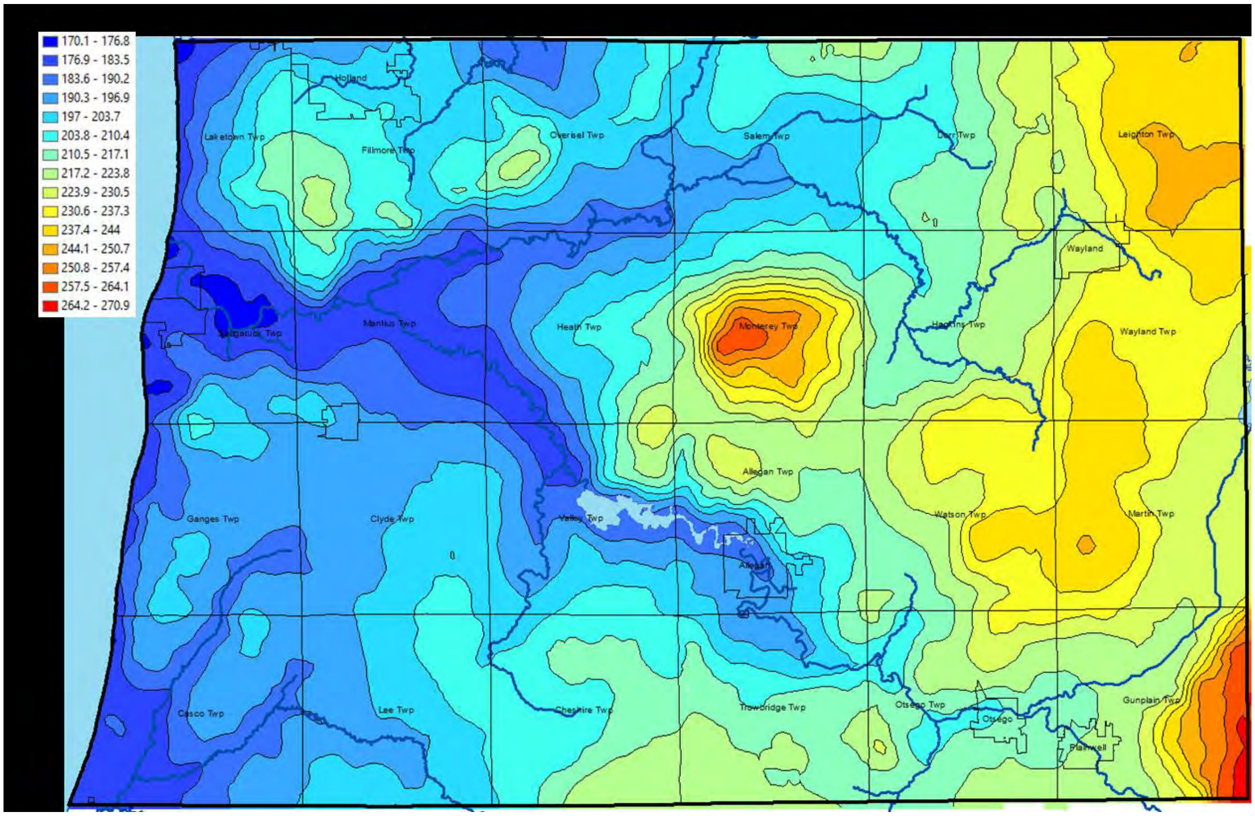

Figure 2.23 Long-term mean water table pattern in the glacial aquifer in Allegan County.
Source: Allegan County Health Department, (Allegan County, 2021)

2.7.5 Designated County Drains

The Michigan Drain Code (Public Act 40 of 1056, as amended) is the law that governs the responsibilities of County Drain Commissioners/Water Resources Commissioners (CDCs/WRCs). The CDCs are responsible for the construction, operation, and maintenance of established county drains. Most of the streams in the Macatawa Watershed, including the main channel of the Macatawa River, have been altered for efficient drainage and/or maintained as designated county drains (drain maps are available via interactive maps on each county's website: Ottawa County and Allegan County). As such, they may no longer provide some of their natural functions described in previous sections, but instead provide other important functions necessary for use of the land by humans. Because county drains are often created or maintained by dredging, it is important to understand the difference between designated county drains and natural streams to identify the potential for water quality, instream habitat and other stream functions.

Roadside ditches, agricultural field tile lines, and curb and gutter systems, are all part of an efficient drainage system that has been designed to bypass the natural processes that might cause standing water and flooding. Field drains leading to ditches and streams are commonplace in agricultural areas, and numerous in the agricultural areas of the Macatawa Watershed. Because the area was mostly wetlands, artificial drainage tile became standard practice in agricultural areas to allow faster drainage of the soil after rain and earlier planting of crops. The ongoing demand for maintenance to provide efficient drainage from agricultural lands while balancing concerns of downstream riparian landowners is often the responsibility of CDC's/WRC's.

Unfortunately, the creation of drainage ways for agriculture, construction of storm sewers for development and filling or disconnection of floodplains have historically transferred problems such as flooding, streambank erosion and decreased water quality to downstream neighbors. Increased drainage can result in excessive flows in receiving streams. The results of excess flows can be increased streambank erosion, increased streambed scouring, sediment resuspension, habitat destruction, and decreased diversity and number of fish and aquatic organisms. Along with water, the drains deliver high amounts of soil particles and organic matter into the streams. This contributes to high sediment buildup, nutrient enrichment, and eutrophication of the streams.

2.8 Dams

Dams play a large role in river systems and have major effects in altering the landscape by changing water flow, trapping sediment, and altering water quality. By impounding rivers, dams slow water movement, causing sediment buildup upstream and increased erosion downstream. Reduction in water velocity can lead to warmer temperatures, lower oxygen levels, and excessive algal and vascular plant growth. Additionally, dams fragment habitats, fish communities become limited to more warm water tolerant species, and certain aquatic species, including fishes, may be eliminated. While dams can provide flood control and recreational benefits, they can also exacerbate flooding if not properly maintained. These combined effects negatively influence the overall health and function of the watershed.

There are twelve dams in the Macatawa Watershed, which are all managed by the Ottawa County Water Resources Commissioner's Office (see Figures 2.24 and Table 2.8). Most of the dams are earthen structures rather than smaller impoundments. The main purpose of these earthen structures and impoundments are to keep water from entering agricultural crop fields. Many of these dams date back to the Dutch settlers altering the landscape to create canals that would drain water from the surrounding wetlands.

Table 2.8 Dams in the Macatawa Watershed

Dam Name	Location
Barry	Harlem Drain (Pine Creek), 14839 Barry St
Berens	Beaverdam (Upper Macatawa), 5898 New Holland St
Duck Farm	Harlem Drain (Pine Creek), 4260 144th Ave
Harlem	Harlem Drain (Pine Creek), 144th Ave, 1,300 ft south of Van Buren St
Ottogan	Ottogan Intercounty Drain (Direct Drainage), south of W 32nd St
Steenwyk	Upper Macatawa, 3965 56th Ave
Timmer	Upper Macatawa, across from 5147 Quincy St

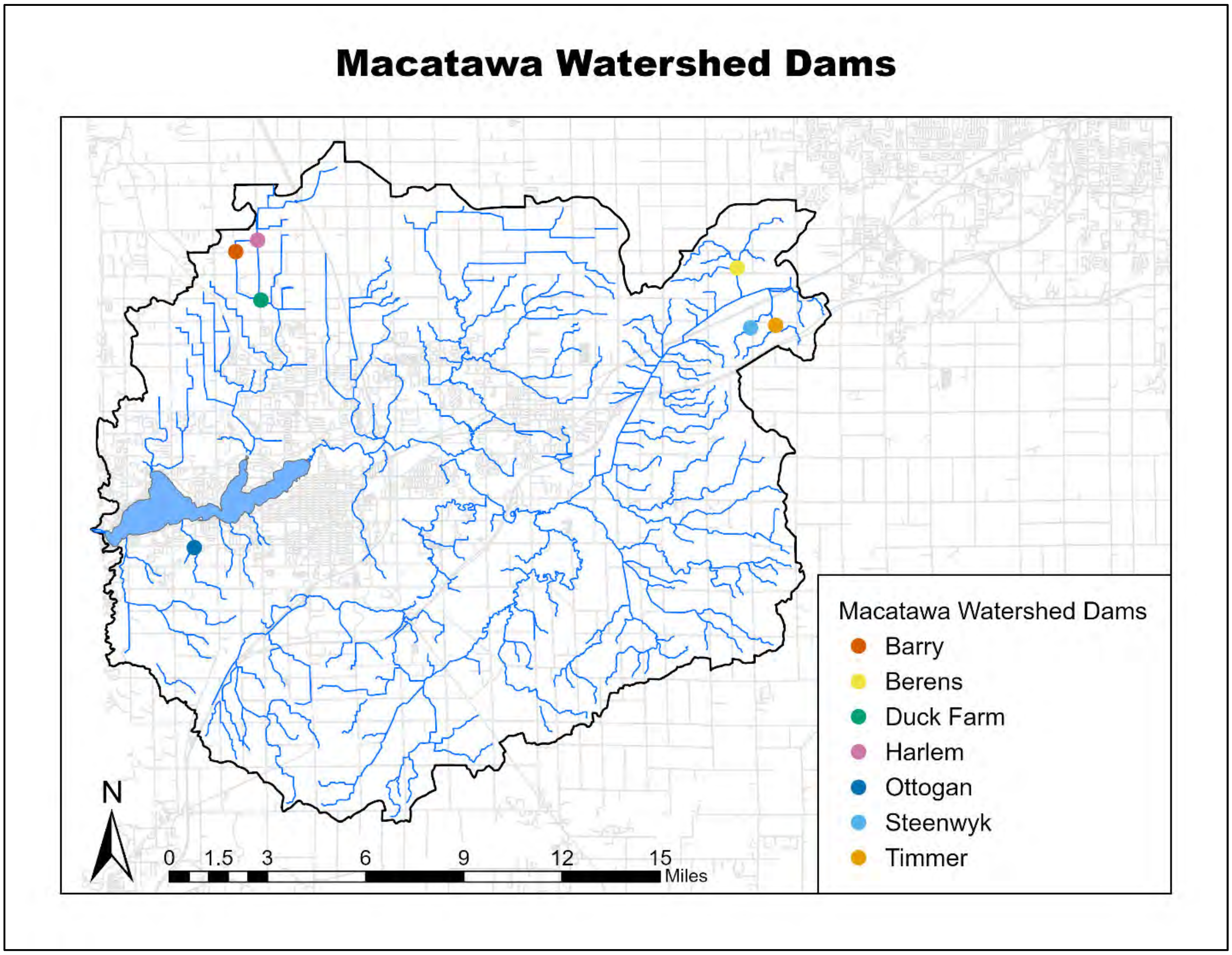

Figure 2.24 Dams in the Macatawa Watershed
Source: Ottawa County Water Resources Commissioner's Office
Date Prepared: March 2024

2.9 Current Ecology of the Macatawa Watershed

2.9.1 Macatawa River Greenway

The Macatawa River Greenway (MRG) consists of a network of permanently protected public and private lands that wind their way through the heart of the Holland/Zeeland area (Figure 2.25). Wide community support has made the greenway possible thanks to partnerships between the ODC Network, Ottawa County Parks and Recreation Department, the City of Holland, the City of Zeeland, local townships, and other local organizations. The Macatawa River Greenway Trail is a paved route across the greenway that connects Laketown and Park Townships all the way to Zeeland Township and beyond. Designed for both local and regional users, it connects the MRG community to local parks as well as the Fred Meijer Kenowa Trail and Bike Route US-35, tying MRG pathways to Grand Rapids, Grand Haven, Saugatuck, and beyond.

The greenway also serves as an important habitat corridor along the river. Featuring much of the remaining floodplain and wetland habitats within the watershed, it allows for the connection of what would otherwise be disparate population clusters of mammals, fish, invertebrates, reptiles, and amphibians. It also provides some of the best opportunities for wildlife viewing and can help serve as a gateway for residents to enjoy and appreciate the natural features of the watershed.

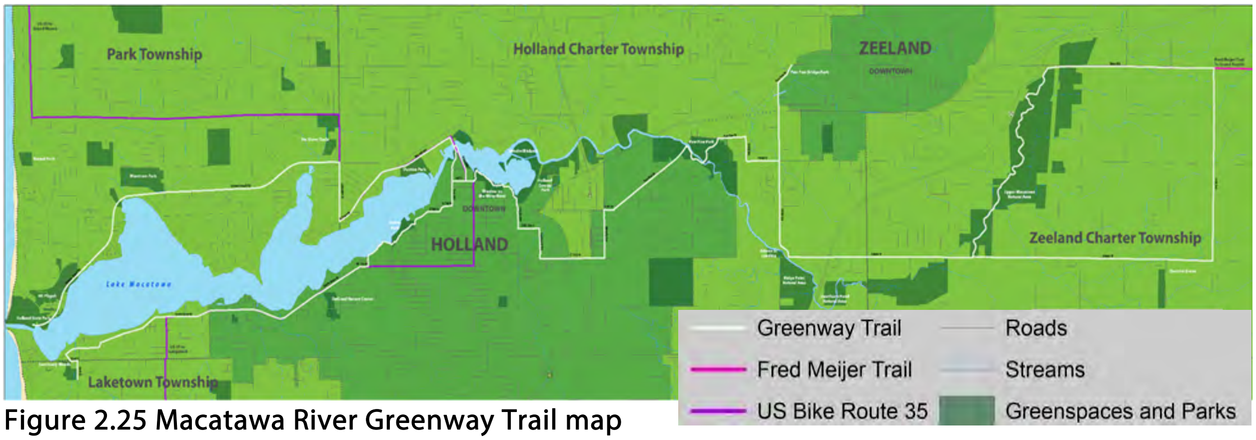

Figure 2.25 Macatawa River Greenway Trail map
Source: ODC Network
Date Prepared: December 2024

2.9.2 Flora and Fauna

As Section 2.6.1 detailed, the Macatawa Watershed was historically rich in diverse flora and fauna, encompassing dense forests of birch, sugar maple, and hemlock, as well as extensive wetlands. As more of the wetlands converted to farmland, the larger animals such as wolves, bobcats, bears, and beaver fled the area and, essentially becoming eradicated. Animals that were able to adapt to the ever-changing landscape include muskrats, coyotes, bald eagles, hawks, waterfowl, and owls are still present and thriving on the landscape. The once abundant eastern massasauga (*Sistrurus catentatus)* is listed as a species of concern in the Macatawa Watershed, due to the Dutch settlers seeing the species as a large threat during the settlement period and habitat loss.

The decline in many species that inhabit wetlands, including king rail (*Rallus elegans)*, eastern box turtle (*Terrapene carolina carolina)*, wild rice, and many others can be directly linked to the loss of wetland habitat. Species with a status highlighted in yellow have increased to a threatened or endangered status since the 2012 Macatawa Watershed Management Plan (Table 2.9). Species with a status highlighted in blue have decreased to a species of concern status.

Table 2.9 Endangered, threatened species and species of concern confirmed in the Macatawa Watershed

Common Name	Scientific Name	State Status	General Location
Birds			
King Rail	*Rallus elegans*	Endangered	Pine Creek, Direct Lake Macatawa Tributaries, Lower Macatawa, Noordeloos Creek, Peters Creek, South Branch Macatawa River, North Branch Macatawa River
Bald Eagle	*Haliaeetus leucocephalus*	Special Concern	Direct Lake Macatawa Tributaries
Reptiles			
Kirtland's snake	*Clonophis kirtlandii*	Endangered	Lower Macatawa
Spotted Turtle	*Clemmys guttata*	Threatened	Pine Creek, Lower Macatawa
Eastern Massasauga	*Sistrurus catentatus*	Threatened	Direct Lake Macatawa Tributaries
Eastern Box Turtle	*Terrapene Carolina*	Threatened	Direct Lake Macatawa Tributaries
Plants			
Pitcher's Thistle	*Cirsium pitcheri*	Threatened	Direct Lake Macatawa Tributaries
Globe-fruited seedbox	*Ludwigia sphaerocarpa*	Endangered	Direct Lake Macatawa Tributaries
Ginseng	*Panax quinquefolius*	Threatened	Direct Lake Macatawa Tributaries
Wild Rice	*Zizania aquatic var. aquatica*	Threatened	Direct Lake Macatawa Tributaries, Pine Creek, Lower Macatawa, Noordeloos Creek, South Branch Macatawa River, North Branch Macatawa River
Maryland meadow beauty	*Rhexia mariana*	Threatened	Pine Creek
Gentian-leaved St. John's Wort	*Hypericum gentianiodes*	Special Concern	Direct Lake Macatawa Tributaries
Northern appressed club moss	*Lycopodium subappressa*	Special Concern	Direct Lake Macatawa Tributaries, Pine Creek, Lower Macatawa, Noordeloos Creek, South Branch Macatawa River, North Branch Macatawa River
Northern prostrate club moss	*Lycopodium appressum*	Threatened	Direct Lake Macatawa Tributaries, Pine Creek, Lower Macatawa, Noordeloos Creek, South Branch Macatawa River, North Branch Macatawa River
Whorled Mountain Mint	*Pycnanthemum verticillatum*	Special Concern	Direct Lake Macatawa Tributaries, Pine Creek, Lower Macatawa, Noordeloos Creek, South Branch Macatawa River, North Branch Macatawa River
Whiskered Sunflower	*Helianthus hirsutus*	Special Concern	Peters Creek, South Branch Macatawa River, North Branch Macatawa River
Mussels			
Round Lake Floater	*Pyganodon subgibbosa*	Special Concern	Direct Lake Macatawa Tributaries
Insects			
Frosted Elfin	*Incisalia irus*	Threatened	South Branch Macatawa River
Fish			
Bigmouth Shiner	*Notropis dorsalis*	Threatened	Peters Creek

Source: Michigan Natural Features Inventory
Date Prepared: December 2024

Although the species listed above may be present somewhere in the Macatawa Watershed, the data is vague and incomplete across large portions of the watershed. Most of the watershed has a low probability of housing these species or has no status at all. Despite advancements in understanding the watershed's ecology, data gaps persist, particularly regarding less common or elusive species.

For more information on fish communities in the Macatawa Watershed, see Section 3.4.2.

2.9.3 Invasive species

Invasive species in the Macatawa Watershed are abundant and widespread to varying degrees. Widespread invasive plant species include purple loosestrife (*Lythrum salicaria*), multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiolata*), narrow leaved cattail (*Typha angustifolia*), autumn olive (*Elaeagnus umbellata*), bull thistle (*Cirsium vulgare*), common teasel (*Dipsacus fullonum*), Japanese barberry (*Berberis thunbergii*), Japanese knotweed (*Fallopia japonica)*, phragmites (*Phragmites australis*), and others. More concerning are lesser known or less widespread plant species such as water primrose and yellow floating heart, both discovered more recently (2019 and 2018, respectively) and included in the EGLE Aquatic Invasive Monitoring program (EGLE, 2024b).

Other types of non-plant invasive species present in the Macatawa Watershed include mute swan (*Cygnus olor*), rusty crayfish (*Faxonius rusticus*), Asian clam (*Corbicula fluminea*), round goby (*Apollonia melanostomus*), emerald ash borer (*Agrilus planipennis*), spongy moth (*Lymantria dispar*), beech bark disease (*Litylenchus crenatae*), and oak wilt (*Bretziella fagacearum*). Some of these species, in particular ones that impact trees, can and are having impacts on water quality in the Macatawa Watershed. For example, emerald ash borer has resulted in the death of significant numbers of ash trees. Green ash (*Fraxinus pennsylvanica*) in particular has an affinity for growing in riparian areas and as these trees die and fall into adjacent streams, they can cause stream bank erosion and may create logjams or otherwise block the flow of streams and/or stormwater causing upstream flooding.

The ODC Network actively manages invasive species on properties throughout the Macatawa Watershed including hemlock wooly adelgid (*Adelges tsugae*), phragmites (*Phragmites australis*), oriental bittersweet (*Celastrus orbiculatus*), Japanese knotweed (*Fallopia japonica*), pale swallowwort (*Vincetoxicum rossicum*), black swallowwort (*Vincetoxicum hirundinaria*), Japanese barberry (*Berberis thunbergii*), common buckthorn (*Rhamnus cathartica*), Japanese honeysuckle (*Lonicera japonica*), autumn olive (*Elaeagnus umbellata*), black locust (*Robinia pseudoacacia*). The Ottawa Conservation District, as well as the West Michigan Conservation Network, provide outreach, information, and assistance on invasive species in the area.

2.10 Recreational Uses of the Macatawa Watershed

Residents and visitors to the Macatawa Watershed are most likely to interact with water resources through recreational activities such as swimming, boating, fishing, hiking, bird watching, kayaking, and canoeing. Several of these activities are directly dependent on certain water quality standards, total and partial body contact *(E. coli*), so it is important to evaluate and identify areas of high recreation to protect and improve water quality to support recreation. Furthermore, it is important to enhance recreational opportunities to foster greater community stewardship and engagement with Lake Macatawa. The more recreation is encouraged, promoted, and expanded; the more people will connect with, appreciate and steward the watershed.

The use of area waterways has a geographic distribution impacted in good part by water quality. Activities like swimming, sailing, and inboard/outboard boating tend to be more common in the west end of Lake Macatawa extending out through the channel to Lake Michigan. Fishing activities take place along the entire length of the lake and up the navigable stretch of the river; however, fish species tend to be more diverse closer to Lake Michigan. Paddling activities take place throughout the lower river and lake but are particularly common in the marsh between the River Avenue Bridge and Windmill Island. More passive activities, including birdwatching and spending time along shorefront parks and properties, can also be enhanced by water quality improvements.

Figure 2.26 shows public parks and water access points in the Macatawa Watershed. Protection and restoration of park properties not only provide safe spaces for public recreation and education, but also lead to protection and improvement of water quality, especially in parks along waterways. Additionally, partners in the Macatawa Watershed have been working to connect the Macatawa Greenway along the main channel of the Macatawa River. These efforts also support water quality protection as properties are restored and recreational access provided. They also provide valuable corridors for wildlife habitat in the watershed. These current and potential future park properties have potential to impact water quality in the Macatawa Watershed based on how they are managed. As much as possible, water quality best practices should be used to manage and maintain these properties.

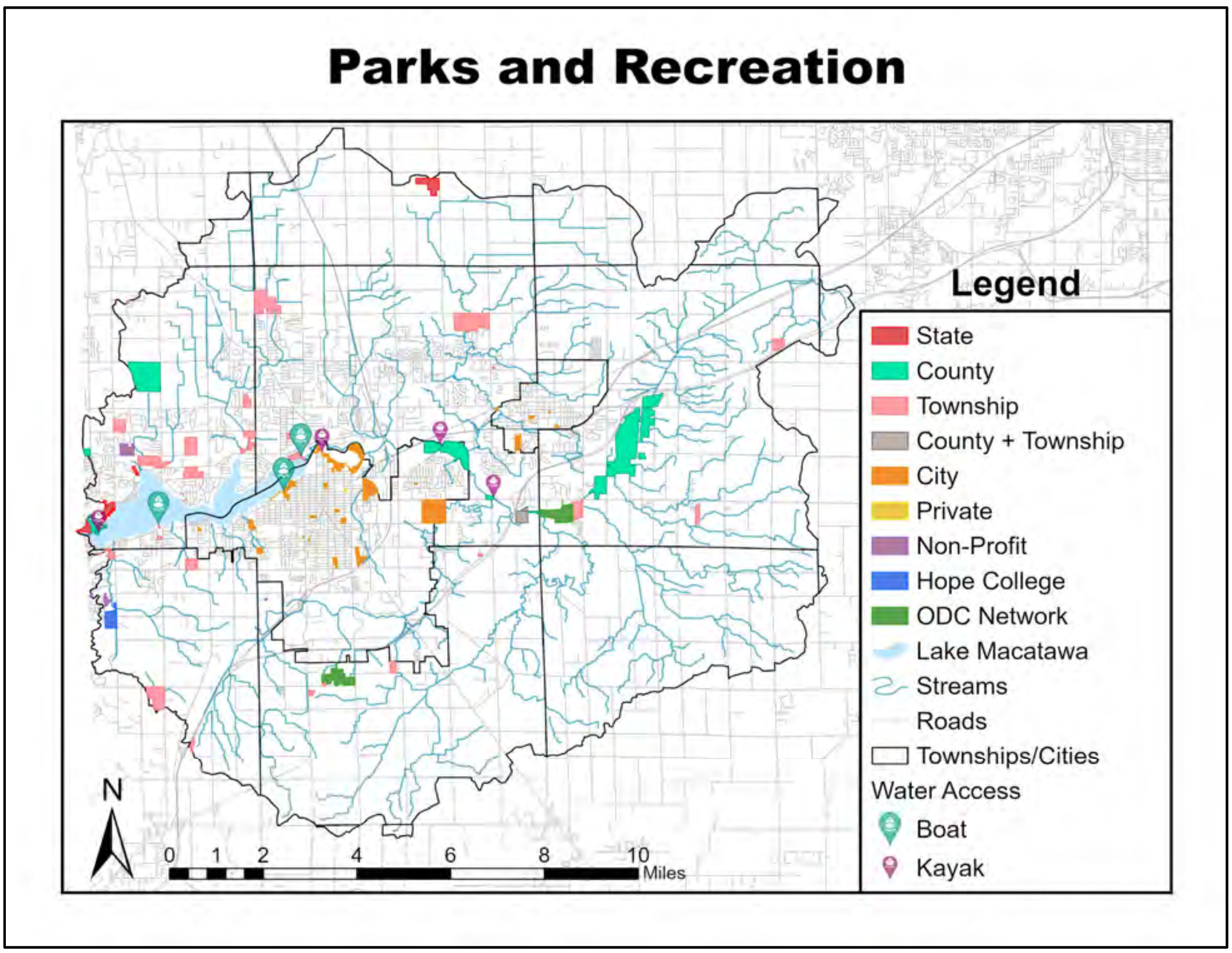

Figure 2.26 Recreational land and access in the Macatawa Watershed
Source: ODC Network
Date Prepared: December 2024

3.0 SUMMARY OF WATER QUALITY IN THE MACATAWA WATERSHED

3.1 Project Clarity and History of Watershed Management

Project Clarity is a business line of the ODC Network launched in 2012 to accelerate water quality improvements in the Macatawa Watershed. Prior to Project Clarity, the Macatawa Area Coordinating Council (MACC) managed the Macatawa Watershed Project, launched in 1996 in response to Lake Macatawa's water quality issues. The MACC is an intergovernmental organization that includes the two (2) cities and seven (7) of the townships that control land within the Macatawa Watershed. The MACC and ODC Network worked side by side from 2012-2021 managing both programs that were working toward the same goals of water quality improvement. In 2021, the Macatawa Watershed Project was absorbed into Project Clarity and all watershed management efforts became housed within the ODC Network. The MACC continues to work collaboratively with the ODC Network and support the efforts of Project Clarity. The ODC Network has also managed the Macatawa River Greenway since 2009, which has held a stake in the water quality of Lake Macatawa and the Macatawa River. Project Clarity and the Macatawa River Greenway initiatives work collaboratively to identify key land to protect and preserve for water quality while providing recreational access.

In 1996, biologists from the Michigan Department of Environmental Quality (MDEQ) conducted a yearlong monitoring study of water quality in the watershed (Walterhouse 1998). They sampled for total and ortho-phosphorus, nitrates, nitrites, ammonia, and suspended solids at 44 locations throughout the watershed. Their ensuing report indicated that the annual total phosphorus load to Lake Macatawa was approximately 138,100 lbs. The MDEQ reported that the total amount of phosphorus contributed to the Macatawa Watershed by nonpoint sources (126,100 lbs), primarily during storm events, was ninety-one percent (91%) of the total phosphorus load.

In 1999, the MDEQ developed a Phosphorus Total Maximum Daily Load (TMDL) for Lake Macatawa. The USEPA approved the TMDL in 2000 (Walterhouse 1999). A TMDL establishes pollutant reduction targets for a given waterbody. To begin meeting water quality standards, the TMDL identified an annual phosphorus-loading goal of 55,000 lbs, which represents a sixty percent (60%) reduction. However, since most of the loading in Lake Macatawa is from nonpoint sources, most of the reduction must also come from reducing the nonpoint source load. The TMDL allows the point source dischargers to Lake Macatawa an annual discharge limit of 20,000 lbs of phosphorus. In turn, that equates to a reduction in nonpoint phosphorus loading by seventy percent (70%) to reduce from the estimated 126,100 lbs annually to 35,000 lbs annually.

Since 1999, local partners, under the direction of the MACC and later ODC Network, have been working to reduce the phosphorus load to Lake Macatawa. Since around ninety percent (90%) of the phosphorus load comes from nonpoint sources, partners have been working with local landowners in urban and rural areas to educate them about the effect of land use on water quality as well as encourage and incentivize the use of BMPs. In addition, partners have worked to encourage local units of government to adopt stormwater management practices that protect Lake Macatawa and its tributaries as well as support numerous water quality monitoring efforts.

3.2 Designated Uses and Water Quality Standards

All surface waters of Michigan (i.e. the Great Lakes and their connecting waters, all inland lakes, rivers, streams, impoundments, open drains, wetlands, other surface bodies of water within the confines of the state) are expected to meet water quality standards (WQS) to provide eight designated uses. These designated uses, specified in Part 4 Rules issued in accordance with Part 31 of the NREPA (1994 PA 451, as amended), are protected, by law, and include:

- **Agriculture** – Surface water must be of the quality that it can be used for livestock watering, irrigation, and other agricultural activities.
- **Industrial water supply** – Surface waters must meet quality standards for use in commercial or industrial applications.
- **Public water supply** - After conventional treatment methods, surface waters must provide a source of water that is safe for human consumption, food processing, and cooking.
- **Navigation** – Surface waters must be of the quality sufficient for passage of boat traffic.
- **Warm water/cold water fishery** – Water bodies designated as warm water (WW) fisheries should be able to sustain populations of fish species. Water bodies designated as cold water (CW) fisheries should be able to sustain populations of fish species such as trout.
- **Habitat for other indigenous aquatic life and wildlife** – Surface waters must support fish, other aquatic life and wildlife that use the water for any stage of their life cycle.
- **Partial body contact recreation** – Residents of the state should be able to use surface waters for activities that involve direct contact with the water but does not involve the immersion of the head, such as fishing and kayaking.
- **Total body contact recreatio**n between May 1 and October 31 – The waters of the state should allow for activities that involve complete submersion of the head such as swimming.

In addition, Rule 323.1050 states that the waters of the state shall not have any of the following unnatural physical properties in quantities that are or may become injurious to any of the designated uses listed above: including turbidity, color, oil films, floating solids, foams, settable solids, suspended solids and deposits.

EGLE periodically evaluates surface waters to determine whether a waterbody is meeting the required WQS and supporting its designated uses. A waterbody is classified as impaired by the State of Michigan if it fails to meet any of the eight designated uses due to a violation of WQS. Once EGLE identifies a waterbody as impaired, they must develop a TMDL for the impacted waterway(s) and their watersheds. A TMDL represents the maximum amount of a specific pollutant that a waterbody can receive without violating the WQS. EGLE assigns each TMDL reach a unique AUID number. It is important to note that EGLE does not regularly assess all subwatersheds or waterbodies, so if a waterbody does not appear on the list as impaired, it does not necessarily mean it meets all WQS; it may simply not have been assessed yet.

Table 3.1 lists the WQS for pollutants measured and/or present in the Macatawa Watershed. For pollutants that do not have established WQS, including total phosphorus and total suspended solids (TSS) comparison values based upon other trusted state or federal sources.

Table 3.1 Water quality standards used to assess pollutants of concern

Parameter	Target Value	WQS or Comparable	Type or Designated Use
E. coli[1]	130 cfu/100 mL	WQS	Total Body Contact Recreation in all waters of the state. Calculated as a 30-day geometric mean from 5 or more sampling events.
E. coli[1]	300 cfu/100 mL 1,000 cfu/100 mL	WQS	Total Body Contact in all waters of the state Partial Body Contact in all waters of the state
Total Phosphorus[2]	0.050 mg/L (interim) 0.020 mg/L (final)	Comparable	Other indigenous aquatic life and wildlife
Total Suspended Solids[3]	80 mg/L	Comparable	Other indigenous aquatic life and wildlife, warm water fishery
Chloride[4]	150 mg/L 320 mg/L 640 mg/L	WQS	Final acute (640), aquatic maximum (320) and final chronic values (150) for aquatic life.
Temperature[1]	Monthly maximum temperatures (see Table 3.2)	WQS	1 - Lake Michigan and connecting waters south of a line due west from the City of Pentwater 2 - Rivers, streams, and impoundments south of a line between Bay City, Midland, Alma, and North Muskegon
Dissolved Oxygen[1]	7 mg/L (coldwater) 5 mg/L (other)	WQS	Great Lakes, connecting waters and inland streams

[1] State of Michigan's Part 4 Rules, Water Quality Standards (of Part 31, Water Resources Protection, of Act 451 of 1994).
[2] Interim value of 0.050 mg/L was set by the Lake Macatawa phosphorus TMDL approved by the USEPA in 2000 (Walterhouse, 1999).
[3] MS4 post construction water quality treatment standard
[4] EGLE Chloride and Sulfate Water Quality Values Implementation Plan, 2021
Data sources: as listed above
Date prepared: December 2024

Table 3.2 Monthly maximum temperatures for surface waters

Waterbody Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lake Michigan and connecting waters	45	45	45	55	60	70	80	80	80	65	60	50
Rivers, streams, and impoundments	41	40	50	63	76	84	85	85	79	68	55	43

Data source: Michigan Part 4 Water Quality Standards (MDEQ, 2006)
Date prepared: December 2024

3.3 Impaired Designated Uses in the Macatawa Watershed

According to the EGLE's 2024 Integrated Report, the Macatawa Watershed has approximately 329 miles of waterways that are impaired and not meeting multiple designated uses (Figure 3.1 and Table 3.3). The designated use of warm water fishery, other aquatic life and wildlife, partial body contact, total body contact and fish consumption are impaired in multiple subbasins and in some cases, due to multiple causes. The primary pollutants of concern addressed by this WMP are sediment/siltation, phosphorus, and *E. coli*. Other contaminants present in fish tissue (DDT, PCBs, mercury, toxaphene, and PFOS) are not addressed in this WMP.

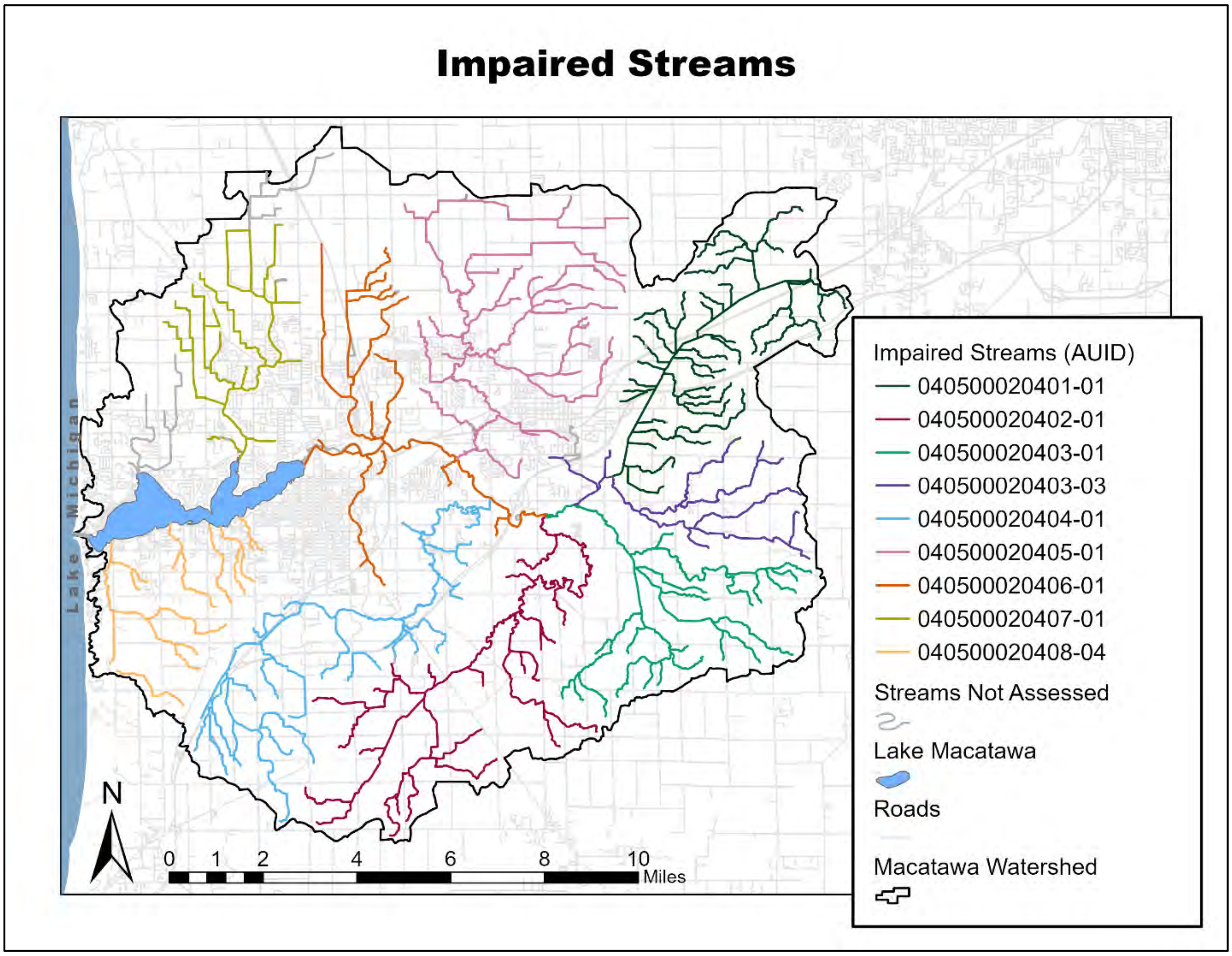

Figure 3.1 Impaired Streams in the Macatawa Watershed
Data Source: 2024 Integrated Report (EGLE, 2024a)
Date Prepared: February 2024

Table 3.3 Macatawa Watershed subbasins not meeting designated uses

<table>
<tr><th rowspan="2">Subbasin Name</th><th rowspan="2">Subbasin HUC Code</th><th rowspan="2"># impaired stream miles</th><th colspan="5">Designated Uses</th></tr>
<tr><th>Warm water Fishery</th><th>Other Aquatic Life/Wildlife</th><th>Partial Body Contact</th><th>Total Body Contact</th><th>Fish Consumption</th></tr>
<tr><td>Upper Macatawa</td><td>40500020401-01</td><td>50.2</td><td rowspan="6">Not supporting (sediment/ siltation)</td><td>Not supporting (sediment/siltation and phosphorus)</td><td>Not assessed</td><td>Not assessed</td><td>Not assessed</td></tr>
<tr><td>South Branch Macatawa</td><td>40500020402-01</td><td>45.9</td><td>Not supporting (mercury in water column, sediment/siltation, phosphorus)</td><td rowspan="2">Not supporting (E. coli)</td><td rowspan="8">Not supporting (E. coli)</td><td>Not supporting (mercury in water column)</td></tr>
<tr><td rowspan="2">Middle Macatawa (Peters Creek and tributary to Upper Macatawa)</td><td>40500020403-01</td><td rowspan="2">56.8</td><td>Not supporting (sediment/siltation, phosphorus, benthic macroinvertebrate bioassessments)</td><td rowspan="7">Not assessed</td></tr>
<tr><td>40500020403-03</td><td>Not supporting (sediment/siltation, phosphorus)</td><td>Fully supporting</td></tr>
<tr><td>North Branch</td><td>40500020404-01</td><td>44.4</td><td>Not supporting (sediment/siltation, phosphorus, benthic macroinvertebrate bioassessments)</td><td rowspan="5">Not supporting (E. coli)</td></tr>
<tr><td>Noordeloos Creek</td><td>40500020405-01</td><td rowspan="2">52.1</td><td>Not supporting (sediment/siltation, phosphorus)</td></tr>
<tr><td>Huizenga Park Pond</td><td>40500020405-02</td><td>Not assessed</td><td>Not assessed</td></tr>
<tr><td>Lower Macatawa</td><td>40500020406-01</td><td>32.1</td><td rowspan="2">Not supporting (sediment/ siltation)</td><td>Not supporting (sediment/siltation, phosphorus)</td></tr>
<tr><td>Pine Creek</td><td>40500020407-01</td><td>26.2</td><td>Not supporting (sediment/siltation, phosphorus, benthic macroinvertebrate bioassessments)</td></tr>
<tr><td>Lake Macatawa</td><td>40500020408-01</td><td>1,799 (acres)</td><td rowspan="2">Not assessed</td><td>Not supporting (phosphorus)</td><td>Not Assessed</td><td>Not Assessed</td><td>Not Supporting (DDT, mercury, PCBs, PFOS, and toxaphene in fish tissue)</td></tr>
<tr><td>Dunton Park Beach</td><td>40500020408-02</td><td>0.2</td><td>Not Assessed</td><td>Not Supporting (E. coli)</td><td>Not Supporting (E. coli)</td><td rowspan="2">Not assessed</td></tr>
<tr><td>Kelly Lake Drain</td><td>40500020408-03</td><td>20.7</td><td>Not supporting (sediment/ siltation)</td><td>Not supporting (sediment/siltation, phosphorus)</td><td>Fully supporting</td><td>Fully supporting</td></tr>
<tr><td>Total</td><td></td><td>328.8</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Data Source: 2024 Integrated Report (EGLE, 2024a)
Date Prepared: January 2026

3.3.1 Warm Water Fisheries

Most of the upper watershed and the tributaries to Lake Macatawa are warm water streams. All the major tributaries to Lake Macatawa are impaired for the designated use of warm water fishery due to sediment and siltation. Since most tributaries and Lake Macatawa are also impaired due to phosphorus, EGLE developed a TMDL for phosphorus and not sediment since a large amount of the phosphorus is delivered to Lake Macatawa adsorbed to sediment (Walterhouse, 1999).

3.3.2 Habitat for Other Indigenous Aquatic Life and Wildlife

Surface waters must support native aquatic life and wildlife that use the water for any stage of their life cycle. All the major tributaries to Lake Macatawa as well as Lake Macatawa are impaired for the designated use of other indigenous aquatic life and wildlife. The tributary impairments are due to both sediment/siltation and phosphorus while Lake Macatawa is impaired due to phosphorus. In addition, the South Branch Macatawa tributary is also impaired due to mercury in the water column. The USEPA approved a phosphorus TMDL for Lake Macatawa in 2000 that established an interim goal of achieving an in-lake concentration of 0.050 mg/L of phosphorus (Walterhouse, 1999).

3.3.3 Partial and Total Body Contact for Recreation

The Michigan WQS, established by the Part 4 Rules under Part 31 of the Natural Resources and Environmental Protection Act (NREPA), regulate the concentration of microorganisms, such as *E. coli*, in the surface waters of the state and in surface water discharges. To meet the total body contact (TBC) recreation standard, Lake Macatawa and all tributaries must have an *E. coli* concentration of no more than 130 colony-forming units (cfu) per 100 milliliters (mL) of water, calculated as the 30-day geometric mean from five sampling events, with each event consisting of three samples. Additionally, surface waters must not exceed 300 cfu per 100 mL for any single sampling event during the May 1 through October 31 period. For partial body contact (PBC) recreation, the standard is a geometric mean of 1,000 cfu per 100 mL for any single sampling event, year-round (MDEQ, 2006).

Recent monitoring data for Lake Macatawa indicate that *E. coli* concentrations exceed these WQS thresholds, impairing the designated recreational uses of the lake for both TBC and PBC activities. Elevated *E. coli* levels in the lake are a concern for public health and recreational safety, highlighting the need for continued monitoring and potential remediation efforts to reduce contamination levels and protect water quality in the lake.

3.3.4 Fish Consumption

Lake Macatawa and its tributaries are impaired due to the presence of mercury, PCBs and/or PFOS in the water column and/or fish tissue and are not meeting the designated use of fish consumption. The USEPA approved statewide TMDLs for PCBs and mercury in 2017 and 2019, respectively. There is not a statewide TMDL for PFOS. This WMP plan does not address these TMDLs other than to include fish consumption advisories as part of the information and education strategy.

3.3.5 Desired Uses

Desired uses are resources not defined as a designated uses in the Part 4 Rules that may still have significance to the local community. Watershed stakeholders identified the following desired uses as important in Macatawa Watershed: recreation, public access, fish and wildlife, open space, and groundwater protection and recharge.

3.4 Detailed Description of Water Quality in the Macatawa Watershed

3.4.1 Review of Existing Information

Researchers from Hope College, the Grand Valley State University's Annis Water Resources Institute (AWRI), state environmental agencies, local public and private groups and individuals have studied the quality of water in Lake Macatawa, the Macatawa River, and their tributaries for many years. Research on biological communities, sediment quality, waste discharges, nutrients, and toxic measurements in the Macatawa Watershed have indicated the presence of water quality impairments. Since the approval of the 2012 WMP plan, AWRI, Hope College and ODC have gathered additional data on water quality, contributing to a robust understanding of watershed conditions.

Grand Valley Annis Water Research Institute

Lake Macatawa

Since 2012, AWRI has conducted research on water quality in the Macatawa Watershed as part of Project Clarity (Appendix B). During this time, they performed sampling in spring, summer and fall at five sites in Lake Macatawa (surface and bottom). They recorded water quality measurements such as dissolved oxygen, pH, and turbidity, and collected and analyzed samples for pollutants such as phosphorus and nitrogen. In 2017, they added testing for microcystin, a cyanotoxin produced by algae (Hassett et al. 2024). From 2013 to 2024, total phosphorus in Lake Macatawa was consistently above the TMDL goal, though the overall trend shows decreasing total phosphorus compared to historic levels (Figure 3.2). The annual mean appears to be stabilizing over the last several years, but seasonal means have shifted with lower total phosphorus in the summer and higher values in the fall (Appendix B, Figure 8 in 2024 report).

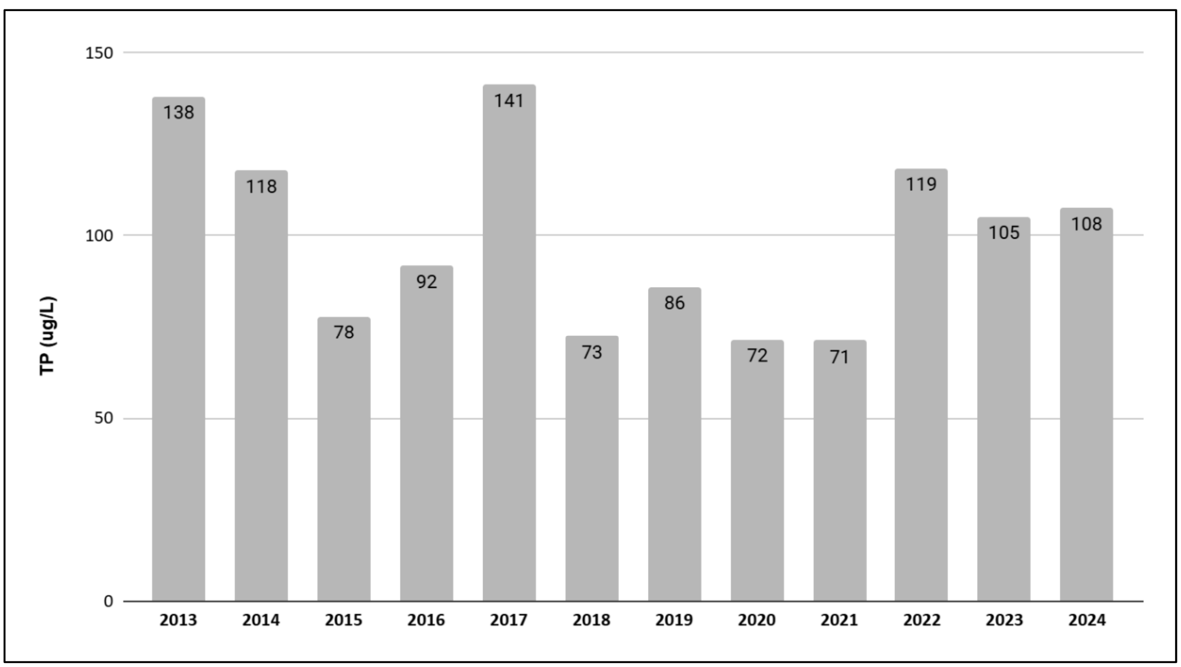

Figure 3.2 Total Phosphorus in Lake Macatawa, 2013-2024. Values are averages of spring, summer and fall samples taken at five (5) locations, surface and bottom samples.
Data source: Grand Valley State University Annis Water Resources Institute (Appendix B)
Date prepared: June 2026

In their 2023 Annual Report, the AWRI summarized their findings from the past decade. Overall, they saw mixed results in water quality measurements. They compared two date ranges, one prior to the commencement of Project Clarity (summer 2013 to fall 2015) and one post-restoration (summer 2021 to fall 2023). Before including the most recent data from 2023, mean total phosphorus (TP) and chlorophyll *a* showed improvement. However, including data from 2023, there was no significant difference between pre- and post-restoration timeframes. TP and chlorophyll *a* continue to remain above their recommended maximum values of 50µg/L and 22µg/L, respectively. Despite this, water clarity had significantly improved. Additionally, all microcystin measurements fell below the USEPA guides for the toxin. Unfortunately, soluble reactive phosphorus (SRP) levels were significantly greater in the later time period. Soluble reactive phosphorus is the component of total phosphorus that is bioavailable. Increases in SRP is problematic since it is form of phosphorus readily available for plant uptake.

The study concludes by stating that, despite the localized successes of Project Clarity, significant impacts to Lake Macatawa are yet to be seen. They note that this is expected because of both the modest scale of changes and the natural time lag between implementation of conservation measures and their effects. Because of this, they recommend continuing current conservation practices, as well as increasing efforts.

Based on their findings, they end with the following recommendations:

- Although the current monitoring program provides important baseline information from which to assess Lake Macatawa water quality trends across time and space, grab samples taken only three (3) times per year leaves information gaps and may create a biased picture of lake status. The installation of a monitoring buoy in the lake, which can provide near real-time data on a continuous basis throughout its time deployed, would help increase the amount of data collected and ability to see trends in water quality over time.

- Review and incorporate recommendations from the Surface Water Assessment Tool (SWAT) model (Iavorivska et al., 2021) developed for the Macatawa Watershed, into management decisions. In addition, continue seeking funding from MDARD to further study the optimization of iron slag filters.

- The current monitoring program does not analyze two important biotic components in the lake: algal taxonomic composition, and aquatic vegetation biomass and taxonomic composition. The phytoplankton community structure can provide important information on water quality. The algal species composition can serve as an early warning sign for the onset of cyanobacteria species capable of forming cyanotoxins. Aquatic vegetation provides critical habitat for fish and wildlife, stabilizes lake sediments, and takes up nutrients in the lake. In addition, it is important for developing rapid response control plans to know if invasive vegetation is developing in the lake. If funding is available, consider conducting plant surveys and phytoplankton identification in the future.

