MACATAWA WATERSHED MANAGEMENT PLAN

JUNE 2012

Macatawa Watershed Project

Macatawa Area Coordinating Council

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ACRONYMS

BMP: Best Management Practice

I & E: Information and Education

EPA: United State Environmental Protection Agency

MACC: Macatawa Area Coordinating Council

MDEQ: Michigan Department of Environmental Quality

MS4: Municipal Separate Sewer System

MWP: Macatawa Watershed Project

NRCS: Natural Resources Conservation Service

ODCMG: Outdoor Discovery Center Macatawa Greenway

TMDL: Total Maximum Daily Load

WMP: Watershed Management Plan

ACKNOWLEDGEMENTS

CURRENT ACKNOWLEDGEMENTS

Work to create an updated management plan for the Macatawa Watershed began in 2008 when the Macatawa Area Coordinating Council (MACC) secured a Section 319 grant from the Michigan Department of Environmental Quality (Tracking Code #2008-0016). At that time, the MACC reconfigured the number and frequency of stakeholder committees and set out on an ambitious work plan of gathering a vast amount of new and updated monitoring and modeling data with significant community input.

The MACC greatly appreciates the help of Julia Kirkwood, Michelle Storey and Peter Vincent from the Michigan Department of Environmental Quality (MDEQ) for their technical assistance throughout the process of developing the watershed management plan. The MACC also appreciates the flexibility that was afforded to this project and the Section 319 grant, both in scope and timeline.

The development of this new and updated plan would not have been possible without our collaborating partners including Hope College, the Outdoor Discovery Center-Macatawa Greenway, the Ottawa and Allegan Conservation Districts and the local units of government who are members of the MACC. These partners contributed an extensive amount of time, knowledge and funding to help support this project. Also crucial is the dedication and interest of a large number of committee members who regularly attended over 40 committee meetings during the three year period of the grant. Committee membership is described in Section 1.3.

Finally special recognition should be afforded to the various MACC staff members that were involved in this project and led the way to create a renewed sense of ownership and stewardship for Lake Macatawa. Those staff members are Beth McDonald (former Storm Water Specialist), Mary Fales (current Watershed Coordinator), Sue Higgins (former Executive Director) and Steve Bulthuis (current Executive Director). Special help was contributed by MACC support staff including Kara Scheerhorn and Dan Callam.

HISTORICAL ACKNOWLEDGEMENTS

This first Implementation Plan for the Macatawa Watershed was developed in 1999 by community members who recognized the value of the clean water and wanted to pursue that goal in the Macatawa Watershed. The plan was later updated in 2005. The cooperation of local residents, business, industry and municipal leaders, the MDEQ, and the U.S. Environmental

Protection Agency (EPA) made the development of the project truly unique. The following groups and individuals deserve distinguished recognition for their early involvement in the Macatawa Watershed Project.

Past Watershed Project Committee members, including Ted Bosgraaf, Lee Dell, Carol Quinn, Robert DenHerder, Bruce Rabe, and Charamy Butterworth, provided the Project with the necessary and invaluable leadership to ensure its acceptability and success.

Bill Creal deserves special recognition for securing the initial grant from the EPA and approaching the Macatawa Area Coordinating Council to host the project. Mike Walterhouse and Doyle Brunson organized and executed one of the most extensive sampling efforts ever to be conducted for a watershed in Michigan during that time.

Finally, the first phase of this project would not have been possible without the financial backing of local contributors. The support of the following contributors enabled project staff and committee members to assemble the most comprehensive, scientific, and meaningful study and Implementation Plan possible.

Aves, John and Melanie
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Frey Foundation
Haworth, Inc.
Heinz HJ CO
Herman Miller
Holland Board of Public Works
Holland Country Club
Mead Johnson
Miller, Jack
Parke-Davis
Slikkers Foundation
The George and Lucile Heeringa Foundation
The Louis and Helen Padnos Foundation
Uniform Color Co
Zeeland Waste Water Fund

1.0 INTRODUCTION

IN THIS SECTION YOU WILL UNDERSTAND:

- THE HISTORY OF THE MACATAWA WATERSHED PROJECT
- THE PURPOSE OF DEVELOPING THIS PLAN
- HOW THE PUBLIC WAS INVOLVED IN DEVELOPING THIS PLAN
- THE CURRENT WATER QUALITY CONDITION OF THE MACATAWA WATERSHED
- THE OVERALL WATER QUALITY GOALS OF THIS PLAN

Acronyms are defined on page xi

1.1 THE MACATAWA WATERSHED PROJECT

The Macatawa Watershed Project (MWP) is a program of the Macatawa Area Coordinating Council (MACC). The MACC is an area-wide association of governmental units adjacent to Lake Macatawa, including the Cities of Holland and Zeeland, the Townships of Holland, Zeeland, Fillmore, Laketown, Park, Port Sheldon, and Olive; Ottawa and Allegan Counties, and Ottawa and Allegan County Road Commissions.

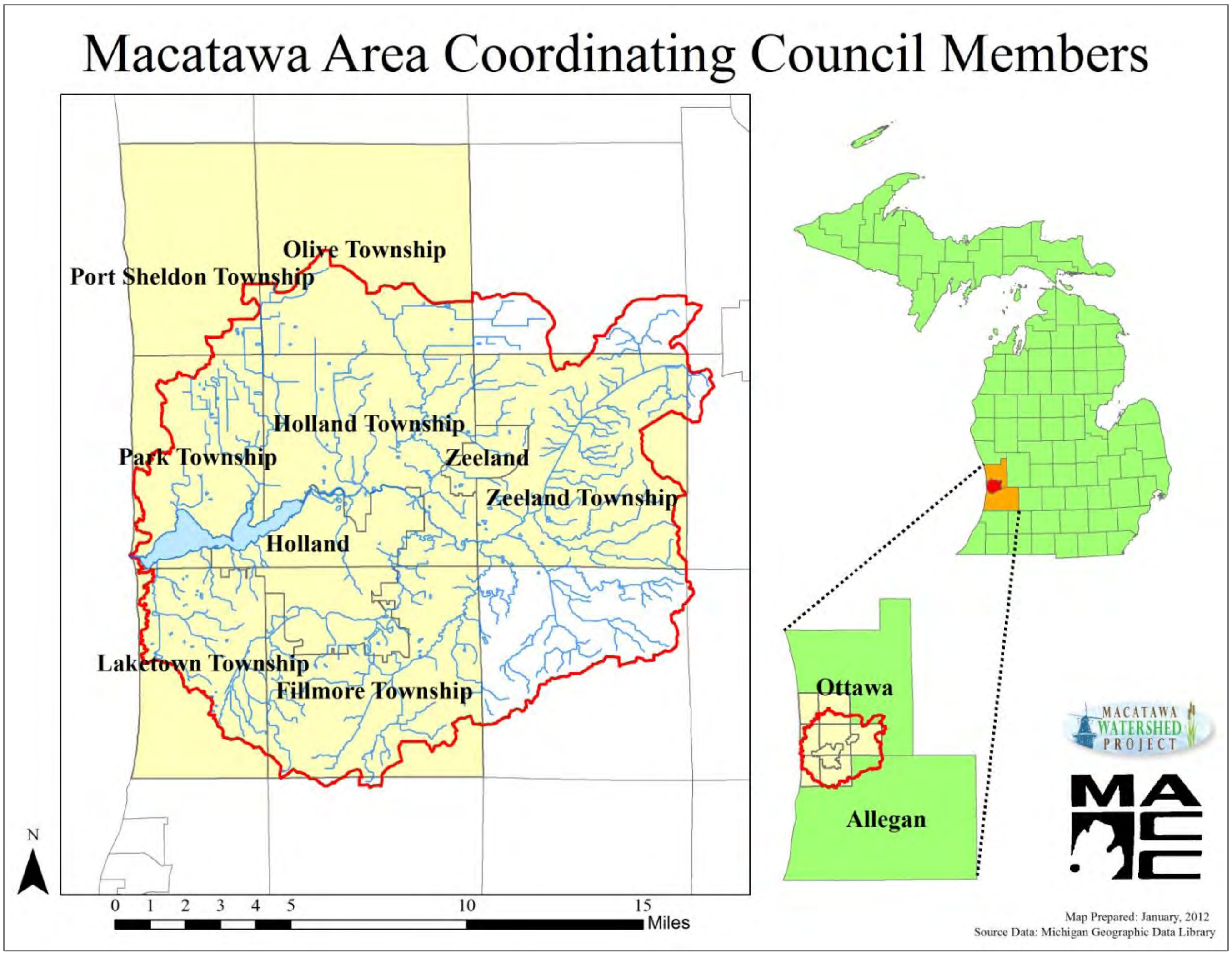


Figure 1. Governmental units that are members of the MACC (Macatawa Watershed boundary shown in red).

The MACC began as a voluntary association in 1988. However, in 1993 it gained official status as a Metropolitan Planning Organization (MPO).The MACC facilitates consensus building on public policy decisions, which impact the greater Holland/Zeeland community and is specifically charged to "encourage cooperation among neighboring units of government on area-wide issues". Currently, the MACC is involved with numerous community projects including transportation planning, the Clean Air

Action Program, planning for non-motorized trails, brownfield redevelopment, and governmental collaboration in service delivery.

In 1996, biologists from the Michigan Department of Environmental Quality (MDEQ) conducted a year-long 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 (see Appendix A) 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 of the total phosphorus load.