- The 2023 data is consistent with the 2022 data suggesting nutrient release from the sediments may be important, especially in the deeper sites where low dissolved oxygen is likely. There has not been a rigorous analysis of internal nutrient loading from sediments in Lake Macatawa. Consider developing a lake management plan, including actions, timelines, and costs that includes a comprehensive nutrient budget.

- Finally, re-examining the feasibility of a public works program to treat the Macatawa River inflow before it enters Lake Macatawa should be a top priority. In January 2017, Progressive AE delivered their Feasibility Study Final Report to ODC. Their preliminary findings concluded that a centralized alum injection facility might provide an effective means of reducing pollutant levels in the Macatawa watershed, but several critical obstacles impacted feasibility (Progressive AE, 2017). A more detailed report that evaluates these obstacles, examines other inactivates besides alum (e.g., Phoslock), and updates the financing, should be considered.

Iron Slag Filters

Agricultural drain tile effluent is a significant source of phosphorus in the Macatawa Watershed. As part of Project Clarity's effort to reduce phosphorus pollution, three iron slag filters were installed in 2019, and a fourth in 2021 (Hassett and Steinman, 2022). Iron slag, a byproduct of steel, can bind chemically to phosphorus. As water exits agricultural drain tiles at these four locations, it passes through these iron slag filters. Phosphorus is bound to the iron slag, removing it from the water before it flows into waterways. (Figure 3.3)

To determine the effectiveness of the filters, the Annis Water Research Institute monitored these filters from 2019 to 2021, except for some months in 2020 due to the COVID-19 pandemic. Water samples were taken monthly and tested for total phosphorus (TP), soluble reactive phosphorus (SRP) as well as other water quality parameters. All iron slag filters showed statistically significant reduction in TP, ranging from a 35.3% to 97.7% reduction. The reduction in SRP was only significant at one location.

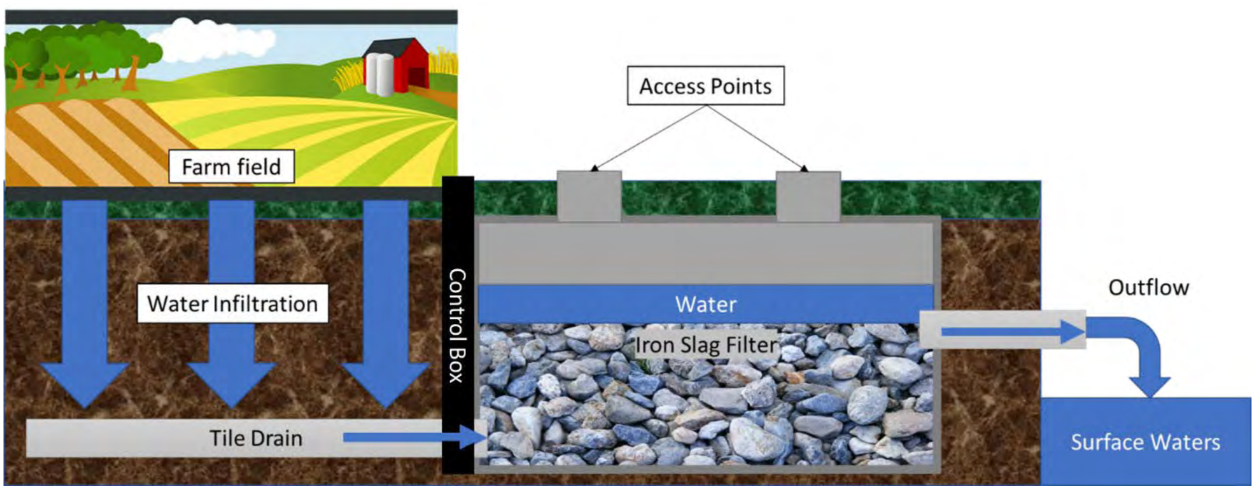

Figure 3.3 Stylized cross-section of iron slag filter's design/function. *Note, figure is not to scale as iron slag filter size is dependent on multiple factors. Image credit: Maggie Oudsema.*

The water was also tested for toxic metals, to determine if the filters were having any negative impacts on water quality. Mercury was two orders of magnitude below drinking water standards, and all other heavy metals were below detectable levels. This study concludes that these filters have shown to be effective, with no concern for negative effects. They recommend continued monitoring of these filters, and the installation of more filters along with other best management practices.

Stream Monitoring and Restored Wetlands

One focus of Project Clarity was acquiring property on which to create restored wetlands. These properties, named the Middle Macatawa and Haworth, were restored in 2015, and monitoring began afterwards. During the first years, water quality measurements and hydrologic monitoring were conducted at locations upstream and downstream of these wetlands. However, after seeing minimal differences, it was determined that upstream-downstream monitoring of the wetlands was not adequate for determining effectiveness of the wetlands and this monitoring was replaced with sediment phosphorus analyses (Hassett et al., 2019).

In 2019, stream monitoring ended and was replaced with sediment monitoring to collect data that are more useful on the accumulation of phosphorus. Sampling took place at four sites per wetland, where sediment cores were removed, and analyzed to understand their phosphorus content and ability to absorb more of the nutrient. They found that soils were close to holding their full capacity of phosphorus, and therefore limited in their ability to uptake more (Hassett et al., 2021).

Hope College

Since 2021, the Hope College Global Water Research Institute (GWRI) has also contributed to water quality monitoring efforts as part of Project Clarity (Appendix C). They collect data from seven (7) streams sites in the watershed, representing the major sub basins, monitor *E. coli* and conduct other standard water quality measurements.

Results show that phosphorus concentrations in streams tend to be higher than the Lake Macatawa sampling sites, indicating that all subbasins continue to be a source of phosphorus to the lake (Figure 3.4). Of the seven (7) sampled streams, generally Upper Macatawa and Peters Creek had the highest mean total phosphorus (TP) and North Branch and Pine Creek had the lowest (Figure 3.4, see Appendix C for full reports). On a seasonal basis, total phosphorus tends to be the highest in the winter months in both lake and stream sites (Figure 3.5). However, some of the highest values on the Macatawa River occurred during dry weather in April and November. Samples collected during wet weather exceeded the TMDL goal 100% of the time at all sites. The highest percent exceedances occurred in the spring in Noordeloos Creek, Peters Creek, South Branch and the Upper Macatawa River, with Noordeloos Creek exceeding the TMDL goal more than 90% of the time spring through fall. See Appendix D for a full summary of Hope College data from 2020-2025 (Keson, 2026).

Nitrate levels at both the stream and lake sites were above healthy concentrations in terms of current Michigan drinking water standards (there is currently no surface water standard for nitrate). There was a similar pattern of stream sites having higher concentrations than lake sites.

The *E. coli* levels for lake sites are generally below the guidelines for TBC and PBC (Figure 3.6). No stream sites sampled fully support the TBC recreation designated use. There were higher percentages of samples exceeding TBC during wet weather at all sites, and sources of *E. coli* causing these exceedances appear to be entering the water in the summer and fall. Exceedances of PBC occurred at most sites during wet weather except in Peters Creek where all PBC exceedances occurred during dry weather. Several tributaries support PBC including North Branch, Noordeloos Creek, Pine Creek and South Branch. See Appendix D for a full summary of Hope College data from 2020-2025 (Keson, 2026).

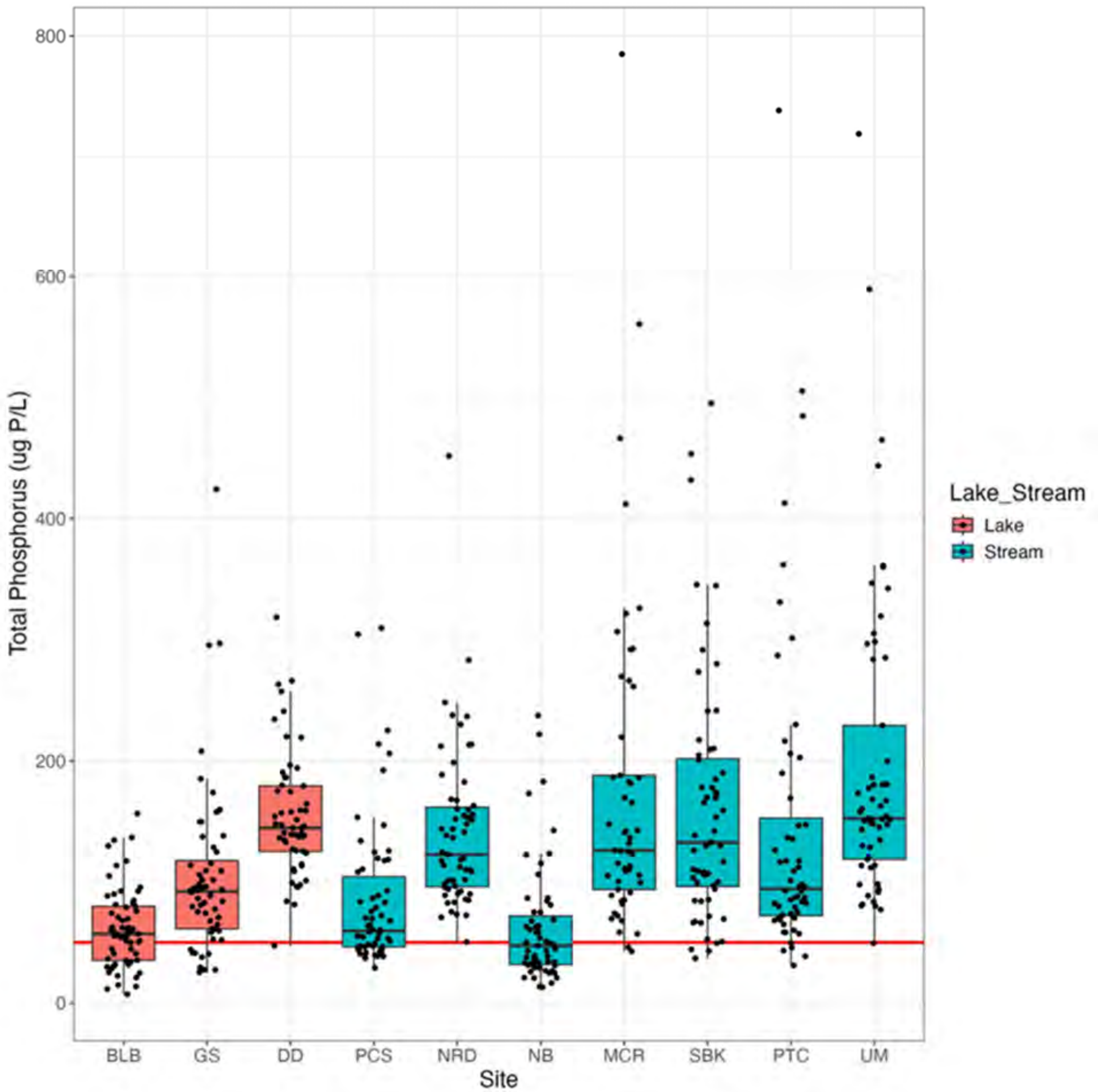

Figure 3.4 Mean total phosphorus by location, July 2020-December 2025. Each mean TP value for every location exceeded the TMDL limit of 50 µg/L.

Data source: Hope College Global Water Research Institute (Best et al., 2026)

Date prepared: January 2026

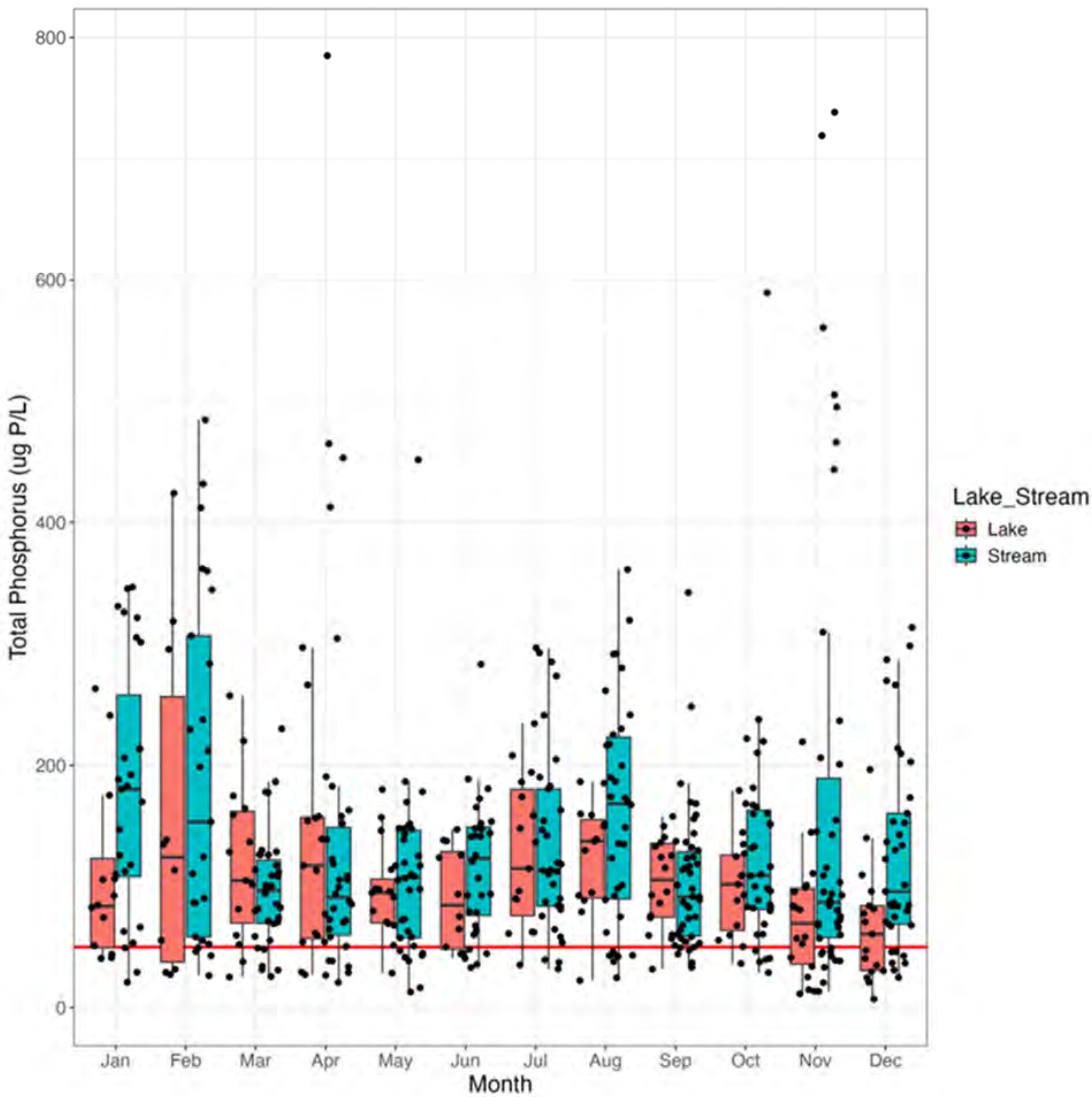

Figure 3.5 Mean total phosphorus by month, July 2020-December 2025. Each monthly mean TP value for both stream and lake sites exceed the TMDL limit of 50 µg/L.
Data source: Hope College Global Water Research Institute (Best et al., 2026)
Date prepared: January 2026

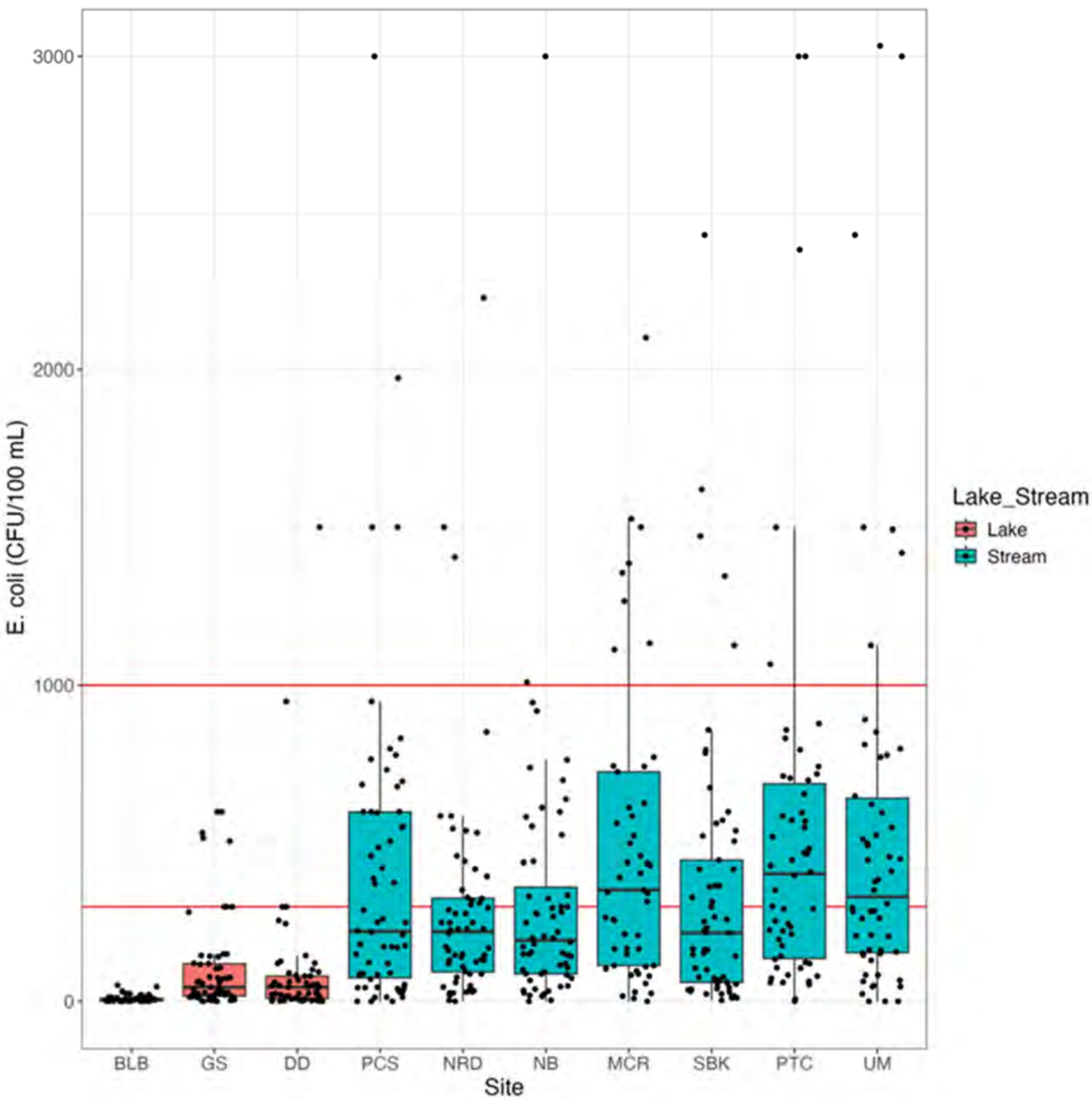

Figure 3.6 *E. coli* levels for all lake and stream locations, July 2020-December 2025
Data source: Hope College Global Water Research Institute (Best et al., 2026)
Date prepared: January 2026

State Data

Phosphorus

To evaluate the effectiveness of watershed management efforts, EGLE monitors the water quality of Lake Macatawa every other year. Reports before the development of the first Watershed Management Plan in 2012 found high levels of phosphorus and chlorophyll *a* (Walterhouse, 2006; Waterhouse, 2010).

Since then, EGLE has released two reports, one for 2012 and a second that covers 2014-2018 (Appendix E). Both reports compare results with historic data gathered on watershed health in 1997. EGLE conducts water quality assessments at five sites on Lake Macatawa once per month from April to September each sampling year, as well as once per month for six tributary sites. EGLE collects samples from each site and analyzes them for various pollutants including phosphorus and chlorophyll *a*. Despite monthly and yearly variability, including a few record low concentrations, phosphorus levels from 2012-2018 were generally similar to historic concentrations, and far above the TMDL of 50 µg/L (Figure 3.7).

The trend in EGLE total phosphorus does not match the trend indicated by GVSU data, but samples are not collected at the same time so variability is expected. Hope College data does not overlap with EGLE data, but is more consistent with GVSU results over the same time period (2021-2025). All data sources indicate that total phosphorus continues to consistently be above the TMDL goal of 50 µg/L. GVSU and Hope add additional value by providing further data and analysis. GVSU's results show variability in seasonal means with lower TP in the summer compared to fall. Hope College's results show that contributions of total phosphorus to Lake Macatawa continue to come from major subbasins, with higher concentrations coming from Peters Creek and the Upper Macatawa.

Similar to phosphorus, chlorophyll *a* concentration showed variability, but were consistently at unacceptably high levels. For all sampling months from 2012-2018, chlorophyll *a* concentration exceeded 22 µg/L, indicating that Lake Macatawa remains hypereutrophic. Shallow Secchi depth readings, equating to low water clarity, also confirm the lake's hypereutrophic status. In general, water quality measurements in the western basin of Lake Macatawa revealed healthier conditions than the eastern basin.

Phosphorus sampling in Lake Macatawa tributaries reveals that phosphorus concentrations relate to stream flow. When flow increases due to storm events, phosphorus reaches higher concentrations. Stormwater carries this phosphorus into Lake Macatawa, resulting in higher lake concentrations following peak water flows. Because of this, increasing the use of BMP designed to reduce the flashiness of the watershed is recommended (Holden, 2012b; Chambers, 2022).

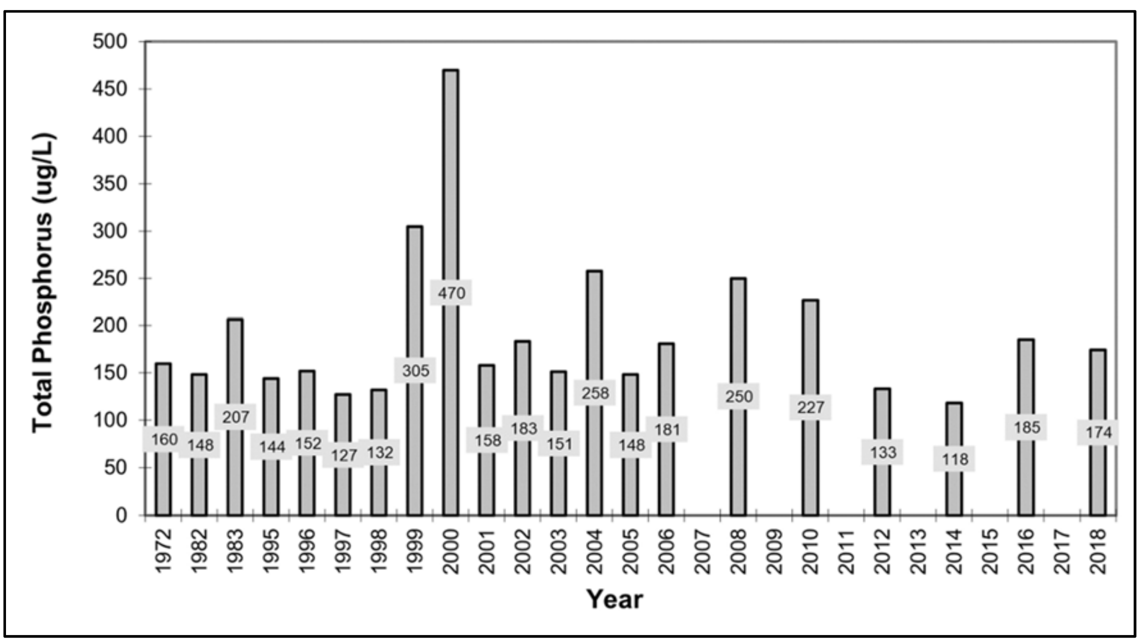

Figure 3.7 Average historic spring phosphorus concentrations at Sites 1, 2 and 4 in Lake Macatawa
Data Source: Chambers, 2022
Date Prepared: June 2022

Biological

MDEQ conducted biological assessments in the Macatawa Watersheds in 2005. The assessment included twelve (12) sites: fish community was evaluates at 8 sites, macroinvertebrates at 10 sites and habitat was assessed at 11 sites (Figure 3.8). Fish and macroinvertebrate communities rated acceptable to poor and habitat ranged from good to poor (Table 3.4). Results were attributed to habitat limitations caused by artificial drainage, particularly in agricultural areas of the watershed. Of particular note was historic drainage of wetlands and dredging of streams, lack of riparian buffer strips. (Walterhouse, 2007).

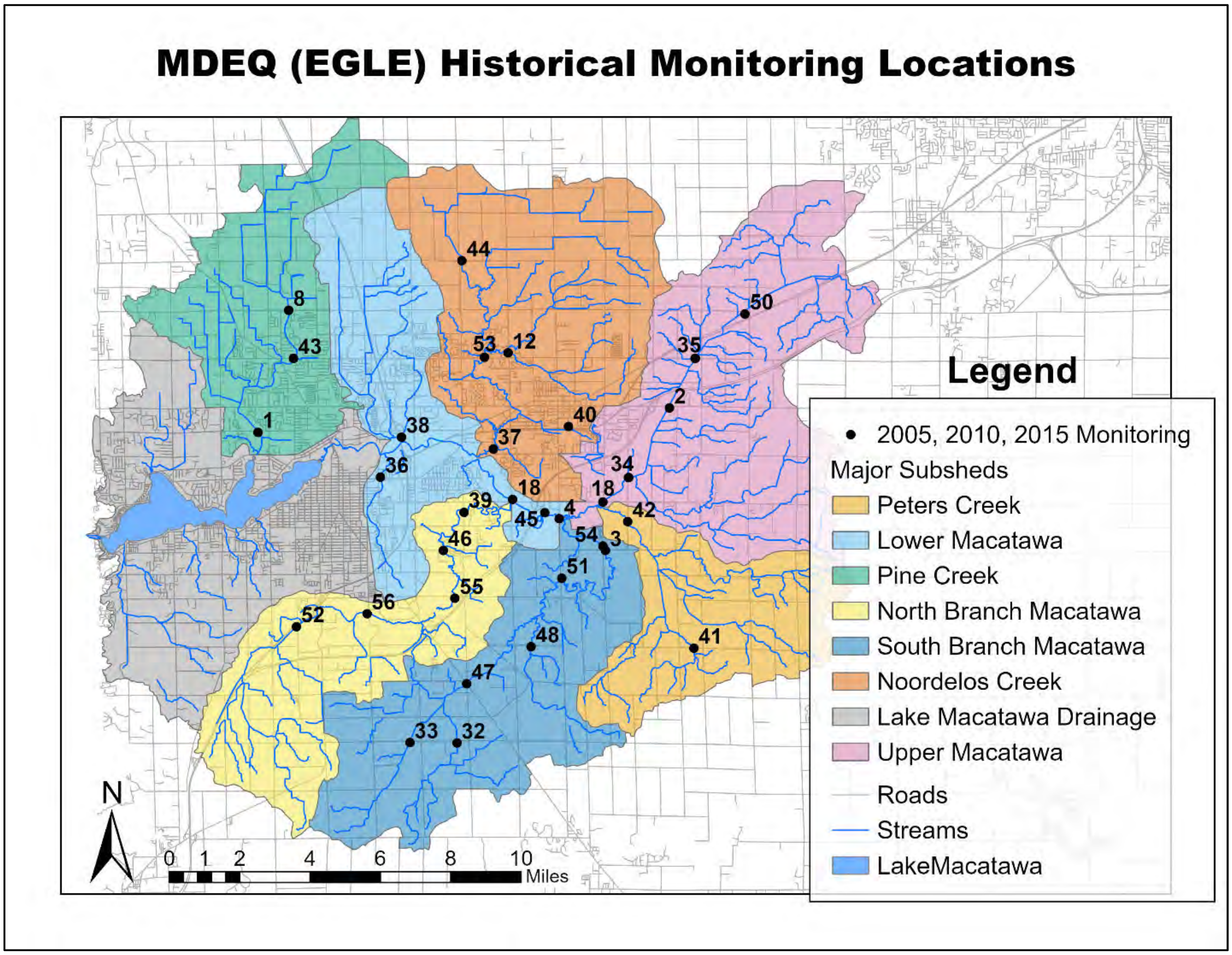

Figure 3.8 MDEQ /EGLE biological monitoring sites 2005-2015
Source: Walterhouse, 2007, Holden, 2012a and Holden, 2016
Date Prepared: March 2026

In 2010, MDEQ conducted macroinvertebrate at thirteen (13) sites in the Macatawa Watersheds and evaluated habitat conditions at an additional three (3) sites in the South Branch of the Macatawa River (Figure 3.8, Table 3.5). Macroinvertebrate assessment results at all sites were acceptable. The habitat assessments at those sites were marginal with the exception of Noordeloos Creek at New Holland St (44) which was rated as poor. Only two (2) of the sites (34 and 35) were also evaluated in 2005. Results were similar at site 35 on the Macatawa River at Riley St and better at site 34 on the Macatawa River at 84th St. Two of the three (3) additional habitat sites in South Branch were also rated as poor (32 and 33). (Holden, 2012a).

In 2015, MDEQ conducted similar assessments evaluating macroinvertebrate, habitat conditions, and fish communities at sites in the Macatawa Watershed (Figure 3.8, Table 3.6). All fourteen (14) sites were assessed for habitat which ranged from good to poor. One site on the Macatawa River at 84th St (34) was also evaluated in 2010 and the habitat declined from marginal to poor. The report noted that at one site on the North Branch (52), discarded tires made up a significant portion of the habitat. Across the watershed, sediment deposition scored low in the assessment as well as bank metrics. Of the five (5) sites assessed for macroinvertebrates, one scored poor (Macatawa River at Quincy St) and the other four (4) on the lower end of acceptable. Macroinvertebrate community makeup generally indicated a lack of in-stream habitat. Fish community assessments conducted at eight (8) sites ranged from poor to acceptable. Overall, high percentages of fish species tolerant to poor water quality were a main driver of bringing scores down. The study concludes by stating that the gathered data supports the presence of water quality issues that recognized for decades. (Holden, 2016).

Table 3.4 DEQ Biological Monitoring Results, June 2005

EGLE Site No. (map reference)	Location	Subwatershed	Fish	Macroinvertebrates	Habitat	Water Temp	Total P (mg/L)	Trend (if sampled previously)
4	Macatawa River @96th	Lower Macatawa	Acceptable	Acceptable	Marginal	70	N/A	Improved from 1990
34	Macatawa River @84th	Upper Macatawa	Poor	Poor	Poor	70	N/A	N/A
2	Macatawa River @Byron	Upper Macatawa	N/A	Acceptable	Marginal	69	N/A	Same as 2000
35	Macatawa River @Riley	Upper Macatawa	Poor	N/A	Marginal	70	N/A	N/A
1	Pine Creek @Lakewood	Pine Creek	Poor	Poor	Good	68	N/A	Fish decline, habitat improved, macros same
38	Railroad tracks	Lower Macatawa	Acceptable	Acceptable	Good	70	N/A	N/A
36	Maplewood Drain @6th St	Lower Macatawa	Acceptable	Acceptable	Marginal	66	N/A	N/A
39	N Branch @112th	North Branch	N/A	Acceptable	Good	64	N/A	N/A
3	S Branch @ 108th Ave	South Branch	Poor	Acceptable	Marginal	66	N/A	N/A
37	Noordeloos @107th Ave	Noodeloos	Poor	Acceptable	Good	73	N/A	Fish decline, habitat improved
40	Zeeland CWP	Noordeloos	N/A	N/A	0.36	N/A	N/A	
12	Noordeloos @104th	Noordeloos	N/A	Acceptable	Marginal	70	0.15	Macros and habitat same, less P than 2000

Date Source: Walterhouse, 2007
Date Prepared: March 2026

Table 3.5 DEQ Biological Monitoring Results, August 2010

EGLE Site No. (map reference)	Location	Subwatershed	Fish	Macroinvertebrates	Habitat	Water Temp	Trend (if sampled previously)
8	Pine Creek @Quincy	Pine Creek	N/A	Acceptable	Marginal	74	N/A
43	Pine Creek @Riley	Pine Creek	N/A	Acceptable	Marginal	68	N/A
44	Noordeloos @New Holland	Noordeloos	N/A	Acceptable	Poor	75	N/A
35	Macatawa River @Riley	Upper Macatawa	N/A	Acceptable	Marginal	68	Same as 2005
41	Peters Creek @144th	Peters Creek	N/A	Acceptable	Marginal	64	N/A
42	Peters Creek @84th	Peters Creek	N/A	Acceptable	Marginal	68	N/A
34	Macatawa River @84th	Upper Macatawa	N/A	Acceptable	Marginal	74	Better than 2005
18	Macatawa River @Adams	Lower Macatawa	N/A	Acceptable	Marginal	70	N/A
45	Macatawa River @Black River Dr	Lower Macatawa	N/A	Acceptable	Marginal	74	N/A
46	N Branch @Ottogan	North Branch	N/A	Acceptable	Marginal	68	N/A
47	S Branch @M-40	South Branch	N/A	Acceptable	Marginal	66	N/A
33	Jaarda Drain @140th	South Branch	N/A	N/A	Poor	N/A	N/A
32	Kleinheksel Drain @140th	South Branch	N/A	N/A	Poor	N/A	N/A
48	East Fillmore Drain @144th	South Branch	N/A	N/A	Marginal	N/A	N/A

Date Source: Holden, 2012a
Date Prepared: March 2026

Table 3.6 DEQ Biological Monitoring Results, July-September 2015

EGLE Site No. (map reference)	Location	Subwatershed	Fish	Macroinvertebrates	Habitat	Water Temp	Trend (if sampled previously)
43	Pine Creek @Riley	Pine Creek	N/A	Acceptable	Good	61	Habitat better than 2010
50	Macatwa River @Quincy	Upper Macatawa	N/A	Poor	Marginal	64	N/A
51	S Branch @48t	South Branch	N/A	Acceptable	Marginal	66	N/A
46	N Branch @Ottogan	North Branch	N/A	Acceptable	Good	71	Habitat better than 2010
52	N Branch @Ottawa Ave	North Branch	N/A	Acceptable	Good	70	N/A
53	Noordeloos @Riley	Noodeloos	Acceptable	N/A	Poor	65	N/A
12	Noordeloos @104th	Noordeloos	Acceptable	N/A	Good	65	Habitat better than 2005
34	Macatawa River @84th	Upper Macatawa	Acceptable	N/A	Poor	68	Habitat worse than 2010
42	Peters Creek @84th	Peters Creek	Poor	N/A	Good	72	Habitat better than 2010
54	S Branch @Ottogan	South Branch	Acceptable	N/A	Marginal	72	N/A
18	Macatawa River @Adams	Lower Macatawa	Acceptable	N/A	Marginal	66	Habitat same as 2010
55	N Branch @146th	North Branch	Acceptable	N/A	Good	72	N/A
56	N Branch @Lincoln	North Branch	Poor	N/A	Good	72	N/A

Date Source: Holden, 2016
Date Prepared: March 2026

3.4.2 Studies Completed as Part of Watershed Management Planning

3.4.2.1 Aquatic Habitat Quality and Macroinvertebrate Community Health

Macroinvertebrate samples are collected at seven (7) sampling locations in the Macatawa Watershed twice a year in the spring and the fall. In addition, habitat assessments are completed every other year. Seven (7) study sites were selected that represent six (6) of the eight (8) subbasins in the Macatawa Watershed. Five (5) sites are located on major tributaries before their confluence with either the Macatawa River or Lake Macatawa. Two (2) sites are located on the Macatawa River. All sites are accessible at road-stream crossings or public parks. Study sites were selected based on historical sampling data collected by EGLE. The sites encompass most of the agricultural areas in the watershed and include some urban influences.

1. Pine Creek at Stu Visser Trails (N 42° 48'17 W 86° 8'34)
2. Noordeloos Creek at Paw Paw Park (N 42° 47'50 W 86° 3'10)
3. Upper Macatawa River at the Upper Macatawa Natural Area (N 42° 48'32 W 85° 58'32)
4. Peters Creek at Poppen Woods (N 42° 46'57 W 86° 0'6)
5. South Branch near Winding Creek Golf Course (N 42° 46'8 W 85° 59'58)
6. Macatawa River at Adams Street Landing (N 42° 47'3 W 86° 2'15)
7. North Branch at Van Raalte Farm Park (N 42° 46'43 W 86° 3'36)

Macroinvertebrate community sampling is completed in a 300-foot length of stream at each site following the Michigan Clean Water Corps (MiCorps) Volunteer Stream Monitoring Program Procedures. Studies conducted from 2012-2019 assessed these community stream quality scores (SQS) in the 'acceptable' range across seven (7) sites, with scores between excellent (>48), good (34-48), fair (19-33), and poor (<19). The average score for most of the inventory sites are "Fair." The only site with a score of "Good" was North Branch (MACC-7) with an average score of 34.

In 2020, MiCorps developed a new rating system and scale for stream quality assessments, and this new system has been used in the Macatawa Watershed since 2021. From 2021-2024 all sites within the Macatawa Watershed scored an average rating of fair except for MACC-6 at Adams St. Landing (Macatawa River) which scored as fairly poor (Appendix F). This new scoring system ranks the sites lower than the previous system, but there is still consistency with the water quality within the streams (Table 3.7). Unfortunately, there is not a simple way to compare the old scores to the new scores. Continued water quality monitoring at Adams St. Landing for potential sources of contamination should be a priority moving forward.

Table 3.7 Average stream quality scores for macroinvertebrate sampling sites in the Macatawa Watershed

Site ID #	Location	Average SQS 2012-2019	Average SQS 2021-2024
Pine Creek (MACC-1)	Stu Visser Trails	32 (Fair)	6.11 (Fair)
Noordeloos Creek (MACC-2)	Paw Paw Park	26 (Fair)	6.07 (Fair)
Upper Macatawa River (MACC-3)	Upper Mac Natural Area	24 (Fair)	6.08 (Fair)
Peters Creek (MACC-4)	Poppen Woods	24 (Fair)	5.93 (Fair)
South Branch (MACC-5)	Winding Creek Golf Course	27 (Fair)	5.6 (Fair)
Macatawa River (MACC-6)	Adams St Landing	26 (Fair)	6.72 (Fairly Poor)
North Branch (MACC-7)	Van Raalte Farm Park	34 (Good)	5.7 (Fair)

Date Source: ODC Network, MiCorps
Date Prepared: December 2024

3.4.2.2 Fish Community Survey

The Annis Water Resources Institute (AWRI) has conducted fish monitoring in Lake Macatawa since 2014 (Appendix B). Using a combination of fyke netting and electrofishing, they sample four (4) locations along the northern bays of Lake Macatawa (selected for more naturalized shoreline conditions with fewer seawalls), typically in September.

In 2024, AWRI assessed water quality at various sites in Lake Macatawa during fish sampling, with key variables such as water depth, temperature, and macrophyte cover measured. The mean water depth at fyke nets (85 cm) was consistent with long-term averages, and water temperature during sampling (23.2°C) was similar to past conditions. Macrophyte cover varied by site, with the highest growth recorded at sites #3 and #4. The overall macrophyte cover in 2024 was the highest observed to date, although it was influenced by factors such as water clarity and turbidity, which impact light penetration necessary for plant growth. The mean turbidity in 2024 was higher than the long-term average, suggesting that water quality issues like sediment influx and phytoplankton blooms continue to impact macrophyte habitats.

The fish sampling in 2024 yielded 2,081 fish representing 26 species, with non-native species like round goby and white perch comprising a significant portion of the catch (Figures 3.9 and 3.10). The species composition differed slightly from previous years, with a higher prevalence of round goby and white perch, and a lower presence of species associated with better water quality, such as rock bass, which was absent in 2024. In comparison, Muskegon Lake showed a lower proportion of non-native species. The fish assemblage in Lake Macatawa indicates poor ecological conditions, as evidenced by the dominance of species linked to low water quality. Despite the presence of some species indicative of better water quality, the overall condition suggests that environmental improvements are needed for the lake's ecosystem to recover. Future statistical analyses will be essential to more rigorously evaluate these trends (Ruetz and Scarborough, 2024, Appendix B).

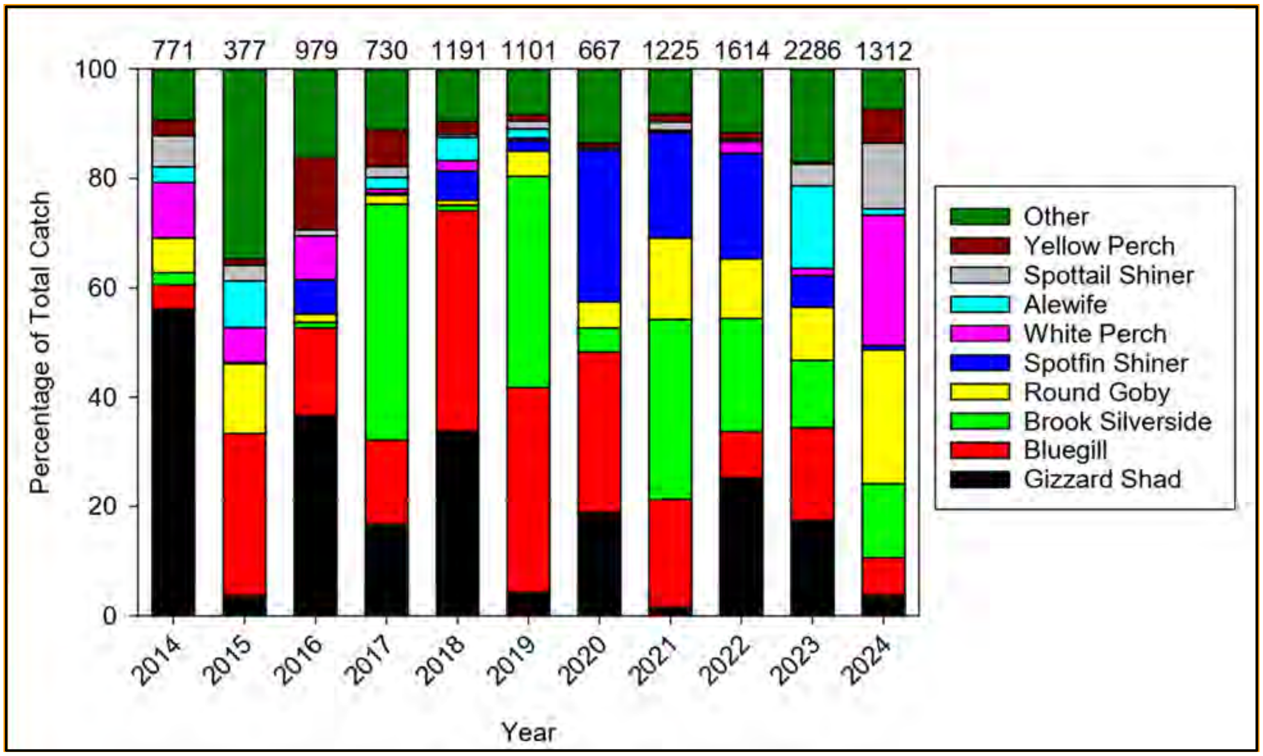

Figure 3.9 Fish species composition (pooled across sites) in fyke netting surveys for each sampling year

Data source: Ruetz and Scarborough, 2024

Date prepared: February 2025

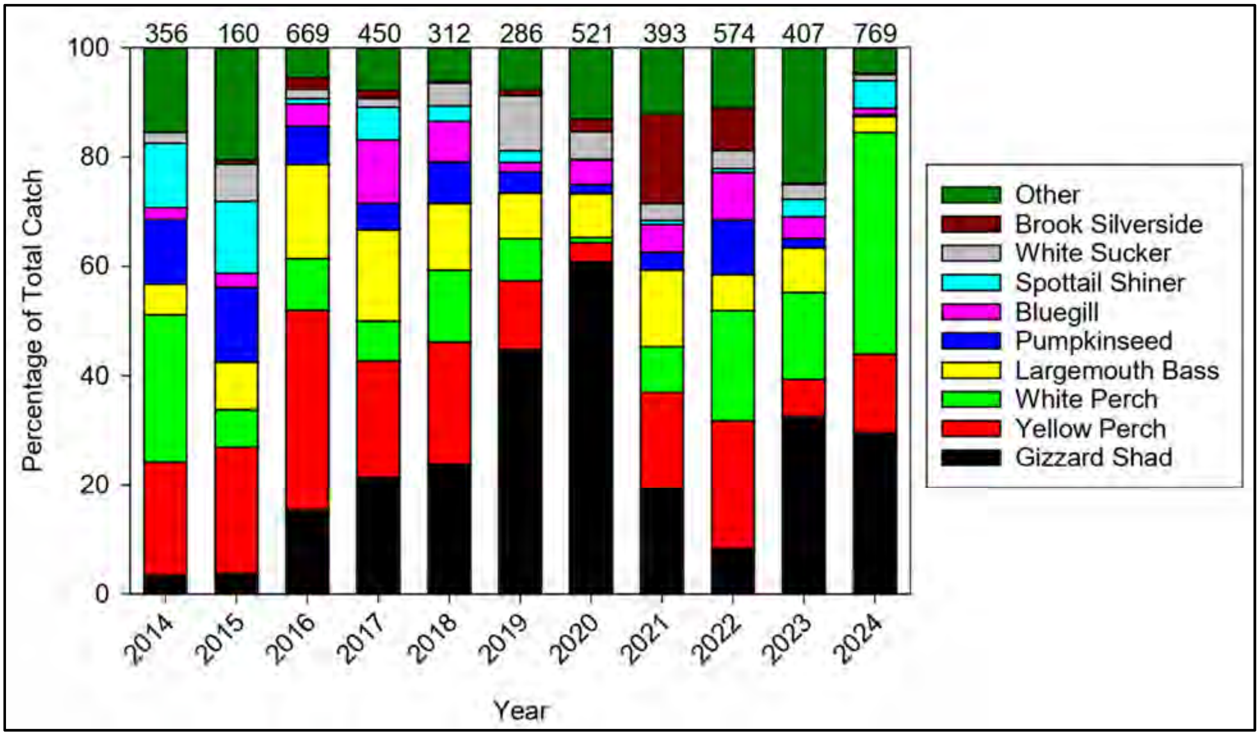

Figure 3.10 Fish species composition (pooled across sites) in nighttime boat electrofishing surveys for each sampling year
Data source: Ruetz and Scarborough, 2024
Date prepared: February 2025.

3.4.2.3 Road Stream Crossings

Overview

Road stream crossings occur when roads intersect with rivers or streams, typically through culverts or bridges. These structures allow water to flow beneath the roadway, facilitating transportation infrastructure while maintaining stream movement. Properly maintained and designed crossings are critical for ecological and hydrological health. Improperly designed or deteriorating crossings pose a significant threat to biological movement. Many crossings create barriers that prevent fish and other aquatic species from accessing crucial habitats for feeding, spawning and migration. Poor structure designs can result in perched culverts, insufficient stream flow or excessive velocities that aquatic species are unable to navigate. Inadequate crossings can alter the natural flow of streams/rivers, leading to habitat fragmentation and increased erosion of sediment downstream. There is also a flood risk from damaged infrastructure, where undersized or failing crossings can exacerbate flooding during heavy precipitation episodes. This event damages both aquatic habitats and road infrastructure, prohibiting movement of animals and humans.

The MACC and ODC Network conducted road stream crossing inventories from 2016-2024 and gathered data on 268 crossings (Appendix G). This plan prioritizes improving crossings that are limiting fish passage or contributing to stream degradation. The Michigan Department of Natural Resources (DNR) provides a standardized process, APP-A1-Great Lakes Stream Crossing Inventory, for evaluating and addressing road stream crossings (Great Lakes Stream Crossing Inventory, 2024). This protocol was developed, reviewed, and tested by the following organizations: Michigan DNR, U.S. Forest Service, Trout Unlimited, Wisconsin DNR, U.S. Fish & Wildlife Service, Huron Pines, Conservation Resource Alliance, Michigan Technological University, and road commissions. It includes detailed instructions for completing road stream crossing assessments. Here is a summary of the process of completing a road stream crossing inventory:

1. **Initial Assessment**: Conduct field surveys to document the crossing's physical condition, stream alignment, and passage for aquatic organisms.

2. **Data Collection**: Gather information on stream dimensions, flow characteristics, and other parameters. This typically includes measuring culvert height, width, and length, as well as water depth and velocity.

3. **Scoring System**: Rank road stream crossings based on their ecological and structural impact using passage and erosion scores generated by the Michigan DNR. Crossings with significant barriers and high rates of erosions will be prioritized for replacement or repair.

Road Stream Crossing Inventory Results

Over an eight (8) year period, 284 road stream crossings were inventoried in the Macatawa Watershed (Figure 3.11, Appendix G). The goal of the inventory process was to work through each subbasin over the course of ten (10) years until all known sites were visited. Subbasins with known erosion problems were prioritized for completion earlier in the ten (10) year cycle. Properly trained summer interns conducted most inventories. Due to the COVID-19 pandemic, interns were not hired in 2020 and 2021, so inventories were not completed in those years. Some sites that are unsafe due to traffic will likely not ever have complete inventories (e.g. state highways).

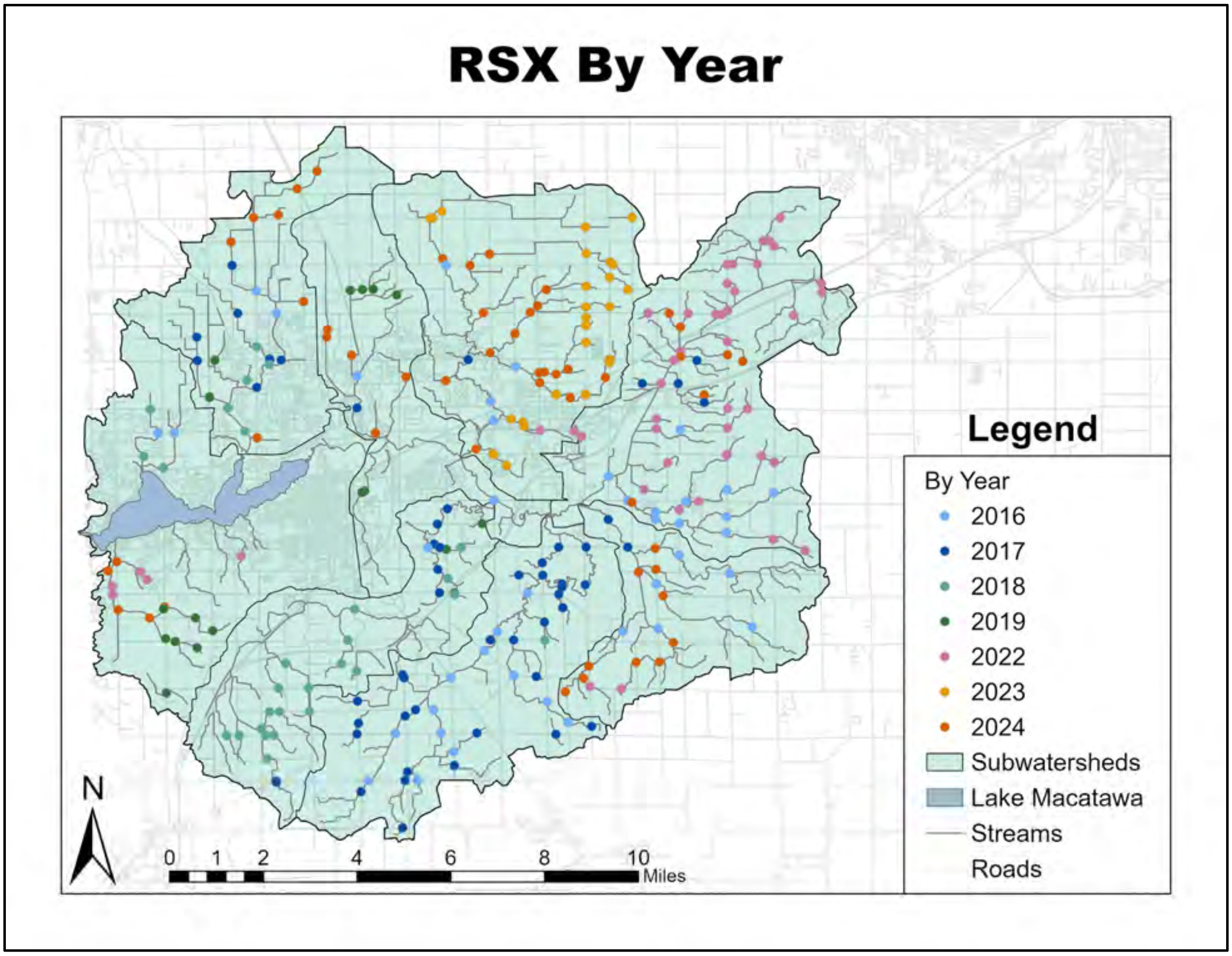

Figure 3.11 Road stream crossing inventories completed in the Macatawa Watershed
Source: ODC Network, Michigan DNR
Date Prepared: December 2024

Erosion Severity

Of the 284 sites inventoried for erosion, 124 sites had with minor erosion, 113 sites had moderate erosion, and 47 sites are of critical concern with severe erosion. The erosion rate (minor, moderate, or severe) calculates within the Great Lakes Stream Crossing Inventory by assessing the left and right approach to the culvert, the road surface, and the road width. Based on the number reported within this assessment, sites were sorted into the three categories. Minor was assigned to sites with less than 0.10 tons sediment load per year, moderate was assigned to sites with >0.1 and <1.0 tons of sediment load per year, and severe was assigned to sites with greater than 1 ton of sediment load per year. There are clear patterns of more severe erosion sites in subwatershed with higher agricultural production (see Peters Creek, Upper Macatawa, and Lower Branch on the far right of Figure 3.12).

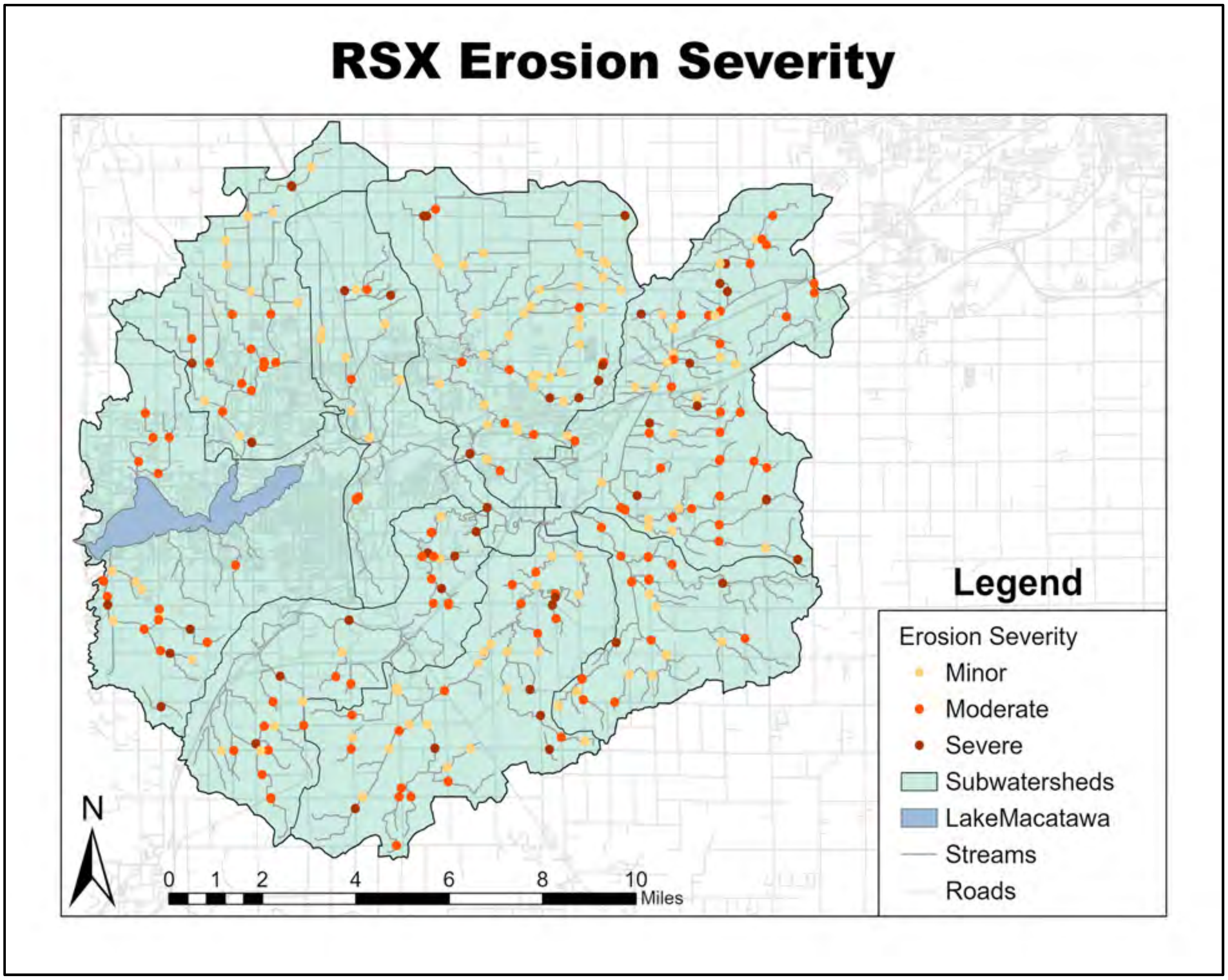

Figure 3.12 Erosion severity at all inventoried sites
Source: ODC Network, Michigan DNR
Date Prepared: December 2024

Fish Passage

Of the 284 sites inventoried for fish passage, 36 had a passage score of 1, 68 had a passage score of 2, 110 had a passage score of 3, and 33 had a passage score of 4. Thirty-seven (37) of the sites inventoried had a passage score of 0 meaning that it could not be assessed based on the data collected. The Michigan DNR interprets passage scores based on the following criteria:

Passage = 1
Barrier - Most species and life stages cannot pass at most stream flows. These criteria do not apply to open bottom structures.

- The outlet of the structure is perched, or
- The ratio of the structure water depth to the stream water depth is less than 0.1, or
- The water velocity in the structure is greater than 3 ft/s during base flow.

Passage = 2

Barrier at most flows - Some species and/or life stages cannot pass at most stream flows. These criteria do not apply to open bottom structures.

- The water depth in the structure is less than 0.2 feet, or
- The water velocity in the structure is 2-3 ft/s during base flow, or
- The structure is longer than 30 ft, does not have natural substrate through its entire length, and water depth in structure is less than 1 ft

Passage = 3

Barrier at high flows

- The constriction ratio (structure width/bankfull stream width) is less than 0.5, or
- There is a scour pool below the structure.

Passage = 4

Not a barrier - No passage problem. None of the criteria above are met.

Not Assessed = 0

Not enough data to make passage assessment

Figure 3.13 shows several key areas that are of concern including the Kelly Lake Drain (bottom left portion) and portions of the North Branch of the Macatawa River (east of Downtown Holland) that need to be targeted for improved fish passage requirements. Many of the culverts within the watershed are equipped for agricultural fields and not to accommodate fish, but several of the larger culverts near Lake Michigan, Lake Macatawa, and the Macatawa River are of greater concern for fish passage during spawning and migration seasons. These areas of concern will need to be addressed promptly to ensure fish can navigate through the waterways within the Macatawa Watershed.

Summary

Overall, 32 sites have both severe erosion and are barriers to fish passage for most life stages and all stream flows (passage = 1). These sites will be prioritized for repair or replacement. Since some of the inventory data was collected almost 10 years ago, it is possible that conditions have changed or that some structures have been replaced. Additional field scouting and collaboration with the appropriate road and drain agencies is necessary to identify exact sites for repair or replacement.

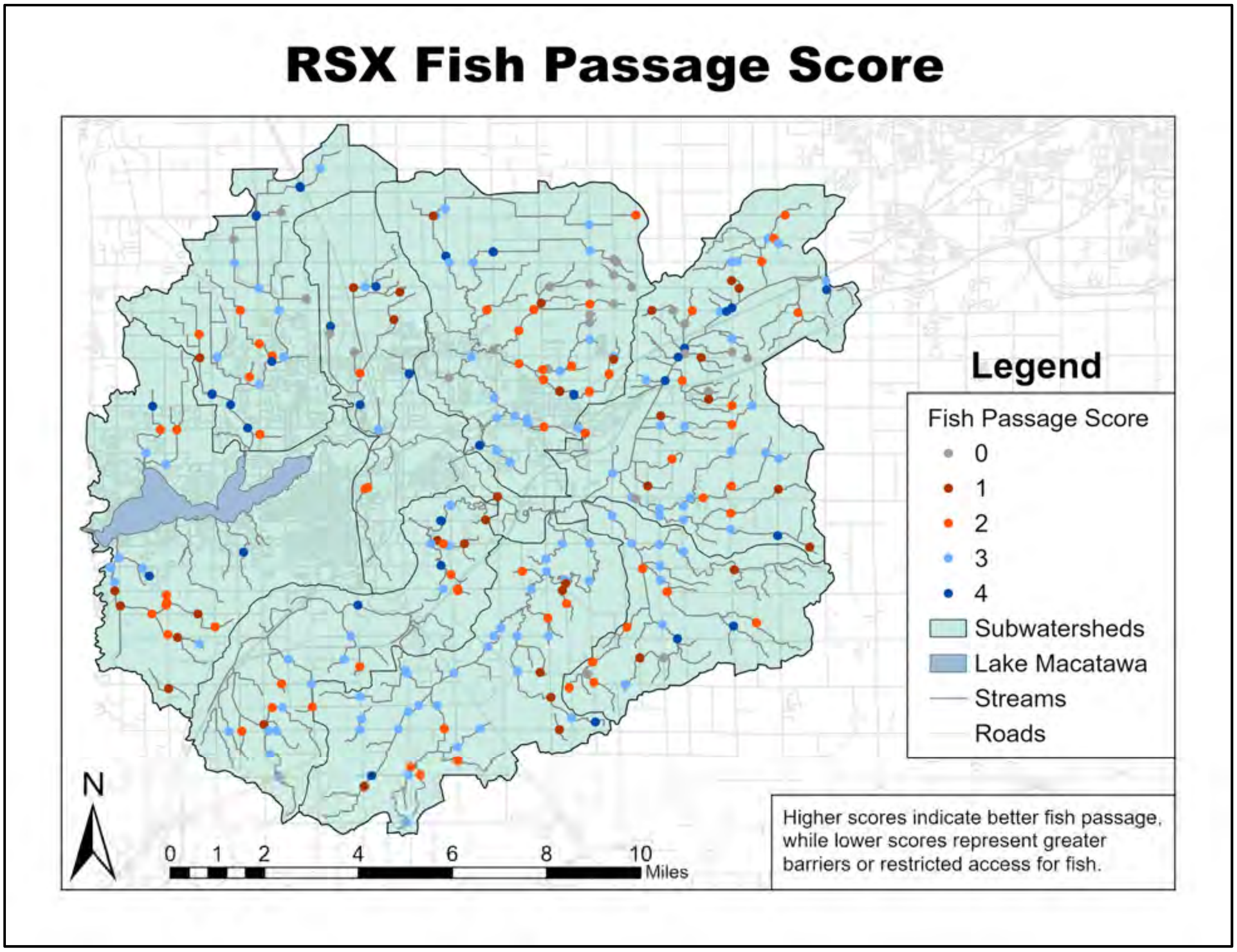

Figure 3.13 Fish passage scores in the Macatawa Watershed
Source: ODC Network, Michigan DNR
Date Prepared: December 2024

3.4.2.4 Chloride

High chloride concentrations in the Macatawa Watershed pose a significant threat to aquatic life, largely due to road salt (sodium chloride) runoff from urban areas. Chlorides accumulate in stream habitats during periods of high runoff, leading to long-term salinization and toxic conditions that harm aquatic vegetation, fish, insects, and freshwater mussels. Chloride is not broken down naturally, so this accumulation represents an ongoing environmental challenge.

Since 2020, the MACC and ODC Network staff have monitored chloride levels in two (2) urban streams. ODC has monitored the Maplewood Drain, just west of the DeWtitt Tennis Center (Hope College) since 2020 and the Azalea Drain, located at the DeGraff Nature Center since 2021 (Appendix H). At both sites, water samples are collected weekly and chloride levels are measured using Quantab chloride strips. Data is recorded on Google spreadsheets. Chloride concentrations are compared against Michigan's water quality standards:

- **150 ppm** – Chronic threshold: Long-term exposure affects organism survival, growth, and reproduction.

- **320 ppm** – Maximum value: Short-term exposure may cause acute stress to aquatic life.
- **640 ppm** – Acute value: Concentrations above this level can be lethal to 50% of aquatic organisms after 96 hours

Both monitoring sites show seasonal chloride fluctuations, with significant winter peaks likely due to road salt application (Figure 3.14). These peaks often surpass the acute toxicity threshold (640 ppm), with some readings exceeding the chronic (150 ppm) and maximum (320 ppm) values even during warmer months. In less than 5% of sampling days, Maplewood Drain recorded chloride levels below the chronic threshold. Approximately 80% of days exceeded this threshold, highlighting persistent chloride pollution. At the Azalea Drain, roughly 25% of days showed chloride levels below the chronic threshold. However, this higher percentage is influenced by more recent data collection starting in late 2021, when levels were comparatively lower.

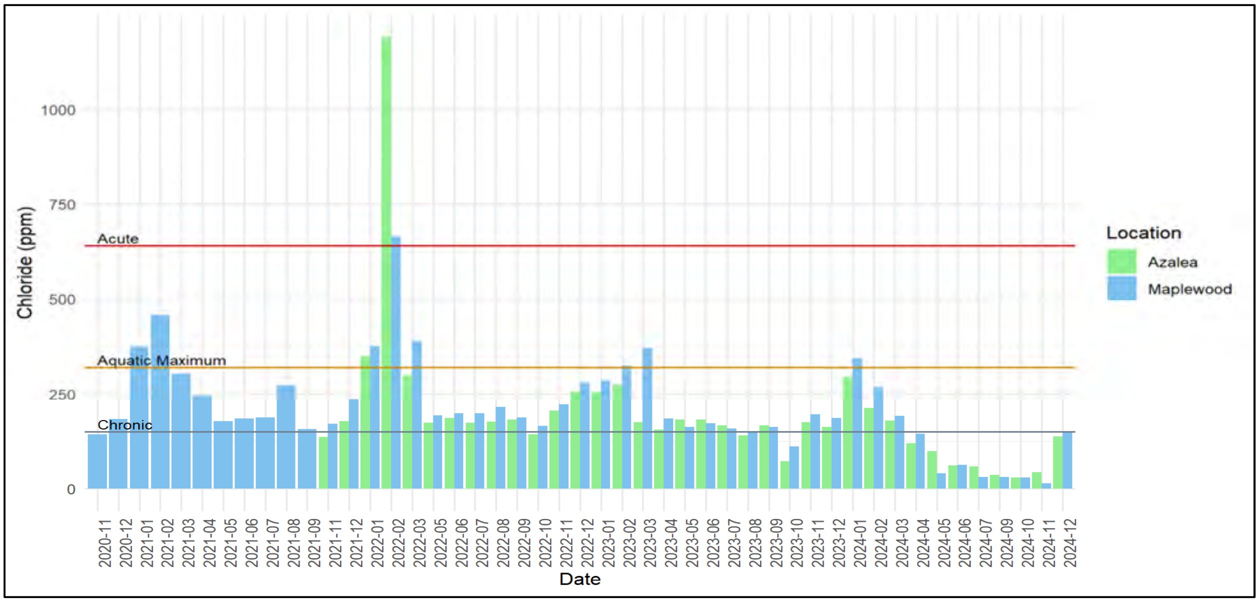

Figure 3.14 Monthly average chloride concentrations in the Azalea and Maplewood Drains
Date Source: ODC Network
Date Prepared: January 2025

3.4.2.5 Secchi Disk

A small group of local volunteers has been taking Secchi disk readings in Lake Macatawa and the main branch of the Macatawa River weekly during the growing season since 2002 (Appendix I). Since 2016, ODC Network staff and interns have also been taking weekly Secchi disk readings in Lake Macatawa at two different locations. A Secchi disk evaluation is a simple and effective method used to measure the transparency of a waterbody, which serves as an indicator of water clarity and overall water quality. To conduct a Secchi disk evaluation, a Secchi disk is lowered into the water using a marked measuring line, and the depth at which the disk is no longer visible is recorded as the Secchi depth. This measurement helps assess the presence of suspended particles such as algae, sediment, or organic matter in the water.

Figure 3.15 shows the yearly average Secchi depth readings at each survey location within the watershed. The y-axis indicates depth in the water column, so 0.00 is the surface of the water and 1.5 is 1.5 m below the surface. The greater the Secchi depth, the clearer the water. The orange line shown across the figure indicates the trend in the average data for all sites. The trend is relatively flat, generally increasing beginning around 2016. This indicates that overall, there is an improvement in water quality over the last few years. However, with secchi disk values ranging less than 1.0 m at Dunton Park and most values less than 1.0 m at the channel, the lake is in a hypereutrophic state.

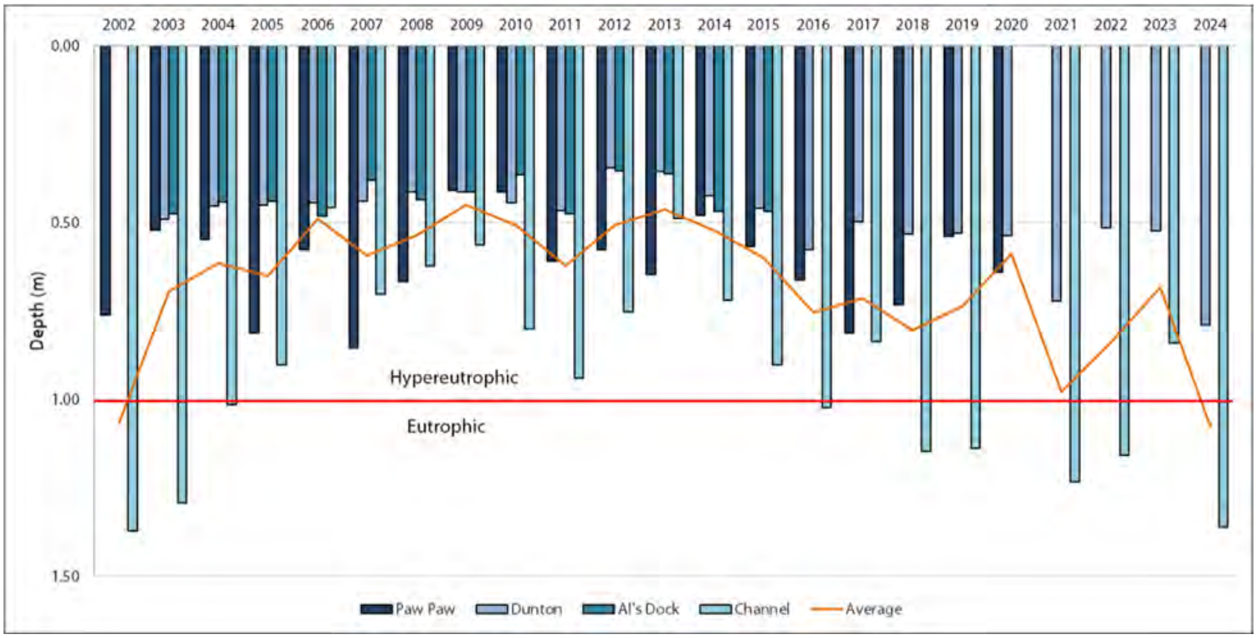

Figure 3.15 Average Secchi disk depth 2002-2024
Date Source: ODC Network
Date Prepared: June 2026

3.4.2.6 Tillage and Residue Surveys

A fall tillage and spring residue survey were completed to gain an understanding of general agricultural management practices used in the watershed, identify potential agriculturally based sources and causes of NPS pollution, determine areas where BMPs would be implemented to protect water quality, and to prioritize these areas based on their potential to generate NPS pollution. Surveys were prioritized in four (4) subwatersheds with high amounts of agricultural land and historically high sediment and phosphorus export: Upper Macatawa River, Noordeloos Creek, Peters Creek, and North Branch Macatawa River. The tillage survey was completed following 2024 crop harvest and the residue survey was completed following 2025 crop planting. Both surveys were conducted as visual windshield surveys following an approved QAPP (Appendix J). Crop type, method of tillage used, cover crop presence, residue percentage, and other information was recorded in a FieldMaps application provided by EGLE.

Figures 3.16, 3.17 and 3.18 show the results of the fall tillage and spring residue surveys that were completed in the Macatawa Watershed. Data was able to be collected for 401 of the 1,745 fields surveyed. Many fields were not visible from the road, and some fields were determined to not be in agricultural production or in permanent agriculture (pasture). Based on fall 2024 surveys, the majority of crops produced in the areas that were able to be surveyed are corn (57%) and soybean (30%) (Figure 3.16, Table 3.8). At the time of the fall 2024 survey, it appeared that most farm fields were under no till (57%), but this may be reflective of actual practices due to field conditions (fairly wet fall) or timing of the survey and not necessarily reflect true tillage practices (Figure 3.17, Table 3.9). In spring 2025, the majority of fields surveyed had less than 30% residue (83%) (Figure 3.18, Table 3.10). This indicates that many fields that appeared to be no-till in the fall could have been tilled in the spring. Additional years of survey are necessary to draw more precise conclusions. See Appendix K for full tillage and residue survey results.

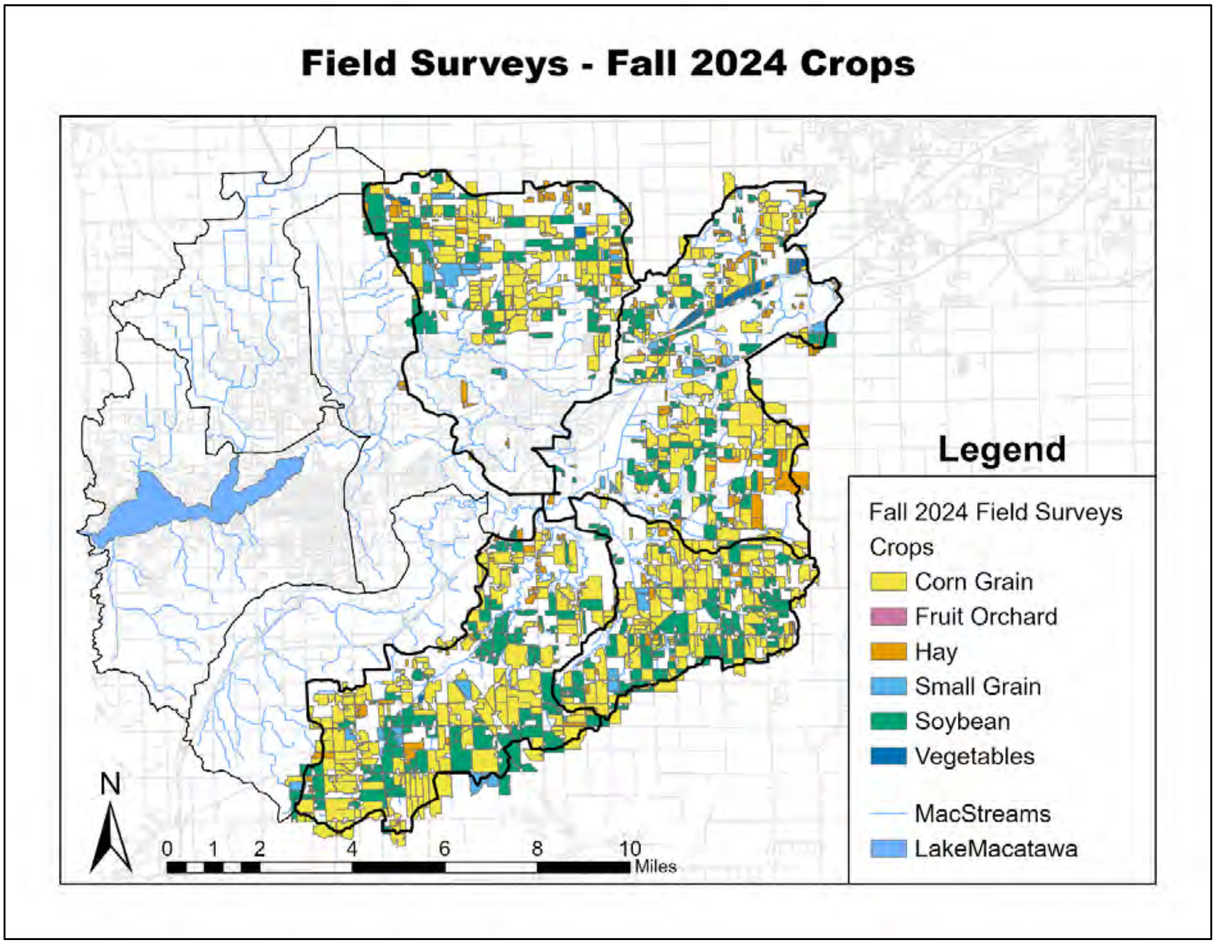

Figure 3.16 Crops in select areas of the Macatawa Watershed
Source: ODC Network, EGLE
Date Prepared: March 2026

Table 3.8 Survey results: Crop type

Crop Type	Total Acres	% of All Acres[1] (35,118)	% of Active Acres[2] (30,213)
Corn Grain	17,255	49%	57%
Fruit Orchard	5	<1%	<1%
Hay	2,055	6%	7%
Small Grain	1,092	3%	4%
Soybean	9,143	26%	30%
Vegetables	379	1%	1%

[1] *"all acres" is the total number of agricultural acres within the target subwatersheds*
[2] *"active acres" excludes the agricultural acres that could not be surveyed or were not in agricultural production at the time of the survey*
Source: ODC Network, EGLE
Date Prepared: March 2026

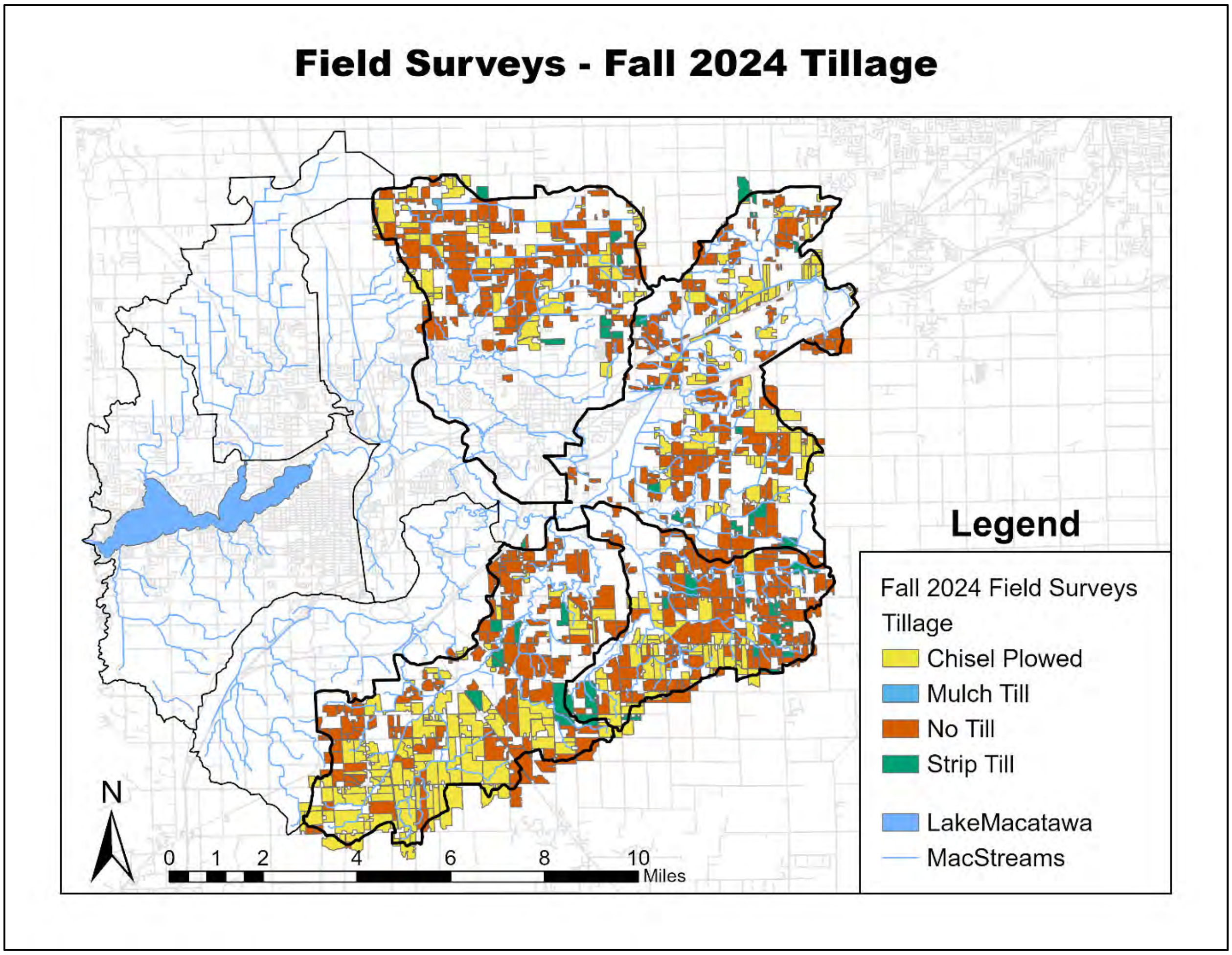

Figure 3.17 Fall tillage in select areas of the Macatawa Watershed
Source: ODC Network, EGLE
Date Prepared: March 2026

Table 3.9 Survey results: Fall 2024 tillage

Tillage	**Total Acres**	**% of All Acres** (35,118)	**% of Active Acres** (28,382)
Chisel Plowed	10,642	30%	37%
Mulch Till	24	<1%	<1%
No Till	16,174	46%	57%
Strip Till	1,542	4%	5%

[1] "all acres" is the total number of agricultural acres within the target subwatersheds
[2] "active acres" excludes the agricultural acres that could not be surveyed or were not in agricultural production at the time of the survey
Source: ODC Network, EGLE
Date Prepared: March 2026

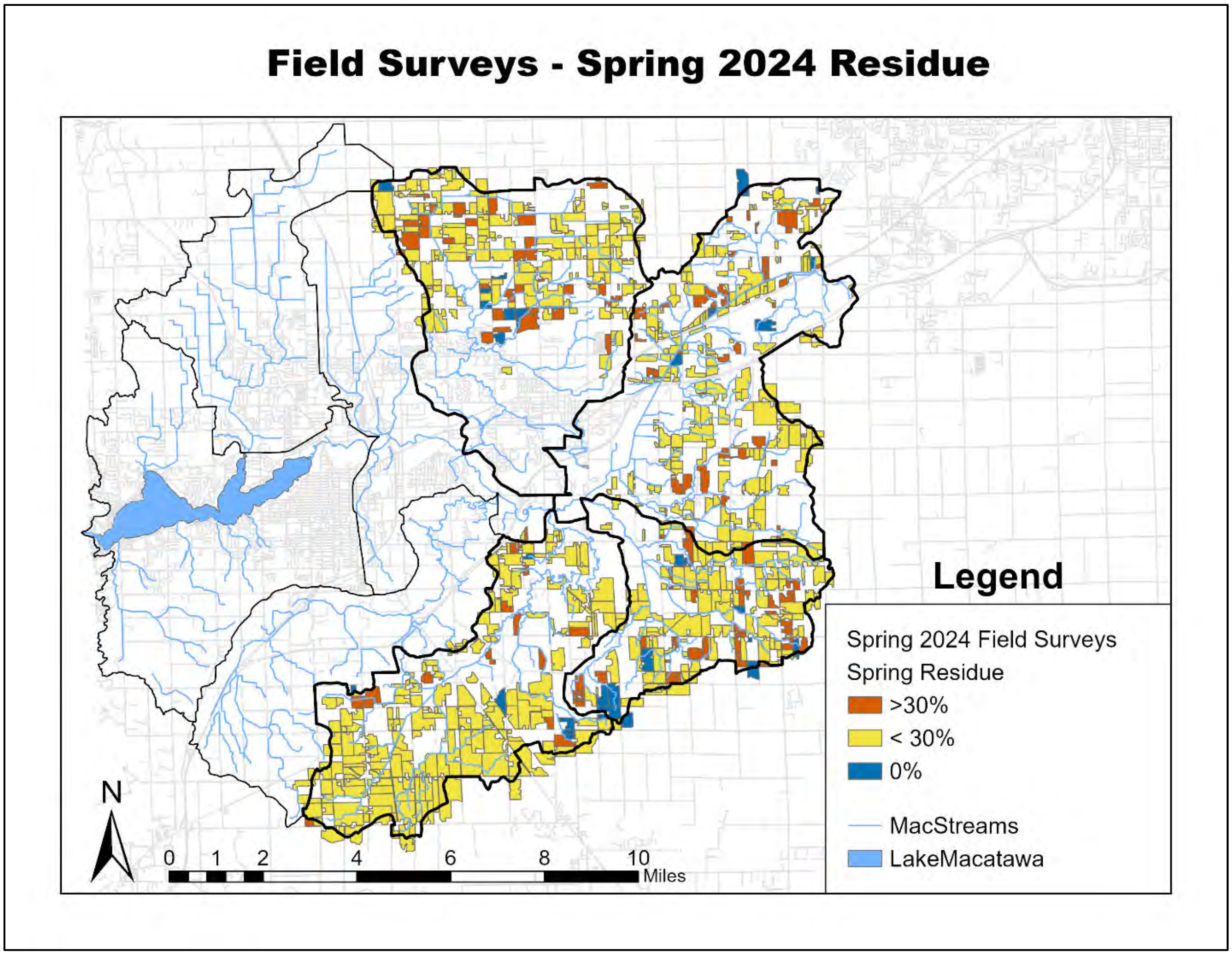

Figure 3.18 Spring residue in select areas of the Macatawa Watershed
Source: ODC Network, EGLE
Date Prepared: March 2026

Table 3.10 Survey results: Spring 2025 residue

Spring Residue	Total Acres	% of All Acres (35,118)	% of Active Acres (23,353)
>30%	2,959	8%	13%
<30%	19,415	55%	83%
0%	978	3%	4%

[1] "all acres" is the total number of agricultural acres within the target subwatersheds
[2] "active acres" excludes the agricultural acres that could not be surveyed or were not in agricultural production at the time of the survey
Source: ODC Network, EGLE
Date Prepared: March 2026

3.4.2.7 Agricultural Conservation Planning Framework

The Agricultural Conservation Planning Framework (ACPF) is an ArcGIS compatible toolbox that utilizes high resolution LiDAR derived Digital Elevation Models to identify slopes within a given farm field, overland flow paths within a watershed, and candidate locations for specific BMPs such as grassed waterways and water and sediment control basins Digitization of field boundaries allows for site-specific analyses based upon input parameters such as tillage practices, crop rotations, and manure applications. EGLE staff ran the ACPF model for four (4) high priority subwatersheds and provided the results to the ODC. Figure 3.19 shows the model outputs for suggested locations of grassed waterways and water and sediment control basins (WASCOBs) superimposed on the agricultural critical areas (described in Section 5.1). The full outputs of the ACPF model are not included within the plan as they are in digital, ArcGIS formatted files. Copies of digital outputs are available through the ODC Network and will be provided upon request.

The ACPF output of runoff risk can be used in association with tillage and residue survey results (Figure 3.18) to identify agricultural fields located in critical agricultural subwatersheds that are considered high priority due to potential for contributing NPS pollution (See Section 5.1).

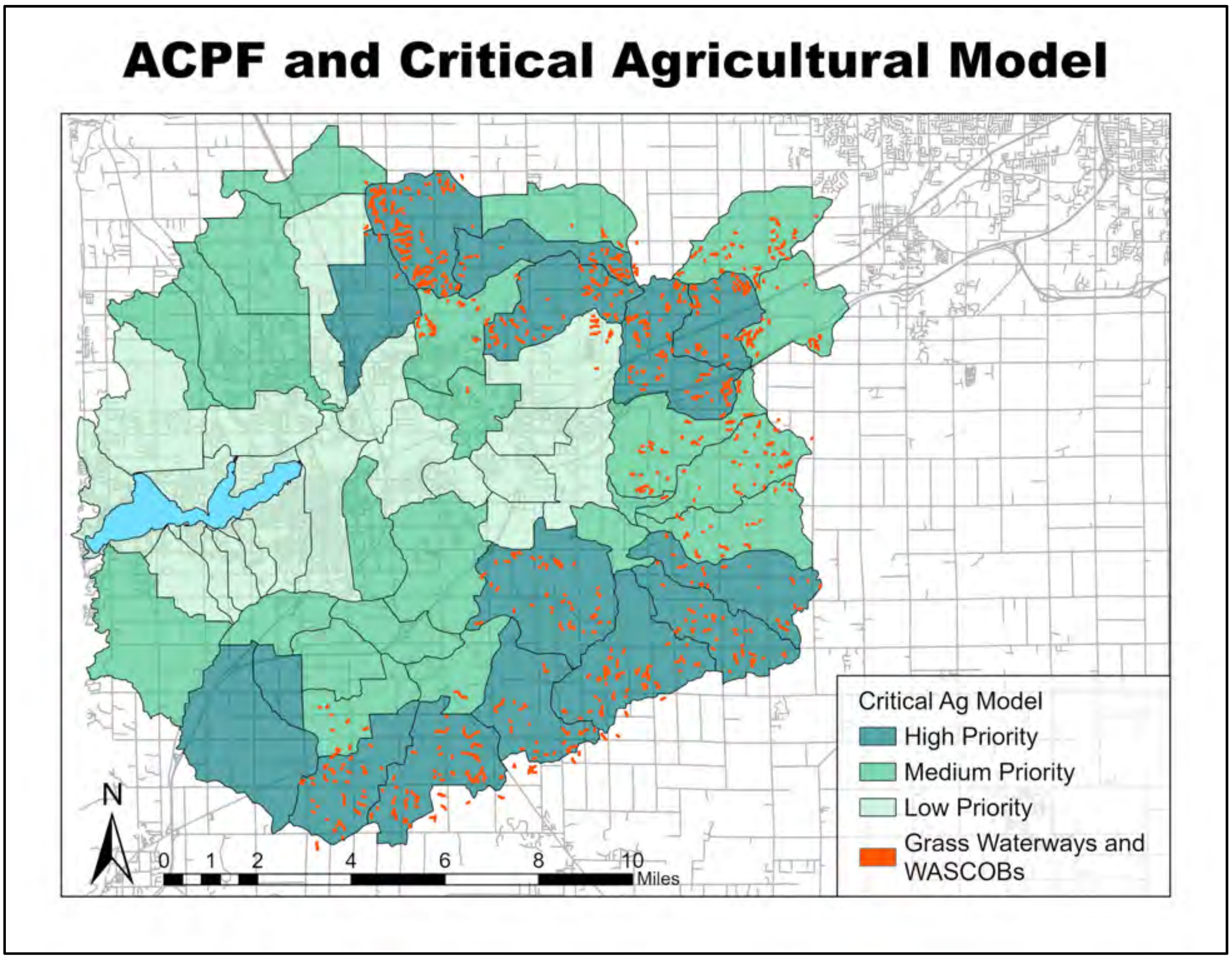

Figure 3.19 Grassed waterways and WASCOBs in agricultural critical areas
Source: ODC Network, EGLE
Date Prepared: December 2024

4.0 POLLUTANTS, SOURCES AND CAUSES

4.1 Pollutants Prioritized

The main goal of the watershed management plan is to improve water quality by meeting state standards, achieving Phosphorus TMDL goals, restoring designated uses, reducing beach closures, and enhancing public perception. To achieve this, it is necessary to reduce pollutants entering Lake Macatawa and its tributaries. The watershed committees identified and ranked pollutants based on their impact on issues like algae blooms, flooding, beach closures, and murky water, and refined this ranking through multiple meetings.

This plan does not address the fish consumption designated use. This designated use is impaired in Lake Macatawa (for carp and walleye) based on the presence of polychlorinated biphenyls (PCBs) and mercury which are persistent, bioaccumulative chemicals (MDEQ 2010 Integrated Report). This phenomenon occurs statewide in Michigan and is thought to be caused by atmospheric deposition. In addition, perfluorooctanesulfonic (PFOS) acid was more recently tested and identified in fish tissue from fish caught in Lake Macatawa (EGLE, 2024a). While EGLE is still working to investigate and understand the sources of PFOS in the watershed, it PFOS is generally considered a point source pollutant. Since this designated use impairment is not due to local nonpoint source pollution, the remediation of this designated use is outside the scope of this watershed management plan.

Pollutants of concern within the Macatawa Watershed include:

- Nutrients (phosphorus)
- Sediment
- Hydrology
- Temperature
- *E. coli*
- Chloride

4.2 Sources and Causes of NPS Pollutants

Identifying the priority pollutants (above) is only the first step in creating a restoration strategy. The source of pollution refers to the site or organism discharging it, while the cause describes the behavior at a specific location that lets the pollution enter waterways. Different management techniques will be needed to address different sources, as many of them originate in disparate areas of the watershed. This section explains the sources and causes of pollution in the Macatawa Watershed and notes their known, suspected, and potential presence.

Sources and causes are labeled as:

- Known (k): Confirmed through lab data, field assessment, or watershed study
- Suspected (s): Observed or reported impacts, but not measured
- Potential (p): Suitable conditions for pollutants, but none observed

A summary of sources and causes is in Table 4.1. Further details on the impacts and their sources follow the table. Additional inventories by EGLE and local entities are needed to fully assess the watershed.

Table 4.1 Pollutants, sources and causes present in the Macatawa Watershed

Pollutant	Source	Cause
Nutrients	Agricultural sources/runoff	Tillage practices (k)
		Improper manure and/or fertilizer application (s)
		Tile drainage (k)
		County and private drains (s)
		Loss of wetlands, floodplains, and vegetation (k)
		Improper livestock and manure management (p)
		Manure spills (s)
	Urban sources/runoff	Loss of wetlands, floodplains, and vegetation (k)
		Improper use or application of fertilizers (s)
		Lack of riparian buffers (k)
		Poor stormwater management (k)
		Marinas/boating (s)
		NPDES permit noncompliance (p)
		Car washing (s)
	Streambanks	Erosion from loss of vegetation and logjams (k)
	Untreated sewage	Failing septic systems (s)
		Illicit connections (p)
Sediment	Agricultural sources/runoff	Tillage practices (k)
		Tile drainage (k)
		County and private drains (k)
		Loss of wetlands, floodplains, and vegetation (k)
	Urban stormwater	Impervious surfaces (s)
		Storm drains (s)
		Urban and residential development (s)
		Construction sites (s)
	Streambanks	Erosion from loss of vegetation and logjams (k)
	Road Stream Crossings	Improper design/alignment/maintenance (k)
Hydrology	Agricultural runoff	Tile drainage and other artificial drainage (k)
		Wetland loss (k)
	Urban/residential runoff	Impervious surfaces (k)
		Wetland loss (k)
	Road stream Crossings	Improper design, alignment (s)
Temperature	Urban/residential runoff or direct discharge	Impervious surfaces (s)
		Lack of riparian buffers (s)
		Industrial discharge (s)
	Agricultural runoff	Lack of riparian buffers (s)
		Tiling and artificial drainage (s)

Pollutant	Source	Cause
E. coli bacteria	Agricultural sources/runoff	Application of Manure (s)
		Biofilms in tile drains and artificial drainage (k)
	Urban sources/runoff	Biofilms in storm drains (k)
		Pet waste (s)
		Heavily-modified landscaping (p)
	Untreated sewage	Failing septic systems (s)
		Illicit connections (p)
		Sewer overflows (p)
	Sediment	Harbor endemic bacteria (s)
Chloride	Roads	Over application of road salts (k)
	Industrial	NPDES Permit Non-Compliance due to New Water Quality Standards (p)
	Groundwater	Aquifer withdrawals (k)[1]

Data Source: ODC Network, Project Clarity Committee
Date Prepared: December 2024

4.2.1 Nutrients

Nutrients like nitrogen and phosphorus are natural chemical elements that are part of a healthy aquatic ecosystem's cycle. Human activities can interfere with this cycle by adding excess nutrients to the watershed. This extra nutrient load can cause elevated nitrate levels in drinking water, blue-green algae blooms, excessive algal growth that embeds substrates and alters food web structures, increased costs treating drinking water, or health risks for ingesting algae in untreated water. Moreover, when the nutrients are depleted, the resulting algal blooms decompose, reducing dissolved oxygen levels, further impacting aquatic biota. Stormwater runoff transports nutrients and sediment to waterways.

Phosphorus (P) is the priority nutrient due to the TMDL encompassing the entire watershed. The limiting reagent in algal blooms, there are many known sources of phosphorus and several significant ones that are highlighted in this plan. Soluble reactive phosphorus (SRP) is of particular concern as it is unbound to sediment and readily available for algal uptake. Nitrogen (N) is also a concern in the watershed, although its sources and remediation techniques are different from those having the greatest impact on phosphorus removal. The sources and subsequent causes of nutrient pollution include the following:

4.2.1.1 Agricultural Sources and Runoff

- *Tillage practices*: Sediment that erodes into area waterways often has high nutrient contents, such that are suitable for crop production. Numerous fields within the watershed still have aggressive, traditional tillage practices that can contribute to nutrient loading.
- *Improper manure and/or fertilizer application*: Livestock manure and fertilizers often are applied to fields for promoting increased crop yield. The application of excess manure is a major contributing cause of nutrient loading to the watershed.

[1] See Section 2.7.4. Recent studies in Ottawa County have shown that aquifer withdrawals are bringing geologic chloride closer to the surface, contaminating wells to the point that they are no longer usable without significant treatment to remove chloride.

- *Tile drainage*: Extensive artificial drainage, particularly the increased use of tile drains, have helped to improve field conditions for area farms. While these reduce overland runoff, they contribute a high amount of SRP.
- *County and private drains*: Another form of artificial drainage, county and private drains are artificially straightened, which can lead to an increased risk of erosion, channel entrenchment, and a reduction of floodplain connectivity, resulting in higher nutrient loading to area waterways.
- *Loss of wetlands, floodplains, and vegetation*: The development of the greater Holland/Zeeland community has resulted in the historic loss of significant tracts of wetlands (down 86% from pre settlement levels), as well as decreased floodplain connectivity and a lack of vegetation and tree canopy. These features all would have helped minimize nutrient loading during pre-settlement times.
- *Improper livestock and manure management*: Livestock can contribute through direct access of streams where they can cause erosion and contribute manure to streams.
- *Manure spills*: Manure leaking from storage or spilled during transport can result in large spikes in waterway nutrient levels. While rare and unlikely, at least one significant occurrence has occurred since the last management plan update.

4.2.1.2 Urban Sources and Runoff

- *Loss of wetlands, floodplains, and vegetatio*n: Most built-up areas around the watershed have significantly fewer natural features than pre settlement conditions. The loss of these features increases the amount of runoff reaching streams, resulting in higher nutrient loads.
- *Improper use or application of fertilizers*: Fertilizers contain high levels of nutrients to encourage plant growth. The over application or improper use of fertilizers, combined with nearby impervious surfaces, can result in a source of bioavailable nutrients in waterways.
- *Lack of riparian buffers*: A lack of natural space that can filter overland runoff and stabilize stream erosion can contribute higher nutrient loads.
- *Poor stormwater management*: Management of stormwater in the watershed is often suboptimal for several reasons. These include a lack of green infrastructure designed to infiltrate stormwater, outdated 'gray' infrastructure designed to move water quickly, and traditional drainage techniques used to move water away from a site as quickly as possible.
- *Marinas/boating*: The potential for increased nutrient loading from marine activities include cleaning treatments on boats and illicit human waste disposal.
- *NPDES permit noncompliance*: While current oversight and monitoring show compliance, entities within the watershed requiring NPDES permits do have the capability of releasing high levels of nutrients into local waterways.
- *Car washing*: Detergents used to clean cars contain high levels of nutrients, which if not used at a professional car wash facility, can reach storm drains.

4.2.1.3 Streambanks

- *Erosion from loss of vegetation and logjams*: Unstable hydrology in local streams can self-perpetuate erosion, leading to steep and unvegetated banks, tree loss, and high sediment and nutrient loads.

4.2.1.4 Untreated Sewage

- *Failing septic systems*: Septic systems usually include underground tanks to hold wastewater solids and a drainage field where wastewater filters through soil. If not properly installed, maintained, or replaced, these systems can leak or overflow, allowing untreated waste to enter surface water. This is especially concerning in areas with poorly drained soils near surface waters. Installing conventional septic systems in these areas could cause untreated human waste to reach groundwater and surface water.
- *Illicit connections*: The illegal connection of untreated sewage from homes or businesses to surface waters could still be a source of pollution in the Macatawa Watershed. Although no illicit connections have been identified or reported in recent years, unidentified ones may still exist and pose a potential risk.

4.2.2 Sediment

Sedimentation is a natural process that moves sediment through streams and fills out beaches with sand. However, human activity has resulted in sediment turning into a pollutant. Sediment can result in turbidity that limits light penetration and limits the sunlight available to aquatic plants. It also covers streambeds, smothering aquatic life, disturbing vital habitats, while also filling in navigable waterways, and leading to costly dredging projects. Perhaps most important is the high correlation between sediment and phosphorus levels within the Macatawa Watershed, presenting a significant obstacle in reaching the TMDL goal.

4.2.2.1 Agricultural Sources and Runoff

- *Tillage practices*: Sediment that erodes into area waterways is often from agricultural runoff. There are numerous fields within the watershed that still have aggressive, traditional tillage practices that can disturb soil structure and lead to significant quantities of sediment reaching nearby waterways.
- *Tile drainage*: While tile drainage does tend to limit the amount of overland flow on fields that they drain (as well as discharging minimal sediment loads themselves), these artificial drains dramatically reduce the amount of time it takes for water to reach streams. This modified hydrology results in flashier streams that have great erosive power and carrying capacity for sediment transport.
- *County and private drains*: The extensive network of county- and privately-maintained drains, especially in farmed areas, creates extra sediment loads from artificial straightening and poor maintenance techniques with limited soil and erosion control measures.
- *Loss of wetlands, floodplains, and vegetation*: The development of the greater Holland/Zeeland community has resulted in the historic loss of significant tracts of wetlands (down 86% from pre settlement levels), as well as decreased floodplain connectivity and a lack of vegetation and tree canopy. These features all would have helped minimize sediment loading during pre-settlement times.