In 1999, the MDEQ developed a Phosphorus Total Maximum Daily Load (TMDL) for Lake Macatawa, which was approved by the EPA in 2000 (Walterhouse 1999; see Appendix A). A TMDL effectively develops pollutant reduction targets for the local community. To begin meeting water quality standards, the TMDL identified an annual phosphorus loading goal of 55,000 lbs which represents a 60% reduction. However since most of the loading in Lake Macatawa is from nonpoint sources, most of that required reduction must also come from reductions in nonpoint source loading. The point source dischargers of Lake Macatawa have been granted an annual discharge limit of 20,000 lbs of phosphorus. In turn, that means that we must reduce nonpoint phosphorus loading from an estimated 126,100 lbs annually to 35,000 lbs annual for a 70% reduction.

Shortly after the development of the Phosphorus TMDL, the members of the MACC, recognizing the importance of working collaboratively to meet this enormous goal, negotiated a document entitled *The Lake Macatawa Watershed Agreement Reduction of Phosphorus Loading*, commonly referred to as the “Voluntary Agreement” (see Appendix A). The Voluntary Agreement was signed by MDEQ, representatives from the major point sources and pertinent members of the MACC in May 2000. The document serves as a formal symbol of the commitment of community members to continually work to improve water quality in Lake Macatawa. The Voluntary Agreement (slightly revised) was formally renewed in July 2010 by resolution of the MACC Policy Committee (see Appendix A). **All members of the MACC provide funding to support the long-term goals of the Macatawa Watershed Project.**

1.2 Purpose of the Watershed Management Plan

The MACC has developed this watershed management plan under the auspices of the Macatawa Watershed Project (MWP). The plan was developed *for* the community with substantial input *from* the community. It is intended to provide a framework for water quality improvement activities for approximately the next 10 years. It is our understanding via communication with the MDEQ that the

Phosphorus TMDL remains in effect for the Macatawa Watershed until water quality monitoring demonstrates that water quality parameters meet state water quality standards.

The EPA has developed certain minimum criteria that watershed management plans must meet. These criteria are commonly referred to as the "the Nine Key Elements". The Michigan Department of Environmental Quality (MDEQ) has reviewed this document and has certified that it is in compliance with these strict standards.

The purpose of having such a plan is to efficiently guide watershed-related outreach, research and implementation projects to ensure continued and measurably progress over time. All of the goals, objectives and tasks in this plan have been prioritized in such a way to ensure that the most pressing water quality issues are focused on at all times.

1.3 PUBLIC PARTICIPATION AND INPUT

This strength of this plan is that it was developed with significant guidance from a wide variety of local stakeholders over a three year period. Stakeholders represent local units of government, schools, environmental advocacy groups, agricultural agencies, road commissions, county drain offices, conservation districts, business, and private citizens among others.

A draft version of this watershed management plan was posted on the MACC's website for public comment and review on March 8, 2012. Comments were accepted until June 19, 2012.

There are currently five active committees including the Policy Committee, the Watershed Planning Committee, the Information and Education Subcommittee, the Agricultural Outreach Committee and the Storm Water Committee. With the exception of the Storm Water Committee, all meetings are public and announced to various stakeholders via email, the MACC's website and watershed newsletters. Committee meetings are held on a regular basis. Following is a description of the Macatawa Watershed Project Committees, their functions, and membership.

1. MACC Policy Committee

The MACC Policy Committee meets monthly and consists of representatives from each of the member local units of government along with representatives from the Michigan Department of Transportation, the local public transit authority, and five representatives from the local community. Activities of the MWP and elements of this watershed management plan were presented to the MACC Policy and Executive Committee members monthly.

The MACC Policy Committee meetings are recorded and air multiple times on the local community access broadcasting company, MacTv (MacMedia). This outreach tool is a very effective way to reach the public. We receive reports of residents who have viewed our meetings on the community access station and have become aware of local watershed issues, events, meeting dates and locations.

2. Watershed Planning Committee and Information and Education Subcommittee

The Watershed Planning Committee (WPC) meets every other month and is comprised of various community stakeholders including MACC member units of government, the Macatawa Watershed Association, Hope College, Ottawa County Health Department, Michigan State University Extension, local Conservation Districts, Ottawa County Parks Department, Ottawa and Allegan County Drain Offices, Ottawa and Allegan County Road Commissions, representatives from the MDEQ, local environmental advocacy groups, and interested private citizens.

The WPC has been meeting regularly since 2009 and was the primary group that provided guidance and review of this planning document. Some members of the WPC also participated on the Information and Education Subcommittee that developed the Information and Education Strategy (Section 4.8, Appendix B). The WPC hosted two well-attended public events in preparation for the development of this plan, the Conservation Planning Meeting (November 2009) and the Watershed Visioning Meeting (March 2010).

Watershed Planning Committee Meeting, 2011

3. Agricultural Outreach Committee

The Agricultural Outreach Committee (AOC) meets every other month and is comprised of various community stakeholders including local farmers, MACC member units of government, Hope College, the Ottawa and Allegan County Drain Offices, Michigan State University Extension, local Conservation Districts, representatives from the MDEQ, local environmental advocacy groups, and interested private citizens.

The AOC has been meeting regularly since 2009 and was the primary group that provided guidance and review of the agricultural-related sections of this document. The AOC hosted a Fall Farmer Event (October 2011) as a way to involve local farmers in the development of this plan and other projects.

4. Storm Water Committee

The Storm Water Committee (SWC) meets quarterly and is comprised of a representative from the MDEQ and the six local units of government that are permitted under the State of Michigan's MS4 Program (Municipal Separate Storm Sewer System) including the City of Holland, the City of Zeeland, Ottawa County Drain Office, Allegan County Drain Office, Ottawa County Road Commission and Allegan County Road Commission.

The SWC reviews and oversees implementation of the MS4 NPDES Permit (National Pollutant Discharge Elimination System) under six broad categories including public education, public participation, illicit discharge detection and elimination, construction site runoff control, post-construction site runoff control, and pollution prevention and good housekeeping.

1.4 THE VISION

In March of 2010, the MACC brought a wide array of stakeholders together to dream about what Lake Macatawa could be like in the future. The meeting resulted in the development of a broad vision statement for the Macatawa Watershed:

The goal of this plan, of the Macatawa Watershed Project and of the broader community, is clear. We strive for a cleaner, more enjoyable Lake Macatawa, and we believe that we can make progress towards achieving this vision by implementing this management plan.

Recreation at Kollen Park alongisde Lake Macatawa,
Photo contributed by Greg Holcombe

1.5 General Water Quality Condition

Lake Macatawa, which falls along the border of Ottawa and Allegan Counties in southwestern Michigan, is a 1780-acre drowned river mouth that empties into Lake Michigan. The Macatawa Watershed extends 175 mi^2 across southern Ottawa County and northern Allegan County and includes Lake Macatawa, the Macatawa River, and numerous smaller tributaries (Fongers 2009).

Lake Macatawa is considered to be one of the most hypereutrophic lakes in the State of Michigan and suffers from excessive levels of phosphorus and sediment, intense blue green algae blooms (with detectable levels of microcystin), and frequent beach closures due to unsafe levels of *Escherichia Coli* (*E.coli*) bacteria. Lake Macatawa and all of its major tributaries have been designated by the State of Michigan as not meeting basic water quality standards, largely due to nonpoint source pollution. The cause of these impairments is listed as sedimentation, siltation and total phosphorus (MDEQ's 2010 Integrated Report, Appendix F, see Section 3.3 for more explanation).

1.6 OVERALL WATERSHED MANAGEMENT PLAN GOALS

The MWP worked closely with watershed stakeholders to discuss the ultimate goals and objectives of this plan. In general, there are three overarching goals:

1. ***Restore*** water quality to meet state water quality standards and the Total Maximum Daily Load

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

There are many pollutants that can threaten to degrade water quality in any one ecosystem. Some of these pollutants are naturally occurring or affect properties of the water that make it hard to support aquatic life. This plan is intended to address the following pollutants, listed in order of priority:

Tier 1	Tier 2	Tier 3
• Nutrients • Sediment • Temperature • Hydrology	• *E.Coli* bacteria	• Chemical Contaminants • Invasive Species • Chloride • Man-made debris • Mercury/PCBs

Figure 2. Pollutants of concern in the Macatawa Watershed, prioritized by importance.

Tier 1 and Tier 2 pollutants are known to directly impede the Macatawa Watershed from meeting water quality standards as designated by the State of Michigan. Tier 3 pollutants include contaminants that were identified by stakeholders to be of community concern. Tier 3 pollutants deserve further research to identify the level of threat they pose to water quality in the Macatawa Watershed. In general, this plan addresses only Tier 1 and Tier 2 pollutants.

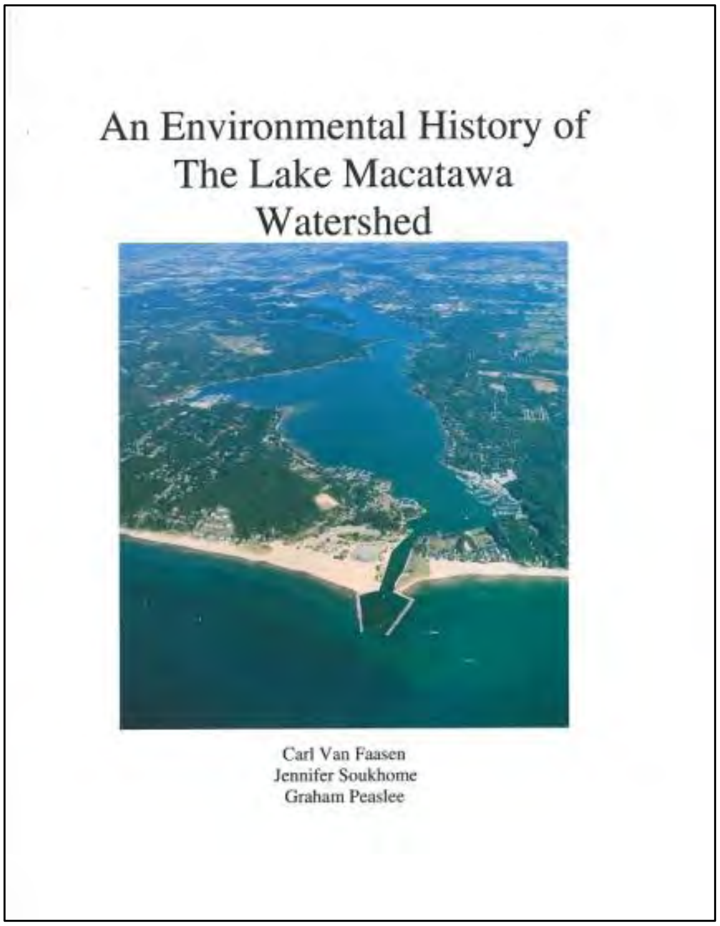
1.7 SECTION 1.0 REFERENCES

Fongers, D. 2009. Macatawa Watershed Hydrologic Study. Hydrologic Studies Unit. Land and Water Management Division. Michigan Department of Environment Quality.