4.2.2.2 Urban Stormwater

- *Impervious surfaces*: The sheer amount of impervious surfaces currently found across the watershed – including buildings, roads, and other artificial structures – has drastically reduced the areas where water naturally infiltrates into the ground. These hard surfaces increase overland flow, resulting in increased erosion both within and outside stream channels.

- *Storm drains*: To help move water that is unable to infiltrate due to impervious surfaces, storm drains carry water and any sediment they might be carrying directly into local waterways, increasing stream flashiness and risk of erosion.
- *Urban and residential development*: Ottawa County remains the fastest growing county in the entire state of Michigan with a population already in the top ten (10), with Allegan County trailing not far behind in growth rate. The impact of development pressure will only increase the amount of impervious surfaces, which will require reducing the amount of storm drains and other traditional infrastructure.
- *Construction sites*: Exposed sediment at construction sites can run into local waterways if proper erosion control methods are not utilized. This can include on-site activities or vehicles entering and exiting the site.

4.2.2.3 Streambanks

- *Erosion from loss of vegetation and logjams*: Unstable hydrology in local streams can self-perpetuate erosion, leading to steep and unvegetated banks, tree loss, and high sediment and nutrient loads.

4.2.2.4 Road Stream Crossings

- *Improper design/alignment/maintenance*: There are 620 road stream crossings in the watershed. Aging or poorly designed structures can lead to erosion above or below these crossings, introducing additional sediment loads to tributaries in the upper reaches of the watershed. In addition, some of the structures can be barriers to fish passage and limit access in the upper reaches of streams.

4.2.3 Hydrology

The hydrology of the Macatawa Watershed has been severely and significantly altered since the area was settled by Europeans. Landscape changes significantly influence stream channel functionality and the associated habitats. Increased bank erosion and ongoing channel modifications often lead to excessive sedimentation, which affects nutrients, habitats, temperature, and the natural flood cycle. Common modifications, such as road crossings that restrict flow through culverts or converting streams into drainage ditches for agriculture, degrade habitats for warm- and cold-water fish as well as aquatic macroinvertebrates. Stream straightening and channelization have locked many streams within their channels, robbing them of opportunities to connect to their historic floodplains. This degradation favors species that tolerate poor conditions, reducing diversity and richness. Habitat destruction and loss severely impact plant and animal species, often leaving them without shelter or food sources.

4.2.3.1 Agricultural Runoff

- *Tile drainage and other artificial drainage*: The manipulation of area waterways to ease road construction, development, and farming has resulted in severely altered hydrology. Artificial drainage moves water into streams at a far faster rate than pre-settlement. This results in flashier stream flows, capable of greater scouring and flooding. It lowers base flow and can result in streams drying out during periods of drought, jeopardizing habitat in headwater areas.
- *Wetland loss*: Draining and filling wetlands in agricultural areas has resulted in fewer areas for storing and absorbing stormwater. This water moves downstream quickly instead of sitting for extended periods of time, raising and speeding up peak storm flows.

4.2.3.2 Urban/residential runoff

- *Impervious surfaces*: The sheer amount of impervious surfaces currently found across the watershed – including buildings, roads, and other artificial structures – has drastically reduced the areas for water naturally infiltrates into the ground. Similar to agricultural settings, this hastens water into waterways faster, resulting in higher peak storm flows.
- *Wetland loss*: Draining and filling wetlands in urban areas has reduced the capacity to store and absorb stormwater. As a result, stormwater travels downstream more rapidly, rather than remaining in place for extended periods, minimizing infiltration and leading to higher and faster peak storm flows.

4.2.3.3 Road Stream Crossings

- *Improper design/alignment/maintenance*: Aging or poorly designed structures can back water up at road crossings, creating unnatural pools. Rerouting of streams for the sake of road crossings can lead to issues of misaligned channels, obstructed flows, or excessively channelized stream reaches.

4.2.4 Temperature

Stream water temperature influences both the types of aquatic life that can thrive and the solubility of oxygen. Warmer water holds less dissolved oxygen (DO), which harms aquatic organisms, particularly in areas historically suited for cold water fisheries, as rising temperatures can render these habitats unsuitable. Warm water fish and macroinvertebrates require DO levels around 5 mg/L to remain healthy, whereas cold water fish need DO levels of 7 mg/L. Prolonged periods of low DO cause fish and macroinvertebrate populations to shift toward more tolerant species.

The water bodies in the Macatawa Watershed are warm water fisheries. While this indicates that more tolerant species naturally existing in the watershed, area streams still can suffer from excessive heat levels. Strategies should be adopted to help water remain at suitable temperatures with appropriate shade and depth.

4.2.4.1 Urban/residential runoff

- *Impervious surfaces*: Many impervious surfaces in urbanized areas can have a warming effect on runoff, such as parking lots and roads. Their impervious nature moves water much more quickly to nearby waterways.
- *Lack of riparian buffers*: A lack of natural tree and plant cover exposes waterways to the sun to warm waters. Combined with flashier flows, this allows stream temperatures to climb unnaturally high.
- *Permitted industrial discharges*: Based on observations made by ODC staff and the Ottawa County Water Resource Commissioner's office, there appears to be at least one (1) suspected thermal discharge in the Macatawa Watershed in the Noodeloos Creek Subwatershed. This issue needs further investigation.

4.2.4.2 Agricultural Runoff

- *Lack of riparian buffers*: A lack of natural tree and plant cover exposes waterways to the sun to warm waters. Combined with flashier flows, this allows stream temperatures to climb unnaturally high.
- *Tile drainage and other artificial drainage*: Moving water faster into streams during warmer months allows the temperature to rise when it reaches the water. This also leads to less steady resupply of groundwater to streams later in the summer, resulting in shallower, warmer water.

4.2.5 *E. coli* Bacteria

E. coli is included as a priority pollutant due to its impairment listing by EGLE, inclusion in the Statewide *E. coli* TMDL, and elevated levels routinely found in sampling conducted by Hope College. *E. coli*, found in manure and septic runoff, is a fecal indicator bacterium because it is easy to test for, cost-effective, and EGLE has established a water quality standard for comparison. When a water body does not meet the designated uses for partial and total body contact recreation, human health is at risk from contact with surface water.

Sources are numerous and varied throughout the watershed. While there are known health risks associated with some direct human sources, such as illicit discharges or poorly maintained septic systems, the virulence of bacteria populations from other sources within the environment is not as clear. While reducing overall numbers of fecal indicator bacteria remains a priority, focusing on genetically identified populations that derive from human sources should be the top priority while partners at Hope College, AWRI, and the state continue further microbial ecology research.

4.2.5.1 Agricultural Sources & Runoff

- *Manure application*: Livestock manure is typically spread on cropland for use as fertilizer. According to the 2022 Census of Agriculture, about 21% of farms in Allegan County and 24% of farms in Ottawa County use manure as fertilizer (USDA-NASS, 2022). The soil conditions, spreading rate, weather, and proximity to surface water, tile lines and overland drainage all affect the runoff path of manure, leading to potential increases in *E. coli* concentrations in water. The extensive amount of drainage within agricultural settings leads to increased bacterial levels in nearby streams.
- *Biofilms in tile drains and artificial drainage*. In the artificial drainage that is now common in fields around the watershed, biofilms are common. They can host bacterial populations due to their relatively consistent temperature along with a steady flow of nutrients and water. These drains can become hydrologically connected with one another during periods of higher flow.

4.2.5.2 Urban sources/runoff

- *Biofilms in storm drains*: Like artificial drainage in agricultural areas, storm drains can host biofilms that contain high levels of fecal indicator bacteria.
- *Pet waste*: When not picked up near hard surfaces or improperly disposed of, fecal bacteria can be sourced from pet waste. This is of particular concern at beaches and waterfront parks.
- *Heavily modified landscaping*: Areas with large quantities of lawn and turf grass, particularly near bodies of water, can provide conditions for attracting large quantities of waterfowl and other potentially nuisance wildlife. Encouraging landscaping utilizing native species can reduce an overabundance of nuisance wildlife and reduce animal waste.

4.2.5.3 Untreated sewage

- *Failing septic systems*: Septic systems generally consist of underground tanks that capture solids in wastewater and a drainage field where the wastewater filters through the soil. If these systems are not properly installed, maintained, or replaced, untreated waste can leak or overflow into surface water. This can lead to higher *E. coli* levels in nearby surface and groundwater. Septic systems may fail if they are not installed with proper consideration of drainage capabilities. Systems located in poorly drained soils near surface waters are of particular concern. Installing traditional septic systems in these areas could allow untreated waste to reach groundwater and surface water.

  The statewide *E. coli* TMDL highlights factors that may render septic systems ineffective, including age, limited land area, poorly drained soils, a high water table, improper maintenance, and hydraulic overload or undersized systems. Research in Lower Michigan watersheds identifies septic systems as the main source of human-related *E. coli* contamination. The State of Michigan, County Health Departments/Districts, and local municipalities have the authority to regulate septic systems. In Allegan and Ottawa County, the Department of Public Health requires permits for the installation of new or repaired septic systems, and the conduct evaluations to ensure a property is suitable for such systems. Additionally in Ottawa County, septic and water supply systems must be inspected for failures before a property is sold. However, there are currently no regulations requiring homeowners to regularly evaluate or maintain their septic systems while living in the home.

- *Illicit connections*: The connection of illicit, untreated household or business sewage systems is a possible source of fecal bacteria to area waterways. No specific sources within the watershed are known, however due to the likely age and limited regulation of these systems, the possibility exists.

- *Sewer overflows*: While unlikely, the potential of sewer overflows during a catastrophic weather event or accident could release fecal bacteria into area waterways. There are no combined septic and stormwater systems in the Macatawa Watershed. However, there have been sewer overflows in the past likely due to illicit connection of sump pumps to the sanitary sewers that overwhelmed treatment plants during extreme rainfall events.

4.2.5.4 Sediment

- *Harbor for endemic bacteria*: Suspended and transported sediment could house endemic populations of *E. coli* and other fecal indicator bacteria. Strategies for limiting sediment and nutrient transport may also have some benefit for reducing bacteria levels.

4.2.6 Chloride

Chloride can harm aquatic plants, insects, fish, and other organisms, impacting various life stages, from growth and reproduction to survival. Elevated chloride levels can also hinder plants' ability to absorb water from the soil, leading to salt accumulation in the surrounding soil. Additionally, increased chloride concentrations can negatively impact groundwater supplies used for drinking water and agricultural purposes, posing risks to public health, livestock, and crop production.

4.2.6.1 Roads

- *Overuse of salts*: The likely main contributor to increased chloride levels in area streams is the over application of salts by municipalities, contractors, and residents. Salt application rates can vary depending on the applicator, equipment, and deicing strategy. Many landowners believe more salt is better in harsh winter conditions, but below 20°F, salt is less effective and wet pavement can refreeze. While salt use has doubled since 1975, Michigan road agencies have recently reduced the amount of salt applied per lane mile. However, further BMPs are needed to better manage salt use on Michigan roads (EGLE, 2021).

4.2.6.2 Industrial

- *NPDES Permit noncompliance due to new standards*: Chloride is a new impairment listing for the state of Michigan, with standards only recently released. As a result, facilities operating under NPDES permits may not have had time to update their wastewater treatment processes to meet these new standards. Further monitoring is needed to determine the exact cause of elevated chloride levels in the Macatawa River.

4.2.6.3 Groundwater

- *Aquifer withdrawals*: Since 1999, increased pumping from both the bedrock and glacial aquifers in Ottawa County has likely triggered the natural upwelling of bedrock brines in wells throughout the region. The rising demand for groundwater due to development and agricultural activities is putting added pressure on these resources, limiting the amount of water available to dilute the naturally occurring brines. [2]

4.3 Pollutant Loadings and Reduction Estimates to Meet TMDL Goals

In the 2000 TMDL for Phosphorus in Lake Macatawa, the annual load to the lake was estimated at 138,500 lbs/year, or concentrations of roughly 125µ/L. The plan called for a reduction in phosphorus loading to 55,000 lbs/year, or in lake concentrations of roughly 50µ/L. Due to the efforts of Project Clarity (2013-2023), an estimated 40,000 lbs/yr reduction in phosphorus has been achieved. Based on the initial TMDL estimates, another 43,500 lbs/year reduction is needed to meet the interim TMDL goal of 55,000 lb./year. Ultimately, the better criteria to use to determine whether load reductions are being achieved is if the lake and connecting streams meet the WQS of 50µ/L of phosphorus.

The Macatawa Watershed was included in the 2019 Michigan Statewide *E. coli* Total Maximum Daily Load (EGLE 2019). Michigan's 2019 integrated report lists the Bosch & Hulst Drain (Noordeloos Creek) and Macatawa Bay as not supporting PBC or TBC due to *E. coli*. The 2018 addendum included South Branch and the 2020 addendum included all other AUIDs. Since the *E. coli* TMDL is based on concentration rather than load, the target values are 130 *E. coli* per 100 mL as a 30-day geometric mean, 300 *E. coli* per 100 mL as a daily maximum for TBC recreation, and 1,000 *E. coli* per 100 mL as a daily maximum for PBC recreation. Therefore, the reduction goals for this project are determined by comparing current *E. coli* concentrations to the Water Quality Criteria (WQC). The ultimate objective is for all water bodies to meet the WQC for *E. coli*.

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[2] See Section 2.7.4 for more information about Ottawa and Allegan County groundwater issues (MSU, 2013, Curtis et al., 2018, Allegan County, 2021, and Allegan County, 2024).

4.4. Pollutant Loadings and Reduction Goals for Other Pollutants

Even though there are no additional TMDL limits set for the watershed, other pollutants in the watershed need to be addressed. These include parameters like temperature, dissolved oxygen, chloride, nitrogen, and others. As opposed to determining pollutant loadings and reduction goals, the goal for all pollutants will be to meet the state WQS or other comparable standards (Tables 4.2 and 4.3). Fortunately, many of these other pollutants can be addressed by implementing BMPs and other practices that also address P and fecal indicator bacteria levels.

Table 4.2 Monthly maximum temperatures for surface waters

Waterbody Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lake Michigan and connecting waters	45	45	45	55	60	70	80	80	80	65	60	50
Rivers, streams, and impoundments	41	40	50	63	76	84	85	85	79	68	55	43

Data source: Michigan Part 4 Water Quality Standards (DEQ, 2006)
Date prepared: December 2024

Table 4.3 Water quality standards used to assess pollutants of concern

Parameter	Target Value	WQS or Comparable	Type or Designated Use
E. coli [1]	130 cfu/100 mL	WQS	Total Body Contact Recreation in all waters of the state. Calculated as a 30-day geometric mean from 5 or more sampling events.
E. coli [1]	300 cfu/100 mL 1,000 cfu/100 mL	WQS	Total Body Contact in all waters of the state Partial Body Contact in all waters of the state
Total Phosphorus[2]	0.050 mg/L (interim) 0.020 mg/L (final)	Comparable	Other indigenous aquatic life and wildlife
Total Suspended Solids[3]	80 mg/L	Comparable	Other indigenous aquatic life and wildlife, warm water fishery
Chloride[4]	150 mg/L 320 mg/L 640 mg/L	WQS	Final acute (640), aquatic maximum (320) and final chronic values (150) for aquatic life.
Temperature[1]	Monthly maximum temperatures (see table 3.2)	WQS	1 - Lake Michigan and connecting waters south of a line due west from the City of Pentwater 2 - Rivers, streams, and impoundments south of a line between Bay City, Midland, Alma, and North Muskegon
Dissolved Oxygen[1]	7 mg/L (cold water) 5 mg/L (other)	WQS	Great Lakes, connecting waters and inland streams

[1] State of Michigan's Part 4 Rules, Water Quality Standards (of Part 31, Water Resources Protection, of Act 451 of 1994).
[2] Interim value of 0.050 mg/L was set by the Lake Macatawa phosphorus TMDL approved by the USEPA in 2000 (Walterhouse, 1999).
[3] MS4 post construction water quality treatment standard
[4] EGLE Chloride and Sulfate Water Quality Values Implementation Plan, 2021
Data sources: as listed above
Date prepared: December 2024

5.0 CRITICAL AREAS AND SITES FOR RESTORATION AND PROTECTION

Chapter 5 outlines the primary critical areas and sites within the Macatawa Watershed that are contributing the most significant sources of NPS pollutants. Critical areas models were developed for agricultural and urban areas to identify subwatersheds with the greatest potential to generate runoff and NPS pollution. Critical sites were identified for certain types of pollution (livestock, road-stream crossings, streambank erosion) and are in the process of being identified for other types of pollution (agricultural residue and tillage surveys). The areas and sites identified in this chapter do not provide a comprehensive list of all potential NPS pollutant-loading sites within the Macatawa Watershed but serve as a starting point for watershed planning efforts.

5.1 Agricultural Land Critical Areas

The 2012 Macatawa Watershed Management Plan included the development of an agricultural critical areas model (Fishbeck, 2011). ODC updated the model for this plan following the same procedures and using updated data as available (see Quality Assurance Project Plan in Appendix J). The purpose of the model is to assign each subwatershed a priority ranking of high, medium, or low to prioritize where to focus agricultural BMP implementation. Of the 55 subwatersheds, 17 are high priority, 18 medium priority, and 20 low priority (Figure 5.1).

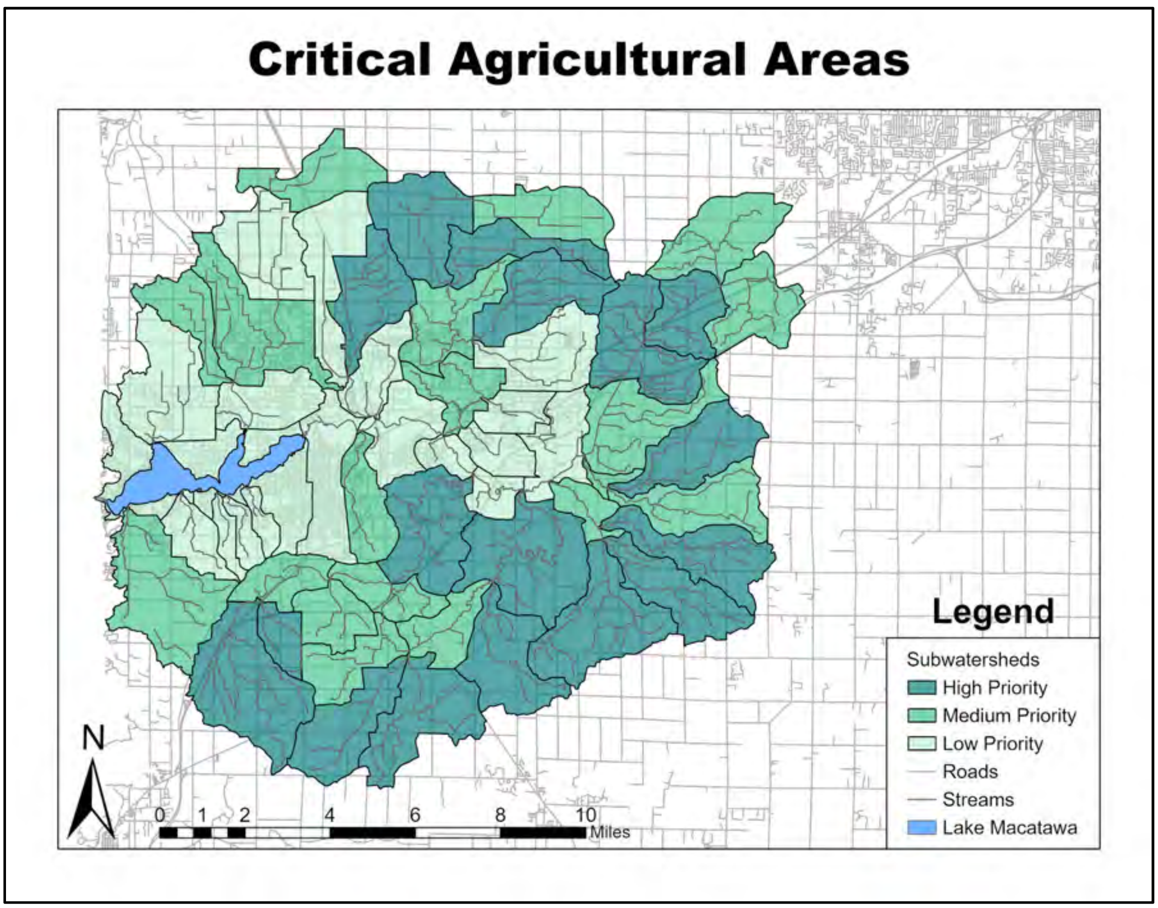

Figure 5.1 Critical agricultural areas
Source: ODC Network
Date Prepared: December 2024

To further narrow the focus, high priority farm fields within the critical areas were identified (Figure 5.2). Thirty-four (34) high priority farm fields were identified based on the results of tillage and residue surveys and the ACPF model. A field is considered high priority if fall tillage was observed, there is a high potential for runoff and the ACPF model included a WASCOB or grassed waterway in the field. These fields will be the highest priority for outreach and BMP implementation efforts. An additional 52 fields were identified as medium priority if they had fall tillage and a high potential for runoff (Figure 5.2)

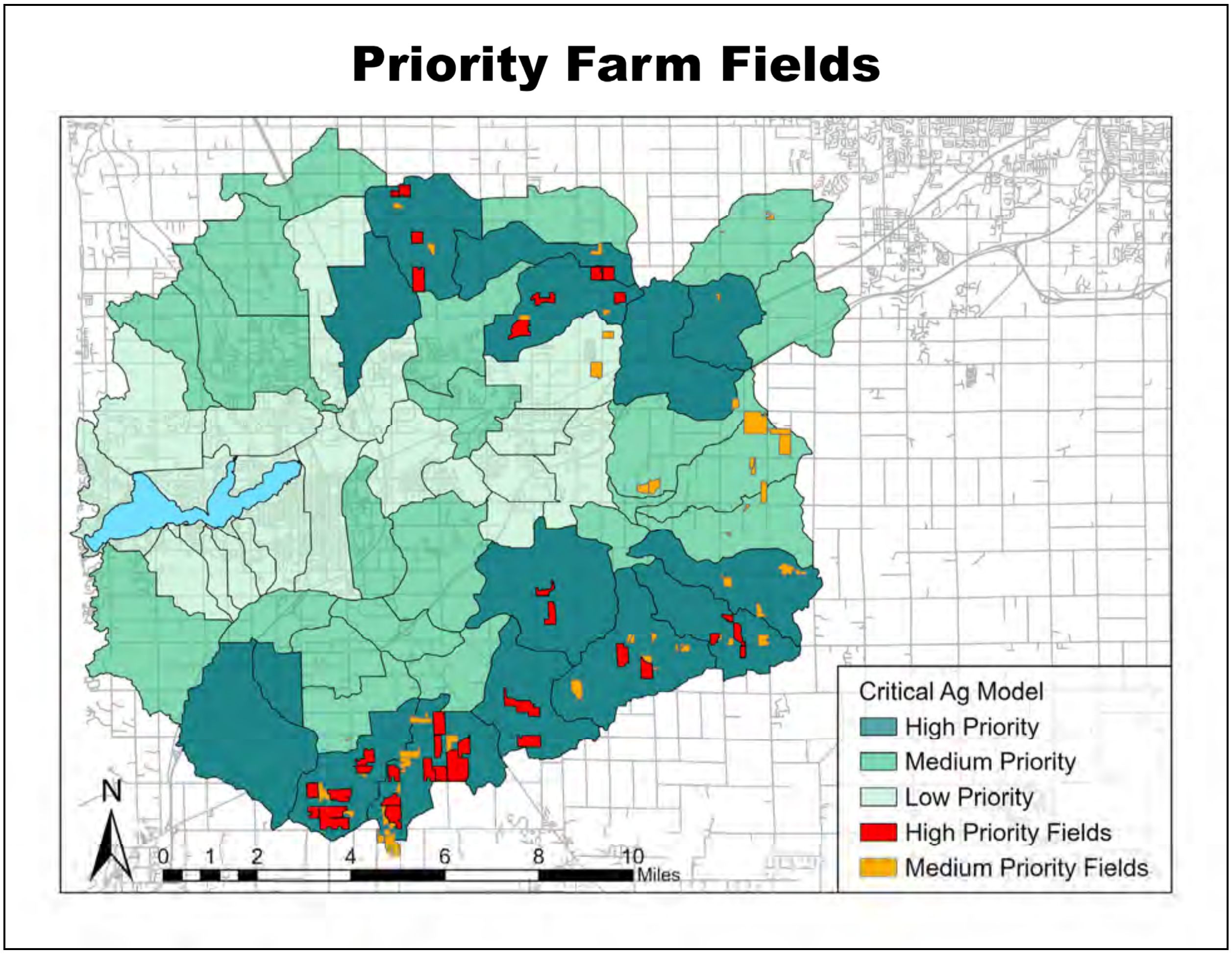

Figure 5.2 Priority farm fields based on survey and model results
Source: ODC Network
Date Prepared: December 2024

Direct outreach will be done once owners or operators of each high and medium priority field are identified. With permission of the owner or operator, these fields will be individually assessed to determine actual water quality concerns and potential solutions. Since these fields were identified based where the ACPF model included a WASCOB or grassed waterway, these BMPs will be prioritized for assessment and implementation. In addition, whole field practices, including reduced tillage and cover crops, will be prioritized if applicable for each field. See Section 8.3 for more information on these and other BMPs that will be prioritized, as applicable, on high priority farm fields. See Table 8.2 for BMP quantity goals and estimated pollutant load reductions.

5.2 Livestock Critical Sites

There are numerous confined animal feeding operations (CAFOs) and animal feeding operations (AFOs) in the watershed, many of which animals have direct access to streams (Figure 5.3). These represent risks to watershed health due to the common practice of using manure as a fertilizer applied to fields (sometimes regardless of nutrient levels needed for crop growth) as well as direct access of livestock to streams, where they can create excess erosion, stir up sediment, alter hydrology, and introduce fecal bacteria and nutrients directly into waterways. The risk also exists of leaks from manure storage containers at these larger operations. Sites where livestock have stream access are a priority, as well as areas of manure application to ensure there are practices in place to minimize manure runoff. Highest priority will be placed on sites in the Peters Creek and Upper Macatawa Subbasins where Hope College monitoring indicates higher levels of total phosphorus, *E. coli* and greater exceedance of the partial body contact standard during dry weather. Further analysis, including microbial source tracking, is needed to determine if the primary source of *E. coli* is livestock.

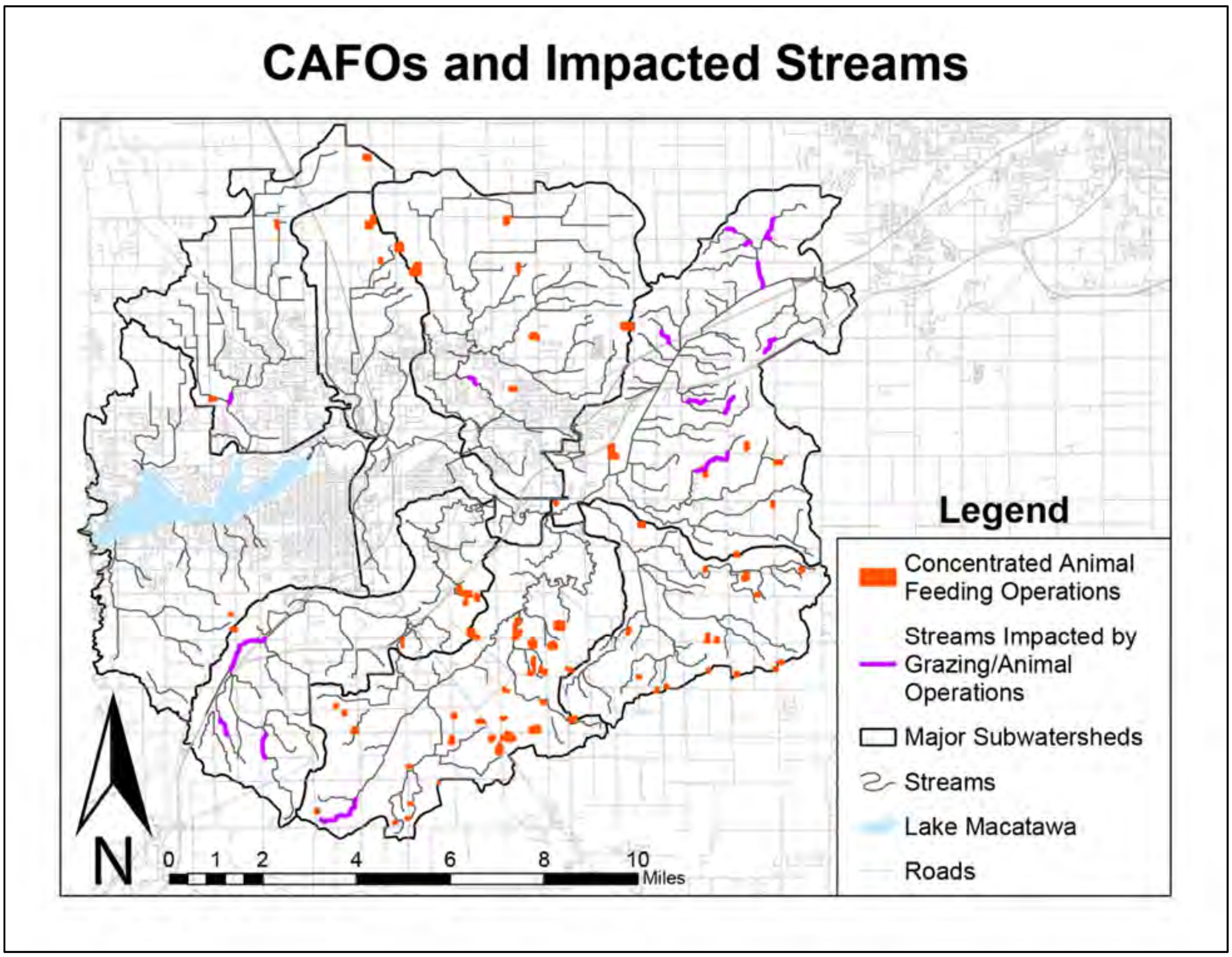

Figure 5.3 CAFOs and streams impacted by grazing operations
Source: Michigan GIS Open Data
Date Prepared: December 2024

Direct outreach will be done once owners or operators of each CAFO near or associated with a stream impacted by grazing are identified (3 total). In addition, all 15 stream segments impacted by grazing will be further investigated to identify farm operations causing the impacts. With permission of the owner or operator, these sites will be individually assessed to determine actual water quality concerns and potential solutions. These locations will be prioritized for exclusion fencing and livestock crossings and assessed for other BMPs applicable to the farm operation. See Section 8.3 for more information on these and other BMPs that will be prioritized, as applicable, on high priority farm fields. See Table 8.2 for BMP quantity goals and estimated pollutant load reductions.

5.3 On-Site Disposal System

Eliminating illicit discharges to area waterways and storm drains is a pollution prevention activity conducted by local units of government regulated by NPDES Stormwater Permits. However, extensive areas of the outer watershed do not fall under such coverage and are not as closely monitored for illicit discharges such as failing septic systems. There is lack of adequate data about the location of septic systems in both Ottawa and Allegan County, therefore, it is not possible to identify exact locations where septic systems should be replaced. The best way to identify areas at greater risk for failing septic systems is to look at rural areas where septic systems are more likely to occur. High risk areas for septic failures include parcels within 30 meters of a waterway that have poorly infiltrating soil (Figure 5.4). Highest priority will be placed on sites in the Peters Creek and Upper Macatawa Subbasins where Hope College monitoring indicates higher levels of total phosphorus, *E. coli* and greater exceedance of the partial body contact standard during dry weather. Further analysis, including microbial source tracking, is needed to determine if the primary source of *E. coli* is human.

Ottawa County has a real estate transfer evaluation program that requires well and septic system inspections at the time a property is sold. System conditions are required to be disclosed as part of the sale. Allegan County does not operate a real estate transfer program but does have sewage regulations that require maintenance of septic systems. These regulations help limit pollution from septic systems, but uninspected and unmaintained systems still pose a threat to water quality.

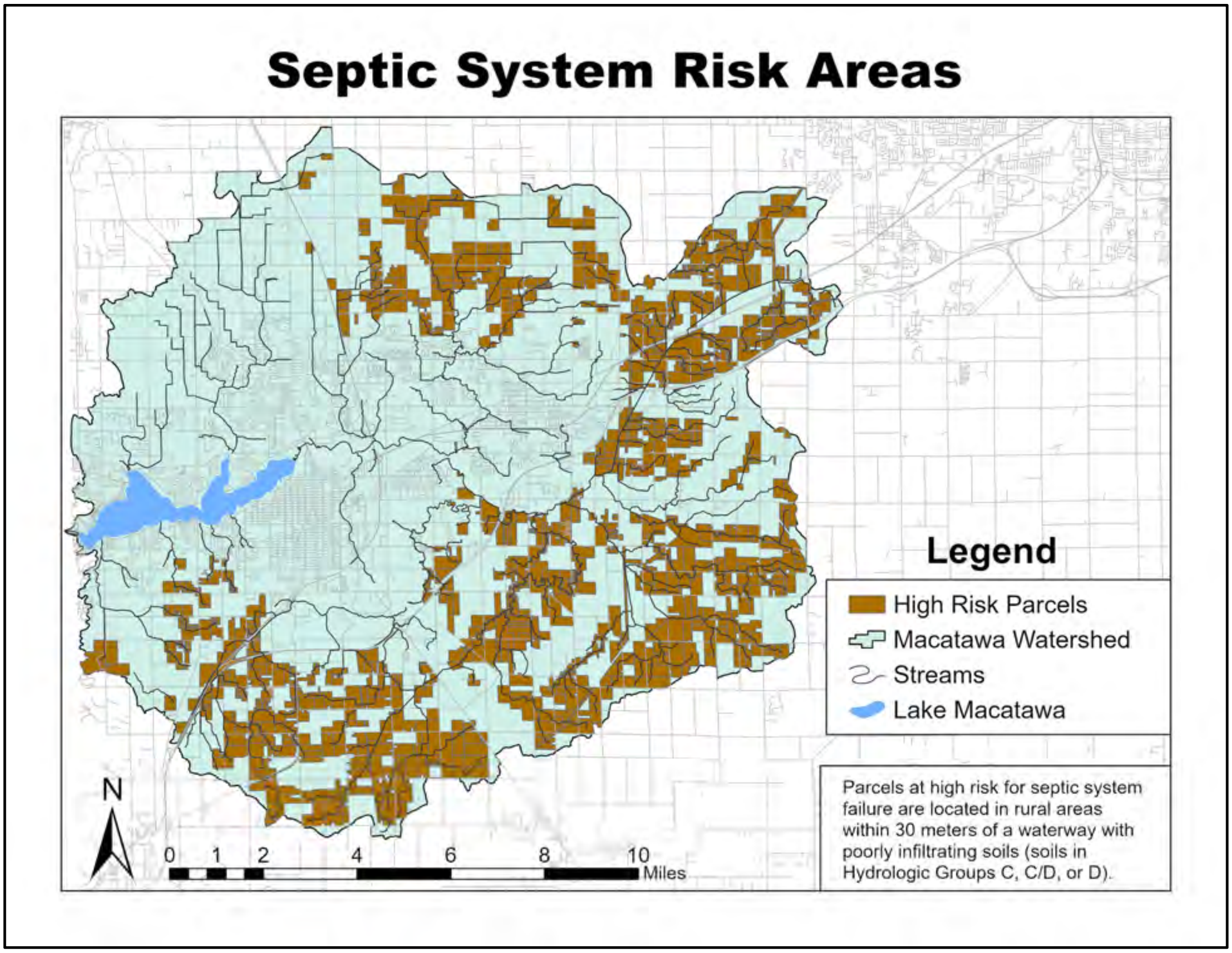

Figure 5.4 High risk areas for septic system failures
Source: Michigan GIS Open Data
Date Prepared: December 2024

5.4 Road Stream Crossing Critical Sites

The MACC and ODC Network conducted road stream crossing inventories from 2016-2024 and gathered data on 268 crossings. Inventories identified sites as critical where there was severe erosion along embankments, downstream streambanks, and outlet areas. This designation was based on the high likelihood that improperly sized or positioned culverts contributed to the erosion. Additionally, sites that scored a 1 on the fish passage assessment were also identified as critical road stream crossing locations. This designation was based on the barrier that these sites pose for species and life stages that cannot pass these locations at most stream flows. Fifty-five (55) sites were identified as critical from these criteria; 32 sites (colored in purple) are deemed as the top priority sites with poor fish passage and severe erosion (Figure 5.5). The estimated sediment load of the 32 priority sites was 44.7 tons per year based on results from the inventory database.

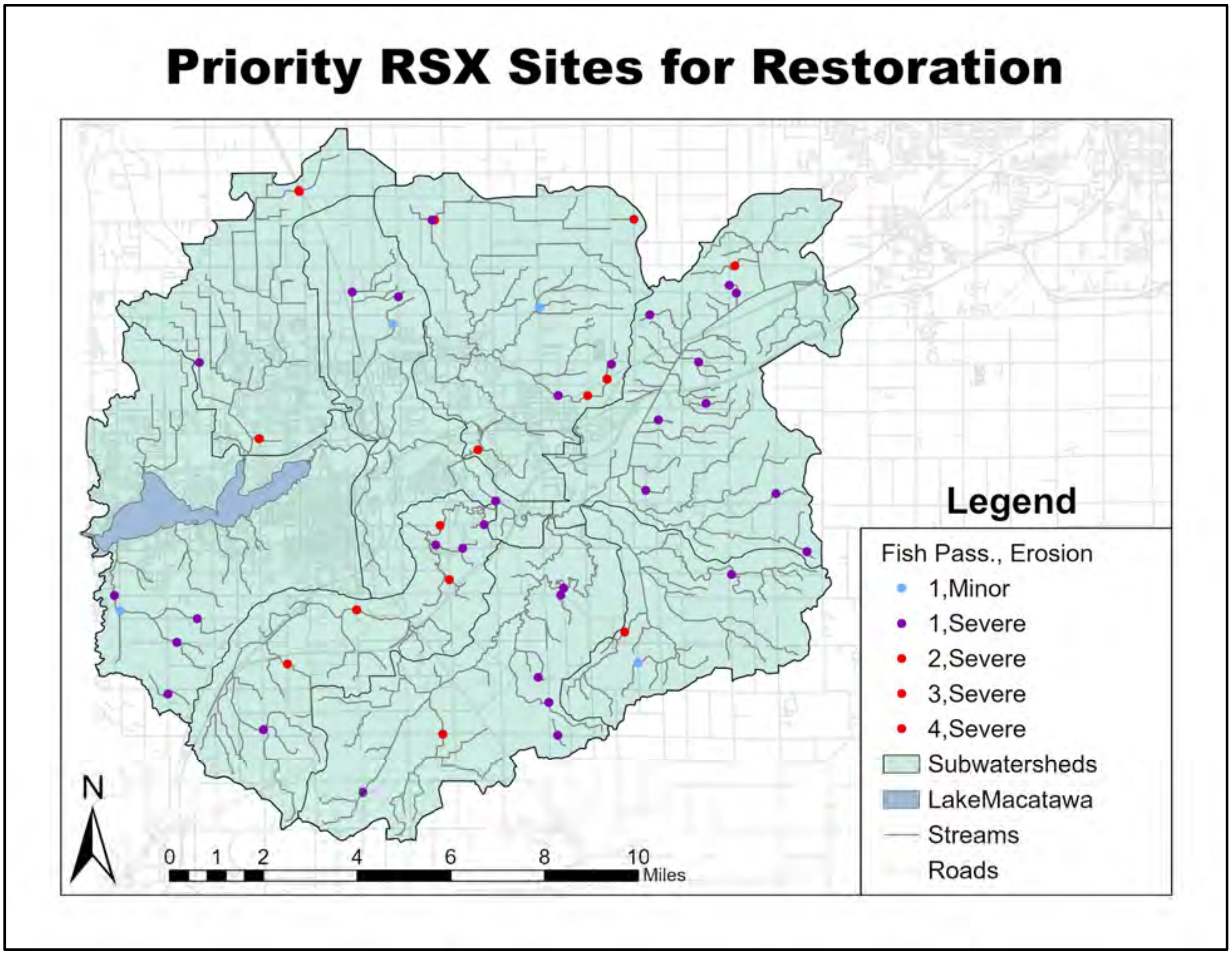

Figure 5.5 Priority road stream crossing sites for restoration
Source: ODC Network, Michigan DNR
Date Prepared: December 2024

The list of the 32 highest priority sites will be reviewed with the applicable drain and road commissions to develop plans for remediation or replacement. Since the inventory data goes back to 2016, it is feasible that some of these sites may have already been addressed through previous remediation or replacement projects. See section 8.3.5 for more information on the targeted BMPs.

5.5 Streambank Erosion Critical Sites

Fishbeck completed a geomorphic assessment and hydrologic analysis for the watershed in 2024 (Fishbeck 2024a and 2024b, Appendix L). Due to unstable hydrology, significant stretches of area waterways need stabilization and restoration to minimize sediment and nutrient loading. Field observations have helped to verify some of these locations. Priority basins were adjusted from 2010 due to erosion severity and the percentage of road/stream crossings. The North Branch, Peters Creek, and the South Branch are the highest priority subbasins based on this new data (See Figure 14 in Appendix L). Additional priority sites include those mentioned by landowners, county drain/water resources commissioners, and other government agencies.

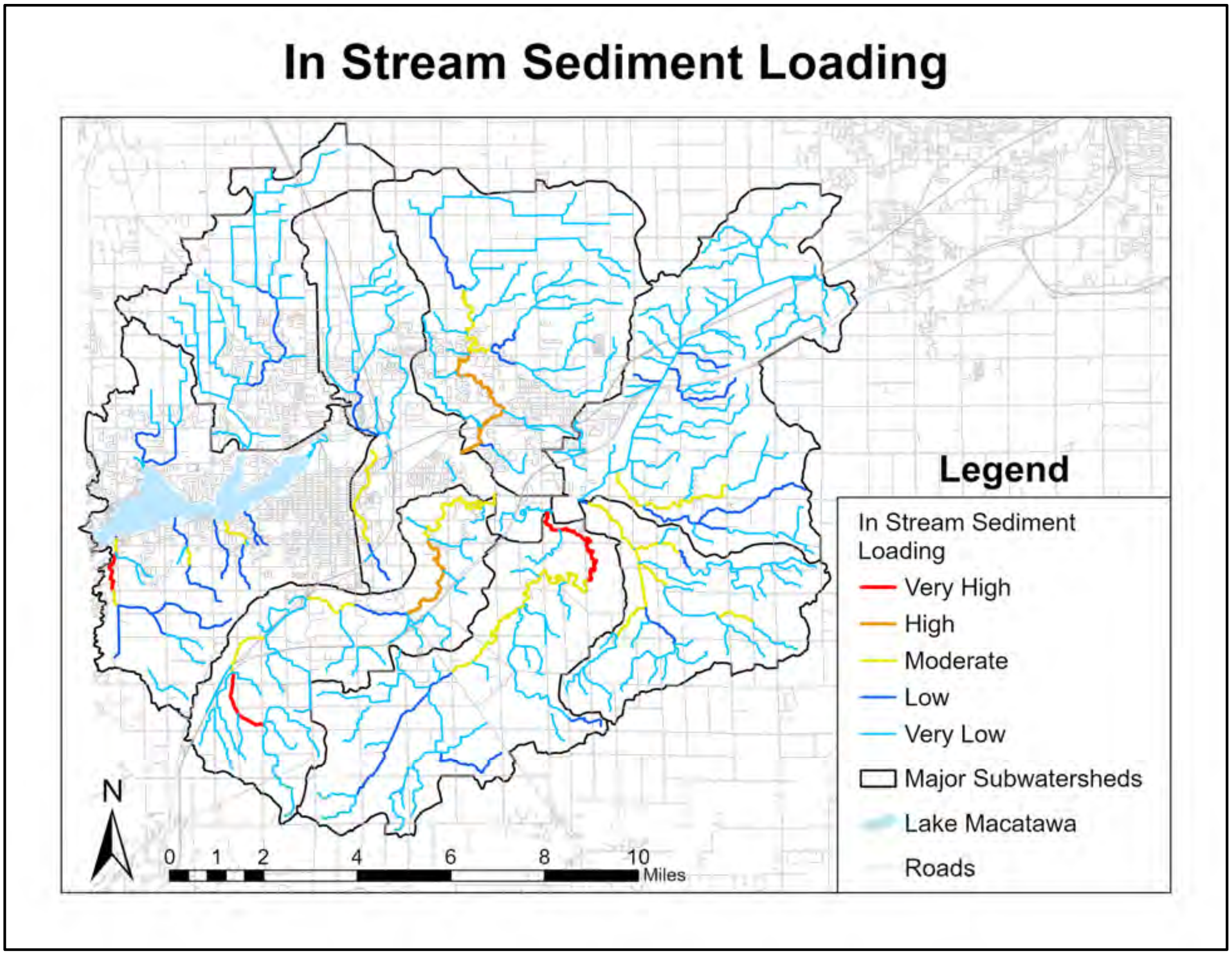

Figure 5.6 In stream sediment loading
Source: Fishbeck, Michigan GIS Open Data
Date Prepared: December 2024

Since 2012, several streambanks restoration projects occurred in high priority areas. While more projects are needed, there are several completed projects that demonstrate different techniques and investment levels based on the scale and severity of the problem. These have included work on Peters Creek, Noordeloos Creek, and the North Branch. These projects used natural channel design, flood bench development, two-stage channels, and floodplain reconnection. These approaches will continue to be recommended to county drain/water resources commissioners and riparian landowners.

Priority areas where restoration should be focused in the watershed include sections of the Lower Macatawa River in Zeeland and Holland Townships, the North Branch of the Macatawa River downstream of US-31, the South Branch in Zeeland Township and below 50th Avenue in Overisel and Fillmore Townships, and Noordeloos Creek in Holland Township (Figure 5.6). Total estimated sediment loads from instream sources for each subbasin are shown in Figure 5.7 (see Appendix L for further details).

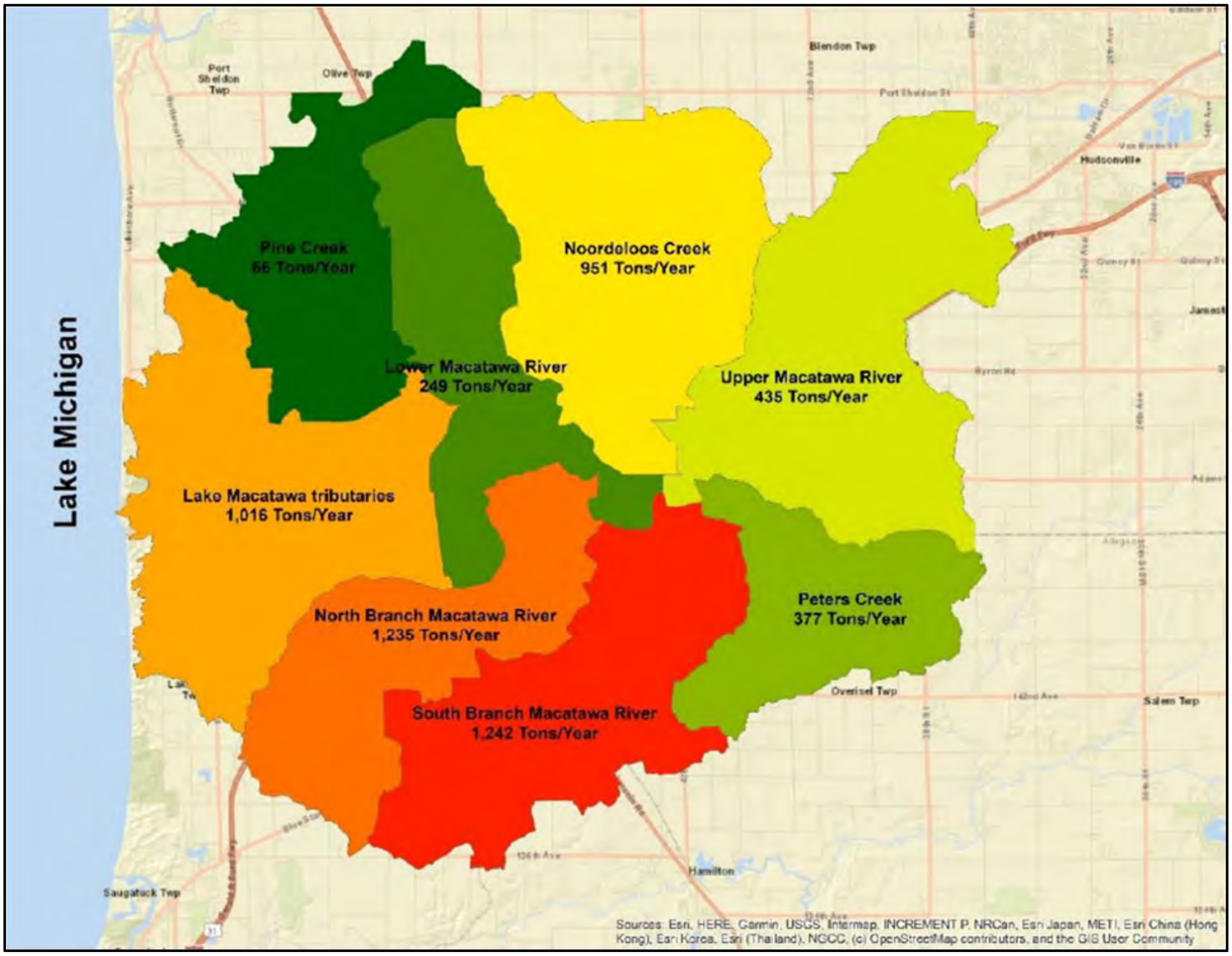

Figure 5.7 Estimated sediment load from instream sources
Source: Fishbeck, Michigan GIS Open Data
Date Prepared: December 2024

The Fishbeck report recommendations focus on various strategies to maintain and improve streambanks in the Macatawa Watershed while supporting agricultural practices. Upland efforts should prioritize reducing pollutant loading by implementing BMPs such as riparian buffers, cover crops, grassed waterways, conservation tillage, and cattle exclusion. Additionally, soil erosion and sedimentation control programs should be enforced for construction sites, and constructed wetland projects should be implemented in priority subwatersheds to capture sediment and treat stormwater runoff. Subwatersheds have been ranked based on risk factors, and BMPs should be applied where sediment generation and delivery are most likely.

For hydrologic processes, the focus is on preventing large increases in runoff volumes and flow rates that could destabilize channels. Local municipalities have already adopted low impact development rules, and they recommend retention or wetland projects in priority subwatersheds to mitigate stormwater runoff, especially in areas impacted by climate change. In terms of channel processes, efforts should center on reducing instream erosion by utilizing natural channel design principles. Recommended practices include managing woody debris, using flood bench excavation, installing instream structures like cross vanes and j-hooks, and relocating channels in areas with severe erosion. These measures aim to stabilize channels and prevent further erosion, while also improving streambank stability using native plantings and bioengineering techniques.

5.6 Urban Stormwater Critical Areas

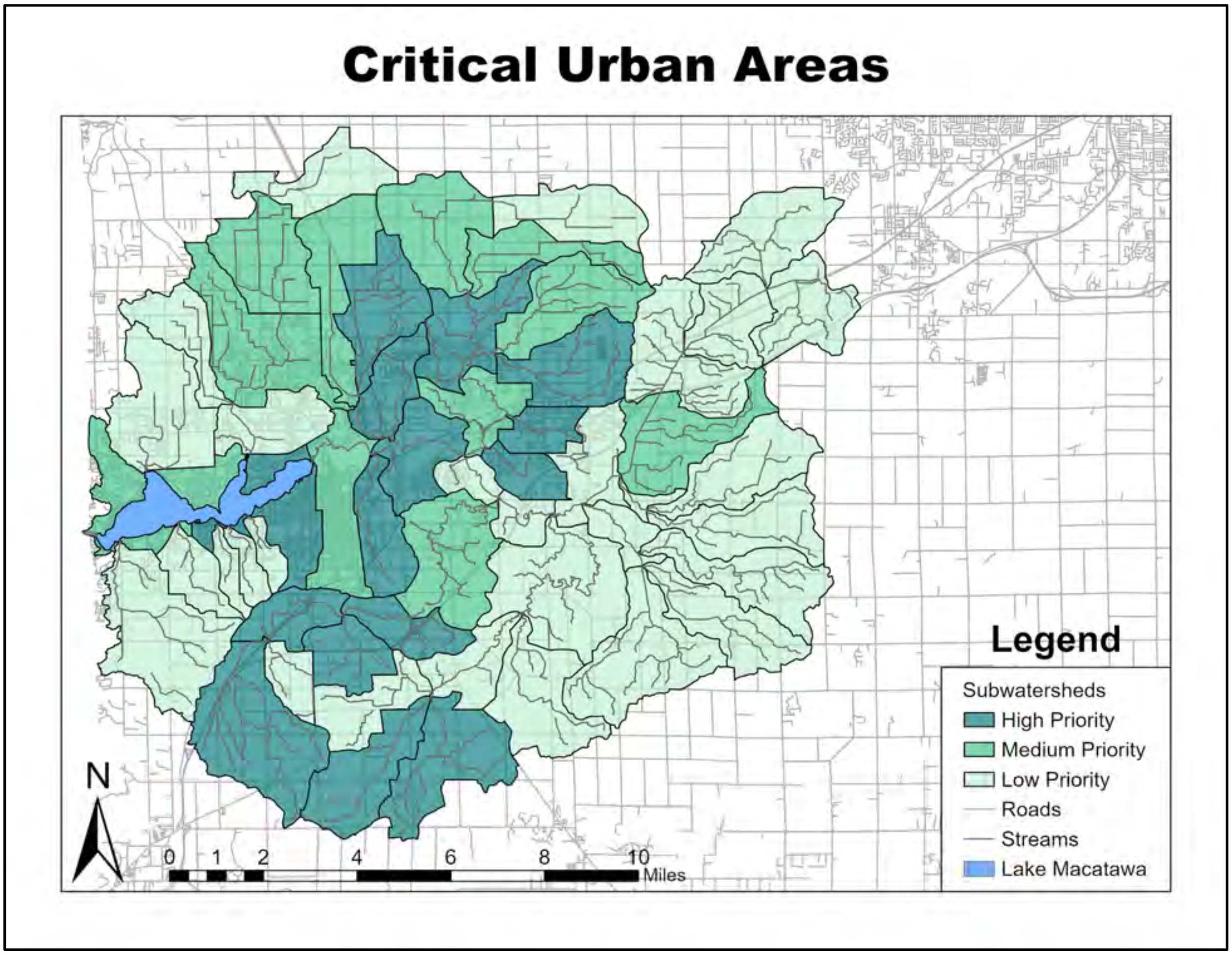

Figure 5.8 Critical urban areas
Source: ODC Network
Date Prepared: December 2024

Along with the agricultural critical areas model, the 2012 Macatawa Watershed Management Plan also included the development of an urban critical areas model. This model was updated for this plan following the same procedures and using updated data as available (see Quality Assurance Project Plan in Appendix J). The purpose of the model is to assign each subwatershed a priority ranking of high, medium, or low to prioritize where to focus urban BMPs. Of the 55 subwatersheds, 15 were high priority, 11 medium priority, and 29 low priority (Figure 5.8).

The Macatawa Area Coordinating Council received a grant from the Community Foundation of the Holland Zeeland Area in December 2016 to support the development of a green stormwater vision for the Macatawa Watershed (Appendix M). A key component was to determine suitability and priority for implementing green stormwater infrastructure in the watershed to ensure the greatest economic and environmental benefit. With the input of local stakeholders, MACC staff developed a suitability map by parcel based on various geospatial data including slope, soil information and building footprints (Appendix N). MACC staff completed the suitability mapping using multiple raster functions in ArcGIS. Final suitability maps are available for all jurisdictions in Ottawa and Allegan Counties (city, township, village) to assist in the approval of green stormwater management proposed in site plan reviews (full county shown in Figure 5.9, individual jurisdictions in Appendix O). This WMP prioritizes implementing green stormwater infrastructure on high suitability parcels located within the highest priority urban critical areas.

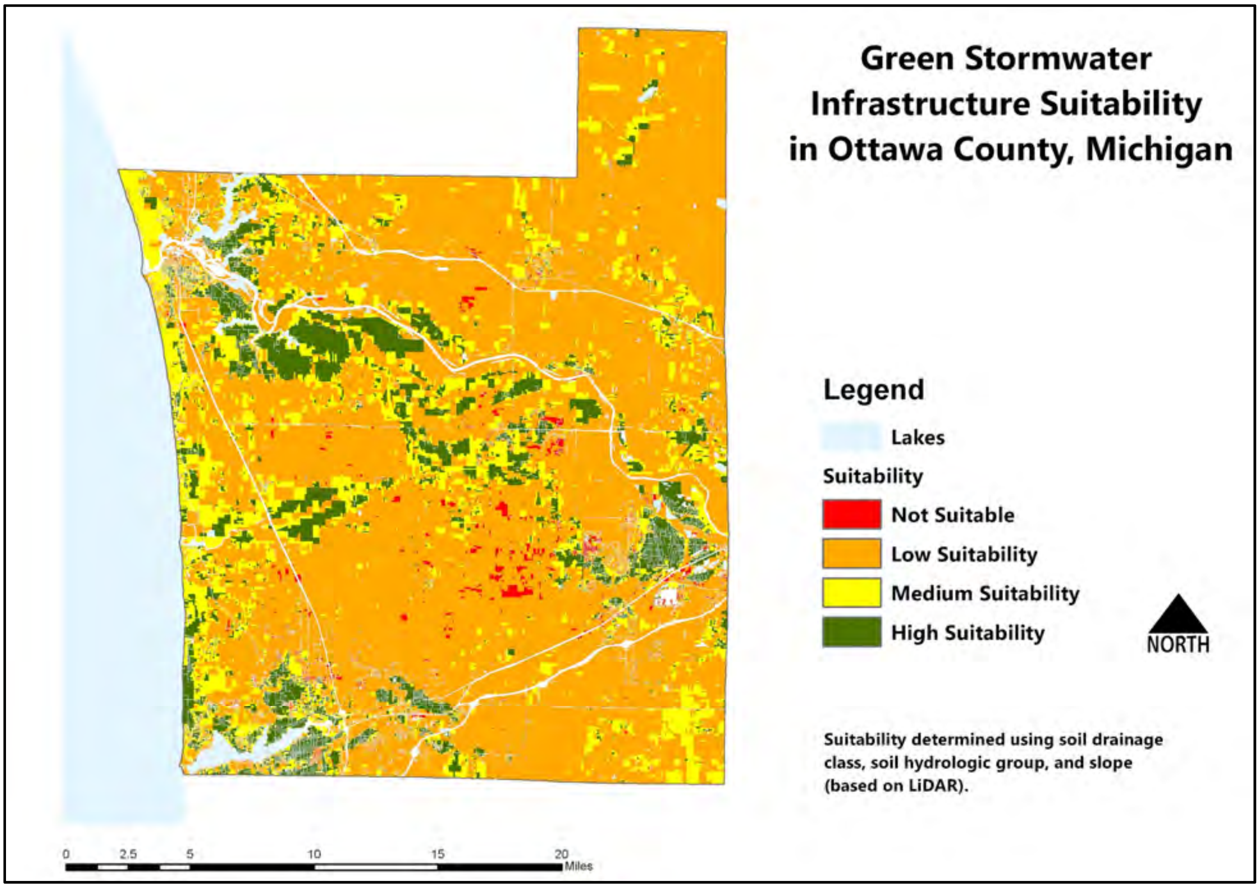

Figure 5.9 Green stormwater infrastructure suitability in Ottawa County, Michigan
Data Source: Macatawa Area Coordinating Council (Appendix N)
Date Prepared: August 2020

In addition to the above models, a group of students from Grand Valley State University, under the instruction of Dr. Alexandra Locher, conducted an urban tree canopy assessment for the cities of Holland and Zeeland in 2025. This assessment identified areas within the two cities where additional tree cover could be established (See Figure 10 in Appendix P). Tree planting will be prioritized within the areas identified in the assessment that fall within the urban critical areas as shown in Figure 5.8. This includes areas zoned as open space and within road rights-of-way.

5.7 Farmland and Natural Lands Protection

5.7.1 Farmland Preservation

Farmland preservation has several benefits for the greater Macatawa community, including the watershed. This limitation of development and ensuring agricultural production allows for greater infiltration rates and provides a more natural, rural character described as a priority for many of the townships within the watershed. While a risk for increased NPS pollution comes with preserving farmland, the benefits of limiting impervious surfaces paired with BMPs can be a net positive.

In 2009, the MACC commissioned the creation of a Farmland Protection Study (Fraser, 2010b), that resulted in a map showing farmland that is likely to score highly under the Ottawa and Allegan County Farmland Preservation Programs. These programs aim to fund the purchase of development rights for high-quality farmland, ensuring that the land remains undeveloped and available for farming indefinitely. ODC staff recreated this model using updated 2018 land use data to refine these inputs (Figure 5.10. See Quality Assurance Project Plan in Appendix J). Farmland preservation efforts should be focused within the high and medium priority areas.

The Ottawa County Farmland Preservation Program, established through a countywide ordinance, aims to protect farmland by acquiring development rights voluntarily offered by landowners. The program restricts future development on the preserved land through the placement of an agricultural conservation easement, ensuring the land remains suitable for agricultural use. The county may purchase these development rights using funds from sources other than the County General Fund, with the goal of preserving the economic, environmental, and scenic value of Ottawa County's agricultural lands. The County created the Farmland Preservation Program to address the growing concern of farmland loss due to residential and commercial development, which poses threats to agriculture, wildlife habitats, and the county's rural character. The program aims to protect valuable agricultural land, enhance water quality, and support long-term sustainability by preventing urban sprawl and preserving open space. Allegan County has a farmland preservation ordinance with limited funding and participation. Other programs and partnerships dedicated to farmland preservation in Ottawa and Allegan Counties include Michigan Farm Bureau, MSU Extension, conservation districts, and local agricultural businesses.

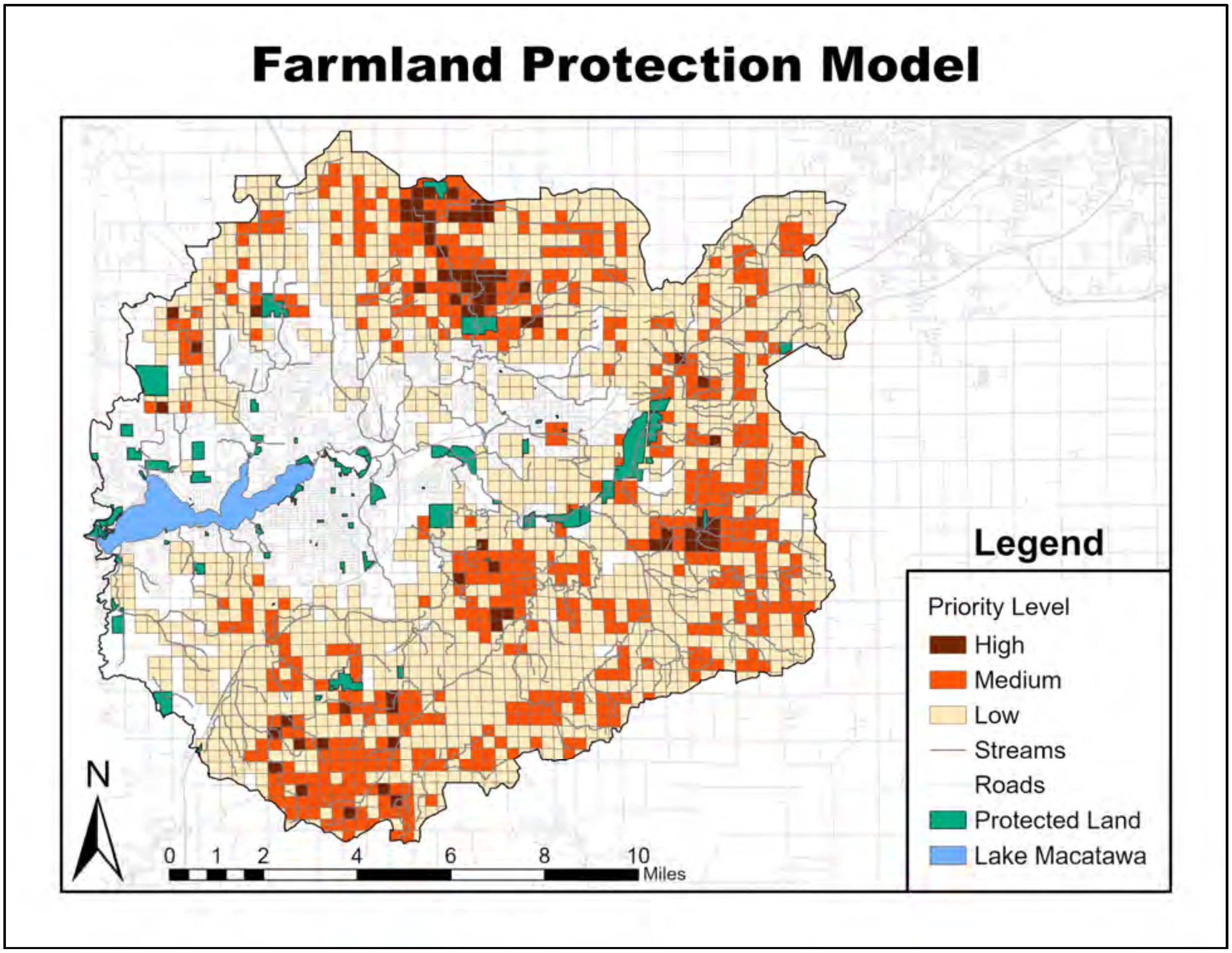

Figure 5.10 Farmland protection model
Source: ODC Network
Date Prepared: December 2024

5.7.2 Natural Lands Protection

In 2009, the MACC commissioned the creation of a Natural Lands Protection Study (Fraser, 2010a). Since that time, the Macatawa Watershed has seen a significant reduction in natural areas, including forests and wetlands, compared to pre-settlement. Currently, only about 15,422 acres of forested land and 551 acres of wetlands remain. Forests and wetlands provide substantial water quality benefits, as they help reduce stormwater runoff and absorb nutrients. Consequently, protecting the remaining natural lands in the watershed is essential.

Project partners and ODC staff identified several factors to pinpoint the most critical areas for protection and used these factors to recreate a natural lands protections model (see Quality Assurance Project Plan in Appendix J). These factors were used to assign a score to each quarter-quarter section of land (40-acre blocks) in the watershed, including:

- Land cover type (with forests and wetlands receiving the highest scores)
- Presence of a waterway
- Potential habitat for rare species (biorarity index)

- Development pressure
- Proximity to already protected land
- Groundwater recharge potential
- Presence of prime farmland (which lowered the land's value for protection)

The final model prioritizes many areas along river corridors and near existing park spaces (Figure 5.11). This aligns well with goals for the Macatawa River Greenway. Additional areas in Laketown and Park Townships have existing forested spaces that can also be prioritized for protection.

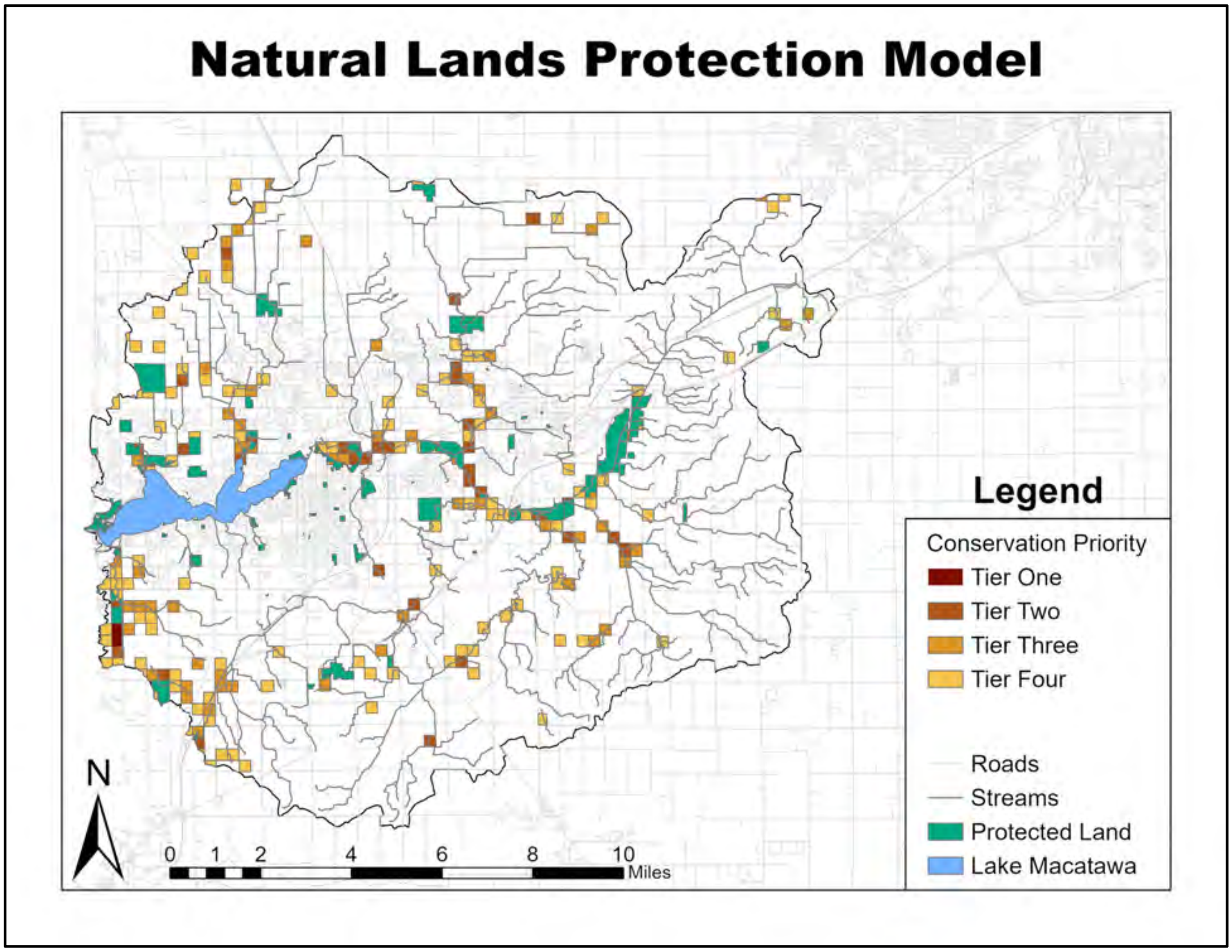

Figure 5.11 Natural lands protection model
Source: ODC Network
Date Prepared: December 2024

5.8 Wetland Restoration Potential

Wetland restoration in the Macatawa Watershed has been prioritized in recent years, with several large-scale restorations completed. With the continual pressure from development, it will be important to create and restore wetlands where possible to help provide water storage and infiltration. Areas targeted for wetland restoration include those where wetlands previously existed, as known from pre-settlement maps and the existence of hydric soils (Figure 5.12). These can provide conditions favorable for the rapid reestablishment of higher-quality wetland species and can help provide floodplain reconnection, as many are near major tributaries that have been down cut and channelized. Additionally, wetland restoration can take place in areas that have a clay lens or other confining soil layer near the surface that can receive enough water to create wetland conditions.

These restorations can be supported by specific wetland restoration programs, or they can be developed as part of a wetland mitigation bank. Wetland mitigation banks allow for a net increase of wetland restoration across a watershed or ecoregion, often resulting in larger, higher quality habitat than what existed before. However, the capital needed to undertake these projects is often prohibitive. Smaller wetland projects funded by grants or other funding mechanisms can address smaller areas that would not be commercially viable for a mitigation bank but are often difficult to compete for funding with other priorities and watersheds. Wetland restoration opportunities should continue to be pursued while kept in balance with other needed land uses within the watershed, such as farming and prudent growth.

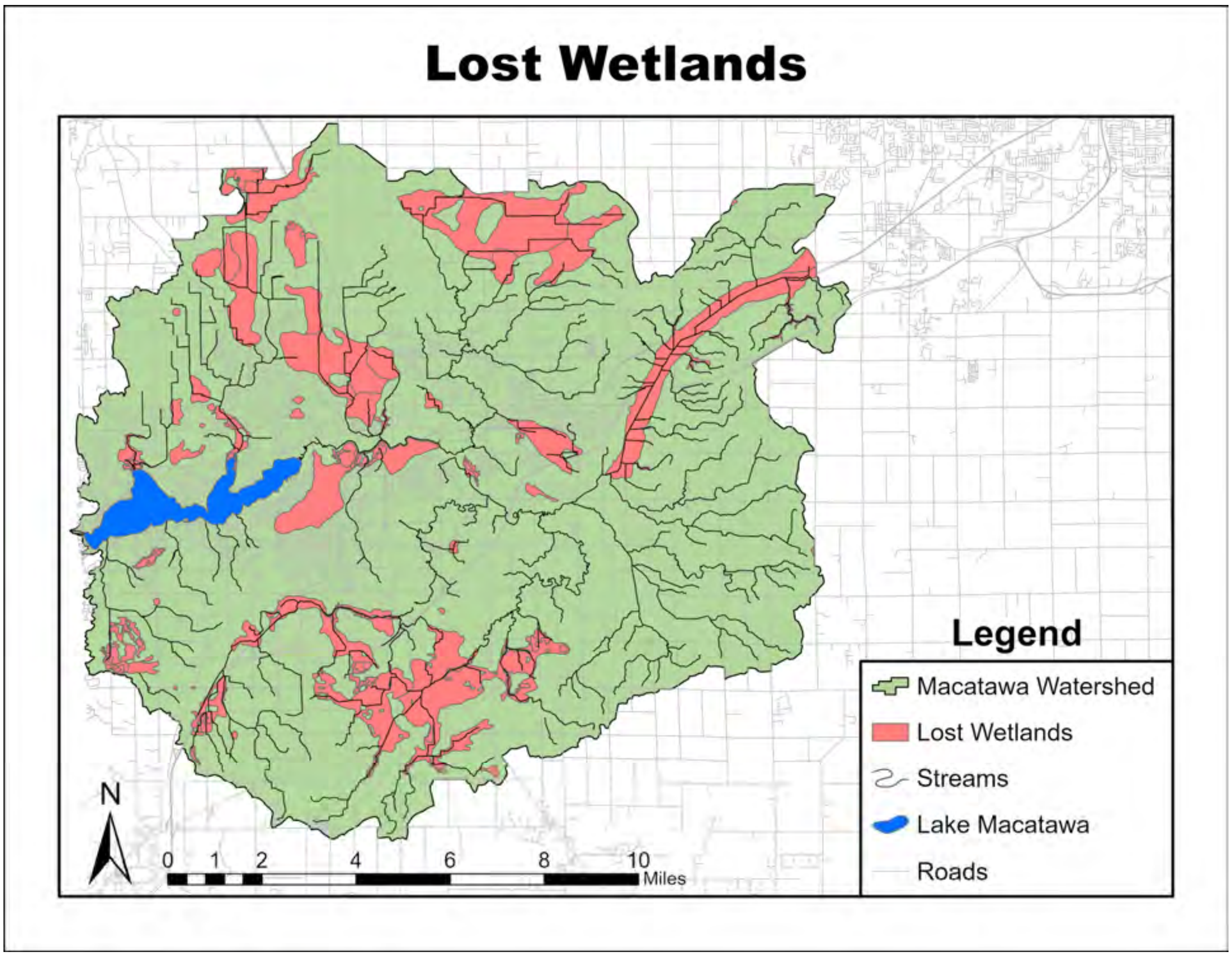

Figure 5.12 Historic wetland loss
Source: Michigan GIS Open Data
Date Prepared: December 2024

5.9 Groundwater Protection Priorities

Both Ottawa and Allegan counties face significant groundwater protection challenges due to both urban development agricultural activities. Urban development in more rural areas of the watershed leads to increased reliance on wells where city water is not provided. Agricultural irrigation needs are increasing as extreme weather, including prolonged dry spells, become more common in West Michigan Key priorities for safeguarding groundwater in the watershed include the management of stormwater runoff to encourage infiltration, reduction of pollution from agricultural practices, and maintaining the quality of water sources. Efforts focus on minimizing contamination from fertilizers, pesticides, and other chemicals, protecting surface water and groundwater from pollutants. Chloride also is a pollutant of concern within the groundwater of the northern part of the watershed (Figure 5.13).

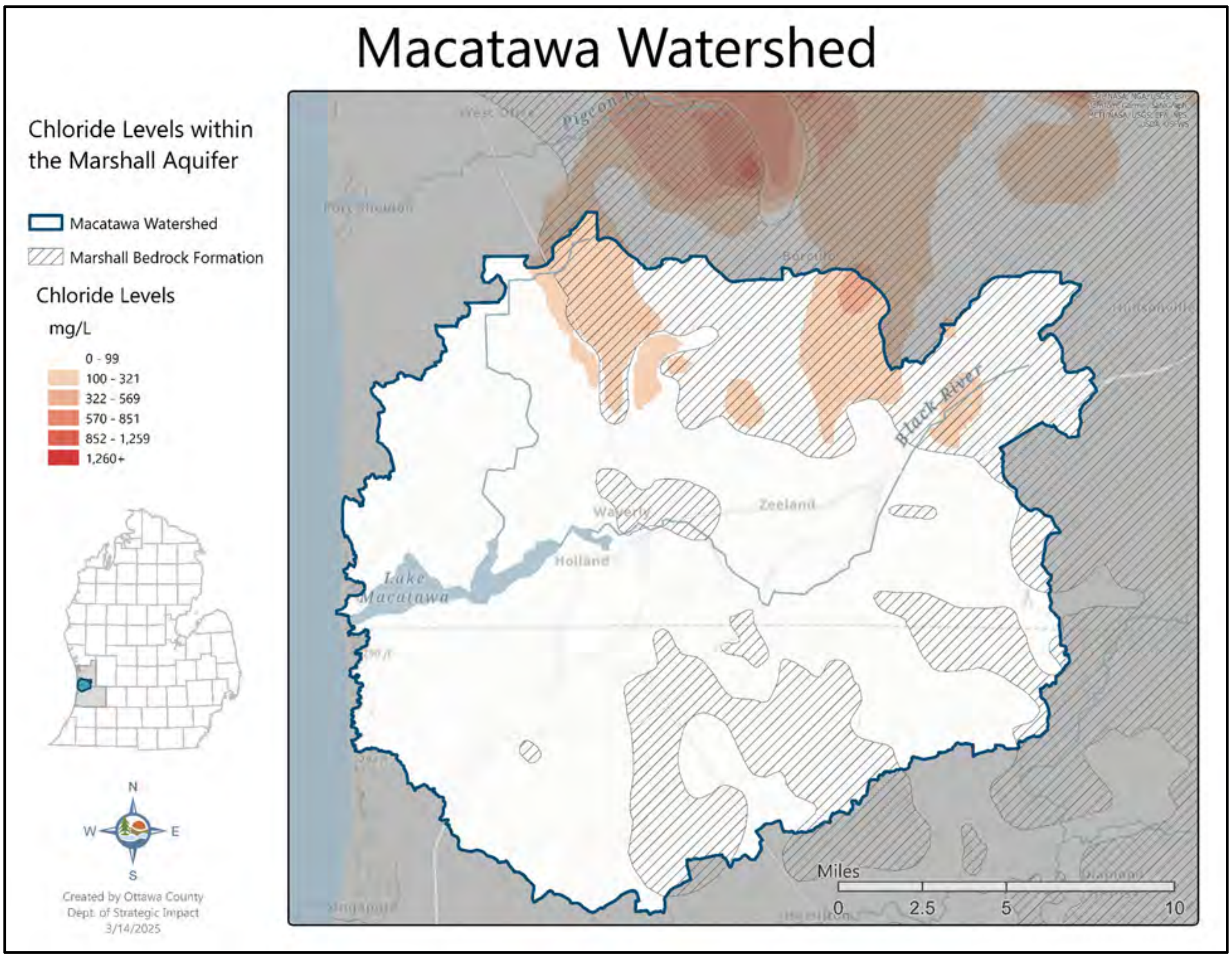

Figure 5.13 Chloride levels in the Marshall Aquifer in the Macatawa Watershed
Source: Ottawa County Department of Strategic Impact
Date Prepared: February 2025

Reduction of groundwater quality and quantity throughout the Macatawa Watershed is becoming a rising concern and has the potential to create negative impacts such as drying wells, crop damage, plumbing corrosion, and public health concerns. While farming operations consume a large quantity of water through activities like irrigation and livestock watering, dense residential developments (which are groundwater dependent) have been found to use a much larger portion of groundwater, increasing drawdown rates—some through household use, and most through lawn irrigation (Figure 5.14). The data indicates that if the current trend of increasing groundwater usage does not change, groundwater levels will continue to decline, and the quality of what water remains will continue to degrade (MSU, 2013, and Curtis et al, 2018).

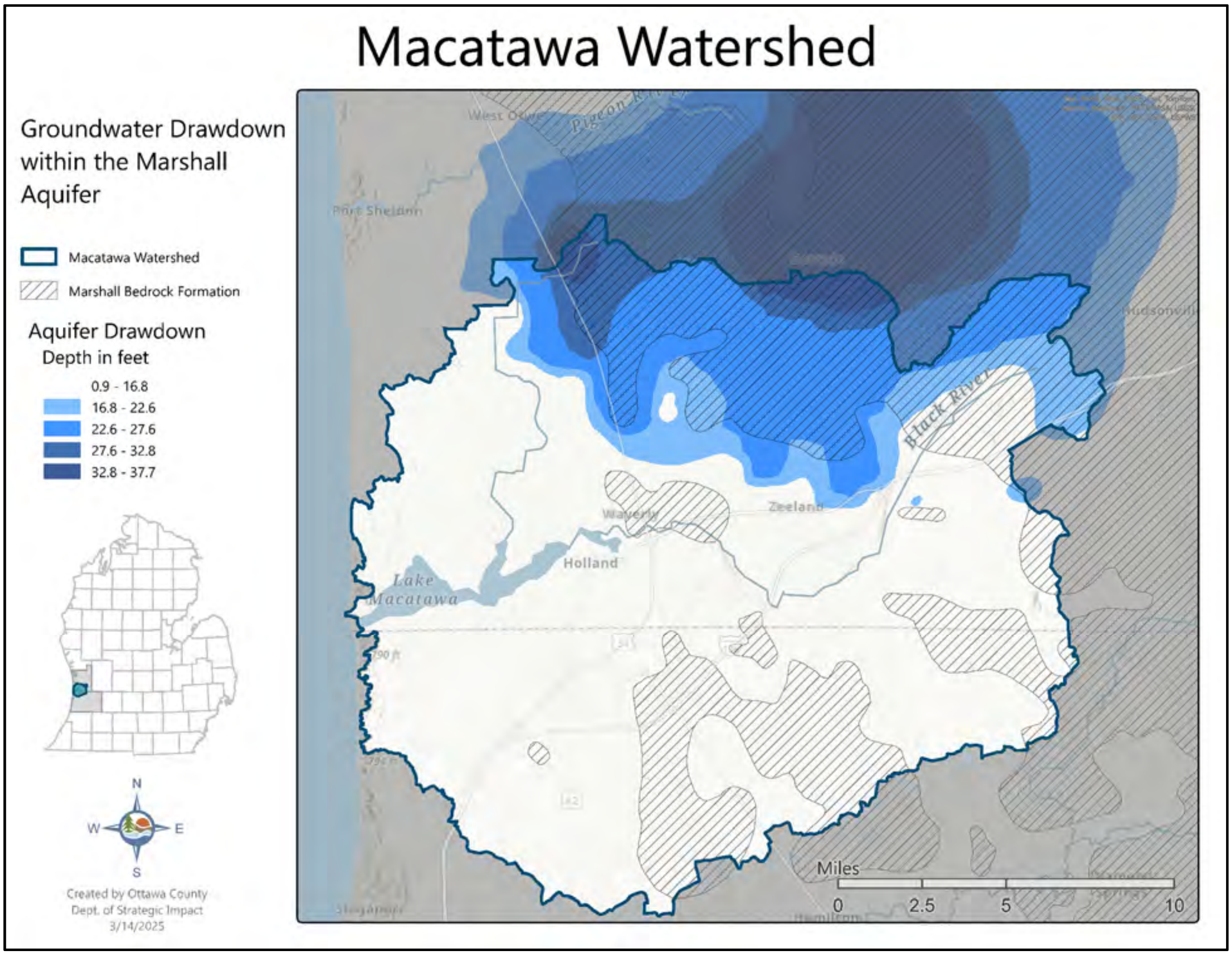

Figure 5.14 Groundwater drawdown in the Marshall Aquifer within the Macatawa Watershed
Source: Ottawa County Department of Strategic Impact
Date Prepared: February 2025

6.0 POLICY REVIEW AND RECOMMENDATIONS

The Macatawa Watershed encompasses fourteen (14) municipalities, including the Cities of Holland and Zeeland and the Townships of Manlius, Laketown, Fillmore, Overisel, Salem, Park, Holland, Zeeland, Port Sheldon, Jamestown, Olive, Blendon, and Georgetown (See Figure 2.1). Though all twelve townships touch the Macatawa Watershed, the inclusion of Manlius, Salem, Jamestown, and Georgetown are minimal. This policy review will focus on the Townships of Laketown, Fillmore, Overisel, Park, Holland, Zeeland, Port Sheldon, Olive, and Blendon with the addition of the Cities of Holland and Zeeland, which contain over 98% of watershed land.

To enact significant positive change, all municipalities should work toward the same goals and utilize similar language in their master plans and ordinances. One difficulty is that current land use plans are variable (urban vs. agricultural) and therefore the needs of their constituents are variable as well. Another is that the two county-level governments of Ottawa and Allegan, which provide several services to townships, also have different levels of services, standards, and regulations. To understand these differences better, ODC conducted an ordinance review of the units of government that are members of the MACC in the summers of 2022 and 2023.

One purpose of this review was to identify municipalities with language that address topics pertaining to watershed protection, land use, stormwater management, best management practices, and tree planting guidelines. Many of the goals and strategies identified by local municipalities have existing language that aligns with the goals of the Watershed Management Plan; improvement in certain identified areas for each municipality could encourage sharing resources to create a set of local ordinances that are more unified and cohesive. The MACC is well suited to assist its members, who include most of the units of government within the watershed, through this process. As part of assisting certain municipalities with Municipal Stormwater Permits, the MACC previously developed a model stormwater ordinance that is currently available for all units of government within the watershed to use or modify (only the cities have adopted it). ODC can work to develop similar standard language for wetland, floodplain, and riparian protection. Additionally, there are resources available for these municipalities to make planting regulations more uniform as well, ensuring that the flora in the area is native and best protects natural resources.

6.1 Review of City Ordinances

The following section reviews the master plan, zoning ordinance, and other ordinances implemented within both cities in the Macatawa Watershed. A master plan is a planning document that enables a city to establish a direction for physical development, capital investment, and growth. Once adopted, a master plan serves as a guide for the physical conservation of certain areas and the development of others. A zoning ordinance then implements the goals of the master plan by adopting strategies to turn these goals into law. Zoning ordinances regulate land use; development; and types of land uses allowed in a district. Additional ordinances or resolutions, such as stormwater ordinances, may be adopted as needed to address municipal concerns.

6.1.1 City of Holland

The City of Holland encompasses the center and western portion of Macatawa Watershed, completely situated within the watershed boundary. Most of the land within the city limit is former wetland that the Dutch settlers drained to begin farming, with lower elevations and more sandy soils than most of the other municipalities. It is one of the most urbanized areas within the watershed, with most of the land area zoned as residential with various densities, commercial, and industrial. As a result, excess stormwater is the biggest source of major pollutants and flash flooding is a common issue in some areas of the city. The Master Plan of Holland adopted in 2017, with a review completed in 2021, focuses on ensuring that the city is *Inviting for All to Enjoy, Thriving, and Resilient*. The major goals and strategies of the City of Holland, relating to natural resources and water quality management are summarized below:

Goals:

- Restore and protect natural and man-made wetlands
- Reduce phosphorus and other sediments
- Slow and treat stormwater
- Focus on low-impact development with a diverse range of housing types and densities
- Ensure a healthy tree canopy

The zoning ordinances of the City of Holland address the need to restore and preserve wetlands, since the city is bordered by wetlands to the north. Although most of the land area of the city is developed already, having clear priorities centered on environmental restoration displays the motivation of the city to collaborate with various environmental agencies to assist with wetland preservation. The City of Holland also included conditions that allow outside organizations, such as Project Clarity, to create new or restore historic wetland areas.

The City of Holland has a stormwater master plan and a commitment to building and maintaining stormwater infrastructure. There is language that ensures protection of those lines from pollution and illicit discharges, along with mandating control of roof runoff. The plan encourages businesses and private citizens to build and maintain stormwater management structures such as rain gardens and rain barrels. Although the City of Holland contains many impervious surfaces, there is language that encourages use of permeable material and sets maximums of impervious surfaces allowed. The City of Holland completed a Resilient Holland plan in 2017 (reviewed in 2021) with the assistance of the Land Information Access Association (LIAA) based in Traverse City, MI. In addition, Appendix A contains the climate resilience plan created by ODC Network in the summer of 2022. The City of Holland also has language that makes it very easy for businesses and private individuals to build renewable energy resources, such as wind turbines or solar arrays. The zoning ordinance also includes language that encourages recycling and composting.

The City of Holland zoning ordinance states that any charge of septic wastewater or groundwater that exceeds the design criteria of said sewer will be given a notice of unsatisfactory condition by the BPW and the person responsible will be directed to correct the condition. It is unlawful to construct, replace, repair, renovate, extend, or expand any septic tank system or other sewage disposal system for any house, building, property, or other purpose. The septic ordinance for the City of Holland complies with the United States Public Health Service Publication No. 526 and the license of liquid waste disposal established by the Department of Community and Neighborhood Services of the City.

In the area of landscaping, the City of Holland has language encouraging a variety of planting, especially trees, demonstrated by the Tree City USA designation given to the City of Holland. Being an urban area, there used to be language that required lawns be mowed at or below a certain height, which has since been removed. As mentioned above, the city encourages the building of rain gardens and has a list of prohibited noxious weeds and invasive plants. Project Clarity recommends that the City of Holland review and maintain that list as conditions change in the future, as well as educate and encourage their residents to continue adopting these green practices.

6.1.2 City of Zeeland

The City of Zeeland encompasses the area in the center and east of the watershed border. A majority of the land in the City of Zeeland is at higher elevation than Holland, with most of the land area zoned as residential with various densities, commercial, and industrial. The Master Plan of the city indicates a commitment to establishing an environmental uniqueness, including land use policies for environmental sustainability goals and environmentally sensitive stormwater maintenance. Excess stormwater is one of the major sources of pollutants that needs to be addressed, along with landscaping within the city limits. The major goals of the City of Zeeland are summarized below:

Goals

- Protect and restore wetlands
- Protect sewers from stormwater
- Protection for natural parks and recreational areas

Because it is an urban area, the City of Zeeland contains a large surface area of paved roads and sidewalks. As a result, stormwater management and excess runoff is the main pollutant they need to address. Zeeland has a robust stormwater management plan that includes taking responsibility for best management practices and keeping stormwater separate from wastewater. Although some language exists to preserve wetlands, the City of Zeeland should adopt additional language that allows for remediation and rebuilding of wetlands. Zeeland was built on an area of relatively high ground, meaning a smaller proportion of wetlands were impacted when compared with other areas.

The City of Zeeland zoning ordinance states that the use of septic tanks or similar private wastewater disposal facilities is deleterious to the health and safety of residents of the city. No person shall construct or maintain any septic tank or any other facility intended or used for the ultimate disposal of wastewater. The licensee shall provide for liquid waste disposal in accordance with all rules and regulations established by the city health officer, in compliance and in accordance with the United States Public Health Service Publication No. 526.

In terms of land use and landscaping, the City of Zeeland does have good language that encourages planting of trees, including a list of allowed tree species and prohibited noxious weeds. It would be advantageous for the City of Zeeland to add language that allows residents and businesses to build structures that help with stormwater retention, such as rain gardens, including those that would allow curb cuts for the inflow of more water from impervious surfaces. The city would benefit from continually reviewing and updating that list to ensure the encouraged species are native and well suited to the soils and climate. Zeeland also has language designed to preserve open spaces, specifically parks, along with language that encourages composting. There are concerns, however, about the language in the zoning ordinance requiring lawns to be mowed to 10 inches or less. It would be beneficial for the City of Zeeland to remove or modify this ordinance to allow for best practices, such as rain gardens and pollinator gardens to be chosen by residents for their homes, thus reducing the potential impact of stormwater runoff.

6.2 Review of Township Ordinances

Other than Holland Township, most of the townships that fall within the Macatawa Watershed are primarily rural and agricultural. As a result, the master plans of these municipalities mostly focus on preserving the rural character of their township. The sections below address specific differences in each township.

6.2.1 Blendon Township

Blendon Township is in the northeastern portion of the Macatawa Watershed and is primarily zoned as agricultural land and low density residential. Adopted in March of 2018, the Blendon Township master plan recognizes the importance of its natural features, citing the geology and soils, wetlands, groundwater, woodlands, and farmland as important factors to take into consideration for future planning efforts. The major goals and strategies of the Blendon Township Master Plan, relating to natural resources and water quality management, are summarized below:

Goals

- Protect and preserve farmland, wetlands, and natural areas
- Encourage implementation of bike paths
- Preserve environmentally sensitive areas
- Plan extensions of sewer and water utilities
- Remain sensitive to the growing concern regarding the groundwater supply
- Commercial and industrial developments should be designed and landscaped using native plants

Blendon Township's zoning ordinance contains a good deal of language meant to "preserve natural features." Although this does not specifically use the word wetlands, there is some language requiring wetland preservation in site plans for new development. The township would benefit from strengthening that language to include the building or mitigation of old wetland areas. There are also ordinances that encourage new developments to maximize open space, by giving bonus density percentages when open space is included. There is also language encouraging bike paths in the township. The township did include language that allows for the building of wind turbines, but it is relatively complicated and seems to make it cumbersome for an individual or business to construct one. Blendon Township should simplify the language or change it to encourage the construction and use of alternative energy sources.

Any new or replacement on-site waste disposal systems must be located to avoid impairment or contamination from flooding, and all required approvals are typically obtained from the OCDPH. Any new buildings must also conform to the performance requirements established in the National Flood Insurance Program. Under the general provisions for housing, all dwellings must connect to a public sewer and water supply, or to private facilities approved by the OCDPH. Under the junk and unwholesome substance regulation, no sewage or wastewater shall be deposited or drained onto any land or water body unless first approved by the Michigan Department of Public Health (MDPH), the Michigan DNR, the OCDPH, and the township board.

Blendon Township has some residential and suburban areas that do not fall in the Macatawa Watershed, but the ordinance document does contain a good stormwater management plan, along with language meant to minimize impervious surfaces due to construction of parking lots. Private roads must be constructed to sufficiently control stormwater runoff and utilize adequate culverts where necessary as required by the Ottawa County Road Commission (OCRC). In regard to erosion control, all construction activity must obtain a soil erosion and sedimentation permit from Ottawa County for any land use or earth change subject to the provisions of the Michigan Erosion Control and Sedimentation Control Act of 1972. Stormwater management measures, such as areas for infiltration or retention, may also be in the landscaped buffer areas. The township should add language around increasing the amount of permeable surfaces in these areas.

The township ordinance describes that all buildings, construction, and/or topographical alteration will not be permitted unless a detailed site plan has been approved by the Township. Planning Commission and the Township Board. Site plan applications must provide information on natural features such as wood lots, streams, rivers, lakes, shorelines, floodplains, wetlands, drains, and topography; show the proposed location, use, and size of open spaces and location of any landscaping; show the location and size of existing utilities (public and private) serving the site, as well as the location and size of all proposed utilities including sewer lines or septic systems; show the location and design of storm sewers and any retention or detention of ponds; show the elevation and location of existing and proposed stormwater drainage courses and County drains; show the location and type of existing soils on the site; show the location and type of existing vegetation; and show the 100-year floodplain. The Township will only approve site plans if they meet all applicable requirements for natural resource preservation, stormwater design, landscaping standards, on-site treatment standards, and utility service requirements.

In terms of land use and landscaping, Blendon Township has some good language in their ordinance document requiring buffer zones and trees in residential and commercial zones. There is a list of "recommended" and "undesirable" tree species, but some flexibility exists and creativity in landscaping is encouraged by the township. Again, there is a lot of language that refers to "preserving natural features." Blendon Township should consider adopting language to encourage other best practices such as buffer strips near field drainage areas, along with other stormwater retention structures. Additionally, language to encourage farmers to manage carefully their use of nutrient fertilizers would be beneficial.

6.2.2 Fillmore Township

Fillmore Township encompasses the southwestern portion of the Macatawa Watershed, primarily comprising the basin of the South Branch, and a substantial portion of it is primarily zoned as agricultural. As a result, runoff and excess nutrients are the main pollutants of concern. More than 88% of the township lies within the watershed boundaries, making the BMPs at the township level especially important. Although no master plan was found, the zoning ordinance specifically mentions a desire to preserve the rural character of the township. The major goals and strategies of the Fillmore Township zoning ordinance, relating to natural resources and water quality management are summarized below:

Goals

- Prioritize erosion control on farmlands
- Require site stormwater management plans
- Preserve the natural state of land
- Encourage buffers and other forms of erosion control
- Limit pesticide and herbicide use near wetlands
- Prioritize wetland preservation in site plans

In terms of wetland preservation, the township zoning ordinance does have language meant to protect wetlands in site plans for new developments. Additionally, there is language that protects wetlands from pesticide use. They also encourage the protection of "significant natural assets," although that language is a bit vague. Fillmore Township would benefit from adopting stronger and more specific language to protect wetlands, and to include new language that would encourage building or mitigating old wetland areas.

The zoning ordinance of Fillmore Township does also contain language that requires a stormwater management plan for new construction, along with language meant to control erosion, including a required buffer strip near pastureland. Other than that, there is not much language regarding storm water management, and very little language about managing paved surfaces, such as streets and parking lots. By adopting more robust language to ensure that developers design paved surfaces with stormwater management in mind, Fillmore Township can allow additional pervious surfaces to be utilized as well. Septic systems in Fillmore Township must meet the Allegan County sewage disposal requirements following the provisions of Public Act No. 94 of 1933.

In terms of land use and landscaping, Fillmore Township has language in the zoning ordinance that encourages erosion control through planting buffers, and, when new construction occurs, they need to "preserve natural state" as much as possible. The document mentions numbers and densities for planting trees and other plants, but there are no requirements in terms of species. Fillmore Township should adopt stricter landscaping ordinances, which encourage planting of native species and discouraging non-native species.

6.2.3 Holland Charter Township

Among the nine townships in this ordinance review, Holland Charter Township is the only one that entirely lies within the area of the Macatawa Watershed. The population of Holland Charter Township is the largest of all the municipalities in the watershed, so most of the land area is zoned residential, commercial, and industrial, with about ¼ zoned agricultural, mostly falling in the northeast corner of the township. Since a large portion of the township is urban/suburban, the primary pollutant of concern is runoff from large storms and flash flooding. The Holland Township Master Plan, adopted in 2020, highlights the need to preserve wetlands, protect storm drains, and protect floodplains. The major goals and strategies of the Holland Charter Township master plan, relating to natural resources and water quality management, are summarized below:

Goals

- Preservation of natural resources and wetlands
- Protect floodplains
- Protect storm drainage and stormwater infiltration zones
- Implement vegetative buffers and erosion control

Holland Charter Township contains a substantial number of acres of former wetland that were drained for residential use. The zoning ordinance for the township mentions "preservation of resources," which could refer to wetlands but is largely unclear. The document also contains language for building wind turbines, but like many of the other townships, it is rather complicated and makes the process cumbersome. The township would benefit greatly from adopting language that promotes the restoration or mitigation of old wetland areas, along with language making it easy for homeowners and businesses to build and utilize alternative energy sources.

The language regarding stormwater management is robust and it appears the township appreciates the importance of protecting storm drains and ensuring that there is a complete stormwater management system in place. There are requirements in the ordinance for paving which focus on impervious surfaces, such as asphalt. There are also restrictions making it difficult to create new ponds, most likely targeted at planned subdivisions. Holland Charter Township is implementing language promoting pervious paving materials, and making it easier to build new ponds, especially encouraging retention ponds, would be able to prioritize controlling stormwater runoff. With the massive amount of impervious surfaces, examining existing parking requirements and encouraging green infrastructure should be encouraged wherever possible. The septic system regulations of Holland Charter Township state that no person shall construct, maintain, or use any septic system unless specifically approved by the health department or where appropriate MDPH.

The land use and landscaping language of the Holland Charter Township zoning ordinance does address some areas of concern. There is language regarding number and density of plants, including a requirement of no more than 50% of one species, which is good for promoting biodiversity. Other than that, there are few specific landscaping requirements, although buffers and erosion control are part of the requirements, and a tree species list is available upon request. Holland Charter Township should include stronger language regarding which tree species may or may not be planted to encourage runoff control and protect native species.

6.2.4 Laketown Township

Approximately 60% of the land area of Laketown Township falls within the Macatawa Watershed, with the southwest portion near Saugatuck draining into the Kalamazoo River. Being adjacent to Lake Michigan, its total area is less than the traditional 36 square miles of the other townships. Due to its proximity to Lake Michigan, Laketown Township contains more natural area than most in the form of parks and dunes. Some agricultural land drains to the North Branch, but a majority of the township is rural and residential. Because of these factors, stormwater runoff appears to be the most significant sources of pollutants. The Laketown Township Master Plan, adopted in 2020, outlines the importance of preserving the natural features within the township, such as wetlands, sand dunes, floodplains, and waterways. The major goals and strategies of the Laketown Township Master Plan, relating to natural resources and water quality management, are summarized below:

Goals

- Provide adequate storm drainage
- Preserve woodlands and wetlands which are useful as water retention and groundwater discharge areas
- Ensure that future park sites (local and centralized) are identified and preserved
- Stabilize vegetation on dune features
- Protect environmental resources, such as wetlands, tree-lined streets, and other natural features, from the negative impacts of new development

Due to the prevalence of sand dunes, not many areas in Laketown Township were previously wetland. Nonetheless, there is ordinance language that includes natural features counting toward the open space requirement for land use. There is some language requiring the inclusion of wetlands in a site plan, but nothing specifically requiring wetland protection. The document also contains language for building wind turbines. Like many of the other townships, it is rather complicated and makes the process cumbersome. It would be advantageous for Laketown Township to adopt language that promotes the building or mitigation of old wetland areas, along with language making it easy for homeowners and businesses to build and utilize alternative energy sources.