Walterhouse, M. 1998. Phosphorus loading assessment for Lake Macatawa, 1995 through 1997. Report No. MI/DEQ/SWQ-98/015.

Walterhouse, M.1999. Total maximum daily load (TMDL) for phosphorus in Lake Macatawa. Michigan Department of Environmental Quality.

2.0 WATERSHED HISTORY AND CHARACTERISTICS



IN THIS SECTION YOU WILL LEARN IMPORTANT CHARACTERISTICS ABOUT THE WATERSHED:

- GEOGRAPHIC EXTENT
- CULTURAL HISTORY
- GEOLOGY, TOPOGRAPHY, SOILS
- ECOLOGY
- LAND USE AND LAND COVER
- POPULATION AND DEMOGRAPHICS
- TRANSPORTATION, ROAD STREAM CROSSINGS AND STORM WATER

The watershed's environmental and cultural history has been extensively studied and documented in Van Faasen et al. 2008 and that information is summarized here. To find out how to obtain a copy of the book, please contact a local Holland bookstore or email the MACC at info@the.macc.org.

* Van Faasen, C, J. Soukhome and G. Peaslee. 2008. An Environmental History of the Lake Macatawa Watershed. Holland Litho, Holland, Michigan.

2.1 GEOGRAPHIC EXTENT

Lake Macatawa, in southern Ottawa County, Michigan, is an 1800-acre (2.75 mi^2) drowned river mouth which empties into Lake Michigan (Figure 3). The Macatawa Watershed extends into Ottawa and Allegan counties, covers approximately 112,000 acres (175 mi^2), and includes Lake Macatawa, the Macatawa River and numerous small tributaries (Fongers 2009). The watershed is representative of many other coastal watersheds on Michigan's southwestern shore, such as the Pere Marquette, White, Galien, Black, Betsie, Jordon, Big Sable, and Paw Paw River.

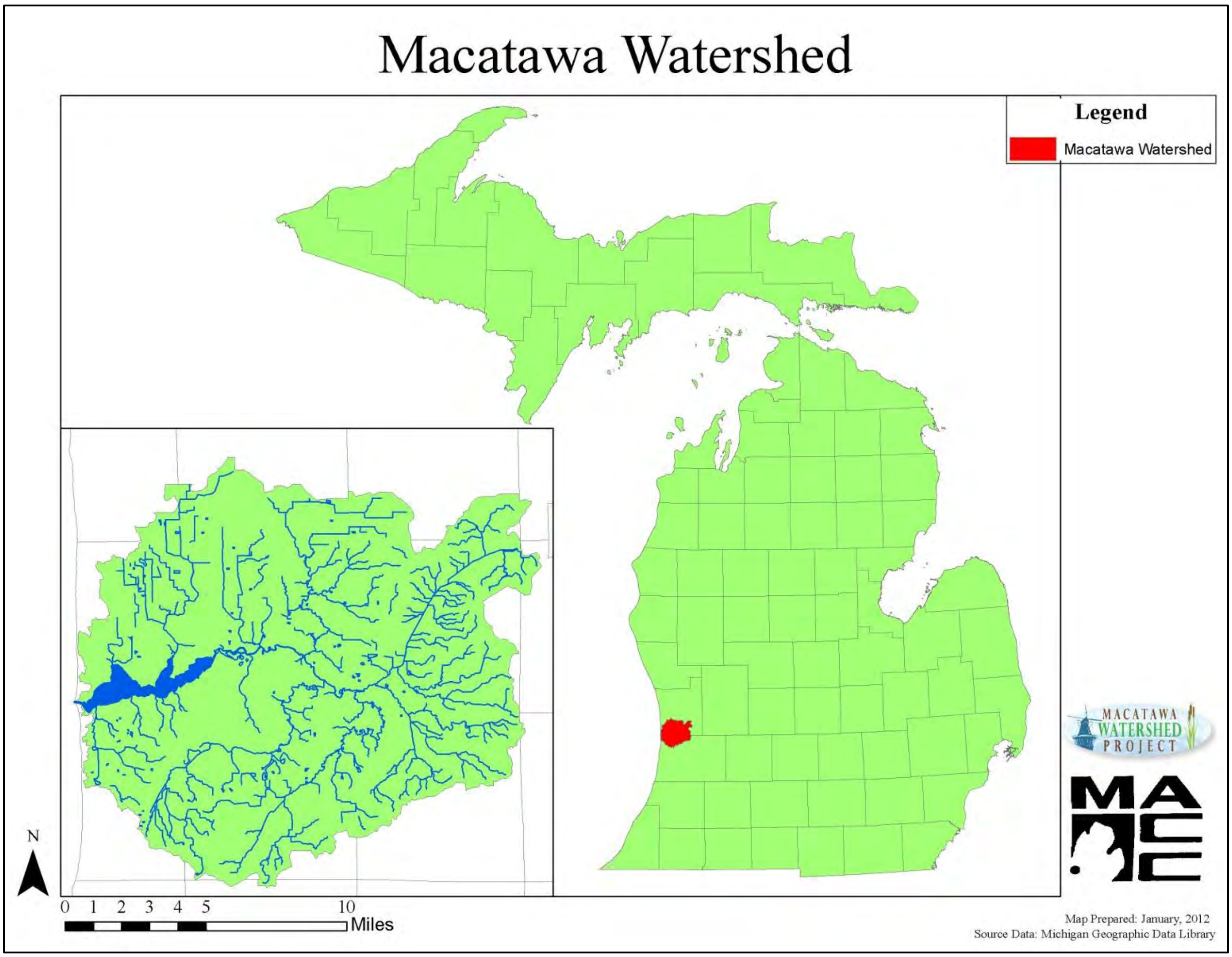


Figure 3. General location of the Macatawa Watershed in southwestern Michigan.

In total, the Macatawa Watershed extends over parts of twelve townships, two cities and two counties. It should be noted that not all the local units of government with land inside the Macatawa Watershed are members of the MACC. MACC members are shown in Figure 1. All the governmental units with land area in the Macatawa Watershed are shown in Figure 4 and described in Table1.

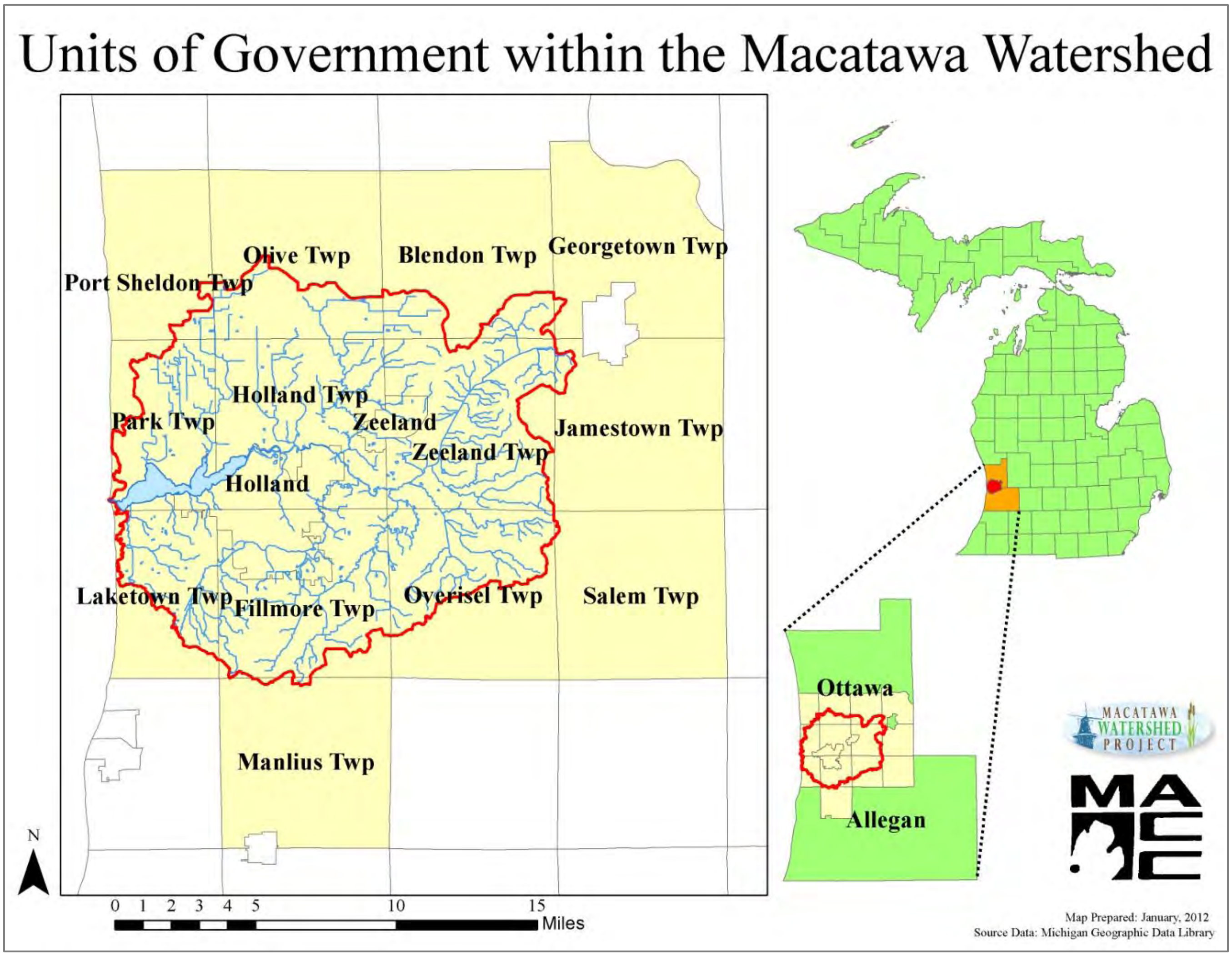


Figure 4. Governmental units in the Macatawa Watershed.