The language regarding stormwater management is robust and it appears the township appreciates the importance of protecting storm drains and ensuring that there is a complete stormwater management system in place. There are requirements in the ordinance for paving which cede control over this to the county road commission. There are also restrictions making it difficult to create new ponds, most likely targeted at planned subdivisions. Laketown Township could improve upon existing policy by further detailing how to maintain control over street construction, promoting pervious paving materials. Language supporting new ponds, especially encouraging retention ponds, which will control stormwater runoff, would be beneficial for the next master plan.

The landscaping and land use portion of the document includes language protecting dune vegetation, which prevents erosion of those areas, a specific area of concern in this township. Other than that, there are few landscaping regulations, and those that exist are relatively general. Laketown Township would benefit from adopting language promoting more and native planting and discouraging invasive species, which have been a problem especially in some critical dune areas.

6.2.5 Olive Township

Approximately 33% of Olive Township's land area falls within the Macatawa Watershed, comprising the southern third of the township. The rest of the Township is in the Pigeon River Watershed. There are some commercial and industrial properties along US-31 in the southwest portion of the township, along with some medium-density residential in the southeast corner north of the City of Zeeland, but a substantial portion of the township is zoned agricultural. As a result, runoff and excess nutrients are the pollutants of concern. The Olive Township Master Plan was established in 2024 and details the ever-growing need for minimizing disturbance to wetlands and the growing concerns of groundwater availability and water quality. The major goals and strategies of the Olive Township Master Plan, relating to natural resources and water quality management, are summarized below:

Goals

- Prioritize protecting existing wetlands
- Minimize disturbance to wetlands
- Prioritize open spaces such as woodlands, wildlife habitat, and farmland
- Encourage adequate storm drainage
- Minimize erosion and runoff from agricultural fields
- Protect native vegetation and limit tree removal
- Protect floodplains
- Protect groundwater quality and quantity

Olive Township's zoning ordinance does contain a good amount of language protecting wetlands, specifically citing the Wetland Protection Act, and including an Environmental Conservation Provision. Even though it is not part of the Macatawa Watershed, the Pigeon River Watershed contains some beautiful parks and preserves to which this language refers. The document also contains language for building wind turbines, but like many of the other townships, it is rather complicated and makes the process cumbersome. Olive Township would benefit from adopting language that promotes the restoration of or mitigation of old wetland areas, along with language making it easy for homeowners and businesses to build and utilize alternative energy sources.

The Olive Township zoning ordinance language regarding stormwater management is robust and it appears the township appreciates the importance of protecting storm drains and ensuring that there is a complete stormwater management system in place. There are requirements in the ordinance for paving which focus on impervious surfaces, such as asphalt. It would be in the best interests of Olive Township to adopt language that encourages the use of pervious paving materials. Within the zoning ordinance of Olive Township there is language about septic system compliance and permits issued through the Ottawa County Environmental Health Department. Language exists within the ordinance that describes mitigating groundwater pollution caused by an over concentration of septic tank systems. Similarly, the master plan for the township also explains the need for studies on the future impacts of failed septic systems.

In terms of landscaping and land use, Olive Township does have a good deal of language intended to protect native vegetation and limit tree removal. As mentioned above, this language appears to refer to the parks and preserves in the Pigeon River Watershed. Despite previous comments about wind turbines, Olive Township does have some language that encourages the construction of alternative energy sources. The landscaping regulations are general, and mention no specific species, although tree planting is encouraged, along with protection of native plants. Olive Township would improve upon policies by adding a specific list of native tree and plant species to promote, along with a list of invasive plants to discourage.

6.2.6 Overisel Township

About 50% of Overisel Township falls within the Macatawa Watershed, comprising most of the northern half of the township, leaning a little bit to the west. The land use in Overisel Township is almost exclusively agricultural with many large farms operating in the area. As a result, the main pollutants of concern are runoff and excess nutrients. The Overisel Township Master Plan, established in 2005, overviews the conservation of natural resources to meet the needs of all industries and residents. The major goals and strategies of the Olive Township Master Plan, relating to natural resources and water quality management, are summarized below:

Goals

- Support improvements for alternative energy sources
- Improve diversity of natural landscaping

There is very little language in the Overisel Township zoning ordinance intended to protect wetlands. There is a mention that the board "shall consider" things that prevent destruction of natural features. Since many acres of the township were wetlands prior to settlement, this is an area of concern. Overisel Township would benefit from adopting language intended to protect wetlands and encourage restoring old wetlands. The document also contains language for building wind turbines, but like many of the other townships, it is rather complicated and makes the process cumbersome. The township would improve upon the existing ordinance by adopting language that promotes the building or mitigation of old wetland areas, along with language making it easy for homeowners and businesses to build and utilize alternative energy sources.

Even though Overisel Township contains many farms that are relatively high in elevation and composed of clay soil, there is very little language regarding stormwater management. The requirements are very general, and there appear to be no restrictions, only that a stormwater management plan needs to be a part of a site plan for construction. Overisel Township can improve upon the existing master plan by adding a uniform approach to stormwater management, including provisions that encourage building buffer strips and retention ponds to inhibit runoff, and, as a result, prevent excess nutrients from entering the watershed. Additionally, the septic ordinance for Overisel Township complies with the rules and regulations governing waste and sewage disposal of Allegan County when issuing permits. According to the ordinance for the township, no septic tank or field should be placed within one hundred feet of the Kalamazoo River's edge. It would be advantageous for Overisel Township to include unique specifications for septic systems that expand upon what Allegan County recommends in their next master plan.

The landscaping requirements for Overisel Township are relatively general, with some mention of tree numbers and density. Overisel Township would benefit from adopting a specific list of native tree and plant species to promote, along with a list of invasive plants to discourage.

6.2.7 Park Township

Approximately 81% of the land area of Park Township falls within the Macatawa Watershed, with the northern portion outside the Macatawa Watershed adjacent to Pigeon Lake. Like Laketown, its total area is less than the traditional 36 square miles of the other townships due to its lake frontage. Due to its proximity to Lake Michigan, Park Township contains more natural area than most in the form of parks and dunes. There is some agricultural land, primarily in the form of blueberry farms, but most of it is rural or suburban and residential. Because of these factors, stormwater runoff appears to be the most significant source of pollution. The Park Township Master Plan, established in 2023, outlines the climate and sustainability goals they will achieve through building climate resilience and protecting natural resources. The major goals and strategies of the Park Township Master Plan, relating to natural resources and water quality management, are summarized below:

Goals

- Protect and preserve wetlands
- Encourage establishment of new wetlands
- Create stormwater retention ponds
- Support BMPs within urban and agricultural areas
- Support tree preservation and native restoration efforts
- Support the protection of Lake Macatawa

Park Township's zoning ordinance contains a lot of robust language intended to protect wetlands. Although only a small portion of the township was formerly wetlands, some remain, such as the area near Pine Creek Bay. Along with regulations preventing any earth changes from impacting wetlands, there is also language that encourages the construction of new wetlands, all of which will benefit the water quality of Lake Macatawa.

Park Township also has a robust and complete stormwater management plan, encouraging "Environmentally Friendly" drainage systems and protecting floodplains. Additionally, there is language protecting sewers from stormwater and provisions meant to encourage the building of retention ponds, which will reduce runoff from stormwater. Although the total area of paving is restricted, there is language requiring paving on all lots. Park Township would benefit from the addition of language that promotes the use of pervious paving materials. Within the code of ordinances of Park Township there is language that describes no person shall construct, maintain, or use any septic tank that is not specifically permitted by the Ottawa County Environmental Health Department.

In terms of landscaping and land use, Park Township does encourage tree preservation and specifically cites and promotes the use of best management practices by landowners. In addition, there is language intended to protect land adjacent to Lake Macatawa. The landscaping language is a bit general, but tree planting is encouraged, along with protection of native plant species. There is a 12-inch mowing requirement for lawns in Park Township. It would be advantageous for Park Township to adopt specific landscaping regulations, including a list of encouraged native species and discouraged invasive ones. Park Township can help to support water quality by modifying their lawn-mowing ordinance and promoting rain and pollinator gardens.

6.2.8 Port Sheldon Township

Only about 7% of Port Sheldon Township falls in the Macatawa Watershed, comprising the southeast corner of the township. Most of Port Sheldon Township falls in the Pigeon River Watershed. The portion that is in the Macatawa Watershed has some agricultural areas, mostly blueberry farms, and some residential areas. As a result, stormwater runoff is the main pollutant of concern. Port Sheldon Township is currently in the process of updating their Master Plan but adopted the existing Master Plan in 2017. While its primary development goals still include preserving rural character, open space, and natural features, the land use priorities of the township look slightly different from the rest of the surrounding area. The major goals and strategies of the Port Sheldon Township Master Plan relating to natural resources and water quality management are summarized below:

Goals

- Preserve the natural features of the community
- Prioritize park planning and development
- Monitor effectiveness of on-site wastewater systems
- Monitor wastewater discharge points

The Port Sheldon Township zoning ordinance document does contain a substantial amount of language meant to protect "natural features," although wetlands are not specifically cited, and some specific wetland protection language was recently removed. Perhaps the township felt this issue was still covered by the new language. Port Sheldon Township would benefit from adopting language intended to protect wetlands and encourage the restoration or mitigation of old wetlands. The document also contains language for building wind turbines, but like many of the other townships, it is rather complicated and makes the process cumbersome. The township can improve upon language that allows for homeowners and businesses to build and utilize alternative energy sources.

In the Port Sheldon zoning ordinance, there is very little language regarding stormwater management. There are some mentions of erosion control and protection of floodplains, but the requirements are very general, and there appear to be no restrictions, only that a stormwater management plan needs to be a part of a site plan for construction. In addition, Port Sheldon Township cedes control of drainage to Ottawa County. Port Sheldon Township should consider putting language into the new master plan that describes control of stormwater management, and adopt a uniform approach, including provisions that encourage building buffer strips and retention ponds to inhibit runoff, and, as a result, prevent excess nutrients from entering the watershed.

There is language within the zoning ordinance for Port Sheldon Township that mandates connection of a building to a septic system that follows protocol and approval of the Ottawa County Health Department. An addition to the new master plan would be specific language about septic system improvement that is applicable to residents within the township other than what the county provides. In terms of landscaping and land use, there is very little language in the Port Sheldon zoning ordinance on this topic. Port Sheldon Township would benefit from adding specific landscaping regulations to their master plan, including a list of encouraged native species and discouraged invasive species.

6.2.9 Zeeland Charter Township

Approximately 91% of Zeeland Charter Township lies in the Macatawa Watershed, with only a few portions to the east and northeast not a part of it. In terms of land use, most of the western portion of Zeeland Charter Township is residential and industrial, adjacent to Zeeland City. The central and eastern portions are mostly agricultural. Soils include some with higher-elevation clay and some muck in the lower areas of the Glacial Grand River, where there are many celery and onion farms. As a result, stormwater runoff and excess nutrients are pollutants of concern. The Zeeland Charter Township Master Plan, established in 2019, includes goals surrounding protecting sensitive landscapes and maintaining open spaces for recreational use. The major goals and strategies of the Zeeland Charter Township Master Plan relating to natural resources and water quality management are summarized below:

Goals:

- Protect natural resources and sensitive environments
- Adopt policies and regulations surrounding wetland protection
- Adopt standards for implementing bioswales or rain gardens

Zeeland Charter Township's zoning ordinance has a good deal of language that protects wetlands. Not only do they prioritize "significant natural resources," but they also prevent building on wetlands altogether. Wetland preservation is required of all site plans, and farmers are required to control pesticide and herbicide use near wetlands as well. Zeeland Charter Township has a good amount of language regarding stormwater management, protecting sewers from stormwater, along with regulations meant to minimize impervious pavement use and encourage growing grasses in lots. There was not, however, a comprehensive stormwater management plan, and the regulations centered on building ponds were rather restrictive. It would be in the best interests of Zeeland Charter Township to adopt a more uniform stormwater management plan and ease restrictions on ponds to help reduce the effects of runoff.

Zeeland Charter Township has clear language surrounding residents must be issued a septic permit by Ottawa County Health Department for sewage disposal facilities. An improvement of the language surrounding recommendations for township residents in relation to septic systems outside of the county regulations would greatly improve the township master plan. In terms of landscaping and land use, Zeeland Charter Township has a lot of good language in the ordinance document. Tree planting is encouraged, and there is a 33% maximum on one species, which promotes biodiversity. Buffer strips are also promoted, and there is a list of tree species that are permitted and not permitted in Zeeland Charter Township. Zeeland Charter Township can improve their existing language around native plants by continually reviewing the tree species list to ensure that native species are promoted and invasive species are discouraged.

6.3 Ottawa County Review

At the time the Macatawa Watershed Management Plan was being developed, Ottawa County was completing a countywide policy review for themselves. The review included in this document will summarize key departments and county ordinances that accompany township ordinances. ODC Network staff will keep up to date on Ottawa County policies and the recommendations identified by the County as they complete their internal review.

6.2.1 Department of Public Health

The Department of Public Health hosts a Real Estate Transfer Evaluation Program that includes a mandatory evaluation of septic systems at a home or business before the time of sale. The program identifies septic systems requiring maintenance, repair, or replacement, which is beneficial for the MWMP. If a system is failing and presenting a public health hazard, then they required that the system is replaced. It does not prevent the sale of the property, nor does it specify who is responsible for correcting any problems found during the inspection. If a system is not up to code, they will recommend the system replaced or repaired, but the buyer can choose to utilize the existing system until failure. Ottawa County, and other municipalities with point-of-sale inspection programs, are eligible to apply for federal grants to voluntarily inspect and or improve septic systems.

The Environmental Health Division of the OCDPH also enforces the Ottawa County Phosphorus Use Regulation Ordinance that bans the use of lawn fertilizers containing phosphorus, aside from a few exceptions whose usage of these fertilizers are then controlled. This ordinance bans the use of lawn fertilizers containing phosphorus on all lawns, including frozen ground and any nearby impervious surfaces. Exceptions to this ban include newly established lawns during their first growing season, lawns whose soils test below phosphorus levels, agricultural uses, vegetable and flower gardens, trees and shrubs, and yard waste compost that are applied to improve the physical condition of the soil.

6.2.2 Department of Strategic Impact

The Department of Strategic Impact oversees planning of a wide variety of quality of life and economic development projects and oversees Land Use Planning throughout the County. Of note, this department houses the Groundwater Sustainability Initiative, which has implemented research studies to understand Ottawa County's groundwater resource issues, and develops resources and management strategies to preserve and restore Ottawa County's groundwater resources. Many of the townships identify management strategies for groundwater protection within their own master plans and ordinances based off the recommendations from this initiative.

The Ottawa County Farmland Preservation Program, established through a countywide ordinance, aims to protect farmland by acquiring development rights voluntarily offered by landowners. The program restricts future development on the preserved land through the placement of an agricultural conservation easement, ensuring the land remains suitable for agricultural use. The county may purchase these development rights using funds from sources other than the County General Fund, with the goal of preserving the economic, environmental, and scenic value of Ottawa County's agricultural lands. They created the Farmland Preservation Program to address the growing concern of farmland loss due to residential and commercial development, which poses threats to agriculture, wildlife habitats, and the county's rural character. The program aims to protect valuable agricultural land, enhance water quality, and support long-term sustainability by preventing urban sprawl and preserving open space.

6.2.3 Water Resources Commissioner

The Ottawa County Water Resource Commissioner (OCWRC) is responsible for maintaining county drains to prevent flooding and protect property. Water Resource Commissioners (also known as Drain Commissioners) have authority to maintain or alter a large percentage of the watershed's tributaries to minimize flooding on agricultural and developed lands. Management and maintenance methods used by Water Resource Commissioners can have a large impact on water quality. It is important for both road and drain commissions to keep current regarding BMPs for water quality. The OCWRC houses information about stormwater, types of drains, and erosion protection methods on their website.

The Water Resources Commissioner is also responsible for protecting water quality and controlling soil erosion and sedimentation and enforcing the Ottawa County Soil Erosion Control Ordinance that establishes rules and regulations to control soil erosion and sedimentation and a system of permits for the regulation of earth changes. This ordinance follows the guidelines set by Part 91 of the NREPA Soil

Erosion and Sediment Control (SESC) that is administered and enforced by EGLE through various county and local government units.

Ottawa County is required to have an MS4 permit due to the National Pollutant Discharge Elimination System (NPDES) permit program established by the Clean Water Act of 1972, which regulates the discharge of pollutants into state waters. The MS4 permit, introduced in 1987, became mandatory for urbanized areas under the Phase II regulation in 1999. Ottawa County obtained its MS4 permit at that time, which is managed by the Water Resources Commissioner's office.

The MS4 permit allows the county to manage and monitor authorized outfalls and points of discharge, ensuring they do not contribute to pollutants like turbidity, oil films, and suspended solids in state waters. The permit requires the county to implement a Stormwater Management Program (SWMP) that minimizes pollutants, along with an Emergency Response Procedure, Public Participation Program, and Public Education Program. It also mandates an Illicit Discharge Elimination Program (IDEP) to identify and address illegal discharges, as well as the maintenance of BMPs like catch basins and detention ponds. The County must inspect and maintain outfalls and BMPs at least every five years.

Another important component of the MS4 permit is the post-construction runoff control program that requires that all developments that disturb more than 1 acre include a stormwater management system that meets water quality treatment and channel protection performance standards. Ottawa County meets this standard through the enforcement of Site Development Rules adopted in 2021. The OCWRC's office reviews all site condominiums and platted developments as well as most of the other construction that disturbs more than 1 acre as directed by most townships and cities in Ottawa County.

6.2.4 Road Commission

The Ottawa County Road Commission (OCRC) is responsible for ensuring the safety and efficiency of all county roads and bridges and they pan and execute road development and maintenance projects. Road installation and road crossings may affect drainage patterns due to the design parameters of bridges and culverts, including size, depth, and debris impaction. Operations and maintenance methods for road grading, repairs, and snow and ice removal can also vary in their impact on water quality. The OCRC engages with the agricultural community in the maintenance of roadside ditches in rural areas of the county. They encourage the use of agricultural best management practices adjacent to roadside ditches to protect water quality.

The OCRC also develops policies for winter maintenance operations, such as requiring snowplow trucks to be equipped with global positioning system (GPS) units to track in real time the use of salt, sand and deicing agents that helps to reduce and minimize salt usage and resulting chloride concentrations in surface water.

6.4 Allegan County Review

At the time the Macatawa Watershed Management Plan was being developed, Allegan County was completing their own countywide policy review. The review included in this document will summarize key departments and county ordinances that accompany township ordinances. ODC Network staff will keep up to date on Allegan County policies and the recommendations identified by the County as they complete their internal review.

6.4.1 Department of Health and Human Services

The Allegan County Soil Erosion and Sedimentation Control Ordinance aims to safeguard public health and the environment by regulating earth change activities that may lead to erosion and sediment accumulation. The Allegan County Health Department enforces this ordinance with exceptions for areas governed by local municipal agencies designated as Municipal Enforcing Agencies or Authorized Public Agencies. This authority comes from Part 91 of the Michigan Natural Resources and Environmental Protection Act (PA 451 of 1994), which provides the legal framework for the control of soil erosion and sedimentation. The ordinance mandates that all earth change activities must adhere to guidelines that prevent soil erosion, sedimentation, and damage to water quality, with enforcement measures such as cease-and-desist orders and stop work orders. Additionally, the ordinance describes various types of erosion and sedimentation control measures, both temporary and permanent, to be applied during and after construction activities. It also defines various water bodies such as lakes, streams, and stormwater basins, all of which are protected under the ordinance to prevent the degradation of water quality through sedimentation and erosion.

Allegan County has enacted an ordinance to ban the use of lawn fertilizers containing phosphorus to protect the county's lakes, rivers, and streams from environmental degradation. The ordinance prohibits applying lawn fertilizers with more than 0% phosphorus, except in specific cases such as newly established lawns, areas with deficient phosphorus levels confirmed by soil tests, agricultural uses, and gardens. The restrictions apply to all areas within Allegan County, though local municipalities may assume regulatory control if they adopt equally strict or stricter standards. The ordinance also prohibits applying lawn fertilizers on impervious surfaces or frozen ground to prevent runoff into waterways.

The Department of Health and Human Services has water and sewage regulations that regulate septic systems based on a permit system issued by a health officer. Due to the lack of urbanized area within the county, numerous septic systems throughout the county increase the risk of potential groundwater contamination. To combat this, Allegan County has mandated sewage disposal systems connect to all buildings and needs to receive a permit approved by a health officer. Additionally, to regulate where people are drawing water from, the Health Department issues permits for manufactured wells and other water supply systems that must meet the existing code.

Allegan County developed the Allegan County Farmland Preservation Purchase of Development Rights Program that protects farmland by acquiring development rights voluntarily offered by landowners by means of donation, cash purchase, or installment purchase. This ordinance requires the creation of agricultural development rights/conservation easements on any property from which the public shall acquire development rights. The ordinance allows Allegan County to continue to ensure there will be viable farmland and promotes the long-term viability of agriculture that enhances the quality of life for all residents.

6.4.2 Drain Commissioner

The Allegan County Drain Commissioner (ACDC) and staff manage over 825 county drains and stormwater systems throughout the county. Their primary function is to manage stormwater, prevent flooding, and protect streams in both agricultural and developed areas. These systems, which include open ditches, streams, underground pipes, retention ponds, and swales, are designated as county drains through a petition process initiated by property owners or local municipalities. The Drain Commissioner oversees the financial management of county drainage districts, ensuring accurate accounting of expenditures and maintaining records of each system's establishment and operations.

They conduct regular inspections and maintenance to ensure the proper functioning of the drainage infrastructure. These efforts help sustain effective water quality management and stormwater control throughout Allegan County.

Allegan County is required to have an MS4 permit due to the National Pollutant Discharge Elimination System (NPDES) permit program established by the Clean Water Act of 1972, which regulates the discharge of pollutants into state waters. The MS4 permit, introduced in 1987, became mandatory for urbanized areas under the Phase II regulation in 1999. Allegan County obtained its MS4 permit at that time, which is managed by the Drain Commissioner's office.

The MS4 permit allows the county to manage and monitor authorized outfalls and points of discharge, ensuring they do not contribute to pollutants like turbidity, oil films, and suspended solids in state waters. The permit requires the county to implement a Stormwater Management Program (SWMP) that minimizes pollutants, along with an Emergency Response Procedure, Public Participation Program, and Public Education Program. It also mandates an Illicit Discharge Elimination Program (IDEP) to identify and address illegal discharges, as well as the maintenance of BMPs like catch basins and detention ponds. The County must inspect and maintain outfalls and BMPs at least every five years.

Another important component of the MS4 permit is the post-construction runoff control program that requires that all developments that disturb more than 1 acre include a stormwater management system that meets water quality treatment and channel protection performance standards. Allegan County meets this standard through the enforcement of Site Development Rules adopted in 2021. The ACDC's office reviews all site condominiums and platted developments as well as most of the other construction that disturbs more than 1 acre as directed by most townships and cities in Ottawa County.

6.4.3 Road Commission

The Allegan County Road Commission (ACRC) integrates water quality management into routine and special maintenance by implementing drainage improvements, culvert replacements, and erosion control measures of approximately 1,800 miles of roads across Allegan County. Routine maintenance activities, such as cleaning culverts, catch basins, and storm sewers, help manage stormwater runoff and prevent sediment buildup in local waterways. Additionally, roadside mowing and vegetation management contribute to stabilizing soil and reducing erosion along roadways. When townships request special maintenance, such as new ditching or brush trimming, ACRC designs these projects to improve drainage efficiency while minimizing environmental impact. Operations and maintenance methods for road grading, repairs, and snow and ice removal can also vary in their impact on water quality.

Local and primary road construction projects also incorporate water quality considerations by ensuring proper drainage and stormwater management. Culvert replacements, which require permits from EGLE, are sized to maintain natural water flow and reduce the risk of flooding or contamination. The ACRC follows best management practices, including compliance with erosion control standards, to protect nearby streams and groundwater sources. As part of its asset management strategy, the ACRC continues to prioritize infrastructure improvements that enhance water quality while maintaining safe and durable roadways.

6.5 Policy Recommendations

Policy recommendations for watershed management should align with existing master plans, zoning ordinances, and environmental regulations to enhance water quality, stormwater management, and ecosystem resilience. Within the Macatawa Watershed, the counties of Allegan and Ottawa, the cities of Holland and Zeeland, and surrounding townships have developed strategies to address stormwater runoff, wetland protection, and sustainable land use. However, this policy review did indicate a few potential areas where updates could be made to zoning ordinances, other protective ordinances, and local government policies to provide stronger protections for water quality within the MW. By integrating these strategies, municipalities within the Macatawa Watershed can enhance water quality, safeguard natural resources, and create more sustainable communities.

- Enhance natural resource management regulations by enacting additional ordinances for **wetlands and floodplains.** All townships should adhere to the permitting requirements and regulations set forth by the State of Michigan and the U.S. Government. Most townships include these requirements within their zoning and local ordinances, however additional regulations set up by local governments would do even more to protect the remaining wetlands and floodplains of the MW.
- Support the role **farmland preservation** can play in climate resilience by keeping open space open, capturing and infiltrating stormwater, and capturing and sequestering carbon. Ottawa County has a Farmland Preservation program, but not all municipalities in the Macatawa Watershed participate. Allegan County does not currently have an active program, but there is great interest from farmers within the Macatawa Watershed and other areas of the county. ODC and the MACC will support and encourage these efforts both in the Macatawa Watershed and throughout each county.
- Enact a **stormwater management** ordinance to encourage additional stormwater management measures and ensure less pollutant contamination of local waterways. Management measures could include policies to protect riparian zones, metering stormwater volumes entering nearby ditches, drains, or tributaries from agricultural sites, and encouraging alternative stormwater management development standards. Many of the townships and cities within the Macatawa Watershed require paved lots, but seeking out alternative permeable pavers would have a large impact on stormwater mitigation and water quality.
- Improve practices for **drain maintenance within rights-of-way**, particularly along roadways, such as encouraging the creation of two-stage channels or minimizing erosion risk, such as proper sediment disposal and revegetation.
- Promote the use of **stabilizing vegetation for dunes** in all municipalities where applicable.
- Encourage the use of native, drought tolerant plants in landscaping across all municipalities within the Macatawa Watershed. Providing **native species** lists to residents would go a long way in providing resources for native restorations that are more accessible for the public. Some townships suggest or require landscaping plant materials to be native to West Michigan but encouraging drought tolerant plants that require less watering and maintenance would reduce the pressures on groundwater resources.
- Expand current efforts to monitor for and **eliminate dumping of organic waste** in waterways. The drain commissions of Allegan and Ottawa County monitor the drains and other tributaries that may carry organic matter through the watershed, but more support to eliminate organic waste from entering Lake Macatawa would continue to improve water quality within the watershed.
- Encourage **urban green stormwater practices** such as rain gardens, pervious surfaces, bioswales, green roofs, greenbelts, and rainwater harvesting to preserve local natural features,

increase filtration of stormwater to protect water quality, and increase groundwater retention. Promote installation of rain gardens in urban areas for all municipalities who do not include rain gardens in their ordinances.

- Encourage best management practices at small **construction sites** (<1 acre of disturbance) such as installing silt fences, regulating site prep, standardizing how an area is cleaned, preserving vegetation, and ensuring native species are being planted.
- Continue to prioritize the implementation of policies and ordinances based on township Master Plan goals and strategies identified. Many townships are currently updating Master Plans to identify additional strategies to achieve water quality and natural resource protection goals that are still being implemented or have not been implemented yet. Prioritizing **education and outreach** on the importance of natural resource management policies will be key.
- Enhance language within municipal ordinances to dissuade planting **invasive species** and improve invasive species management for township, city, and county properties as well as for residents.
- Encourage **tree preservation** along all riparian areas surrounding the Macatawa River and Lake Macatawa. Areas like Park Township and Holland Township will be the priority areas for this policy recommendation.
- Improve ordinances for **expanding protections for existing wetlands** and continue advocating for new ordinances focused on developing new wetlands in the MW. Encouraging the protection of wetlands ensures that these policies are not just focused on the quantity of the landscape but improving the quality of the existing landscape.
- Enhance policy surrounding the need to prioritize **community education before enacting policies**. Promoting public awareness gives reasoning and explanation as to why people should care about these policies and gives residents some ownership and pride for the ordinances that are being enacted.

There are several opportunities for ODC staff to provide policy input to the townships in the Macatawa Watershed based on the findings of this WMP. ODC staff will pay attention to Township efforts to update Master Plans and Zoning Ordinances and should provide community input as requested or seen fit.

7.0 SOCIAL SURVEY ANALYSIS AND INFORMATION AND EDUCATION (I&E) RECOMMENDATIONS

Watershed management and reduction of phosphorus and *E. coli* pollution are largely dependent upon the participation of the community in the watershed. As part of this WMP development, the evaluations of residents' awareness of water quality and common pollutants as well as best management practices was developed using the Social Indicators Data Management and Analysis (SIDMA) system managed by GVSU. ODC Network contracted the GVSU Social Science Lab to create and conduct a survey of residential and agricultural property owners in the Macatawa Watershed. GVSU assisted with tailoring the SIDMA survey tool to the needs of the Project Clarity partners, including integrating questions from previous waves of surveys conducted by the MACC (Buday, 2021, Appendix Q).

The purpose of the survey was to inform the development of educational and informational messaging strategies in the 2021 updates to the MWMP and to provide feedback to Project Clarity partners on the extent to which the public is aware of and satisfied with the project's efforts. The survey was distributed by mail to 1,200 households in the watershed from January – March 2021. In total, 327 completed questionnaires were returned to GVSU (a 27% response rate). Most respondents were white, college-educated males who have lived in the watershed for a long period – 35 years on average. Survey respondents were also older on average than the general Macatawa Watershed population, with 42% of survey respondents aged 65-years or older compared to American Community Survey (ACS) estimates finding 19% of the watershed population in this age range.

Survey respondents reported higher levels of education attainment compared to ACS estimates for watershed residents, with 55% holding a bachelor's or graduate degree. That is higher even than the above-average education levels estimated for the Macatawa Bay subwatershed. The 96 owners of agricultural properties who responded to the survey manage, on average, 363 acres of land in the Macatawa Watershed. Farm size ranges considerably, with individuals reporting as little as no tillable acreage (e.g., greenhouse growers, blueberry farmers), and as many as 4,400 tillable acres in their operations. Most agricultural respondents were long-time farmers, reporting an average of 34 years in the farming business.

The survey results indicate that Macatawa Watershed residents value water resources and are employing many best management practices to reduce the environmental footprint of their property in the watershed. The use of cover crops by farmers in the watershed shows a particularly high rate of adoption. However, there are opportunities for further investments. Many residential property owners are unfamiliar with nature-based solutions for managing stormwater runoff, and vegetated stream buffers are less commonly used on agricultural properties than several other important practices. More respondents to the 2021 survey reported accessing information online than did respondents in previous surveys. Knowledge of watershed terminology was similar to previous years' data, although 2021 respondents demonstrated more awareness about stormwater and its fate. Additionally, awareness of Project Clarity is growing in the watershed, although few respondents reported attending presentations or community events. Consequently, few respondents were able to offer an informed assessment of the impacts Project Clarity has on improving conditions in the watershed.

Survey respondents were generally satisfied with the quality of water in the Macatawa Watershed for many of their favorite water-based activities. Levels of concern about pollutants in the watershed remain consistent with data from previous years (i.e. the 2010 Agricultural Survey), and respondents are more confident in their ability to evaluate the severity of visible pollutants than chemical or biological impairments to water quality. On average, respondents are willing to invest personally $115 per year in water quality improvements in the Macatawa Watershed. However, many respondents expressed needing more detailed information about how their donations would be spent, how previous funds have been spent, and what outcomes were achieved with these prior projects.

7.1 Social Survey and Watershed Demographics

The Macatawa Watershed stretches across 175 square miles of land in Ottawa and Allegan Counties, serving as the drainage basin for the Cities of Holland and Zeeland as well as Park, Port Sheldon, Laketown, Olive, Holland, Fillmore, Overisel, Blendon, and Zeeland Townships. The United States Census Bureau American Community Survey (ACS) estimates that approximately 73,000 residents live in the eight subbasins of the Macatawa (2013-2017 ACS estimates), with nearly half of that population concentrated in the City of Holland. On the outer fringes of the watershed, the population density declines to less than 150 people per square mile, with agricultural operations dominating the landscape. Due to these diverse land uses, the ecological function of the watershed faces challenges associated with residential and commercial land development, nutrient loading from agricultural runoff, and loss of wetlands.

The demographic characteristics of residents in the Macatawa Watershed vary across subbasins. Racial/ethnic diversity is most apparent in the Lower Macatawa River subwatershed, where the Census Bureau estimates nearly one-quarter of residents to be Hispanic. Likewise, the Macatawa Bay and the North Branch of the Macatawa River have robust Hispanic populations, with 16% of residents estimated to be Hispanic. In five of the subbasins white residents comprise 91-96% of the population. 1 In contrast, 77% of residents in the Lower Macatawa River subwatershed, which includes portions of the City of Holland, are white. Across the watershed a substantial proportion of household incomes are estimated to be above the national median ($57,652, 2013-2017 ACS estimates), with 32-56% of households in each subwatershed earning incomes at or above $75,000. Likewise, education attainment levels are at or above the national average in all but the South Branch and North Branch subbasins. Post-secondary degree attainment is highest in the Macatawa Bay subwatershed, where 41% of residents are estimated to hold bachelor's or graduate degrees (compared to the national average of 30.9%).

A summary describing the characteristics of the 327 survey respondents compared to ACS estimates of the watershed population appears in Table 7.1. Seventy-one percent of survey respondents (n=231) own residential properties in the Macatawa Watershed while 29% of respondents (n=96) own agricultural properties. In this report, property type is a proxy indicator for urban/suburban residents who live "in-town" and rural/exurban residents who live "out-of-town" on larger land parcels. This is an important distinction because property type can affect management priorities, and while urban dwellers may relate to land and water resources in the Macatawa Watershed primarily through recreation, rural and exurban dwellers may have working relationships with land used to cultivate food and crops, raise livestock, or grow forage. These differing ways of relating to natural resources in the watershed should be kept in mind when considering similarities and differences in responses between these two groups of residents.

Table 7.1 Demographics of Macatawa Watershed residents and survey respondents

Variable	Mean or %	Census Estimates
Property Type		
Residential	71%	--
Agricultural	29%	--
Gender		
Male	67%	49%
Female	33%	51%
Age	60	--
18-64 years old	58%	81%
65 years and older	42%	19%
Education Level		
High school or less	20%	34%
Two-year or some college	25%	35%
Four-year degree or more	55%	31%
Race		
White	93%	75%
Non-white	7%	25%
Years lived in watershed	35	--
<5 years	9%	--
5-9 years	8%	--
10-24 years	22%	--
25-39 years	24%	--
40-54 years	14%	--
55+ years	24%	--
Residency		
Absentee	5%	--
Seasonal	5%	--
Permanent	90%	--

Data Source: Buday, 2021
Date Prepared: 2021

7.2 Social Survey Results

7.2.1 Summary of Attitudes Related to Water Quality

Survey respondents were asked a series of questions intended to identify the relative importance of perceptions of water quality and stewardship in the Macatawa Watershed, water quality impairments, resident awareness and use of BMPs, watershed knowledge and information sources, and resident's willingness to pay for water quality improvements. Overall, Macatawa Watershed residents highly value water-based recreational activities, with scenic beauty, birdwatching, picnicking, and boating ranking as the most important. Most respondents rated water quality as "good" or "okay" for these activities, though concerns were higher for swimming and consuming harvested fish or game.

Compared to 2010, 2021 respondents—especially residential ones—expressed more concern about pollution from fertilizers, invasive species, and toxic materials, with increasing worries about shoreline erosion and land development due to rising water levels and population growth. While self-reported knowledge about the watershed remained consistent with past surveys, awareness of Project Clarity grew from 26% in 2014 to 46% in 2021, mainly due to increased visibility of signage. Trust in information sources was highest for the Macatawa Watershed Partnership and MSU Extension (trusted by nearly 70%), while skepticism remained about information from neighbors and friends, highlighting opportunities for improved outreach and education.

7.2.2 Perceptions of Water Quality and Stewardship Attitudes

Important Water Activities

The survey asked residents about the importance of several water-based recreational activities, their perceptions of the quality of water in the Macatawa Watershed for those activities, and about their perception of their personal impact on water resources. Survey respondents reported a wide-range of favorite water-based hobbies and were largely satisfied with the quality of water for most of these activities. Most respondents also highly valued local water quality and recognized the impact of their personal property management decisions on the health of the watershed.

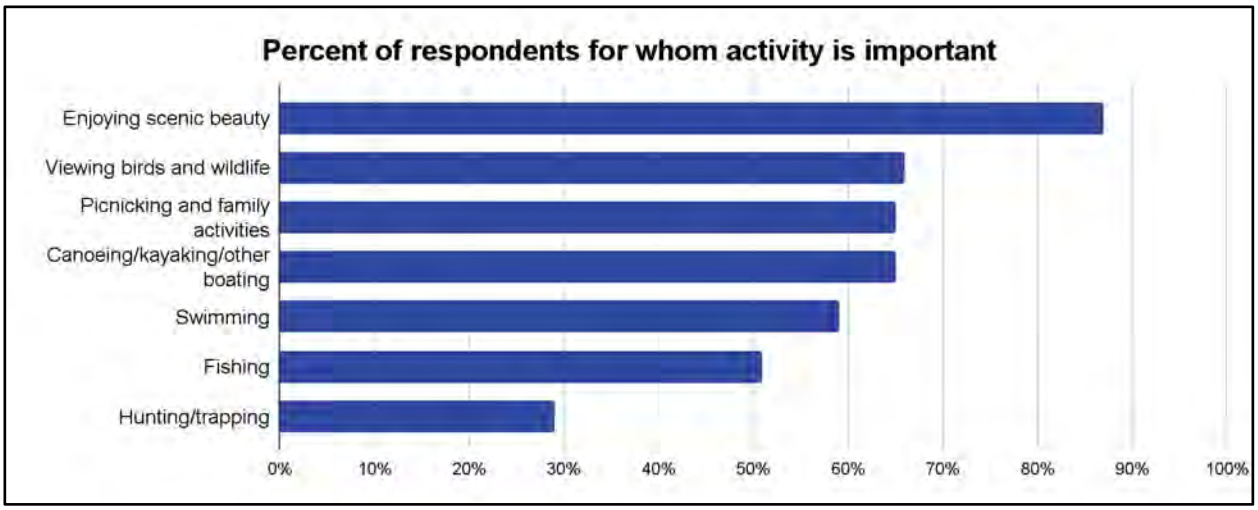

Figure 7.1 Important water activities
Data Source: Buday, 2021
Date Prepared: 2021

The importance of water-based activities was a dichotomous measure, with respondents selecting important activities from a list of six items, as pictured in Figure 7.1. Enjoying scenic beauty was the most important water-related recreational activity for survey participants, with 87% indicating that the aesthetic value of local waterways was important to them. Viewing birds and wildlife (66%), picnicking, and family activities (65%), and boating activities (65%) were also popular activities for survey respondents. Although hunting and trapping ranked lower overall compared to other activities, 57% of agricultural respondents said that hunting was an important activity, compared to only 18% of residential respondents.

Perceptions of Water Quality

Concerning respondents' perceptions of the quality of water for enjoying their favorite activities (Figure 7.2), most respondents ranked water quality as "good" or "okay" for most activities, with the perceived quality of water for enjoying scenic beauty, picnicking, boating activities, and fish and wildlife habitat being particularly high. Respondents were not as positive in their assessments of water quality for swimming, with 19% indicating that they thought local waterways are in poor condition for this activity. Notably, a larger proportion of respondents were unsure about the safety of consuming harvested fish or game, with 27% of respondents saying they "don't know" about this aspect of water quality.

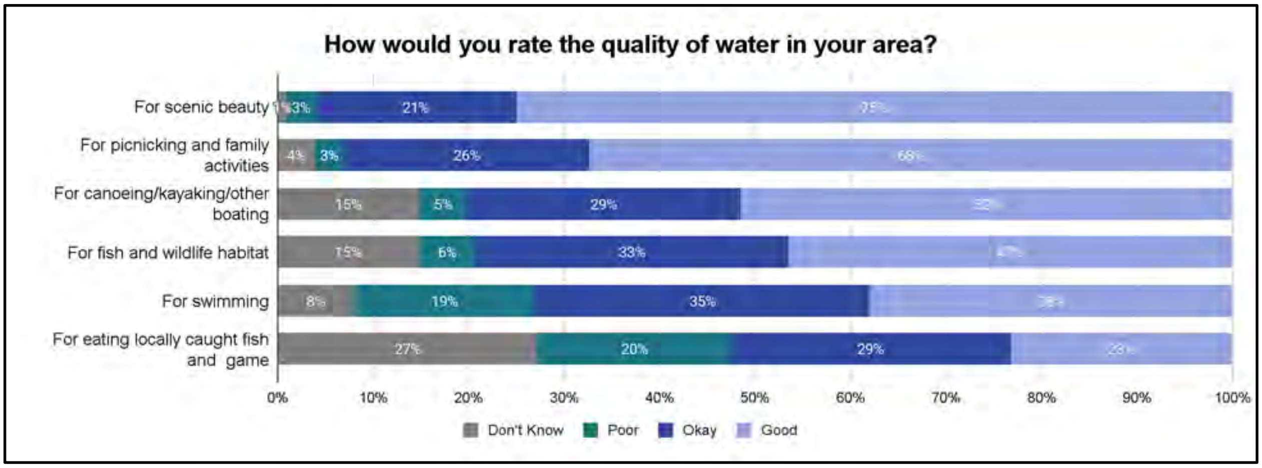

Figure 7.2 Perceptions of water quality
Data Source: Buday, 2021
Date Prepared: 2021

7.2.3 Water Quality Impairments

Perception of Pollution Types and Sources

The survey asked respondents to evaluate the extent to which they believe various water quality impairments, sources of water pollution, and consequences of poor water quality are a problem in the Macatawa Watershed. In Figure 7.3, each measure used a four-point Likert scale with answer options ranging from "not a problem" (1) to "severe problem" (4). Higher scores therefore represent a greater level of concern about a particular pollutant, and its contributors and consequences. Additionally, respondents could report that they "don't know" how much of a problem each issue is in the watershed.

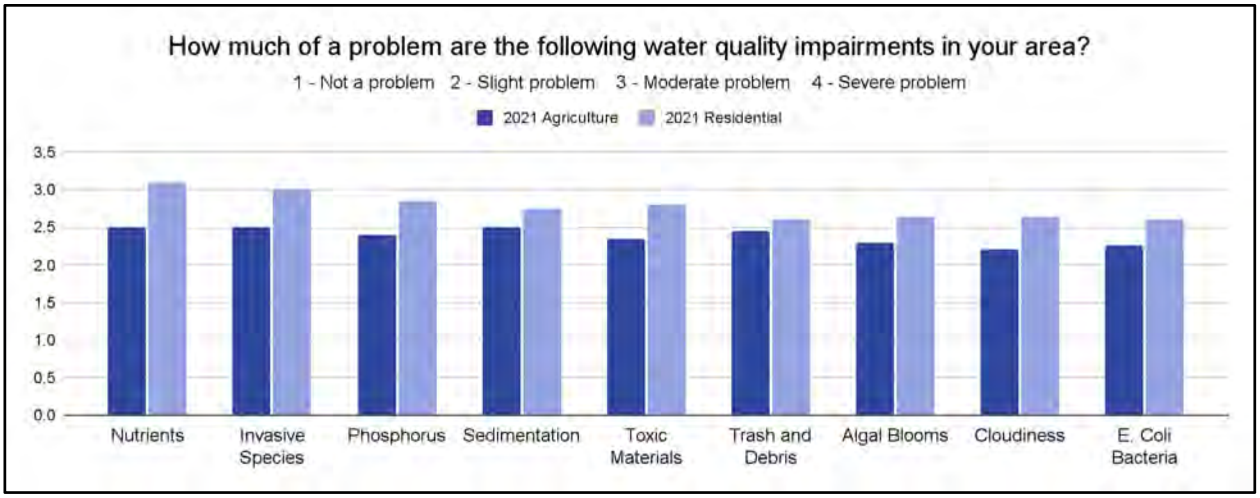

Figure 7.3 Perception of pollution types
Data Source: Buday, 2021
Date Prepared: 2021

Figures 7.4 and 7.5 compare the mean scores on these three sets of items for respondents to the 2010 agricultural survey, the 2021 agricultural survey, and the 2021 residential survey. To facilitate comparison, the 2021 survey used language consistent with the 2010 survey. Respondents perceived all nine water pollutants as representing a slight-to-moderate problem in the watershed (Figure 7.5). Compared to the 2010 study, 2021 agricultural respondents reported similar levels of concern about each pollutant, with 2021 mean scores for concern about phosphorus (2.4), the cloudiness of water (2.2), and the presence of *E. coli* bacteria (2.2) being slightly lower than in 2010. Residential respondents to the 2021 survey evaluated each impairment as more severe than either agricultural respondents from the 2010 or 2021 survey. This was particularly true for nutrients from fertilizers, invasive aquatic plants and animals, and toxic materials in the water. One exception was perceptions of problems associated with *E. coli* bacteria, for which the mean score for 2021 residential respondents was identical to 2010 agricultural respondents (2.6).

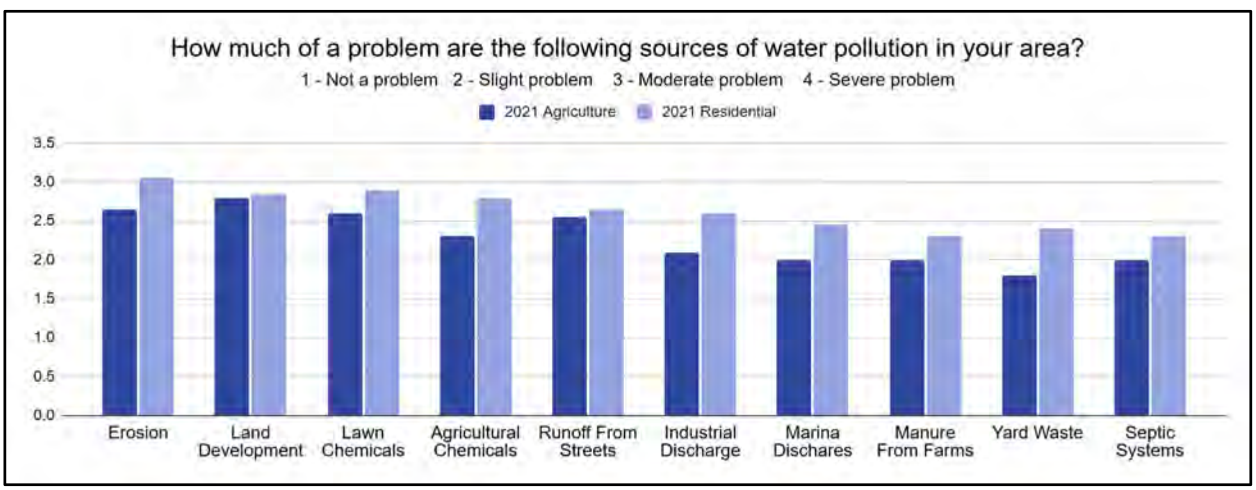

Figure 7.4 Perception of pollution sources
Data Source: Buday, 2021
Date Prepared: 2021

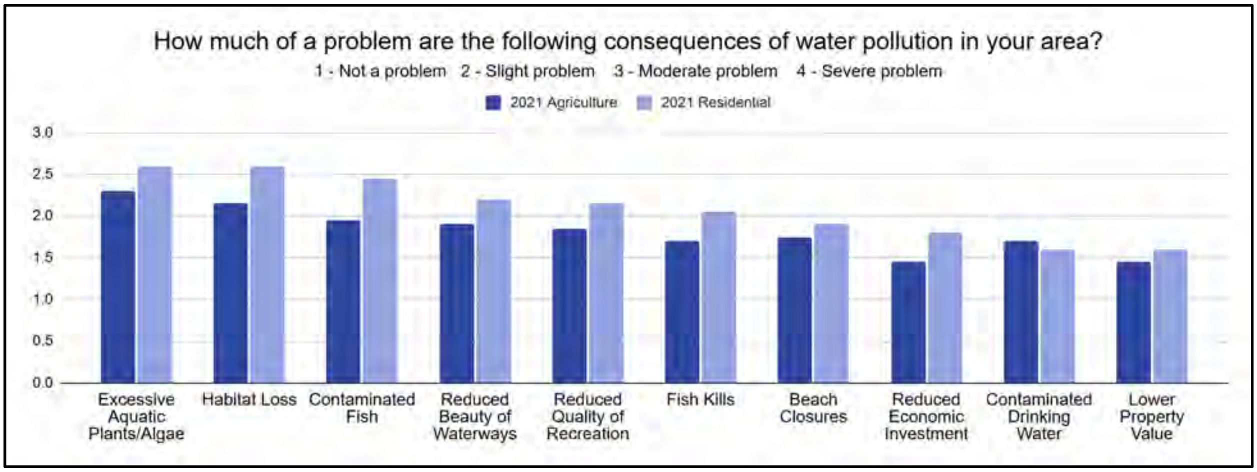

Figure 7.5 Perception of pollution consequences
Data Source: Buday, 2021
Date Prepared: 2021

More variation was observed concerning perceived sources of water pollution in the Macatawa Watershed (Figure 7.5). While mean scores on all ten items again remained consistently in the slight- to-moderate problem range, both 2021 agricultural and residential respondents were more concerned about pollutants contributed by soil erosion from shorelines and/or streambanks (2.7 and 3.1, respectively) than were 2010 agricultural respondents (2.3). This increase in concern likely reflects the mediating factor of record high water levels in Lake Michigan and other inland water bodies during the year preceding this study (2020). Likewise, concern about impacts associated with land development and an increase in impervious surfaces was slightly higher in 2021 than in 2010. The U.S. Census Bureau estimates that the population of Ottawa County increased 11.7% during this decade, making Ottawa County the fastest growing county in Michigan. The survey data suggest that some respondents are concerned about the impacts of this rapid growth and development in the watershed.

Perception of Pollution Consequences

Respondents in 2021 were also slightly more concerned about pollution from agricultural fertilizers and/or pesticides than were respondents in 2010, with residential respondents evaluating this source of pollution as more problematic (M=2.9) than agricultural respondents (M=2.3). It is possible that educational messages communicated to residents from 2010-2021 are raising awareness about the impacts of nutrients in the watershed. Evaluations for most other sources of pollution were consistent with the pattern of responses observed for pollution types, with agricultural respondents in 2021 slightly less concerned than respondents in 2010, and residential respondents as concerned or more concerned than 2010 respondents.