Table 1. Summary of land area and local units of government within 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 Township	34.4	91.4	31.5
Holland 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 Township	35.5	2.1	0.8
Manlius Township	35.9	0.74	0.27
Salem Township	36.0	0.19	0.07
Georgetown Township	34.1	0.05	0.02
Total Square Miles	425.97		**174.4**

The Macatawa River flows west through Zeeland Township and south of the City of Zeeland, where it is joined by several of its largest tributaries from the south in short succession, including Peters Creek, the South Branch of the Macatawa River and the North Branch of the Macatawa River. The main branch continues to flow through the southern part of Holland Township, where it is joined by its largest tributary from the north, Noordeloos Creek. Finally, the river flows along the northern edge of the City of Holland through the Windmill Island marshlands until it reaches Lake Macatawa. Lake Macatawa receives 90% of its water from the Macatawa River (formally called Black River). The second largest direct tributary to the lake is Pine Creek (from the north) with numerous smaller tributaries entering the lake on the south side (Figure 5). Note that Figure 5 is the only map throughout the plan that has individual waterways labeled.

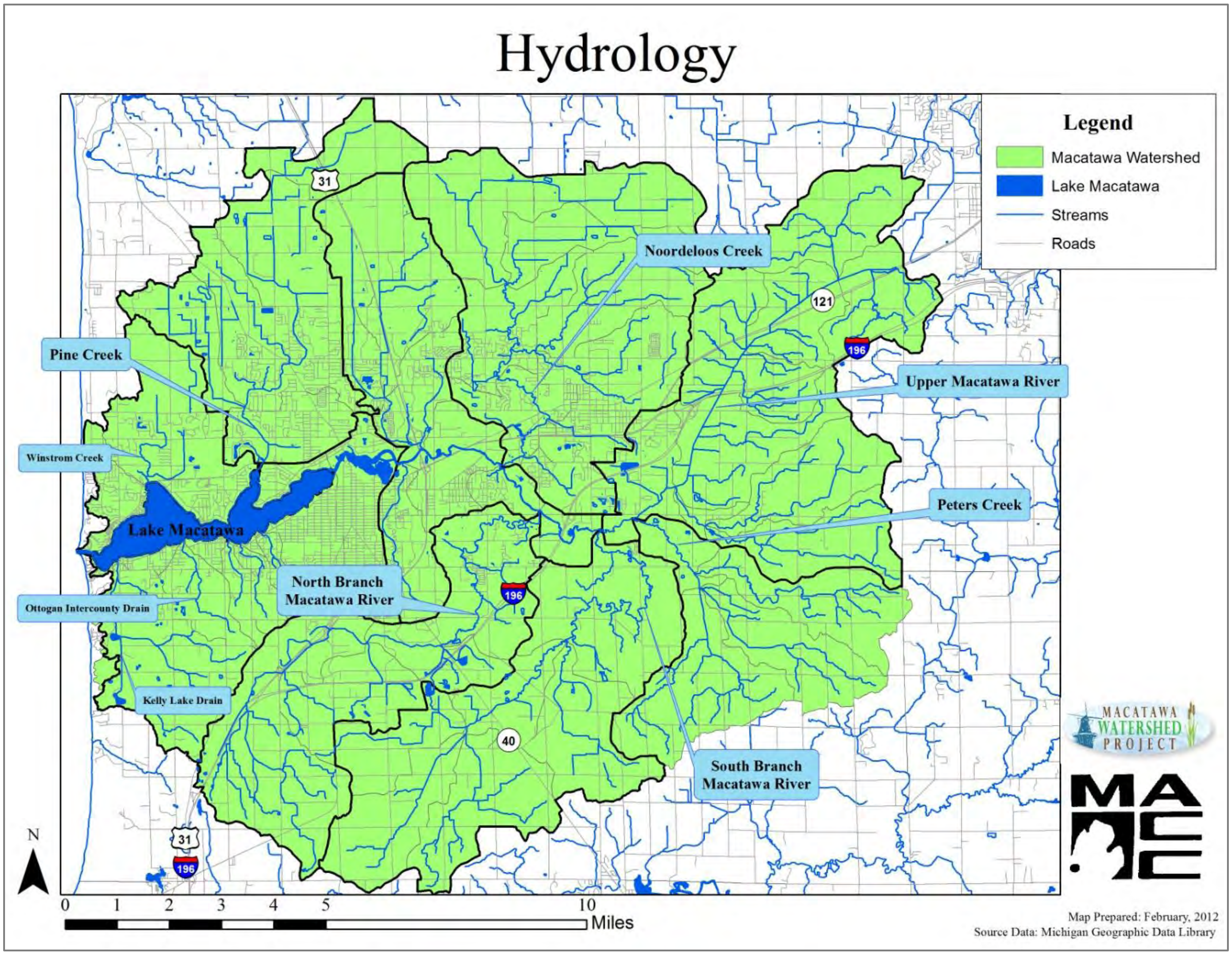


Figure 5. Hydrology of the Macatawa Watershed.

The watershed can be divided into seven major subbasins and 55 minor subwatersheds (Figure 6 and Table 2). The watershed management plan recommendations are predominantly based on analysis and prioritization at the subwatershed level. Note that Figure 6 is the only map throughout the plan that has all 55 subwatersheds labeled.

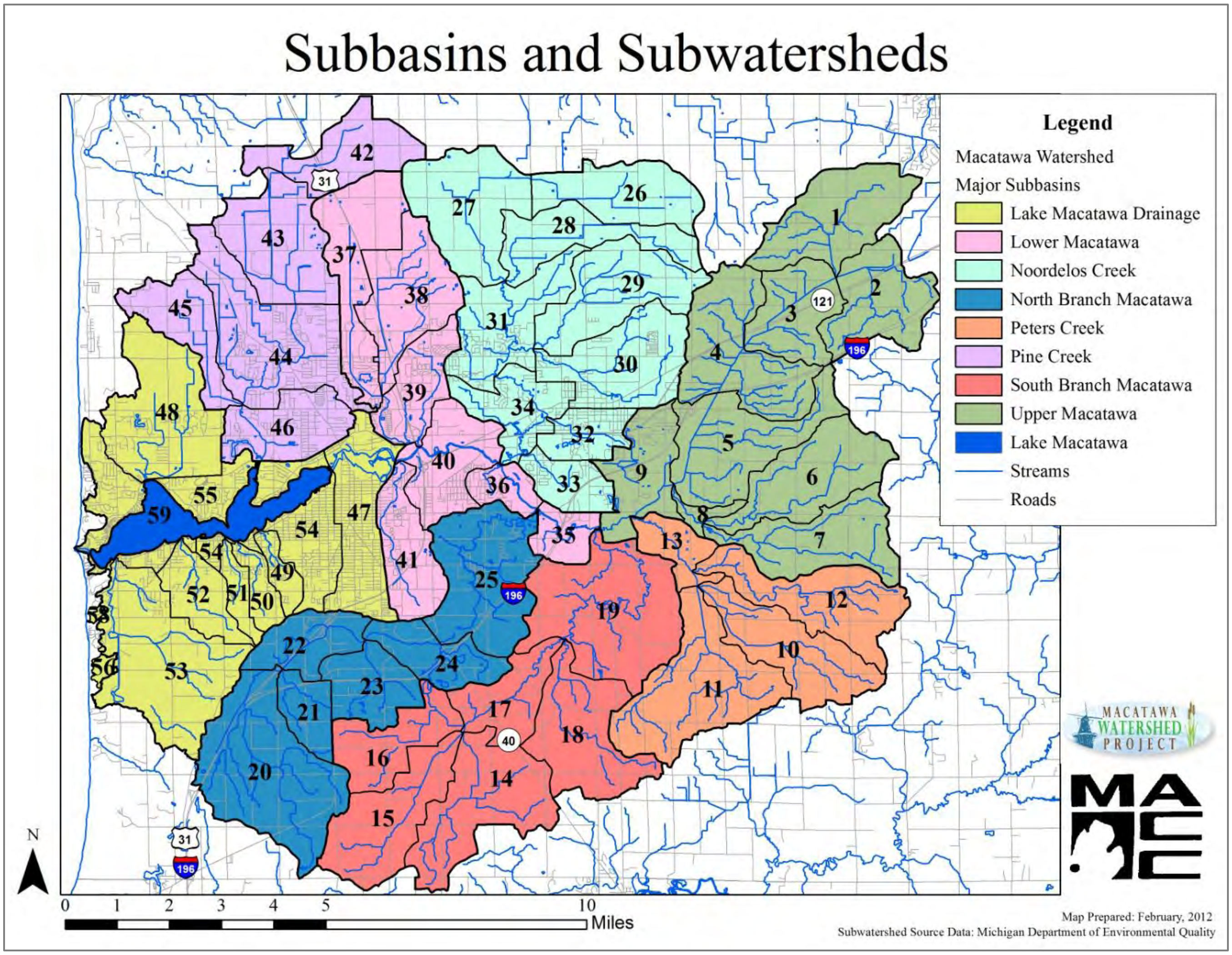


Figure 6. The subbasins and subwatersheds of the Macatawa Watershed.

Table 2. 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		
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		

Subwatershed	Name	Subwatershed Area (acres)	Major Subbasin	Subbasin Area (acres)
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**

2.2 GEOLOGY AND TOPOGRAPHY

Landforms in the Macatawa Watershed include sandy dunes that dot the western edge of the watershed to flat, sandy areas in the western portion of the watershed to rolling hills and valleys in the eastern portion of the watershed (Figure 7). The varied landforms reflect the area's geology and cycle of glacial development, movement and retreat.

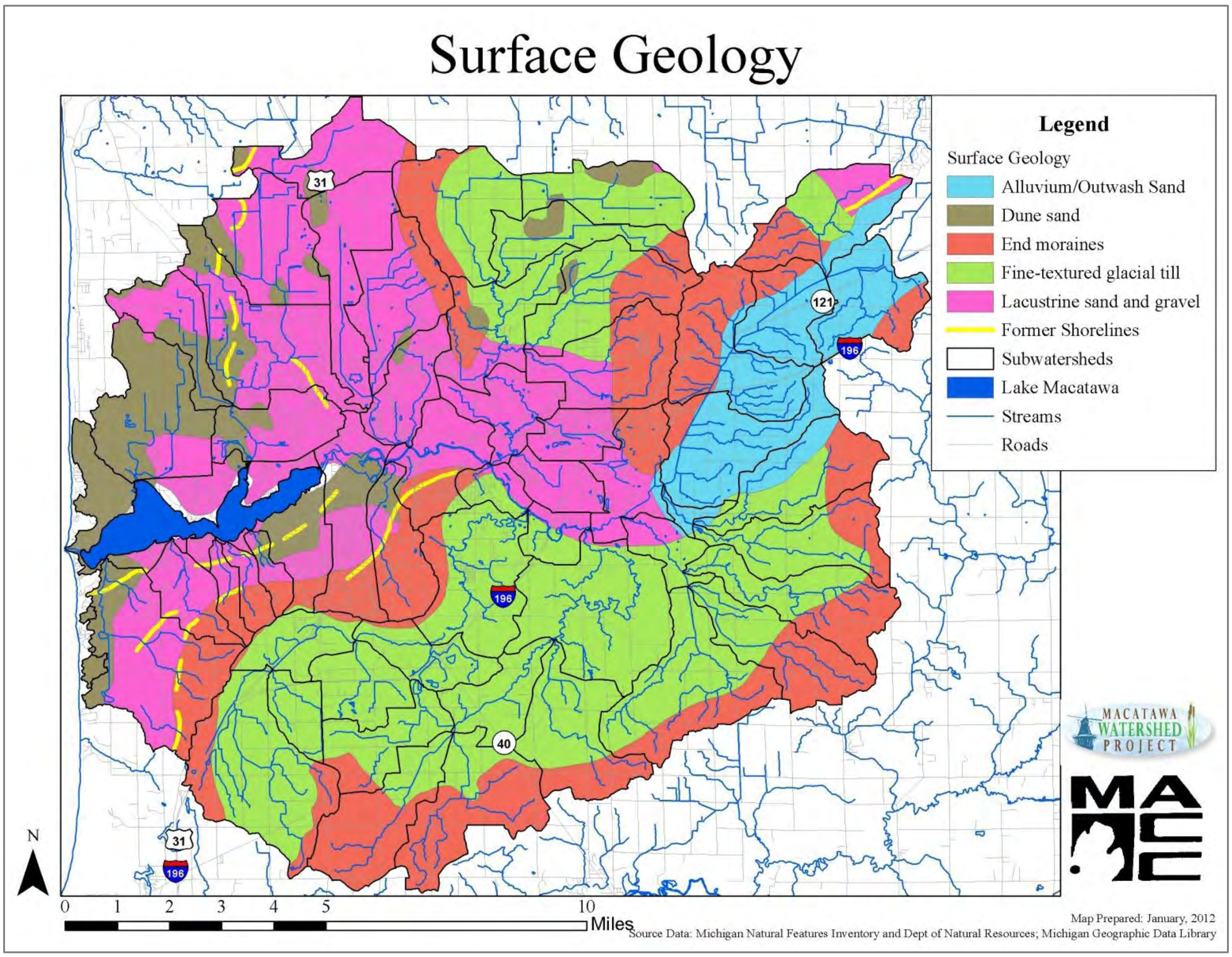


Figure 7. Surface geology of the Macatawa Watershed.

The top layers of bedrock in the watershed date back to the Mississippian period (355 to 320 million years ago) and consist of mostly limestone and shale with occasional pockets of sandstone (known as Waverly Sandstone). This bedrock layer is typically covered by 200-300 feet of glacial drift. Glacial drift refers to the variety of sand, silt and gravel deposited during the glaciers of the Quaternary period (1.8 million years ago). The western one-third of the watershed is characterized by a flat, sandy outwash plain while the eastern two-thirds of the watershed is more hilly and reflect its formation via glacial moraines.

As the glaciers melted and retreated 14,500 years ago, drainage patterns were forming. The historical location of the Grand River flowed through the City of Zeeland. In fact, the old river bed can still be seen today driving along eastbound Chicago Drive in Zeeland Twp, one can see a wide flat-bottom valley, with mucky black soils where the Grand River once flowed. Over time that drainage pattern changed and receded to the present day location of the Grand River (via Grand Haven).

A stream's ability to move water and sediment depends on its slope. 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 is tributaries (Fongers 2009, Figures 8 and 9).

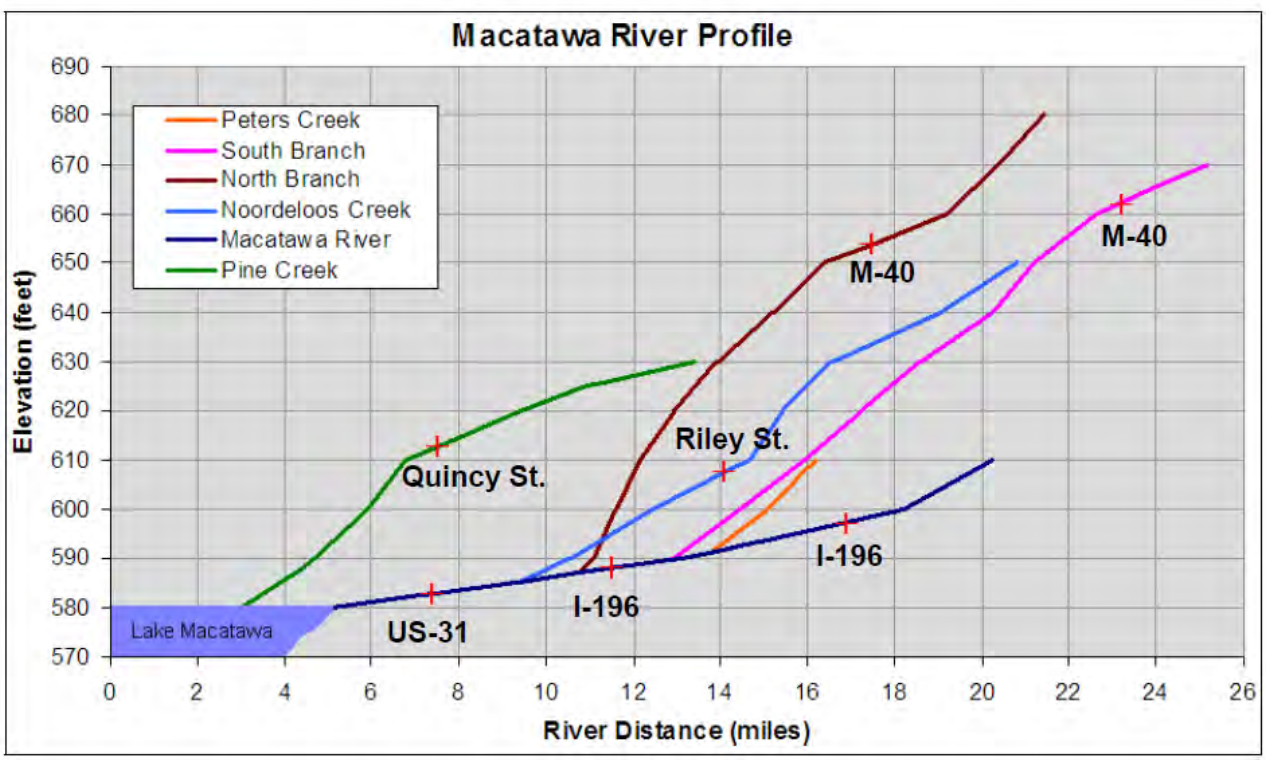


Figure 8. Profile of Lake Macatawa and its major tributaries (Source: MDEQ Macatawa Watershed Hydrologic Study, 2009, Appendix I)