Respondents were additionally asked to evaluate most consequences of pollution as either not a problem or a slight problem in the watershed. Respondents in 2021 were most concerned about algal blooms, habitat loss, and impacts to fish populations, with mean scores reaching into the “slight problem” range, particularly for residential respondents. Respondents were least concerned about reduced economic investment, contaminated drinking water, and lower property values in the watershed, with mean scores for these items falling into the “not a problem” range. Again, for most consequences, mean scores for agricultural respondents in 2021 are equal to or lower than those of the 2010 agricultural respondents, with 2021 residential respondents reporting more concern about every pollution consequence than 2021 agricultural respondents. One exception is contaminated drinking water, which has been a topic of focus in Ottawa County due to aquifer depletion and chloride contamination that are impacting rural and exurban well water.

In addition to evaluating which pollutants are of greatest concern to watershed residents, it is important to review the impairments, pollution sources, and consequences of poor water quality that respondents were unable to assess due to a lack of knowledge or experience. Substantial proportions of survey respondents said they "don't know" how much of a problem most water quality impairments are in the watershed. Residential respondents were less sure about most pollutants and their sources and consequences than agricultural respondents were. Specifically, 30-50% of all respondents did not know how much of a problem toxic materials, phosphorus, or *E. coli* are in the watershed, suggesting that invisible chemical impairments are harder for all watershed residents to evaluate. Respondents were better able to evaluate the severity of pollutants that have a visible presence in the watershed, such as trash and debris, the cloudiness of the water, and sedimentation.

7.2.4 Awareness and Use of Best Management Practices

To evaluate awareness about and use of best management practices (BMPs) among Macatawa Watershed property owners, the survey asked respondents about several practices known to protect and improve water quality. Owners of residential properties were presented a list of eight BMPs typically associated with household impacts to watersheds. The items in the list were measured with a four-point Likert scale ranging from "never heard of it" to "currently use it," with intermediate categories indicating that respondents are "somewhat familiar with it" and that respondents "know how to use it; [but are] not using it." Respondents could also indicate that a BMP was "not relevant" for their property.

Residential Experience with BMPs

Survey respondents reported high levels of familiarity with and use of several BMPs important for reducing nonpoint source pollutants from residential properties (Figure 7.6). Seventy-five percent of residential respondents said that they currently keep grass clippings and leaves out of roads and/or ditches near their home, 74% take care to dispose properly of household wastes, and 68% avoid over applying nutrients by following the manufacturer's instructions when fertilizing their lawn or garden. A large proportion of respondents also reported properly disposing of pet waste, with 48% saying that they currently use this practice.

Concerning target areas for improving residential BMP implementation, 47% of respondents said that they had never heard of using a nature-based solution to manage stormwater. Only 6% of respondents (n=14) are currently using this practice. Forty-eight percent (48%) of residential respondents had never heard of or were only somewhat familiar with conducting regular soil tests. Thirty-five percent (35%) had limited knowledge on implementing water conservation practices in outdoor watering. Additionally, 68% of residential respondents said that they had never heard of or were only somewhat familiar with maintaining a vegetated streambank or shoreline on riparian zones.

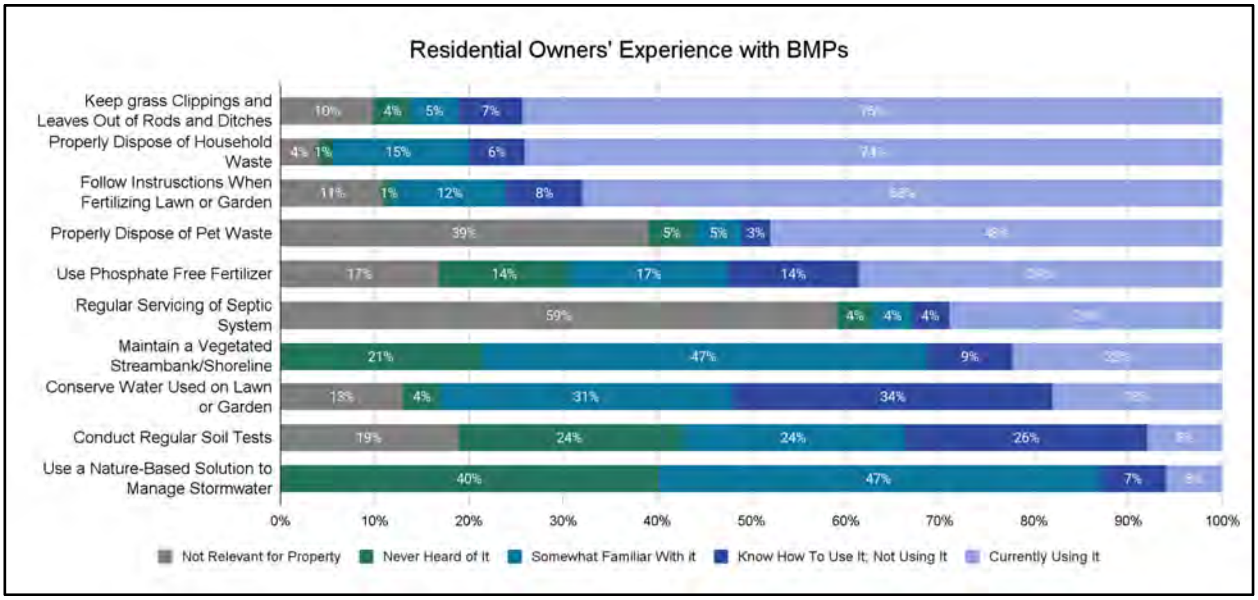

Figure 7.6 Residential respondents' use of water quality BMPs
Data Source: Buday, 2021
Date Prepared: 2021

The survey contained follow-up questions for BMPs of particular interest to future planning in the Macatawa Watershed. For residential respondents, this included vegetated streambanks and using a nature-based solution (NBS) to manage stormwater. While larger proportions of respondents report currently maintaining a vegetated streambank than using an NBS, more respondents are willing to try implementing an NBS, indicating a potential opportunity going forward. Forty-nine percent of residential respondents (n=110) are willing to try an NBS, compared to the 28% of riparian residential property owners who are willing to try vegetating their streambanks or shorelines.

Additionally, residential property owners expressed interest in participating in a cost- share program that would require a one-time, flat fee to match a grant for implementing NBS projects. Two-thirds would probably or definitely contribute $25- $50, half would pay $100, and an additional third would pay $200. Less than one-quarter of all respondents would pay $300-$500. When asked about factors limiting their implementation of BMPs (Figure 7.7), residential property owners cited lack of information about practices as the top-ranking barrier to reducing their footprint in the watershed, followed by the cost of implementation. Forty percent of respondents or more said that physical abilities, lacking social ties to people who are using the practice, doubting the efficacy of the practice, or access to equipment were not at all a reason that they could not implement a practice.

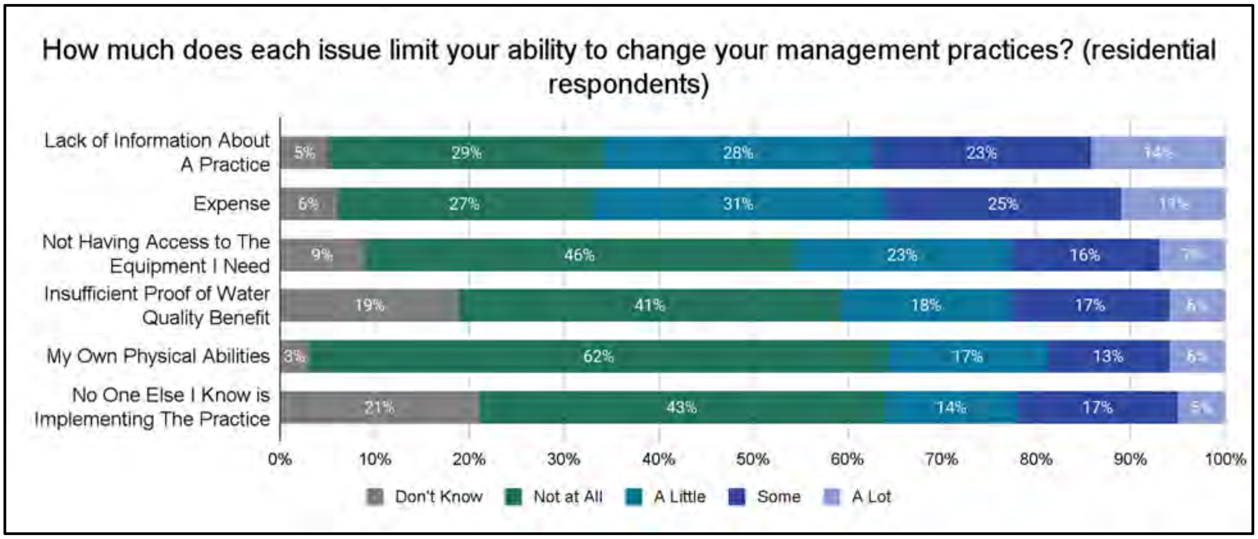

Figure 7.7 Barriers to implementing BMPs, residential respondents
Data Source: Buday, 2021
Date Prepared: 2021

Agricultural Respondents

Agricultural respondents likewise reported engaging in a wide range of activities important for maintaining good water quality. Grassed waterways and cover crops are also commonly used in the watershed, with 57% and 54% of respondents saying they currently use these BMPs, respectively. Fifty-three percent of agricultural property owners are conducting soil tests on a regular basis, 50% use no-till in their row-crop production, and 49% maintain a vegetated streambank or shoreline. For agricultural property owners, practices that are not widely used have large proportions of responses indicating that they are not relevant rather than that they are not known about. Of those BMPs agricultural property owners had less familiarity with, maintaining a vegetated streambank or shoreline stands out, with 41% saying that they did not know anything or very much about this management practice.

As with residential owners, the survey asked agricultural respondents follow-up questions about their use of vegetated streambanks, regular septic servicing, and use of cover crops. Figure 7.8 compares agricultural respondents' willingness to implement these practices. Only a small minority of agricultural respondents are not at all interested in trying any of the BMPs asked about – 12% or fewer across all items. Most respondents indicated that they are already using these BMPs. Interest in cover cropping is particularly impressive, with those saying they are willing to try or are already implementing this practice increasing 63% from 2010 to 2021. The greatest opportunity for further adoption appears to lie with implementing vegetated streambanks. Forty percent of agricultural respondents said that they might be or are willing to try planting vegetated buffers.

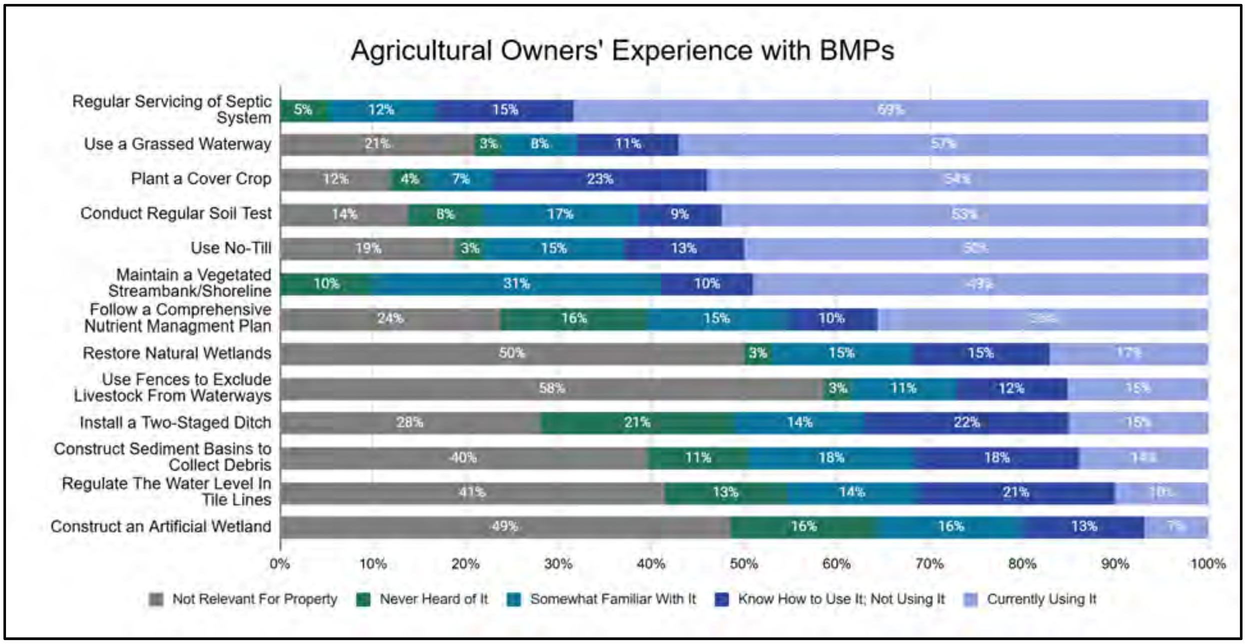

Figure 7.8 Agricultural respondents' use of water quality BMPs
Data Source: Buday, 2021
Date Prepared: 2021

When asked about factors limiting their implementation of BMPs (Figure 7.9), agricultural property owners cited the expense of adoption as the top-ranking barrier, followed closely by requirements and restrictions of government-sponsored conservation programs and lack of information about BMPs. Expense was also reported as the factor explaining "a lot" of the reason that agricultural respondents are limited in implementing vegetated streambanks (23%), regular septic servicing (12%), and cover crops (28%). When it comes to planting cover crops, lacking equipment is a problem for 20% of respondents. Notably, 74% of respondents said that lacking information about cover cropping was not at all a problem, and 71% said that the desire to keep things the same was not at all a problem. This suggests that Macatawa farmers are knowledgeable about the benefits of cover cropping and see it as a valuable component of conservation agriculture but may benefit from access to cost sharing or equipment rentals.

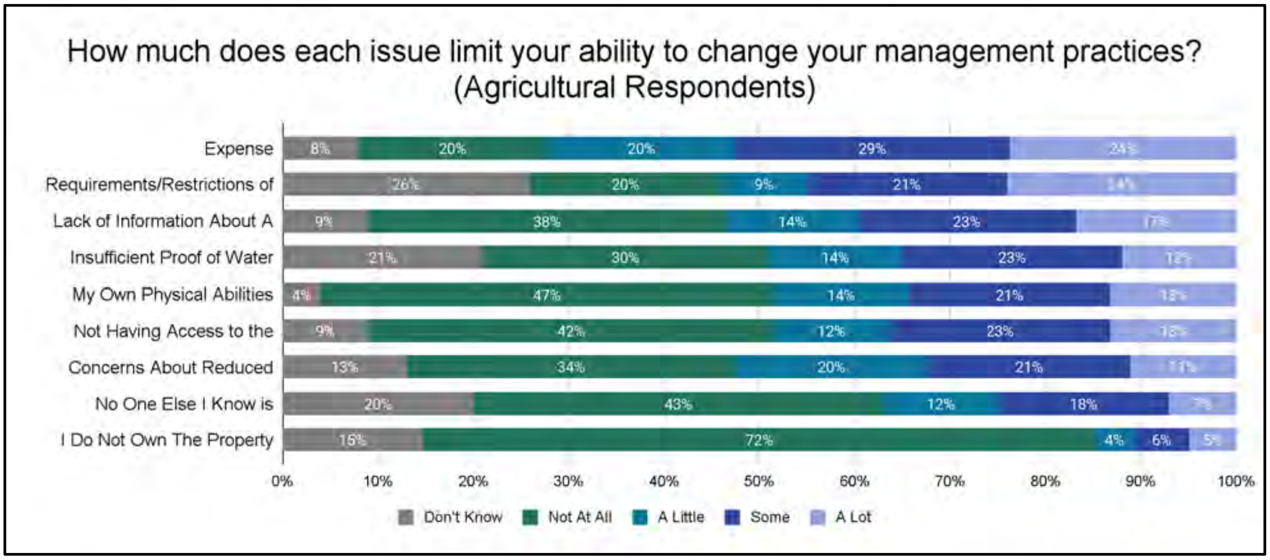

Figure 7.9 Barriers to implementing BMPs, agricultural respondents
Data Source: Buday, 2021
Date Prepared: 2021

7.2.5 Watershed Knowledge and Information Sources

To develop effective communication strategies and identify knowledge gaps, the 2021 watershed survey asked respondents where they commonly seek information and used questions about watershed terminology from previous surveys, for comparison. Because of their focus on urban stormwater, the terminology questions were presented to residential property owners only, while general questions about the information sources and networks that respondents are connected to were asked on both the residential and agricultural surveys. All property owners were also asked a series of questions about their engagement and satisfaction with Project Clarity initiatives.

Self-Assessment of Watershed Knowledge

When asked to reflect generally on the extent to which they stay up to date on issues of concern to the Macatawa Watershed, respondents to the 2021 survey (both residential and agricultural respondents) reported feeling informed at levels consistent with past waves of polling. Further, when asked if they could explain what a watershed is, residential respondents in 2021 reported similar rates of confidence in defining this term as respondents did in 2007 and 2014. Some improvements are evident in residents' knowledge about what stormwater is and where it ends up after entering a storm drain.

Project Clarity's name recognition is growing in the watershed. Forty-six percent of all 2021 survey respondents had heard of Project Clarity, compared to only 26% in 2014. Most of this increased recognition is associated with respondents seeing Project Clarity signs in the watershed – 34% of all respondents have seen Project Clarity signage. Agricultural respondents are engaging directly with Project Clarity, with 22% reporting that they have received funding to implement water quality BMPs on their properties. With active engagement in the project being so low, it follows that roughly two-thirds of respondents could not evaluate the impacts Project Clarity is having, answering that they "don't know" how much Project Clarity is improving various conditions in the watershed.

When asked about how much they trust various sources for information about water quality, the Macatawa Watershed Project and MSU Extension ranked as moderately or very trusted sources of information by nearly 70% of respondents. Of note in Figure 7.10, 54% of respondents said they are "not familiar" with the ODC Network, and 41% were not familiar with Project Clarity, indicating opportunities for further marketing and outreach. Respondents were most skeptical about information from neighbors and friends, suggesting that many do value the expertise provided by local conservation organizations.

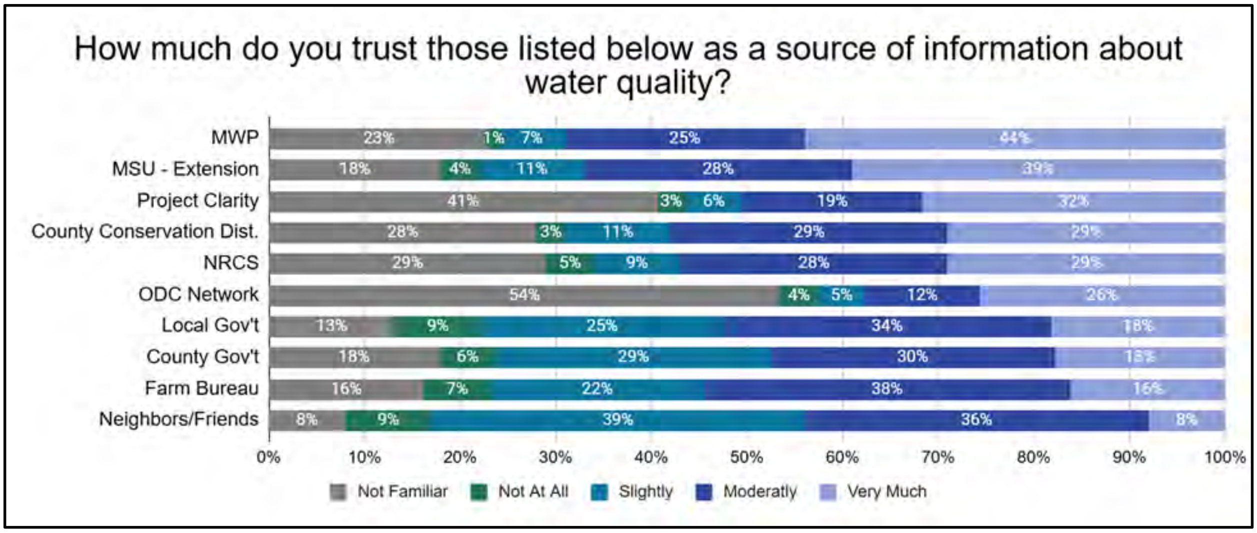

Figure 7.10 Trusted information sources
Data Source: Buday, 2021
Date Prepared: 2021

7.2.6 Recommendations and Conclusions

The importance and value of watershed health expressed by survey respondents suggest that water resources are a large attraction drawing residents to the Macatawa Watershed. Whether for recreational, entrepreneurial, or agricultural pursuits, good water quality supports a high standard of living and thus inspires residents to contribute – through their actions and their generosity – to efforts to improve the watershed.

The 2021 Macatawa Watershed Residential/Agricultural Survey found that scenic beauty and recreation associated with family activities were particularly important to residents from all corners of the watershed. When constructing education/information messages, these highly valued aspects of water resources should be incorporated in framing strategies used to communicate the relevance and importance of suggested property management practices or new infrastructure installations.

When it comes to perceptions of pollution in the watershed, most respondents were better able to evaluate visible consequences of water pollution than the presence of chemical or biological impairments in waterways. Educational messaging should therefore work to provide residents with information explaining priority pollutants in the watershed, their common sources, and the consequences of these impairments. The communication strategy could incorporate a graphic or visual model that familiarizes residents with, a) the sources of priority NPS pollutants in the watershed, b) how they are transported into waterways, and c) the impact they can have on the watershed ecosystem. Developing a series of communications that can be inserted in water and utility bills, featured in electronic newsletters, or shared on social media may help circulate the information to new audiences.

Further, urban residents are generally more concerned about water pollution than rural and exurban residents. Social scientists have documented that “culture clash” can occur in regions experiencing rapid population growth from in-migration, as is the Macatawa Watershed. New residents bring different values and policy preferences that prioritize preserving natural resources for recreational use into areas where traditional land use policy has favored economic activities (e.g., agriculture or mineral extraction). Urban residents are unfamiliar with, and therefore have anxiety about, the impacts of agricultural practices, and farmers are squeezed between competing land uses.

In developing an educational strategy that can bridge this cultural divide, it will be important to work to unify different stakeholder groups so that they see themselves as part of the same team instead of members of competing teams. Methods for achieving this may include:

- Holding public workshops that bring together urban and rural residents to collaborate on developing an advertising, education, or BMP implementation campaign.
- Acknowledging and celebrating efforts both stakeholder groups are already making to improve water quality in the watershed
- Ensuring that the benefits and burdens of policies and resource investments are equitably dispersed across urban and rural communities within the watershed
- Emphasizing that environmental and economic goals are complementary, rather than competing, priorities

Consistent with the high value of water resources expressed by survey respondents, many also reported using a wide range of BMPs to improve and protect water quality. However, the survey results identified opportunities for improvement in several key areas. For urban and suburban residents, priorities should include:

- Using nature-based solutions to manage stormwater runoff
- Conducting regular soil tests to determine if chemical lawn treatments are necessary
- Installing water-efficient household appliances and reducing water used on outdoor landscaping by watering outside of peak evaporation times, watering deeply and infrequently, installing drip irrigation, or using grey water
- Overcoming conservation knowledge limitations

For rural and exurban residents, BMP priorities should include:

- Effective installation and maintenance of vegetated stream buffers
- Targeted analysis to identify and develop relationships with landowners who have potential for implementing wetland restoration, stormwater retention structures, or livestock exclusion fencing
- Overcoming financial and equipment limitations

Given the low levels of confidence survey respondents (residents) expressed in federal and state governance, public messaging for BMP campaigns should emphasize local partnerships and clarify the services that local conservation organizations can provide in navigating regulatory and reporting processes associated with grant programs. Note: federal and state representatives were not included in the survey, and these results only reflect the opinions of the public.

The 2021 watershed survey results underscore the growing importance of digital communication networks, but in-person communication remains important for rural and exurban residents. Using diverse mediums for outreach targeted to the intended audience will increase the effectiveness of communication strategies. Holding public meetings and community events at a variety of times or piggybacking them on existing meetings of environmental or agricultural organizations may help increase active engagement with Project Clarity and recognition of the ODC Network.

Finally, many watershed residents who cannot participate in community events may be willing to donate to water quality initiatives if provided compelling information about current projects, goals, and outcomes of existing efforts to improve the Macatawa Watershed. Many survey respondents requested more details about how Project Clarity funds are spent and how their donations would be used, indicating that they would need this information to be able to decide whether they would make a charitable contribution. The responses of some individuals also indicate confusion about how Project Clarity has been funded to-date; several respondents said they were not interested in donating because they are already overtaxed, but Project Clarity has relied primarily on donations rather than tax revenues. Adding clarity to the project's mission, accomplishments, and existing resources in future communications will help increase residents' confidence and willingness to contribute.

7.4 Goals of the I&E Strategy

The purpose of this I&E Strategy is to effectively disseminate information to garner support of the overall goals of the watershed management plan, determined from the analysis of the 2021 Macatawa Watershed Residential/Agricultural Survey in combination with updated water quality monitoring data. Targeted messages will be created for residents, producers, and business owners within the Macatawa Watershed to promote green stormwater infrastructure, agricultural BMPs, and the Macatawa Greenway natural spaces. To enact this I&E strategy, there are three overarching goals that should be followed:

Objective 1: Encourage community members to adopt sustainable practices that restore water quality to meet state water quality standards, such as reducing fertilizer use, properly disposing of waste, and minimizing stormwater runoff, to help improve water quality in Lake Macatawa, the Macatawa River, and its tributaries.

Objective 2: Inspire individuals through community education and outreach to actively conserve and restore protected natural spaces by planting native vegetation, practicing no trace principles, and supporting land preservation efforts to improve water quality and ecosystem health.

Objective 3: Enhance the Macatawa Watershed for desired community uses by supporting residents to engage in responsible recreation, advocate for public access points, support fish and wildlife habitat conservation, protect open spaces, and educate residents on groundwater recharge and protection to create resilience within the Macatawa Watershed.

To accomplish these goals, the I&E plan will work to unify stakeholders throughout the Macatawa Watershed so that residents, whether they are urban, rural, or exurban, are aware of local water quality issues and actions that can be taken to improve water quality.

7.5 Implementation of the I&E Strategy

Implementation of the I&E strategy will be the responsibility of ODC Network (lead partner), watershed groups, municipalities, and other stakeholders in the watershed. The lead partner will help coordinate efforts, grants, resources, and recommended programs. Other partners that will support implementation of the I&E program as required under the State of Michigan's MS4 Stormwater Permit include the City of Holland, the City of Zeeland, Ottawa County, Allegan County, the Ottawa County Road Commission, and the Allegan County Road Commission.

Outreach typically occurs in two phases: Awareness and Education, followed by Action. Before any behavior change can happen, stakeholders need a solid understanding of water quality issues, their consequences, and potential solutions. The action phase focuses on the steps necessary to alter behaviors. Below is a summary of the objectives for each phase.

- **Awareness and Education Objectives:** Educate the target audience about their watershed, the pollutants impacting it, and the ways various activities affect water quality. Inform them about recommended actions and BMPs (Best Management Practices) to reduce these impacts, highlighting how environmental and economic goals can complement each other. Provide resources such as information, technical support, equipment, details about financial assistance programs, and organize demonstrations on BMP implementation.
- **Action Objective:** Offer in-depth technical assistance on "nature-based solutions" to encourage the adoption of practices that improve water quality. Collaborate with stakeholders to integrate protective actions into regulatory frameworks, policies, land-use planning, and management decisions.

The 2021 Macatawa Watershed Residential/Agricultural Survey found that respondents said they “don’t know” how much of a problem most water quality impairments are in the watershed. Those in urban areas reported primarily using the internet and newsletters/brochures/factsheets to seek information about their watershed. Those in rural areas reported getting information about the watershed primarily from conversations with others and newsletters, brochures, or factsheets. This suggests that online campaigns will be an effective mode of communication of urban residents and face-to-face events or mailers will be effective for rural residents. Radio ads should largely be avoided, as respondents to the survey reported using this method of information collection very little.

Many events occur annually throughout the Macatawa Watershed and the local West Michigan area. These present an opportunity to implement I&E messaging through direct contact with residents and farmers in the area. These events include the Macatawa Water Festival, the Cultivating Resilience Field Day, the Ottawa County Water Quality Forum, and ongoing community events like the Holland Farmers Market and the Zeeland Pig Out. Efforts should be made to procure a booth or speaking time at these events to deliver educational messaging related to the Macatawa Watershed.

7.6 Target Audiences

Effective I&E messaging should reach the stakeholders within the community who can affect the most change to management practices that are causing pollution. The target audiences include:

- Farmers/agricultural landowners
- Residents (churches, environmental advocacy groups, recreational users, etc.)
- Local government (cities, townships and counties)
- Schools
- Business/Commercial Landowners (Lawn Care and Landscaping companies, marinas, etc.)

7.7 Regional Collaboration and Partnerships

Survey respondents (residents) expressed a lack of confidence in federal and state governance, emphasizing that local partnerships are essential to the success of the I&E strategy. Watershed staff, MSU Extension, Conservation Districts, and NRCS were identified as the most trusted sources of water quality information. These stakeholders will be key in driving outreach efforts. In terms of the ODC Network and Project Clarity, awareness has increased from 74% unaware in 2014 to 54% unaware in 2021, signaling progress in building trust within the community. However, many respondents were uncertain about the effectiveness of Project Clarity in improving watershed conditions, highlighting the need for greater public recognition, such as participating in events alongside trusted sources.

Several other partners should be involved in future implementation efforts of the I&E strategy:

Grand Valley State University's Department of Sociology and its **Social Science Lab** played a key role in developing the I&E strategy, particularly by leading the 2021 Macatawa Watershed Residential/Agricultural Survey. Moving forward, GVSU should be involved in any follow-up social surveys to assess the effectiveness of the I&E strategy as it is implemented.

Several departments within **Ottawa County** government will be essential partners in advancing policy changes and supporting I&E messaging. The Water Resources Commissioner, Department of Strategic Impact, and the Department of Public Health are valuable resources for connecting with policymakers and other governmental bodies. The Parks and Recreation Department, which leads the management of the Macatawa River Greenway, and the Agricultural Preservation Board, which advocates for the conservation of agricultural lands, should also play an active role in these efforts.

ODC Network and partner organizations are already in regular contact with the leadership of each of the **major cities and townships** in the watershed. Regular conversations with staff, board members, and trustees are helpful for making key connections, while contributing information to city/township newsletters helps to highlight ongoing watershed work.

The Macatawa Watershed contains a diverse array of agricultural uses, including blueberries, greenhouses, vegetables, poultry, hogs, and cattle. **MSU Extension** has a plethora of information and experts available to provide technical assistance in water resource protection for each of these forms of production.

There are several **other organizations** who will be important partners in the implementation of the I&E strategy. The organizations identified below are recommended as partners in implementing the WMP and parts of the I&E strategy.

- Hope College Global Water Resources Institute
- Grand Valley State University Annis Water Resources Institute
- Macatawa Area Coordinating Council
- MAX Transit
- Local businesses/industry
- Local churches
- Local schools
- Allegan Conservation District
- Ottawa Conservation District
- Groundswell
- Michigan Natural Shoreline Partnership

- West Coast Chamber of Commerce
- West Michigan Sustainable Business Forum

Many organizations already have programs that focus on improving water quality through NPS pollution control or preservation. These programs should be highlighted during the awareness and education phase and promoted throughout the action phase of the strategy.

The development of this WMP helped strengthen existing partnerships and foster new ones. The ODC Network led project coordination, with significant contributions from various partners. Notably, the GVSU Social Science Lab played a key role in developing, distributing, and analyzing the SIDMA survey and should remain involved in the I&E strategy. Future monitoring efforts to assess the strategy's effectiveness should leverage the established partnership with GVSU. GVSU's AWRI was also crucial, conducting chemical monitoring. Partners should be informed when the WMP is approved to assess their willingness to assist in implementing the I&E strategy.

7.8 Information and Education Messages

7.8.1 Opportunities

There are several opportunities in the Macatawa Watershed to provide more robust messaging about pollutants, cultural changes that reduce pollution, and emerging environmental consequences. Information about the major pollutants (*E. coli* and P) need to be addressed as there appears to be some disparity between perceived problems and documented issues. Different messages will need to be developed for urban and rural residents when it comes to addressing the variability of limited resources to implement BMPs between these two demographics. To the extent possible, all I&E strategy messaging should be catered to the specific audience. I&E messages should center on known pollutants and inform Macatawa Watershed respondents on mitigation strategies and resources available to overcome constraints. Due to survey respondents' connection to the watershed for recreation uses, the necessity of implementing BMPs in urban and agricultural settings to protect and improve the recreational quality of the Macatawa Watershed is a key message. Furthermore, cost savings that can be achieved by BMP adoption should be emphasized in I&E messaging.

7.8.2 Pollutants

The survey results indicated that Macatawa Watershed residents marked "Don't Know" for a significant number of options concerning pollution types, pollution sources, and pollution consequences. Many respondents lacked confidence in evaluating the presence of invisible pollutants in area waterways, with more than 35-50% of respondents saying they "don't know" how severe pollution from phosphorus, *E. coli* bacteria, and toxic materials are in the watershed. Residential respondents were more unsure about the presence of almost all pollutants than were agricultural respondents, indicating a particularly great need for outreach to this group.

Among the pollutants, it is particularly concerning that bacteria and viruses (i.e. *E. coli*), as well as phosphorus, were either not seen as a problem in the Macatawa Watershed or respondents did not know whether this pollution is an issue or not. Monitoring efforts for this plan indicate *E. coli* is a pollutant throughout the watershed, and the Macatawa Watershed falls under the statewide *E. coli* TMDL. Information needs to be provided on sources of *E. coli* and why it is harmful to the watershed. Residential homeowners need to be made aware of the effects of pet waste and failing septic systems, and agricultural producers need information on BMPs for manure management and storage for livestock.

Approximately 50% of residential respondents “didn’t know” if phosphorus pollution was a problem in the Macatawa Watershed, indicating that many residents may not recognize that these chemicals are present in lawncare products. High amounts of phosphorus in these conventional household products may be contributing to high phosphorus loads in the Macatawa Watershed, even though the Michigan Fertilizer Law (1994 PA 451, Part 85, Fertilizers) restricts the use of phosphorus fertilizers on residential and commercial lawns. There are a few exceptions to this law where phosphorus fertilizers are allowed, which means these fertilizers are still accessible to residents for purchase in stores. Messaging and education about the current restrictions and their purpose for protecting water quality to residents will be necessary. Excessive phosphorus most notably contributes to algal blooms, excessive plant growth, and decreased oxygen levels, all of which can have significant impacts on both warm and cold-water fisheries. These impacts and the source of pollutants causing these problems need to be communicated to Macatawa Watershed residents, particularly those who own residential properties in the watershed. 60-70% of all respondents marked “Don’t Know” to the following categories, when asked if they believe project Clarity is improving the following conditions in the watershed: recreation opportunities, P levels in the water, public awareness and education, agricultural management practices, fish and aquatic habitat, cloudiness of the water, streambank erosion, algal blooms in the water, and stormwater management. Increasing Project Clarity’s visibility, accomplishments, and ongoing work will be key in educating all residents on pollutants and all stakeholders in their communities working to address these conditions.

Residential respondents marked “Don’t Know” about many rural sources of pollution such as septic systems, manure from farms, and agricultural chemicals. Agricultural respondents marked “Don’t Know” for many urban sources of pollution such as industrial and marina discharge. Both urban and rural residents were almost equally unsure about yard waste as a pollution source. This indicates a need to educate each target audience on the challenges each land use faces, to ensure that the watershed can undertake comprehensive solutions that better target the challenges each residential area faces in implementing BMPs.

Many survey respondents marked that fishing was not a high priority use in the watershed, but fishing is a frequently witnessed activity. Many pollutants accumulate in the flesh of living organisms, including polychlorinated biphenyls (PCBs), dioxins, mercury, and perfluorooctanesulfonic acid (PFOS). Bluegill, carp, freshwater drum, largemouth and smallmouth bass, sunfish, walleye, and yellow perch all have consumption limits under the Eat Safe Fish Guide developed by the State of Michigan. Messaging is needed around the health and safety of fish consumption in the watershed, especially in conjunction with stakeholders encouraging the public to recreate and engage with the watershed.

7.8.3 Urban and Rural Best Management Practices

Urban/residential respondents and rural/agricultural respondents reported different experience levels with and barriers to implementing practices. Different messaging and alternative resources should be developed and provided to these two demographics. For residential respondents, 87% marked that they were either somewhat familiar or not at all familiar with the BMP to “use a nature-based solution to manage stormwater”, 68% marked that they were either somewhat familiar or not at all familiar with the BMP to “maintain a vegetated streambank/shoreline”, and 48% marked that they were either somewhat familiar or not at all familiar with the BMP to “conduct regular soil tests.” Lack of information about a practice and expense were the two biggest barriers that residential respondents reported for changing their management practices. This indicates a need for online messaging to target these specific issues and any current or future funding sources that may help residents address cost barriers to implementing.

For rural/agricultural respondents, 43% marked that they were either somewhat familiar or not at all familiar with the BMP “Maintain a vegetated streambank/shoreline”, 35% were somewhat familiar or had never heard of the BMP to “Install a two-staged ditch”, and 32% were somewhat familiar or had never heard of the BMP to “Construct an artificial wetland.” Agricultural respondents marked that expense, requirements/restrictions from government programs, and lack of information about a practice were the biggest barriers to changing their management practices. This indicated a need to have in-person field days and other face-to-face events to show in-field demonstrations of BMPs and allow farmers to discuss how they achieved these management changes.

Both rural and urban respondents marked a lack of knowledge with the BMP to “Maintain a vegetated streambank/shoreline,” indicating a high priority to tailor messaging across digital and physical marketing about this practice. Both rural and urban respondents also reported cost as one of the biggest barriers to implementing BMPs, pointing to the importance of communicating information about cost sharing programs in the watershed. In addition, messaging about the long-term cost savings and the ability of implemented BMPs to address resource concerns will allow residents to more easily justify the cost of BMPs.

7.8.4 Habitat Loss and Land Development

Both urban and rural residents marked that land development was a moderate problem for a source of water pollution in the watershed, and urban residents marked that erosion was another significant problem and habitat loss was a moderate consequence of water pollution. The Macatawa Watershed has significant commercial/industrial landowners, and residency in Ottawa County is continuing to expand. Messaging on the best practices to reduce erosion and sedimentation during times of construction and landscape establishment, as well as how to establish nature-based solutions for managing stormwater will be key in helping the community adopt cultural practices that allow for growth and protect the watershed.

7.8.5 Communication Strategy

There are substantial differences between what has been shown to impact the Macatawa Watershed and what residents of the watershed believe are major concerns. A comprehensive communication strategy will be essential to implementing the I&E strategy. Some aspects of the survey will be more critical to inform residents about than others. For example, many of the agricultural respondents reported they are already using cover crops, reducing the urgency of further communication about this practice. However, maintaining a vegetative buffer along a streambank or shoreline was not a commonly implemented BMP for either agricultural or urban respondents, pointing to an area of potential opportunity for future outreach. Communication needs to take place using a diversified approach including many different mediums. Internet communications, including social media and e-newsletters, appear to be well used among residential property owners in the Macatawa Watershed. An especially effective form of communication for agricultural property owners is in-person conversations. Efforts should be made by partners to recruit residents to local events or workshops where information specific to the Macatawa Watershed will be available. Other effective in person forms of communication could come from door-to-door visits, attendance at township board meetings, and attending other local events in the community.

Messages will all directly support encouraging behavior changes that will help achieve the overall goals of the WMP, but as seen in the results of the social survey, there is a cultural divide in the watershed between residents in urban and agricultural areas. The I&E strategy will work to address the priorities of urban groups, including using nature-based solutions to manage stormwater runoff, conducting regular soil tests to determine if chemical lawn treatments are necessary, installing water-efficient household appliances and reducing water used on outdoor landscaping by watering outside of peak evaporation times, watering deeply and infrequently, installing drip irrigation, or using grey water, and overcoming conservation knowledge limitations.

For rural and exurban residents, BMP priorities should include effective installation and maintenance of vegetated stream buffers, targeted analysis to identify and develop relationships with landowners who have potential for implementing wetland restoration, stormwater retention structures, or livestock exclusion fencing, and overcoming financial and equipment limitations.

While endeavoring to address the priorities of each group, the I&E plan will also work to ensure all residents of the watershed feel they are members of the same team as opposed to working against each other. Potential methods for achieving this may include holding public workshops that bring together urban and rural residents to collaborate on developing an advertising, education, or BMP implementation campaign, acknowledging and celebrating efforts both stakeholder groups are already making to improve water quality in the watershed, ensuring that the benefits and burdens of policies and resource investments are equitably dispersed across urban and rural communities within the watershed, and emphasizing that environmental and economic goals are complementary, rather than competing, priorities.

7.8.6 Further Information Needed

Future surveys may be needed to gather more information about Macatawa Watershed residents' level of knowledge and concern for some watershed related topics. Many residents reported excessive aquatic plants/algae as a larger problem than reduced quality of recreation, while also reporting that scenic beauty was of high quality in the area but swimming and eating locally caught fish and game were not as high quality. Those would seem like contradictory views without further community input. Additionally, which species of fish are considered locally important is not known.

Residents noted that swimming and fishing were not that important to them, but also that local water quality was not great for these activities. Further information is needed to determine if the perception that if the water is not high enough quality for those activities means people do not get attached to them and therefore do not believe their importance. Would there be more community importance and passion for these forms of recreation if residents knew it was safe and healthy?

Additionally, many residents marked that the Macatawa Watershed Project is their most trusted source of information about water quality, although interestingly, this project has not been active for three and a half years as it was absorbed into Project Clarity in 2021. This indicates that additional, consistent messaging is needed to continue to establish Project Clarity and all associated stakeholders as the leading trusted source of information about water quality in the watershed.

Future inquiries into the use of household lawn products should be made. Special attention should be paid to product labeling and proper use instructions. Where possible, recommendations to companies for ways to improve product labeling should be made to ensure proper use and handling by the public. Efforts should be made to educate residents about the benefits of native plantings and rain gardens, particularly near riparian zones, as both result in long-term reduction of inputs from lawn upkeep and reduced water use.

Using the social survey results, key general messages have been developed and are listed in Table 7.2. Messages intended for target audiences will be based on the goals and objectives previously listed in the WMP but should be customized and targeted for delivery. Estimated costs related to the general messages, proposed activities, and milestones identified in these tables will depend on several different factors. Potential costs incurred would likely include the wages of a staff person to coordinate messaging activities, costs for printed outreach materials, costs for workshops and field days, and potential costs for any additional website construction to promote both print and web-based communication. Costs are estimated at $50,000 per year.

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Table 7.2 An Information and education strategy for the Macatawa Watershed

Target Audience	Key Messages	Current Activities	Proposed Activities	Milestones/Timeline	Implementation Partners
Farmers	**Message**: Sediment and nutrient runoff from rural areas is contributing to poor water quality. **Message**: Maintaining vegetative streambank/shoreline buffers are a key BMP to filter out pollutants before they reach the waterway thereby reducing nonpoint source pollutants. **Message**: There are numerous local partners offering technical assistance and financial assistance to help farmers implement BMPs. **Message**: Clean water is important to maintain livestock health, improve public perception of modern agriculture and to preserve the resource for future generations. **Message**: Rural landowners and farmers can and should take actions to help prevent soil and nutrient loss from their property. **Message**: The watershed is polluted by nutrients, bacteria, and pathogens such as phosphorus, chloride, and *E. coli*. These are considered watershed pollutants because they pose a risk to human and ecological health.	- monitoring in rural areas of the watershed, including windshield surveys for spring residue and fall tillage practices - community presentations such as Cultivating Resilience and Farming Forward - providing cost share funding through Project Clarity for BMPs such as cover crops - monthly newsletter, social media pages, Project Clarity committee meetings, yearly conservation report	1. provide direct evidence of the harm chemical and nutrient runoff can pose to waterways through monitoring results 2. provide articles for township newsletters 3. flyers distributed at locations or events farmers attend 4. partner with Drain Commission staff to distribute educational materials in the field 5. partner with seed, fertilizer, or equipment companies to help distribute materials 6. attend or host regional field days	**Short term (1-3 years):** 1. Share monitoring results with farmers 2. Provide at least 1 article annually to all major townships in the watershed 3. Distribute flyers at community outreach events; explore options for speaking at events 4. Provide flyers to county drain offices 5. Schedule annual meeting with local agribusinesses to share project updates and provide materials 6. Continued partnership to host Cultivating Resilience and associated field days **Mid term (4-7 years):** 1. Continue sharing monitoring results with farmers; engage farmers in participating in monitoring 2. Provide at least 2 articles annually to all major townships in the watershed 3. Distribute flyers at community outreach events; provide brief presentations at select events 4. Continue providing materials to the county drain offices; explore ways to collaborate on farmer outreach 5. Continue annual meetings with local agribusinesses, seek ways to collaborate on farmer outreach 6. Continued partnership to host Cultivating Resilience and associated field days **Long term (8-10 years):** 1. Continue sharing monitoring results with farmers; farmers share monitoring data with ODC and other partners 2. Provide quarterly articles annually to all major townships in the watershed 3. Distribute flyers at community outreach events; provide presentations 4. Continue providing materials to the county drain offices; engage in active farmer outreach (e.g. attend meetings, give presentations) 5. Continue annual meetings with local agribusinesses; engage in activities farmer outreach (e.g. attend agribusiness meetings, give presentations 6. Continued partnership to host Cultivating Resilience and associated field days	1. Hope College GWRI, GVSU-AWRI 2. Townships 3. CDs, MSUE, local agribusinesses 4. ACDC, OCWRC 5. Local agribusiness: Farmer's Co-Op, Nutrien Ag, Greenmark, etc. 6. OCD, ACD, MSUE, Ottawa County

Target Audience	Key Messages	Current Activities	Proposed Activities	Milestones/Timeline	Implementation Partners
Residents	**Message**: Lake Macatawa suffers from too much sediment, too many nutrients, and elevated levels of *E. Coli* bacteria. **Message**: Storm water runoff is the major source of sediment and nutrients to the Macatawa Watershed. **Message**: Storm water is not treated by the wastewater treatment plant which means your property contributes runoff to local waterways. **Message**: Applying fertilizer that contains phosphorus is banned in the State of Michigan. **Message**: Clean water is important so that your family can enjoy Lake Macatawa and stay safe and healthy. **Message**: Lake Macatawa empties to Lake Michigan which supplies the region's drinking water. **Message**: Every single resident in the Macatawa Watershed can make small changes that will make a difference to protect Lake Macatawa for future generations.	- distribute monthly e-newsletters - provide watershed related information upon request - press releases and newspaper articles - take watershed display to community events - community presentations - appearances on local cable programs - volunteer events (rain garden maintenance, river clean ups, kayak tours, macroinvertebrate monitoring, windshield surveys) - maintain website, Facebook, and Instagram pages - maintain Project Clarity Lawn Care & Landscape partner program	1. watershed signs along roadways 2. distribute information at public venues, flyers at community events and festivals 3. involvement in Tulip Time (parade floats) 4. distribute promotional materials, giveaways (ex. rain barrels or native plants) 5. transit ads 6. workshops for homeowners to explore native plantings and outreach materials informing how maintaining vegetation can positively impact water quality	**Short term (1-3 years)**: 1. Design and install watershed signs 2. Participate in at least 3 community events per year 3. Participate in a Tulip Time parade annually 4. Distribute promotional materials at community events; include a giveaway at 1 event 5. Design and install at least 1 ad annually 6. Host an annual workshop at the DeGraaf Nature Center; promote other local programs hosted by other community partners (e.g. tree and native plant sales) **Mid term (4-7 years)**: 1. Inspect and maintain signs, replace as necessary 2. Participate in 4-5 community events per year 3. Continue annual participate in a Tulip Time parade 4. Distribute promotional materials at community events; include a giveaway at 2 or 3 events 5. Design and install 2-3 ads annually 6. Host 2-3 workshops annually at the DeGraaf Nature Center or at another local venue; promote other local programs hosted by other community partners (e.g. tree and native plant sales) **Long term (8-10 years)**: 1. Inspect and maintain signs, replace as necessary 2. Participate in 6 or more community events per year 3. Continue annual participate in a Tulip Time parade 4. Distribute promotional materials at community events; include a giveaway at all events 5. Design and install 4-5 ads annually 6. Host 2-3 workshops annually at the DeGraaf Nature Center or at another local venue; promote other local programs hosted by other community partners (e.g. tree and native plant sales)	1. Cities, townships, OCRC, ACRC 2. Municipalities, churches, non-profit community event organizers 3. Tulip Time organizers, Project Clarity Committee 4. Community event organizers 5. MAX Transit, MACC 6. Holland and Zeeland community organizations, Michigan Natural Shoreline Partnership, CDs

Local Governments	**Message:** Stormwater runoff is the major source of sediment, nutrient, and bacterial pollution to the Macatawa Watershed. **Message:** Improving local water quality is important to increase quality of life and to boost economic growth by attracting jobs, enhancing tourism, and protecting property values **Message:** Local governments can and should play a pivotal role in improving water quality by smart planning and requiring development methods that reduce stormwater runoff. **Message:** Local ordinances can prevent the sale or use of certain over the counter fertilizers. Ordinances can also allow homeowners to install native plants, vegetative buffers, rain barrels, and other BMPs.	- monitoring in urban areas of the watershed - community presentations and MACC Board meetings - committee meetings - press releases and newspaper articles - monthly newsletter - grant applications with local government partners - watershed display at local meetings - maintain website and social media pages	1. provide direct evidence through monitoring results, develop and distribute case studies related to the "Water-Based Economy" and how water quality impacts economic growth 2. conduct one-on-one meetings 3. host local workshops 4. offer stormwater related training 5. conduct tours 6. demonstrate citizen support of water quality programs 7. attend township board meetings 8. provide information about existing ordinance changes which may be adopted	Short term (1-3 years): 1. Share monitoring results with local municipalities; develop and share local economic case studies 2. Meet with each township and city (staff and/or elected officials) annually to discuss water quality issues and solutions 3. Host at least 1 watershed workshop annually for municipal staff and elected officials 4. Offer stormwater training for non-MS4 municipal staff (illicit discharge awareness and pollution prevention and good housekeeping) 5. Host an annual watershed tour for municipal staff and elected officials to see watershed projects in action 6. Provide metrics on number of residents that participate in water quality workshops, programs and citizen science 7. Attend at least 1 board meeting of each major township to provide watershed updates 8. Share ordinance review findings and recommendations with each municipality; start working toward ordinance changes Mid term (4-7 years): 1. Share monitoring results; develop and share local economic case studies of newly implemented projects 2. Continue to meet annually to discuss water quality issues and solutions 3. Continue hosting 1 watershed workshop annually for municipal staff and elected officials 4. Offer stormwater training for non-MS4 municipal staff 5. Host at least 2 annual watershed tours for municipal staff and elected officials to see watershed projects in action 6. Provide metrics on number of residents that participate in water quality workshops, programs and citizen science 7. Continue attending at least 1 board meeting of each major township to provide watershed updates 8. Continue working on ordinance changes; half of the municipalities in the watershed have implemented changes Long term (8-10 years): 1. Share monitoring results; develop and share local economic case studies of newly implemented projects 2. Continue to meet annually to discuss water quality issues and solutions 3. Continue hosting 1 watershed workshop annually for municipal staff and elected officials 4. Offer stormwater training for non-MS4 municipal staff 5. Host at least 3 annual watershed tours for municipal staff and elected officials to see watershed projects in action 6. Provide metrics on number of residents that participate in water quality workshops, programs and citizen science 7. Continue attending at least 1 board meeting of each major township to provide watershed updates 8. Continue working on ordinance changes; all of the municipalities in the watershed have implemented changes	1. Townships, cities, Ottawa County, Allegan County, MACC 2. Township and city staff and elected officials 3. Township and city staff and elected officials, MACC 4. Non-MS4 townships: Olive, Blendon, Park, Zeeland, Laketown, Fillmore, Overisel 5. Township, City and county staff and elected officials 6. Townships 7. Townships and Cities

Target Audience	Key Messages	Current Activities	Proposed Activities	Milestones/Timeline	Implementation Partners
Schools	**Message**: ODC Network's Education Network can provide watershed curriculum ideas and projects in accordance with MEAP/GLCE standards. **Message**: It is important that students are aware of the value of clean water, as they will be protecting these resources for future generations. **Message**: Incorporate local watershed info into science and math curriculum. **Message**: Invite local speakers into the classroom to present environmental science topics. **Message**: Make science and outdoor education fun by visiting a local nature center or going on outdoor experiences.	- Enviroscapes - presentations - storm drain stenciling - river cleanups - outdoor curriculum - natural play and learn spaces - support of ODC's volunteer league - support of the Holland Youth Advisory Council	1. offer professional development training workshops 2. host field trips 3. develop "Speakers Bureau" 4. develop tabletop watershed display for students to be hosted at schools around the watershed	**Short term (1-3 years)** 1. Develop and host professional development training on watershed topics for local schools 2. Host watershed focused field trips for local schools 3. Develop and advertise a "Speakers Bureau" (list of topics and local experts that can be invited into classrooms for presentations) 4. Develop and advertise availability of a tabletop watershed display **Mid term (4-7 years)**: 1. Continue hosting professional development training on watershed topics for local schools, requests for training increases 2. Continue host watershed focused field trips for local schools, requests for field trips increases 3. Continue advertising a "Speakers Bureau"; track requests and expand as appropriate to add topics and speakers 4. Continue advertising availability of a tabletop watershed display, requests for display increases **Long term (8-10 years)**: 1. Continue hosting professional development training on watershed topics for local schools, requests for training increases 2. Continue host watershed focused field trips for local schools, requests for field trips increases 3. Continue advertising a "Speakers Bureau"; track requests and expand as appropriate to add topics and speakers 4. Continue advertising availability of a tabletop watershed display, requests for display increases	1. ODC's Education Network, local schools, Groundswell 2. ODC's Education Network and Programming Team, local schools, Groundswell 3. Local conservation organizations 4. ODC's Education Network, local schools

Target Audience	Key Messages	Current Activities	Proposed Activities	Milestones/Timeline	Implementation Partners
Business/ Commercial Landowners	**Message**: Lake Macatawa suffers from too much sediment, nutrient, and bacterial pollution. **Message**: Storm water runoff from parking lots, roofs and roads is the major source of sediment and nutrients to the Macatawa Watershed. **Message**: Clean water is important to maintain a high quality of life for everyone in the community, as well as the importance to the local economy. **Message**: It is the responsibility of everyone in the watershed to take steps to reduce stormwater runoff from their property (rain barrels, rain gardens, stormwater retrofits, native vegetation, buffer strips, bioswales, and porous pavement)	- distribute monthly e-newsletter - provide watershed related information upon request - press releases and newspaper articles - take watershed display to community events - host community workshops - volunteer events (rain garden maintenance, river clean ups, kayak tours) - maintain website and social media pages - maintain Project Clarity Lawncare & Landscape Partners	1. one-on-one meetings 2. distributing educational information at institutional venues 3. distribute information through West Coast Chamber of Commerce 4. distribute promotional materials for programs and events 5. ask for representatives on watershed committees 6. develop a sustainability assessment for commercial properties	**Short term (1-3 years)** 1. Offer one-on-one meetings with businesses with whom ODC has existing relationship 2. Begin quarterly newsletter for lawn care and landscaping companies 3. Attend, participate in or sponsor at least 1 Chamber event annually to provide presentations or print materials 4. Provide materials for commercial partners to advertise programs and events to their clients 5. Invite business representatives to participate in the Project Clarity Committee 6. Develop and pilot a sustainability assessment for small businesses that evaluates energy and water consumption and pollution prevention and good housekeeping activities **Mid term (4-7 years)**: 1. Continue to offer one-on-one meetings with businesses 2. Continue quarterly newsletter, increase audience to other businesses 3. Attend, participate in or sponsor 2-3 Chamber events annually 4. Provide materials for commercial partners to advertise programs and events to their clients 5. At least 3 local businesses have representatives that attend Project Clarity Committee meetings regularly 6. Conduct at least 4 sustainability assessments annually, work with businesses to implement recommended changes and BMPs **Long term (8-10 years)**: 1. Continue to offer one-on-one meetings with businesses 2. Continue quarterly newsletter 3. Attend, participate in or sponsor 2-3 Chamber events annually 4. Provide materials for commercial partners to advertise programs and events to their clients 5. At least 5 local businesses have representatives that attend Project Clarity Committee meetings regularly 6. Conduct at least 6 sustainability assessments annually, work with businesses to implement recommended changes and BMPs	1. ODC Development team, local businesses 2. Lawn care and landscaping companies 3. West Coast Chamber of Commerce 4. Local businesses, West Michigan Sustainable Business Forum 5. Local businesses 6. Local businesses

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7.9 Information Resources

Several resources are available that contain messages applicable to the Macatawa Watershed. These resources should be utilized in developing exact content and materials for I&E sharing with the community.