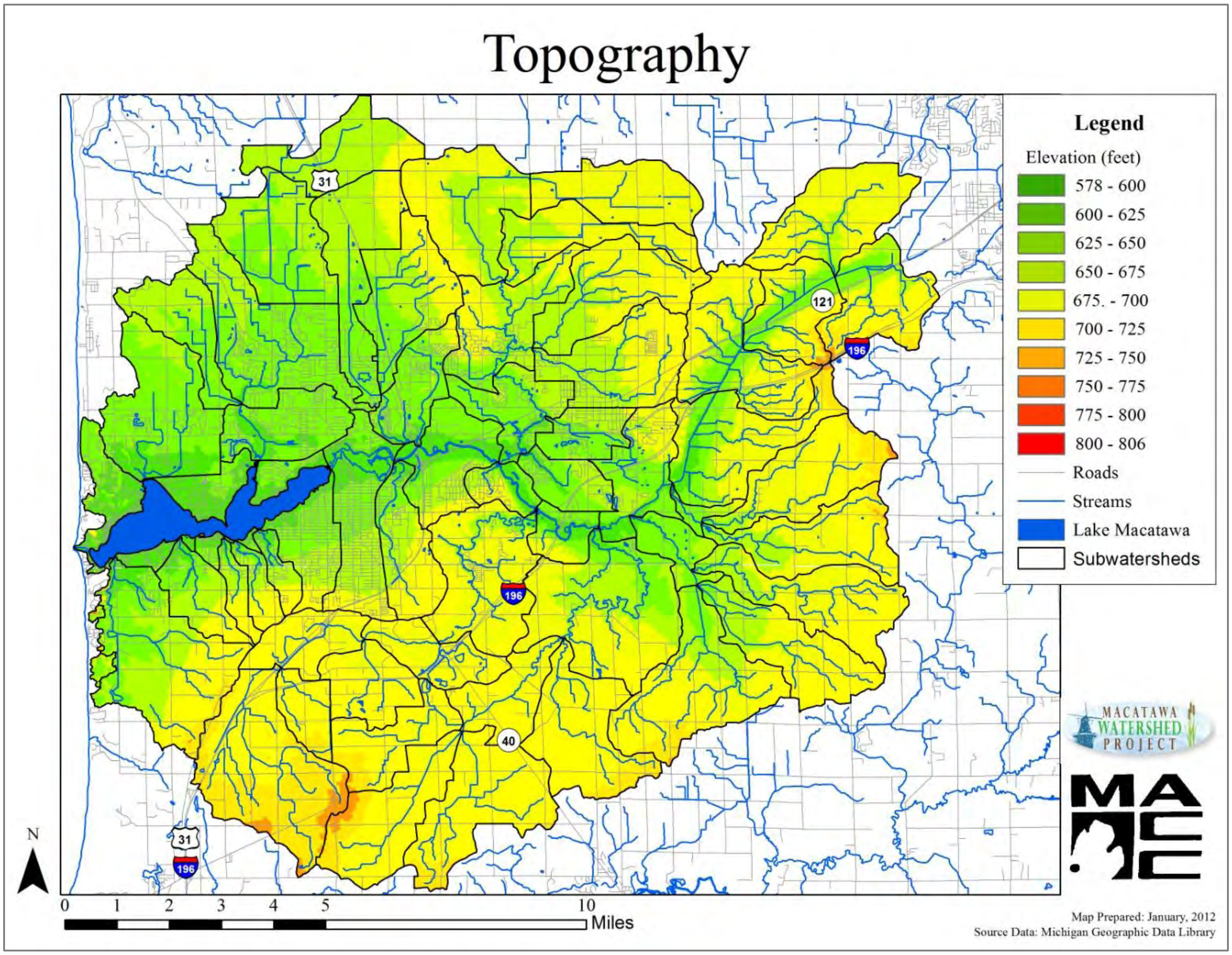


Figure 9. Topography of the Macatawa Watershed.

2.3 SOILS

The land within 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 which hold moisture very well and are rich in nutrients. The most common soil formations are shown in Figure 10 and described in Table 3. The following descriptions are general descriptions of the soil formations (summarized from imformation provided by the Natural Resources Conservation Service) and do not include information specific to the Macatawa Watershed.

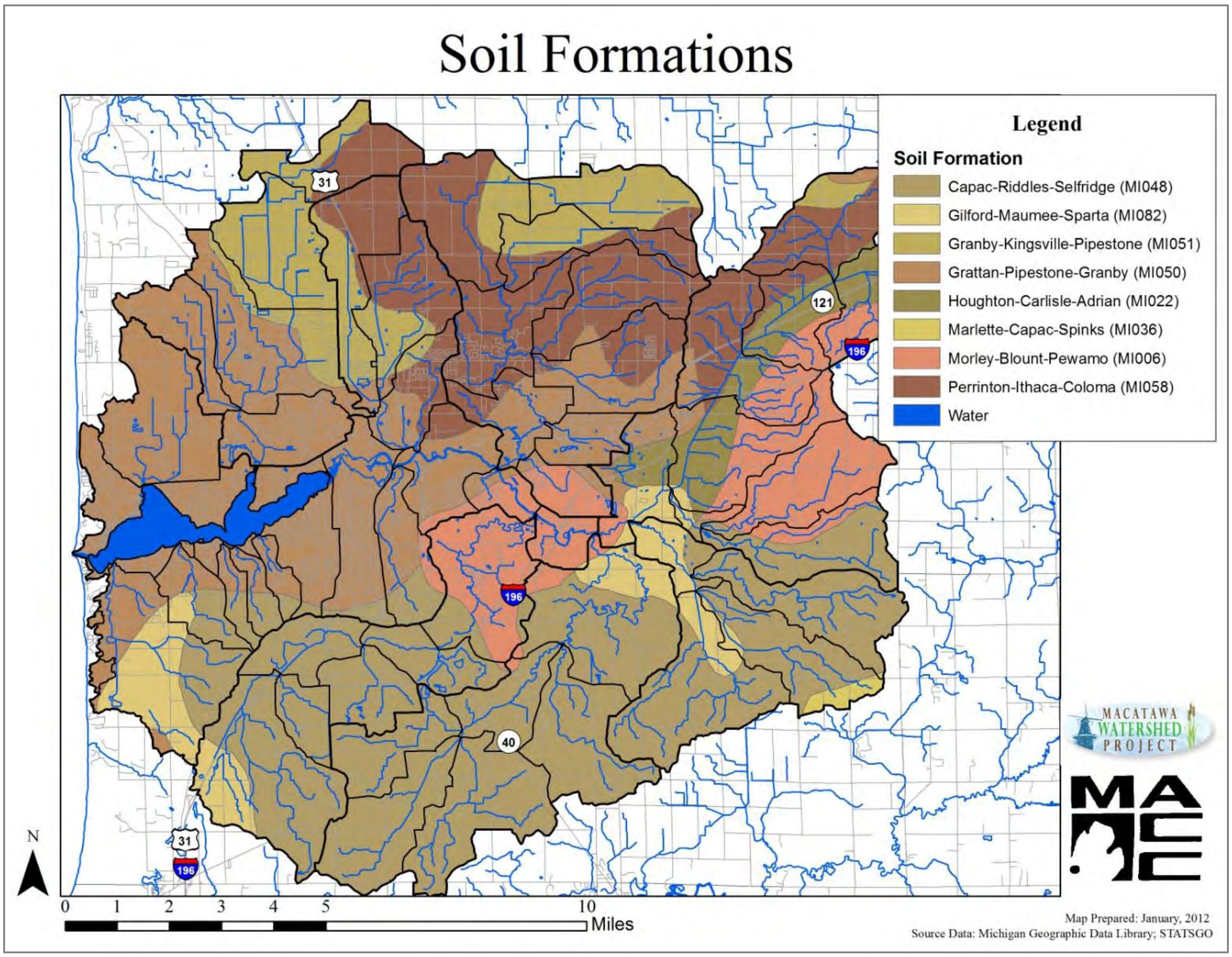


Figure 10. Most common soil formations in the Macatawa Watershed.

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), button bush, 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 also 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 in 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.

Table 3. Land area of most common soil formations in the Macatawa Watershed.

#	Sub-basin	MI006 MBP acres	MBP %	MI022 HCA acres	HCA %	MI036 MCS acres	MCS %	MI048 CRS acres	CRS %	MI050 GPG acres	GPG %	MI051 GKP acres	GKP %	MI058 PIC acres	PIC %	MI082 GMS acres	GMS %
1 2 3 4 5 6 7 8 9	Upper Macatawa	6934	37	3713	20	0	0	1942	10	1095	6	364	2	3858	21	622	3
10 11 12 13	Peters Creek	0	0	0	0	340	4	7473	82	0	0	0	0	0	0	1290	14
14 15 16 17 18 19	South Branch Macatawa	350	2	0	0	0	0	13797	92	0	0	0	0	0	0	846	6
20 21 22 23 24 25	North Branch Macatawa	2441	20	0	0	0	0	8640	72	0	0	0	0	0	0	908	8
26 27 28 29 30 31 32 33 34	Noordeloos Creek	742	4	0.9	0	0	0	0	0	2196	13	4846	28	9221	54	0	0
35 36 37 38 39 40 41	Lower Macatawa	1502	14	0	0	0	0	491	%	3291	30	1990	18	3706	34	12	0
42																	

#	Sub-basin	MI006 MBP acres	MBP %	MI022 HCA acres	HCA %	MI036 MCS acres	MCS %	MI048 CRS acres	CRS %	MI050 GPG acres	GPG %	MI051 GKP acres	GKP %	MI058 PIC acres	PIC %	MI082 GMS acres	GMS %
43 44 45 46	Pine Creek	0	0	0	0	0	0	0	0	5714	51	4328	39	1094	10	0	0
47 48 49 50 51 52 53 54 55	Lake Macatawa Direct Drainage	0	0	0	0	0	0	2438	15	11419	72	0	0	0	0	2028	13
Totals		11970		3714		339		34782		23716		11528		17879		5705	

Soils are more commonly described according to soil texture and the relative quantities of sand, silt and clay. Again, the soil textures reflect the underlying geology with sandy soils to the west and heavier soil to the east (Figure 11). There are even some notable areas of muck soils located along the upper lengths of the Macatawa River.