- Ottawa Conservation District (http://www.ottawacd.org)
    - Resources available related to agricultural programs including the Michigan Agriculture Environmental Assistance Program (MAEAP), technical assistance, BMPs, and forest management.
- EPA (https://www.epa.gov/watershedacademy)
    - Resources available related to all relevant watershed topics
- EGLE (https://www.michigan.gov/egle/about/organization/water-resources)
    - Resources available related to all relevant watershed topics
- Michigan DNR (https://www.michigan.gov/dnr/0,4570,7-350-79136_79236---,00.html)
    - Resources available related to aquatic life, stream habitat, cold water streams
- MSU Extension and other University Extension Resources (https://www.canr.msu.edu/)
    - Resources available related to riparian fencing, septic systems, BMP practices, plants, forests, etc.
- West Michigan Environmental Action Council (https://wmeac.org)
    - Resources available related to rain barrels and green infrastructure benefits and calculations
- NRCS (https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/)
    - Resources available related to agricultural programs, technical and financial assistance, and BMPs
- Michigan Natural Shoreline Partnership (http://www.mishorelinepartnership.org)
    - Resources available related to land management adjacent riparian areas
- Groundswell (https://www.gvsu.edu/groundswell/)
    - Resources available related to watershed education in the schools
- Allegan Conservation District (allegancd.org)
    - Resources available related to agricultural programs including MAEAP, technical assistance, BMPs, and forest management.
- ODC Network/Project Clarity (outdoordiscovery.org/project-clarity)

7.10 Evaluation

To assess the effectiveness of the I&E Strategy and the messages developed, activities should be tracked through annual reports and newsletters. Future surveys must focus on behavioral and environmental changes within the watershed. The initial survey conducted for this WMP will serve as a baseline for future evaluations. A follow-up survey should be conducted to measure changes in residents' attitudes and knowledge over time, using similar questions to the original survey while adjusting for emerging or resolved resource concerns in the Macatawa Watershed. This follow-up should take place after several messaging components of the WMP have been implemented, targeting both urban and rural residents. Additionally, the data from the 2021 survey could be used in community meetings or workshops where landowners can discuss the findings and share their experiences with BMPs on their properties.

Surveys should be included in all outreach events, with pre- and post-assessments to gauge knowledge gained. Based on these results, the I&E Strategy should be adjusted as needed. Focus groups specifically gathered to discuss the I&E Strategy will provide valuable feedback from a diverse range of residents and partners. Key questions to consider during the implementation of the I&E Strategy include:

- Are the planned activities being implemented according to the schedule?
- Is additional support needed?
- Are additional activities needed?
- Do some activities need to be modified or eliminated?
- Are the resources allocated sufficient to carry out the tasks?
- Are all the target audiences being reached?
- What feedback has been received, and how does it impact the I&E strategy program?
- How do the BMP implementation activities correspond to the I&E strategy?

These evaluation methods provide a simple framework for assessing the strategy, but they should remain flexible and evolve as the WMP is implemented.

8.0 SUMMARY OF WATERSHED MANAGEMENT RECOMMENDATIONS

This chapter provides specific implementation recommendations for addressing NPS pollutants in critical areas and at critical sites as well as a plan for addressing the larger, more general issues that the Macatawa Watershed is facing. The chapter integrates the results of data collected throughout the watershed management planning process to develop physical, policy based, informational, and educational BMP recommendations that will serve as an action plan for management of the Macatawa Watershed to reduce NPS pollutant loading concentrations and improve overall water quality and quantity.

Many of the BMPs listed in this plan are generally accepted as means to prevent or reduce pollution and are mentioned in sources such as the phosphorus TMDL, the Michigan Statewide *E. coli* TMDL, and other WMPs. They are recommended, and in well-documented use, by the NRCS through various funding programs, and other organizations through 319 NPS grant programs. This plan will focus on recommended BMPs for critical areas as well as general wetland and groundwater protection and restoration. Lists of financial and technical assistance resources and collaborative partners is included. Table 8.1 includes a list of BMPs recommended throughout this plan.

In addition to the potential solutions recommended in Table 8.1, the ODC Network is, as of April 2025, actively investigating an engineered solution to significantly reduce concentrations of phosphorus and other pollutants within streams using an alum injection treatment system. The consultant will produce a final report with conceptual design, permitting considerations, operation and maintenance recommendations, and construction and maintenance cost estimates by September 2025. Based on recommendations of AWRI, reaching the phosphorus TMDL interim goal and ultimately desired goal of less than 20 g/L may only be possible using an engineered solution. This solution does not replace any of the others listed in this WMP. Physical and managerial BMPs are a critical component to the overall protection and restoration of Lake Macatawa's water quality and all solutions will need to be part of the overall goal of achieving water quality standards.

Certain BMPs address specific sources of NPS pollutants; however, **BMPs must be selected on a site-specific basis.** Cost, site conditions, pollutant removal efficiency, and preference of the landowner installing the BMP should all be taken into consideration, as well as evaluating feasible alternatives. BMPs can include measures to both prevent and mitigate pollution. BMP adoption through the WMP process is on a voluntary basis and done in a collaborative manner.

8.1 Wetlands Protection and Restoration

Protecting existing wetlands from degradation or impact should be a priority for the watershed. The largest remaining tracts of existing wetlands include the Macatawa Marsh, along the mouths and lower reaches of Pine and Winstrom Creeks, significant stretches of Noordeloos Creek, and around Kelly and Gilligan Lakes. Significant restored wetlands include those in the Upper Macatawa Natural Area, Middle Macatawa Preserve, Paw Paw Park, and the Macatawa Mitigation Bank.

In Michigan, state law protects wetlands larger than five (5) acres or those connected to other water bodies from development via a permit process, but numerous exceptions allow for their destruction or mitigation elsewhere. For instance, agriculture may not require a permit to impact wetlands, and the state frequently grants permits to fill wetlands. While mitigation can involve creating new wetlands to offset impacts, these replacements may not match the quality of the original wetlands. It is vital to protect remaining significant wetlands that are over a half-acre in size, especially those with flood storage, nutrient transformation, pathogen filtering, and sediment trapping functions.

Due to the historic loss of wetlands and the valuable function they provided, all wetlands in the Macatawa Watershed should be prioritized for protection to the maximum extent practicable. However, for purposes of this plan, any existing wetlands that are greater than or equal to 2 acres in size and located within 200 feet of streams were identified as high priority for protection (2,045 acres, black areas shown in Figure 8.1). Local ordinances in each township within the watershed are the most cost-effective way to safeguard these valuable resources.

Wetland restoration will be prioritized in areas of historic wetlands located in non-urban/built up land uses that are not prioritized for farmland preservation (Figure 8.1, see Section 5.7.1 for more about farmland preservation). There is a total of 9,250 acres that fit these criteria. Highest priority will be placed on high functioning wetlands as defined by the Landscape Level Functional Wetland Assessment that provide function for sediment retention, nutrient transformation, flood storage and streamflow maintenance. There are 304 acres of high functioning wetlands that fit these criteria (see pink highlighted areas in Figure 8.1). Further investigation is necessary to determine the feasibility and willingness of landowners to implement wetland restoration.

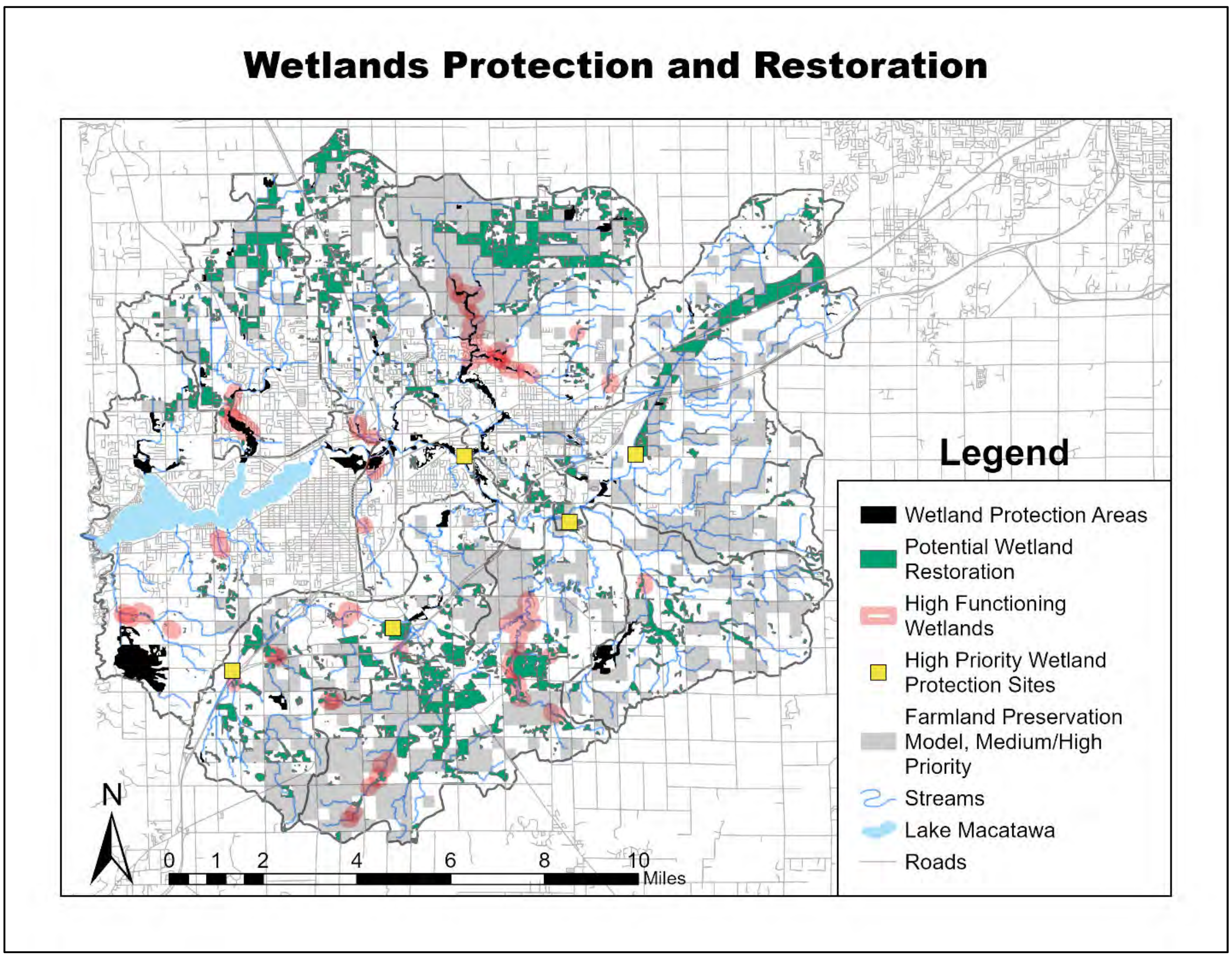

Figure 8.1 Priority wetlands for protection and restoration
Source: Michigan GIS Open Data
Date Prepared: December 2024

Additionally, there are significant areas of historic wetland loss in the watershed. These include areas along the Upper Macatawa River, the headwaters of Noordeloos and Pine Creeks, areas along the South Branch in Fillmore Township, and areas around what is now downtown Holland and the main Holland Township business district. Where feasibility and land use allow, wetland restoration is strongly recommended, especially if it can be paired with other beneficial efforts, such as park development, stream restoration, or farmland preservation. In heavily built-up areas where large-scale restoration is impractical, such as the center of Holland, features such as bioswales, pollinator gardens, and rain gardens should be adopted widely to help manage stormwater runoff and provide habitat for pollinators and urban wildlife.

8.2 Groundwater Protection

Reduction of groundwater quality and quantity throughout the watershed is becoming a rising concern and has the potential to create negative impacts such as drying wells, crop damage, plumbing corrosion, and public health concerns. While farming operations consume a large quantity of water through activities like irrigation and livestock watering, dense residential developments (which are groundwater dependent) have been found to use a much larger portion of groundwater—some through household use, and most through lawn irrigation. The data indicates that if the current trend of increasing groundwater usage does not change, groundwater levels will continue to decline, and the quality of what water remains will continue to degrade (MSU, 2013, and Curtis et al., 2018).

The Macatawa Watershed has had a fast rate of population growth in the past decade, with Ottawa County becoming one of the fastest growing and most agriculturally diverse and productive counties in the State, and nationally. This will ultimately lead to rising population rates and increased pressures on current dwindling groundwater stores within the Macatawa Watershed. Ottawa County, farther ahead in their groundwater monitoring, is applying the science from MSU's groundwater study through their Groundwater Sustainability Initiative, consulting with geological and water resource experts, and engaging stakeholders within our local communities to work towards sharing and implementing proactive strategies to protect groundwater. ODC Network has collaborated with Ottawa County to carry out a number of these strategies (BMPs) and educational initiatives in the past years. ODC Network will continue to assist as a technical partner to promote groundwater saving practices.

Wetland protection and restoration, as described in the previous section, will not only provide water filtration benefits but will also go a long way for protecting current groundwater stores throughout the Macatawa Watershed by encouraging increased groundwater recharge of the shallow aquifers. Unfortunately, due to a locally unique clay barrier in places within the watershed between the shallow and deep aquifers, the deep aquifer is somewhat prohibited to naturally recharge from within the Macatawa Watershed. The Groundwater Sustainability Initiative has identified several BMPs to be implemented throughout Ottawa County and portions of the Macatawa Watershed that will continue to improve groundwater recharge into the deep aquifer in parts of both counties where it is naturally possible. These practices should be implemented throughout the watershed, with a focus on the headwaters region where current groundwater levels within the Marshall Aquifer are lowest (See Figure 5.12). Recommendations include the following goals:

- Work with local governments to implement necessary groundwater protection and stormwater ordinances where possible that promote infiltration-based management solutions.
- Promote and incentivize the adoption of drought tolerant landscape alternatives.
- Determine critical priority areas by mapping and monitoring groundwater withdrawal and recharge zones.

- Encourage homeowners to upgrade outdated or failing septic systems through financial incentives or assistance programs.
- Expand groundwater monitoring programs to track water quality trends and detect potential contamination early.
- Utilize new technologies and techniques for agricultural irrigation.
- Develop policies for the adaptive reuse of rainwater and greywater.
- Provide public education and outreach regarding the groundwater problems as well as various conservation strategies.

8.3 Physical and Managerial BMPs for Critical Sites/Areas

8.3.1 Agricultural Land Critical Sites

There are 9,394 acres of cropland identified as high priority in the Critical Agricultural Model described in Chapter 5 and shown in Figure 5.1. Two methods were used to identify critical sites within the highest priority agricultural areas: the Agricultural Conservation Planning Framework (ACPF) and tillage and residue surveys.

These sites should be addressed by working to educate landowners (Chapter 7) and installing physical BMPs (Table 8.1). BMPs outlined in conservation programs such as MAEAP, NRCS conservation programs and Generally Accepted Agricultural Management Practices (GAAMPs) are recommended, as well as the following that address pollutants of concern in the Macatawa Watershed:

- **Avoid manure land application on frozen or saturated ground.** To avoid this, store manure in appropriately designed storage areas until ground is thawed and no longer saturated. Michigan's GAAMPs for manure include a specification to control runoff with conservation practices, and if manure application on frozen ground is necessary, it should only be done on slopes less than six percent for solid manure, and three percent for liquid manure (MDARD, 2026). If manure must be applied on frozen ground, EGLE and MDARD recommend calculating a Manure Application Risk Index score for each field to determine if the field is high risk (MDARD, 2026). Research has shown that land-applying manure on frozen ground immediately prior to spring snowmelt is especially risky in terms of contaminated runoff volume, therefore EGLE recommends avoiding that time period (varies by climate and locality) (MDARD, 2026).
- **Injection or Incorporation of Manure.** EGLE recommends injecting or incorporating all manure after land application. In addition to reducing bacterial contamination of surface waters, incorporation and injection are also recommended practices to keep nutrients on the field and reduce volatilization of valuable fertilizer (Atta, 2008). If manure cannot be incorporated, conservation practices (residue management, cover crops, perennial crops, etc.) should be used to protect against runoff and erosion losses to surface waters.
- **Tile Line Control Structures (or Drainage Water Management**: When manure is applied on tile-drained fields, water-level management through a tile outlet control is advised to minimize the contamination of surface water; however, these structures require active management and are not suitable for all soil types and fields. Tile line control structures can also be effective at containing manure discharges in case of misapplication of manure, thus minimizing environmental impacts.
- **Cover Crops.** Cover crops are plants that are seeded either within the typical growing season (aerial application, interseeding, etc.), or outside of the typical growing season (after harvest)

and left to cover the soil between cash crops. This can provide many soil health benefits related to nutrient retention and uptake, infiltration, and a significant reduction in erosion and runoff.

- **Conservation Tillage.** A reduction in tillage practices, or the utilization of conservation tillage, which minimizes soil disturbance, is recommended for fields in critical areas. Landowners should be encouraged to adopt practices such as strip till or mulch till, that leave a significant amount of residue on fields to protect them from the impacts of raindrops and runoff. When possible, producers should be encouraged to transition to a no-till system, where new crops are planted directly into the residue from previous crop years or cover crops.
- **Buffer or filter strips**. Buffer strips are areas of permanent vegetation located between agricultural fields and the water courses to which they drain. They can serve to slow runoff, trapping nutrients and sediment prior to entering the surface water.
- **Farmland Preservation**. Farmers, land conservancies, and other organizations should work together to encourage long-term conservation and wildlife protection. Some programs available to landowners include Purchase of Development Rights (PDR), the Wetlands Reserve Program (WRP), the Farmland and Open Space Preservation Program, and conservation easements through local land conservancies.

8.3.2 Human Sources of *E. Coli*

Failing or improperly maintained septic systems can contribute to nutrient and bacterial pollution in the Macatawa Watershed, posing risks to both surface water and groundwater quality (Figure 5.4). The following voluntary activities are recommended as policy-based actions to be completed by local responsible agencies and organizations.

- Maintain outreach to educate residents on the signs of improper connections to a sanitary or storm sewer or a surface water body.
- Educate residents on the importance of clean water to human health and the dangers of surface water contamination by raw sewage.
- If applicable, modify existing on-site septic system isolation distances in local ordinances to treat open county drains as conservatively as other surface waters. Open county drains are waters of the state, and the same WQS apply.
- Investigate on-site septic systems (with assistance from the local responsible agency), prioritizing in areas that are considered high risk; for instance, older housing or housing that is located on poor soils, or densely populated/small lots. Particular attention should be paid to small rural communities in unsewered areas, and unsewered homes around lakes. Effort directed at aging or densely populated housing areas may be the most productive use of resources. Community-wide problems with failing septic systems may best be resolved through a comprehensive solution such as centralized or cluster wastewater treatment systems.
- Increase outreach to educate residents on the routine maintenance of a septic system and signs that their residence may have a failure.
- Apply for funding through CWA Section 319, or similar grants, to offer cost-share for the repair or replacement of failing septic systems. Several other Ottawa County watersheds have similar cost-share programs that have proven successful in recent years.
- Monitor the application of Class B biosolids to ensure that all EGLE regulations are being followed, including isolation distances from surface water and crop harvesting restrictions.

8.3.3 Livestock Critical Sites

There are seventy (70) confined feeding/animal operation sites in the Macatawa Watershed (Figure 5.3). The plan will first prioritize the critical sites that occur in priority subwatersheds, before addressing the additional critical sites. The Statewide *E. coli* TMDL recommends outreach to farmers and producers to connect them with existing voluntary conservation programs, and to utilize the following BMPs (EGLE, 2019):

- Prioritize developing Nutrient Management Plans (NMPs) and Comprehensive Nutrient Management Plans (CNMPs) to document key on-farm details, including animal populations, manure production and storage, nutrient application records, and field inventories. These plans identify potential resource concerns and offer recommendations for addressing them. They are especially useful for livestock operations to assess manure storage requirements and determine suitable fields for safe manure application.
- Provide alternative watering sources to eliminate the need for animals to drink directly from streams. If livestock must cross a water body, EGLE recommends installing crossings that either prevent access to the water or restrict contact to the time needed for crossing. However, controlled crossings may not fully prevent *E. coli* contamination, as animals can still encounter the water. According to Michigan's Generally Accepted Agricultural and Management Practices (GAAMPs), livestock producers have the right to use surface water, but only in ways that do not degrade water quality (MDARD, 2026).
- Reduce or eliminate contaminated runoff from pastures or barnyards. EGLE recommends implementing practices that prevent direct runoff into surface waters. Establishing and maintaining long-term vegetation, including wetland construction or restoration, helps improve infiltration. Additionally, diverting clean stormwater away from manure storage and production areas is an effective strategy for reducing polluted runoff.

8.3.4 Urban Critical Sites

Fifteen critical urban area subwatersheds have been identified (Figure 5.7). The plan will prioritize critical sites, as identified by the green infrastructure suitability and urban tree canopy assessment that occur in priority subwatersheds before addressing additional critical sites. These areas should be addressed and targeted by working to educate landowners, installing BMPs, and updating existing ordinances to include green stormwater infrastructure (GSI) practices (also known as nature-based solutions). GSI practices focus on capturing, infiltrating, treating, and storing stormwater to reduce runoff, improve water quality, and enhance urban resilience. In consistency with the coastal watershed requirement, GSI practices are imperative to controlling post-construction runoff rates and volumes. Communities in the Macatawa Watershed have already adopted these standards with the MS4 permitting practices.

- Install rain gardens and bioswales to naturally capture and treat stormwater. Rain gardens and bioswales restore natural hydrological processes by allowing water to infiltrate and recharge groundwater systems. This helps maintain the natural water balance and reduces the strain on traditional stormwater infrastructure.
- Implement permeable pavements to reduce runoff and enhance water infiltration. This filtration process reduces the amount of contaminants, such as oils, chemicals, and debris, that enter local waterways
- Install green roofs to slow and retain rainfall, incorporate underground storage systems and modular stormwater solutions in space-limited areas to manage excess stormwater.

- Establish vegetated buffers to stabilize soil and reduce erosion, and create constructed wetlands to manage larger storm events and improve ecological functions.
- Plant trees to intercept stormwater and provide additional benefits such as improved air quality, energy efficiency, and wildlife habitat.

8.3.5 Road Stream Crossing Critical Sites

Fifty-five (55) critical sites are causing issues such as significant scouring and erosion due to improperly sized or placed culverts (Figure 5.5). The plan prioritizes critical sites that occur in priority subwatersheds before addressing additional critical sites. These crossings are owned by various road agencies and many are located on streams designated as county drains. Therefore, ODC will collaborate with these agencies to seek and implement solutions. Road stream crossing inventory data has been submitted to each agency, and these sites should be addressed by installing physical BMPs listed later (Table 8.1).

- Optimize culvert drain design to accommodate seasonal flows, ensuring the diameter spans the full bankfull width. They should align with the natural streamflow to minimize sharp turns or abrupt angles at the inlet and outlet and should be installed at or below the existing stream grade.
- Prioritize culvert selection to avoid standard corrugated metal pipes and consider alternative designs. Open-bottom, arch, or box culverts are preferable as they replicate natural stream conditions. While more costly, bridges provide the most effective long-term solution.
- Create erosion control measures to prevent erosion around culvert embankments, both upstream and downstream, using a combination of hard and soft armoring. This may include rock riprap, native vegetation, tree plantings, and stone plunge pools for perched culverts.
- Enhance fish passage through culvert designs and strategic grade control to improve fish migration and habitat while also mitigating erosion at road-stream crossings. Replacing traditional culverts with bridges, open-bottom, arch, or box culverts minimizes disruption to the natural stream ecosystem. For perched culverts where replacement is not an option, step-pool designs can be used to enhance fish passage.

8.3.6 Streambank Erosion Critical Sites

Five (5) critical reaches with streambank erosion issues have been identified (Figure 5.6). The plan will prioritize the critical reaches that occur in priority subwatersheds, before addressing additional critical reaches. Responding to the critical reaches requires collaboration with the OCRC, ACRC, OCWRC, and ACDC to raise awareness and implement physical best management practices (BMPs) (Table 8.1). Since most of these sites are significantly impacted by agricultural activity and altered flow from channelization, physical BMPs should be integrated with efforts to modify agricultural practices. Recommended BMPs include:

- Increased streambank stabilization, which may involve re-grading and re-vegetating. Given that many of these sites are roadside ditches, standard "roadside mixes" may not provide sufficient stabilization.
- Encourage farmers to implement two-stage ditches to enhance flood storage and facilitate the deposition of sediments and other pollutants.
- Establish more buffer or filter strips along stream banks and drainage areas to reduce erosion and runoff.
- Advocate for properly sized culverts to improve water flow and reduce erosion (see Section 8.3.5).

8.3.7 Chloride Critical Sites

Chloride critical sites have not yet been identified within the Macatawa Watershed. More data (i.e. chloride monitoring of more streams) is needed to identify where priority areas are for chloride within each subwatershed. By identifying these critical sites, ODC Network can implement targeted strategies to minimize chloride pollution, reduce environmental damage, and safeguard both ecological health and the quality of water resources used by watershed residents.

8.4 Macatawa Watershed Action Plan

Table 8.1 proposes an overall list of objectives, critical areas addressed, and recommended BMPs and policy-based actions (Chapter 6) necessary to achieve pollutant load reduction goals. The sources of funding and technical assistance partners are certainly not limited to those listed below and should be treated as a starting point for the implementation of future projects. This table identifies the steps ODC and other watershed stakeholders should take to achieve pollutant reduction goals and to achieve overall NPS pollutant reduction throughout the Macatawa Watershed. This action plan includes goals for physical, policy based and educational/outreach BMPs over the next 10 years, at which time the MWMP should be evaluated for a potential update. Estimated quantities of actions per phase have been identified, along with estimated costs per practice.

8.4.1 Technical Resources and Collaborative Partners

In the Macatawa Watershed, several regional partners offer technical assistance and guidance for projects aimed at reducing nonpoint source (NPS) pollution. Technical assistance involves providing expert support, based on scientific knowledge or field expertise, to farmers, homeowners, townships, or other stakeholders interested in implementing conservation practices on their properties. Input from a range of partners is essential for designing effective restoration projects that tackle the underlying causes of impairments and habitat degradation, while also aligning with landowners' goals and capabilities. The level of technical review and support will depend on the scope and complexity of each project. Many of the organizations mentioned in earlier chapters are available to offer technical assistance on various topics, with specific project support outlined in Table 8.1.

- ODC Network
- Conservation Districts
- County Departments of Public Health
- Ottawa County Department of Strategic Impact
- Ottawa County Parks and Recreation Commission
- County Road Commissions
- Ottawa County Water Resources Commissioner
- Allegan County Drain Commissioner
- Michigan Department of Natural Resources
- Michigan Department of Environment, Great Lakes, and Energy
- Natural Resources Conservation Service
- United States Fish and Wildlife Service
- Land Conservancy of West Michigan
- City of Holland
- City of Zeeland
- Townships

- Macatawa Area Coordinating Council
- Holland Board of Public Works
- Agricultural Retailers
- Private Septic Services Companies

8.4.2 Financial Resources Available

The success of watershed management projects in the Macatawa Watershed depends on securing funding from a variety of private, state, local, and federal sources. To ensure the implementation and sustainability of these projects, it is often necessary to diversify and leverage multiple funding streams. Several funding programs are available to support nonpoint source (NPS) pollutant reduction efforts within the watershed. Organizations like the ODC Network can work with local stakeholders to help secure funding for projects. By working with a variety of partners, funding streams that are not available to some can be accessed by others, such as non-profits, government agencies, and academic institutions. Potential funding resources include:

- Ducks Unlimited Midwest Cover Crop Initiative
- EPA Clean Water State Revolving Fund
- Great Lakes Restoration Initiative
- Great Lakes Fishery Trust
- Michigan DNR Grants
- Local Foundation Grants
- Local/County/Township Funds including funding sources from the Ottawa County Department of Strategic Impact and Ottawa County Water Resources Commissioner
- Ottawa County Parks Foundation
- Private Donations
- National Fish and Wildlife Service Sustain Our Great Lakes Program and National Coastal Resilience Program
- NRCS Regional Conservation Partnership Program
- NRCS Environmental Quality Incentives Program
- NRCS Wetlands Reserve Program
- NRCS Conservation Reserve (Enhancement) Program
- US Fish and Wildlife Grants and Cost Share Programs
- EGLE Nonpoint Source Pollution Control Grants – Federal Clean Water Act Section 319

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Table 8.1 General BMP recommendations for Macatawa Watershed pollutant critical areas

Critical Area	Objective	Recommended BMPs	Technical Assistance	Sources of Funding
Wetland Protection (See Figure 5.1 in Section 5.8 and Section 8.1)	Improve hydrology and water quality	Local wetland protection ordinances	Townships, DC/WRC	Local
		Land protection/ conservation easements	CDs, ODC, county parks, land conservancies	WRP, state/federal grants, foundations
		Land procurement for wetland restoration	ODC, CDs, county parks, land conservancies	State/federal grants, foundations
		Restoration without procurement	ODC, CDs, NRCS, EGLE, WRCs	State/federal grants, foundations
Groundwater Protection (See Figure 5.12 in Section 5.9 and Section 8.2)	Improve groundwater retention and reduce aquifer pressures	Local groundwater protection ordinances and/or changes in township policies to encourage groundwater saving development/ features/ landscaping	Townships, OCDSI, ACHD	Local funding
		Implement BMPs that increase infiltration in groundwater recharge areas	ODC, CDs, DC/WRC	Local, state/ federal grants, foundations
Agricultural Land Critical Sites (See Figure 5.2 in Section 5.1 for map of high priority farm fields)	Implement cropland BMPs	Conservation tillage, including no-till, mulch till, and strip till	CDs, NRCS, ODC, agricultural industry partners	State/federal grants, foundations
		Cover crops on all critical fields and fields adjacent to surface water		
		Address rill/gully erosion with grassed waterways		
		Buffer/filter strips along all waterways		
	Minimize tile line impact	Tile line outlet sampling to determine high priority sites		
		Installation of tile line control structures		
		Install P sorption beds for high priority tile lines to capture P		
	Improved manure field application management	Follow GAAMPS and manure application risk index recommendations to determine runoff risk of manure spreading		
		Manure injection or incorporation		
		Reduce/eliminate winter spreading		

Critical Area	Objective	Recommended BMPs	Technical Assistance	Sources of Funding
Septic System Critical Sites (See Figure 5.4 in Section 5.3 and Section 8.3.2)	Address human sources of *E. coli*	Require, encourage, and/or subsidize pump outs and inspections beyond time of sale	ACHD OCDPH, MDPH private septic companies	State/federal grants, foundations
		Cost share for septic repairs/replacements		
		Identify and remove illicit connections		
		Sewer hookups or community septic systems for new developments		
Livestock Critical Sites (See Figure 5.3 in Section 5.2 and Section 8.3.3)	Improved farmstead nutrient management	Nutrient management and CNMPs	CDs, NRCS, agricultural industry partners	State/federal grants, foundations
		Following CNMP guidelines, build manure storage to maintain six months capacity		
		Stormwater management, gutters, diversions		
	Improve or reduce livestock access to surface water	Livestock exclusion fencing along all stream/ditch banks		
		Reinforced livestock crossings		
		Alternative water sources for cattle		
	Improved pasture and feedlot management	Improved fencing and buffers along pastures/ lot edges		
		Grazing management, critical area plantings		
		Two-stage channel design and implementations		
Urban Critical Sites (See Figure 9 in Section 5.8 and Section 8.3.4)	Improve stormwater management using nature-based solutions	Rain gardens and bioswales	ODC, CDs	Local funding, state/federal grants, foundations
		Permeable pavement		
		Green roofs		
		Vegetated buffers		
		Tree planting		

Critical Area	Objective	Recommended BMPs	Technical Assistance	Sources of Funding
Road Stream Crossings Critical Sites (See Figure 5.5 in Section 5.4 and Section 8.3.5)	Address erosion from RSX	Properly aligned and sized culverts	DC/WRCs, RCs, USFWS, DNR, ODC	State/federal grants, city/county budgets, foundations
		Armoring embankments, outlets, and plunge pools for deep scouring		
	Fish passage improvements at RSX	Install alternative culvert designs where possible (bridges, open bottom, arch, and box culverts)		
		Install grade control or step pool designs for perched culverts where replacements are not feasible		
Streambank Erosion Critical Sites (See Figure 5.7 in Section 5.5 and Section 8.3.6)	Address streambank erosion	Buffer/filter strips on critical waterways	ODC, WRCs, CRCs, EGLE, USFWS, DNR	State/federal grants, local , foundations
		Streambank restoration and stabilization and soft armoring of critical points		
		Alternative drain designs, particularly two-stage channels		
Chloride Critical Areas (8.6.7)	Meet chloride standards	Reduce residential salt usage through educational campaigns and/or community Salt Watch monitoring	ODC, ACRC, OCRC, Townships, Cities	Local
		Reduce municipal road salt usage through policy changes and technology updates	ACRC, OCRC, Townships, Cities	Local
		Encourage groundwater preservation practices and limit development in groundwater protection zones	ODC, Townships	Local

Table 8.2 ODC Network Macatawa Watershed Management Action Plan. The actions listed in this plan are the reasonable actions ODC will aim to initiate over the next ten years in the Macatawa Watershed. Load reduction estimates were calculated using STEPL which currently has the capacity to only provide estimated load reductions for sediment, nitrogen, and phosphorus. Estimates were made using land use data and prioritized sites.

Action	Pollutants Addressed	Critical Areas Addressed	Estimated Costs[1]	Load Reduction/ Outcomes	Total Milestones Reached per Phase
Install cover crops on 15,000 acres	Nutrients, sediment	Agricultural Land (Section 5.1 and 8.3.1)	$325K-$525K*	589 tons/yr sediment 1,184 lb/yr P 11,196 lb/yr N	11,718 tons/yr sediment 22,096 lbs/yr P 81,187 lbs/yr N Significant reductions in *E. coli* based on future monitoring results
Implement conservation tillage on 15,000 acres	Nutrients, sediment	Agricultural Land (Section 5.1 and 8.3.1)	$600K	2,041 tons/yr sediment 5,165 lb/yr P 13,610 lb/yr N	
Install three (3) miles of grassed waterways and buffer strips	Nutrients, sediment	Agricultural Land (Section 5.1 and 8.3.1)	$120K	1,899 tons/yr sediment 5,596 lbs/yr P 22,281 lbs/yr N	
Install drainage water management on 5,000 acres	Nutrients, sediment, thermal pollution, altered hydrology	Agricultural Land (Section 5.1 and 8.3.1)	$200K	848 lb/yr P 5,951 lb/yr N	
Install livestock stream crossings	*E. coli*, nutrients, sediment, altered hydrology	Livestock critical sites (Sections 5.2 and 8.3.3)	$25K	53 tons/yr sediment 345 lbs/yr P 3,895 lbs/yr N	
Restore 100 acres of wetlands[2]	Nutrients, sediment, altered hydrology, *E. coli*	Wetlands (Sections 5.8 and 8.1)	$2.5M	2,586 tons/yr sediment 5,535 lbs/yr P 15,037 lbs/yr N	
Install three (3) miles of natural channel design stream restorations[2]	Sediment, nutrients	Streambanks (Sections 5.5 and 8.3.6)	$3.96M	2,388 tons/yr sediment 1,276 lbs/yr P 3,315 lbs/yr N	
Install ten (10) miles of two-stage channel[2]	Nutrients, sediment, altered hydrology	Streambanks (Sections 5.5 and 8.3.6)	$2.64M	2,146 lb/yr P 5,825 lb/yr N	
Stabilize or replace 10 critical RSX[2]	Sediment, nutrients, altered hydrology	Road Stream Crossings (Sections 5.4 and 8.3.5)	$2M	14 tons/yr sediment 0.5 lb/yr P 19 lb/yr N	
Install 80 native plant rain gardens (or equivalent nature-based solutions)[2]	Altered hydrology, nutrients, sediment	Wetlands Protection and Restoration (8.1) Groundwater Protection (8.2)	$400K	2 tons/yr sediment 10 lbs/yr P 58 lbs/yr N	

Action	Pollutants Addressed	Critical Areas Addressed	Estimated Costs[1]	Load Reduction/ Outcomes	Total Milestones Reached per Phase
Plant 1,000 trees	Altered hydrology, nutrients, sediment	Urban Critical Sites (Sections 5.6 and 8.3.4)	$400K	1.4 million gallons of runoff avoided, other energy, carbon dioxide and air quality benefits	Full outcomes realized in 40 years
Conduct alum treatment in Lake Macatawa[2]	Primarily phosphorus; also TSS and bacteria	All	TBD	50 ppb in-lake phosphorus concentration	Meet phosphorus TMDL
Conduct educational workshops/ events to producers/residents throughout Macatawa Watershed following I&E plan (Chapter 7)	All	All	$400K	28,000 individuals attending watershed events, programs, or workshops	58,000 individuals reached
Continuous outreach/ education efforts to watershed residents via online, social media, newspaper, attending community events, etc. See Chapter 7 for more details	All	All	$250K	30,000 residents and stakeholders reached through ODC and other stakeholder newsletters, articles, and social media posts	

[1] Range based on reimbursement rates for single species to multi-species blends
[2] These actions may require permits from regulatory agencies including, but not limited to, local or county soil erosion and sediment control permits and/or EGLE/USACE joint permits

Table 8.3 Timeline for Implementation. This is an estimation for installation of the management activities listed in Table 8.2. Subtasks and major project activities are broken down under each main task (**in bold**). The biggest factor for the feasibility of maintaining this timeline is securing funding for many of these practices, as well as the likely need for staff dedicated to agricultural outreach. Other major factors include the willingness of landowners to adopt or allow the completion of practices on their property and securing permits where necessary.

Management Action	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Install cover crops on 15,000 acres										
Secure funding										
Producer outreach										
Implement contracts										
Implement conservation tillage on 15,000 acres										
Secure funding										
Producer outreach										
Implement contracts										
Install three miles of grassed waterways and buffer strips										
Secure funding										
Producer outreach										
Implement contracts										
Install drainage water management on 5,000 acres										
Secure funding										
Producer outreach										
Implement contracts										

Management Action	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Livestock stream crossings										
Ground truth and investigate identified sites										
Secure funding										
Implement										
Restore 100 acres of wetlands										
Secure land										
Permitting										
Construction										
Install three miles of natural channel design stream restorations										
Secure sites permission										
Secure funding										
Permitting										
Construction										
Install ten miles of two-stage channel										
Coordinate priority installations with DC/WRC										
Secure funding										
Construction										
Stabilize or replace 10 critical RSX										
Work with applicable drain/road agencies to review sites										
Secure designs and necessary permits										
Construction										

Management Action	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Install 80 native plant rain gardens (or equivalent nature-based solutions)										
Design										
Install										
Secure additional funding										
Explore program expansion with township partners										
Plant 1,000 trees										
Outreach and fundraising										
Tree installation and maintenance										
Alum Treatment of Lake Macatawa										
Complete feasibility study										
Permitting										
Treatment (as needed based on monitoring)										
Monitoring										
Conduct educational workshops/ events to producers/ residents throughout Macatawa Watershed following I&E plan (Chapter 7)										
Continuous outreach/ education efforts to watershed residents via online, social media, newspaper, attending community events, etc. See Chapter 7 for more details										

9.0 EVALUATION AND MONITORING PLAN

The goal of this watershed management plan is to assist the community of the Macatawa Watershed in ensuring the long-term protection and improvement of its streams and surrounding lands, with focus on the designated uses applicable to the Macatawa Watershed that are mandated by state and federal water quality programs. The progress made in achieving the goals and objectives of this plan must be measured to determine overall effectiveness. Chemical, physical, and biological water quality monitoring, as well as social monitoring, can be used to help assess progress towards meeting watershed goals, including ensuring that the Macatawa Watershed is meeting WQS and providing the designated uses. Data collected through monitoring should be utilized to take an adaptive management approach to refining the implementation of the WMP. Adaptive management is a complicated process but essentially involves accruing information necessary to guide future management. An iterative and ongoing process connects project objectives, implementation, timelines, and budgets with some measure of success (monitoring).

Progress in implementing this WMP will be tracked by monitoring:

- Social indicators
- Use of existing partnership programs
- Policy adoption and implementation
- BMP adoption
- Water quality

9.1 Social Indicators

Program assessments can be conducted on an ongoing basis through evaluations and surveys at workshops and educational events, focus groups, meetings, media coverage, and social media participation. Interactive events provide opportunities to gather Community feedback from the public. This feedback can be used to adapt the I&E strategy, as needed. Larger scale community surveys, such as the Social Survey, should follow an approved QAPP and results compared to previous survey results described in Chapter 7.

Evaluation measures will provide feedback to determine what methods work and areas that still need improvement. Although evaluation of specific components within the I&E Strategy will occur continuously, the I&E Strategy should be periodically reviewed and adjusted, as necessary. Questions that should be considered during implementation of the I&E Strategy are listed below.

- Are the planned activities being implemented according to the schedule?
- Is additional support needed?
- Are additional activities needed?
- Do some activities need to be modified or eliminated?
- Are the resources allocated sufficient to carry out the tasks?
- Are all of the target audiences being reached?
- What feedback has been received and how does it affect the I&E strategy program?
- How do the BMP implementation activities correspond to the I&E strategy?

The most meaningful evaluation measure will be to improve water quality and stability of the Macatawa River and its tributaries.

9.2 Partnership Programs

Several existing programs that also assist in protecting water from NPS pollutants, such as conservation easements, NRCS Farm Bill Programs, and MAEAP. The WMP plan should leverage these programs to seek technical and financial assistance for landowners to implemented BMPs. Participation in these programs in the future compared to previous years can be tracked and evaluated.

9.3 Policy Adoption and Implementation

Recommendations are included in this plan related to septic system policies, wetland protection, and other protective policies at the local municipality level, among others. The number of policies adopted and being implemented should be measured as a benchmark.

9.4 BMP Tracking and Interim Measurable Milestones

BMPs recommended in this plan to address the watershed impairments are practices known to help improve water quality. Monitoring associated with BMPs provides evidence that progress is or is not being made at reducing pollutant loading. Agricultural BMPs can be tracked using tillage surveys that should follow an approved QAPP (Appendix J).

9.5 Water Quality Monitoring

Direct surface water measurements and biological monitoring can be used to determine if the watershed is meeting the goals and objectives of this WMP. Tracking water quality improvements associated with the implementation of BMPs is a top priority. Maintaining the water quality where designated uses are currently being met and assessing subwatersheds where the conditions are unknown is a secondary monitoring priority. Specific monitoring should include:

- ODC: Continue annual (year-round, monthly, or biweekly) water temperature monitoring to ensure compliance/document exceedances of water quality standards and to understand long-term variability or change.
- ODC: Conduct periodic (every 3-5 years) sampling for *E. coli* to document compliance or exceedances of water quality standards and conduct microbial source tracking (MST) analysis.
- AWRI/Hope College: Continue annual (growing season) monitoring for phosphorus to document progress toward meeting the TMDL.
- ODC: Develop stream hydrographs to document existing hydrology and to monitor change over time.
- ODC: Understand macroinvertebrate density and diversity (including crayfish) by continuing semi-annual monitoring (twice a year); at least one site on every tributary stream should be established. Follows a MiCorps approved QAPP.
- AWRI: Annually monitor the fish community in Lake Macatawa to understand species composition and monitor for invasive species.
- Work with GVSU and Hope College to combine efforts and continue annual (monthly or bi-weekly, spring through fall) nutrient monitoring at several points throughout the watershed.
- ODC, West Michigan Cooperative Invasive Species Management Area: Document occurrences of any new or particularly destructive invasive species. QAPP not needed.

- ODC: Continue tillage and residue surveys of agricultural lands to identify critical sites for BMP implementation (2024-2025 and repeated after at least 5 years of implementation). Following an EGLE approved QAPP that will be updated as needed (Appendix J).
- ODC: Examine efficacy of soluble and total phosphorus removal techniques novel to Michigan.
- ODC: Continue conducting road stream crossing surveys. The goal is to visit every site in the watershed and then develop a new plan to revisit critical sites to monitor for changes since the initial inventory. Following an EGLE approved QAPP that will be updated as needed (Appendix J).
- ODC and volunteers: Continue conducting weekly (spring through fall) Secchi disk and color readings for Lake Macatawa.
- ODC and volunteers: Continue to expand surface water chloride monitoring (year-round, weekly).
- ODC: Install and maintain Lake Macatawa water quality monitoring buoy using the following parameters: conductivity, temperature, pH, oxidation-reduction potential, dissolved oxygen, turbidity, total algae (chlorophyll and phycocyanin), and fluorescent dissolved organic matter. The buoy will operate spring through fall and take readings every 10 minutes.

Water quality monitoring should follow an approved QAPP, and results should be compared against existing water quality standards. Water quality monitoring results and benchmarks will be assessed to determine whether the practices are resulting in the desired water quality pollutant load reductions. The goal of this WMP is to ensure that the Macatawa Watershed Management Plan is meeting the designated uses described in Chapter 3, and meeting water quality standards for streams whose designated uses are not currently listed as impaired due to limited assessments completed. If pollutant load reductions or water quality improvements are realized following BMP adoption or I&E program implementation, it can be assumed that the BMPs are effectively achieving the goals of the WMP and TMDL. Determining the location of monitoring sites is extremely important in establishing a quality data set. Site locations will depend on a variety of factors, including the parameter being measured, the purpose of the monitoring (to describe baseline conditions, to understand long-term trends, to record change over time, to evaluate site-specific BMPs, etc.), accessibility and more. As monitoring plans are developed, expertise of local project partners must be utilized to determine the best site locations for all data collection.

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