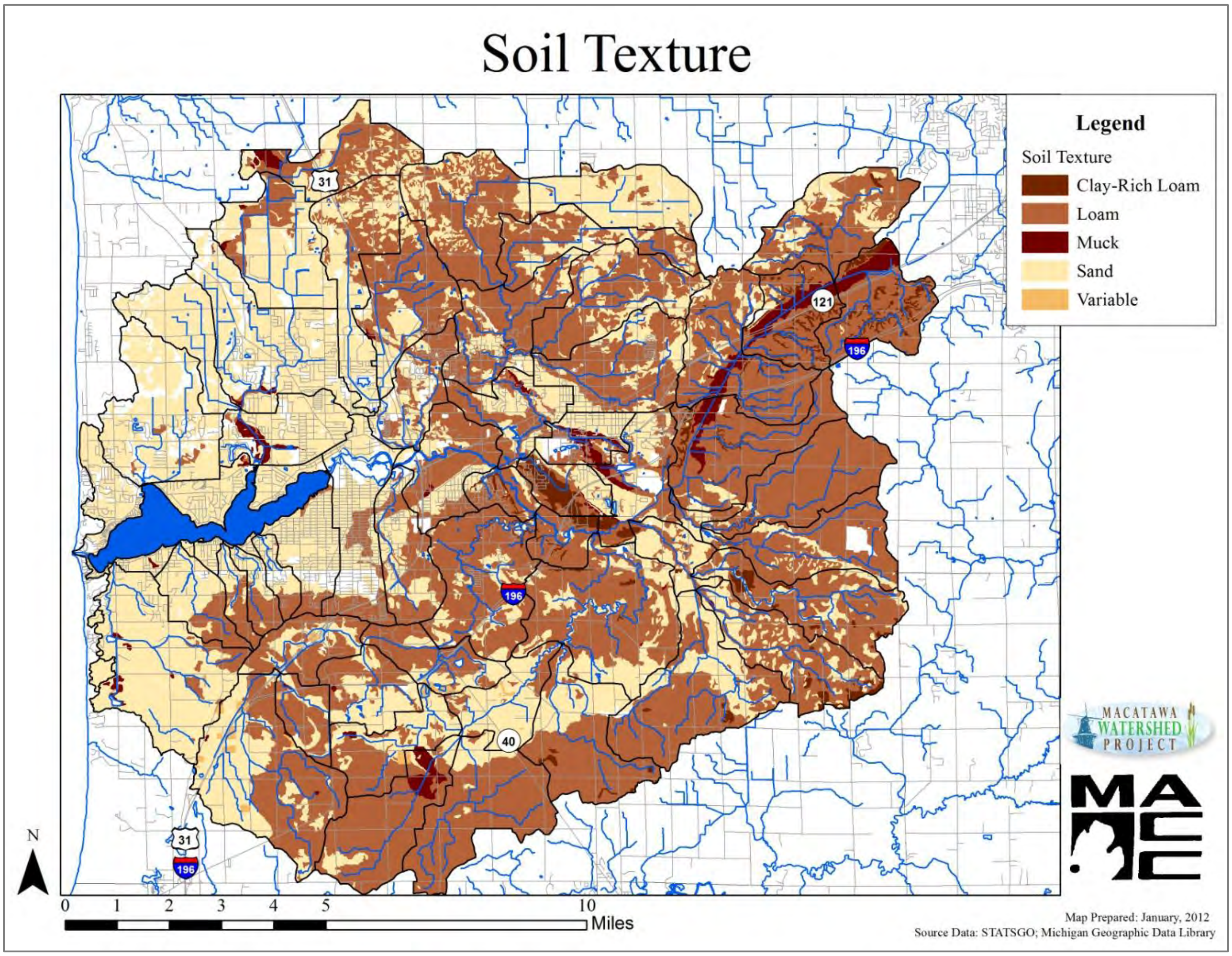


Figure 11. Soil textures of the Macatawa Watershed.

Understanding the soil hydrologic groups in the Macatawa Watershed is important as the infiltration capacity of the soil directly affects runoff. The Natural Resources Conservation Service (NRCS) has classified soil into four main hydrologic groups and three subgroups (Figure 12 and Tables 4 and 5). The majority of soils in the Macatawa Watershed are Class C soils with moderately high runoff potential.

Table 4. Summary of hydrologic soil groups in the Macatawa Watershed.

Hydrologic Group	Description	Total Acres	% of watershed area
A	Low runoff potential, water is transmitted freely	13,153	12
A/D	High water table, but would be Class A if drained	12,241	11
B	Moderately low runoff, water is transmitted unimpeded	24,781	22
B/D	High water table, but would be Class B if drained	10,004	9
C	Moderately high runoff potential, water transmission is somewhat restricted	40,590	37
C/D	High water table, but would be Class C if drained	1,855	2
D	High runoff potential, water transmission is very restricted	2,170	2
Not Assigned		4,704	4

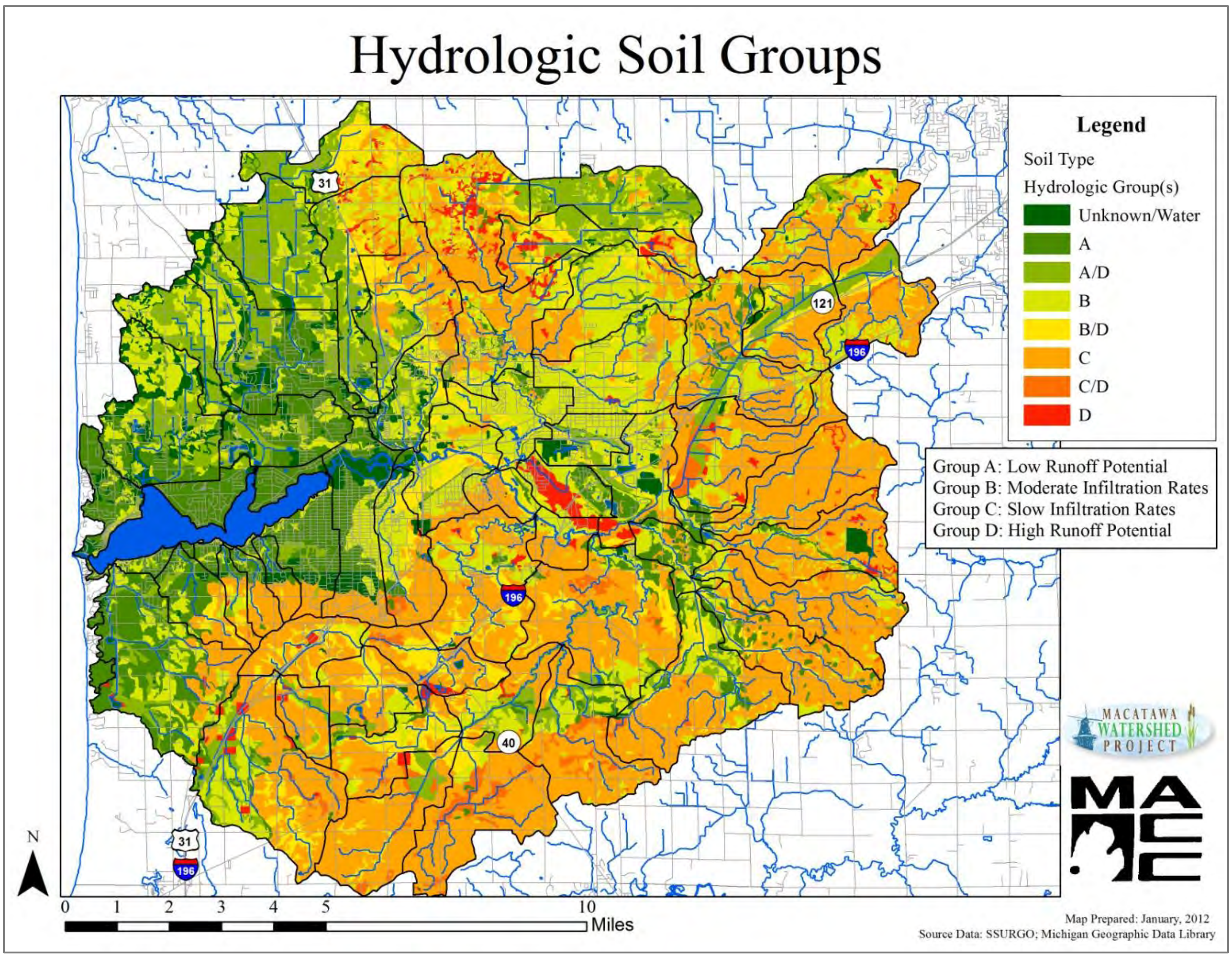


Figure 12. Soil hydrologic groups present in the Macatawa Watershed.

Table 5. Soil hydrologic group summary by subwatershed.

Sub-shed	Name	A (acres)	A %	A/D (acres)	A/D %	B (acres)	B %	B/D (acres)	B/D %	C (acres)	C %	C/D (acres)	C/D %	D (acres)	D%
1	Beaver Dam Drain to Macatawa River	85.5	3.4	117.9	4.7	668.6	26.8	128.0	0.1	1391.6	55.8	-	-	73.7	0.03
2	Macatawa River to Beaver Dam Drain	5.2	0.3	258.3	12.6	472.4	23.1	276.9	0.1	985.7	48.2	40.6	2.0	5.7	-
3	Macatawa River at 72nd Avenue	20.3	1.2	20.1	1.2	287.2	16.8	196.1	0.1	833.7	48.7	18.1	1.1	-	-
4	Macatawa River at I-196 Overpass	214.6	7.4	169.9	5.9	739.0	25.5	57.9	0.0	1666.2	57.4	14.5	0.5	2.3	0.00
5	Macatawa River at Hunderman Creek	44.2	1.6	200.8	7.4	460.4	17.1	61.8	0.0	1593.1	59.1	252.6	9.4	58.8	0.02
6	Big Creek to Hunderman Creek	13.3	0.6	1.2	0.1	208.1	8.6	2.3	0.0	2112.0	87.8	0	0.0	69.7	0.03
7	Hunderman Creek to Big Creek	113.3	4.9	3.9	0.2	376.6	16.4	13.4	0.0	1511.5	65.8	30.0	1.3	116.5	0.05
8	Hunderman Creek to Macatawa River	96.0	37.6	0	0.0	90.4	35.4	5.2	0.0	63.8	25.0	0	0.0		0.00
9	Macatawa River to the South Branch	229.7	13.4	84.3	4.9	684.1	39.8	179.1	0.1	299.3	17.4	1.4	0.1	84.8	0.05
10	Unnamed tributary to Peters Drain	276.5	11.9	37.4	1.6	208.4	9.0	230.4	0.1	1524.8	65.6	48.3	2.1		0.00
11	Peters Drain	318.6	9.3	158.2	4.6	569.8	16.6	309.9	0.1	1970.2	57.5	82.8	2.4		0.00
12	Unnamed tributary to Peters Creek	49.0	2.0	59.7	2.4	284.9	11.4	106.7	0.0	1927.9	77.0	70.3	2.8	3.1	0.00
13	Peters Creek to Macatawa River	345.2	40.9	20.6	2.4	288.3	34.1	50.9	0.1	116.5	13.8	3.4	0.4	11.1	0.01
14	Kleinheksel Drain to South Branch	22.7	0.8	37.5	1.3	94.0	3.3	153.1	0.1	2131.8	74.3	427.2	14.9		0.00
15	Jaarda Drain to South Branch	0	0.0	221.3	9.2	33.3	1.4	270.2	0.1	1723.4	71.4	148.9	6.2	15.1	0.01
16	South Branch Macatawa River to Jaarda Drain	54.3	3.3	64.3	3.9	232.9	14.1	439.4	0.3	735.4	44.5	56.8	3.4	62.7	0.04
17	South Branch Macatawa River to Unnamed Tributary near 146th	33.9	2.4	334.4	23.2	323.0	22.4	136.9	0.1	577.1	40.0	5.6	0.4	24.2	0.02
18	East Fillmore Drain (including Eskes Drain)	129.1	5.0	261.0	10.0	399.4	15.3	49.5	0.0	1500.7	57.6	242.3	9.3	3.8	0.00
19	South Branch Macatawa River to Macatawa River	272.1	6.8	202.1	5.0	487.6	12.1	447.2	0.1	2400.3	59.8	170.3	4.2	2.7	0.00
20	Uppermost North Branch Macatawa River	234.7	5.8	478.4	11.7	676.4	16.6	553.4	0.1	1892.7	46.5	83.9	2.1	143.7	0.04
21	Vanderbie Drain and Rotman Drain	1.1	0.1	132.9	15.7	92.0	10.9	16.1	0.0	578.0	68.2	2.4	0.3	21.9	0.03
22	North Branch Macatawa River to Den Bleyker Drain	1.9	0.1	0	0.0	62.5	4.8	421.9	0.3	774.6	60.0	0	0.0	22.6	0.02
23	Den Bleyker Drain	35.0	2.5	91.5	6.5	168.8	11.9	322.2	0.2	775.7	54.8	0	0.0	4.4	0.00
24	North Branch Macatawa River at M-40	5.5	0.4	0	0.0	17.7	1.3	470.2	0.4	677.4	51.5	70.4	5.4	55.9	0.04
25	North Branch Macatawa River to Macatawa River	39.0	1.3	23.4	0.8	625.3	20.5	595.0	0.2	1706.1	56.0	6.0	0.2	37.9	0.01
26	Bosch and Hulst Drain at 104th Avenue	131.5	6.7	177.6	59.6	477.0	24.1	59.5	0.0	99.8	5.1	0	0.0	0.8	0.00
27	Bosch and Hulst Drain to Noordeloos Creek	29.3	1.1	160.5	5.9	669.9	24.6	369.1	0.1	1101.1	40.4	0	0.0	396.8	0.15
28	Tributary to Bosch and Hulst Drain	36.2	2.1	372.8	21.3	332.3	18.9	350.4	0.2	468.1	26.7	0	0.0	176.4	0.10
29	Hunters Creek to Brower Drain	63.2	2.6	72.7	2.9	1350.4	54.7	186.3	0.1	727.7	29.5	2.8	0.1	45.1	0.02
30	Brower Drain to Hunters Creek	70.1	2.8	28.6	1.2	1551.6	62.8	322.3	0.1	498.8	20.2	0.7	0.0	21.4	0.01

Sub-shed	Name	A (acres)	A %	A/D (acres)	A/D %	B (acres)	B %	B/D (acres)	B/D %	C (acres)	C %	C/D (acres)	C/D %	D (acres)	D%
31	Noordeloos Creek to Drain #52	83.7	3.8	65.3	2.9	756.5	34.0	289.9	0.1	932.3	41.9	0	0.0	72.2	0.03
32	Cedar Drain to Noordeloos Creek	21.8	2.3	174.9	18.8	529.7	56.8	69.6	0.1	0.8	0.1	0	0.0	0	0.00
33	Drain #4 and #43 to Noordeloos Creek	164.0	17.4	61.4	6.5	315.7	33.5	55.7	0.1	0	0.0	0	0.0	334.8	0.36
34	Noordeloos Creek to Macatawa River	83.9	5.7	27.2	1.8	964.3	65.3	337.2	0.2	47.7	3.2	0	0.0	1.7	0.00
35	Macatawa River to the North Branch	12.3	1.7	0	0.0	183.6	25.1	65.8	0.1	391.3	53.4	0	0.0	78.4	0.11
36	Macatawa River to Noordeloos Creek	28.7	4.5	0	0.0	175.7	27.5	116.2	0.2	307.3	48.1	0	0.0	0	0.00
37	North Holland Creek to Drain #40	89.3	3.6	805.4	32.5	735.9	29.7	278.4	0.1	348.5	14.1	2.7	0.1	63.6	0.03
38	Drain #15 and #17 to Drain #40	35.5	1.5	342.2	14.8	530.1	23.0	375.0	0.2	916.1	39.7	0	0.0	56.3	0.02
39	Drain #40 to Macatawa River	193.8	13.8	130.0	9.2	518.4	36.9	259.0	0.2	123.5	8.8	0	0.0	6.3	0.00
40	Macatawa River to Windmill Island	86.5	4.7	20.0	1.1	850.7	46.6	448.4	0.2	262.2	14.4	0	0.0	5.6	0.00
41	Maplewood Intercounty Drain to Macatawa River	109.5	6.8	3.5	0.2	544.8	34.0	214.4	0.1	608.9	38.0	61.3	3.8	7.4	0.00
42	Troost and Boven Dam Drains to Harlem Drain	33.4	1.8	601.3	32.0	441.3	23.5	478.7	0.3	224.2	11.9	0	0.0	42.8	0.02
43	Harlem Drain at Quincy St	80.2	3.2	1722.5	68.0	530.5	20.9	0	0.0	0	0.0	0	0.0	0	0.00
44	Pine Creek to Drain #37	1160.0	33.0	822.4	23.4	852.7	24.2	0	0.0	0	0.0	0	0.0	0	0.00
45	Drain #37 to Pine Creek	39.4	2.6	601.8	39.9	628.5	41.7	0	0.0	0	0.0	0	0.0	0	0.00
46	Pine Creek to Lake Macatawa	900.2	53.0	318.6	18.7	281.9	16.6	0	0.0	0	0.0	0	0.0	0	0.00
47	Macatawa River marsh	750.7	32.9	5.7	0.2	477.4	20.9	13.6	0.0	405.4	17.8	5.8	0.3	0	0.00
48	Winstrom Creek and Drains #20A, #23, #53 to Lake Macatawa	603.3	19.0	729.4	23.0	1073.0	33.8	0	0.0	0	0.0	0	0.0	0	0.00
49	Old Lela Drain	144.2	32.3	27.2	6.1	15.4	3.4	5.9	0.0	195.4	43.8	0	0.0	0	0.00
50	Weller Drain	117.8	22.3	38.7	7.3	27.0	5.1	20.2	0.0	308.0	58.4	2.1	0.4	0	0.00
51	Arbor Creek	75.2	16.4	51.5	11.2	72.9	15.9	60.7	0.1	176.2	38.5	3.3	0.7	3.3	0.01
52	Ottogan Intercounty Drain	495.1	43.6	78.7	6.9	143.5	12.6	116.8	0.1	271.1	23.9	0	0.0	0.0	0.00
53	Kelly Lake Drain	1888.1	48.1	582.6	14.9	840.1	21.4	17.7	0.0	517.0	13.2	0	0.0	35.8	0.01
54	East Lake Macatawa Direct Drainage	1316.6	66.9	141.6	7.2	124.9	6.3	0	0.0	189.9	9.6	0	0.0	0	0.00
55	West Lake Macatawa Direct Drainage	1502.4	73.1	97.6	4.7	234.5	11.4	0	0.0	0	0.0	0	0.0	0	0.00

The soil hydrologic group was important in calculating pollutant load reductions of various best management practices using EPA's STEPL Model (Spreadsheet Tool for Estimating Pollutant Loads) as described in Section 4.5.

Many of the geologic and soil characteristics described above contribute to the fertile soils in the area. The Natural Resources Conservation Service (NRCS) has identified areas of "prime farmland" based on a variety of factors including soil properties, growing season, and moisture supply. The majority of the watershed is categorized as prime farmland (Figure 13).

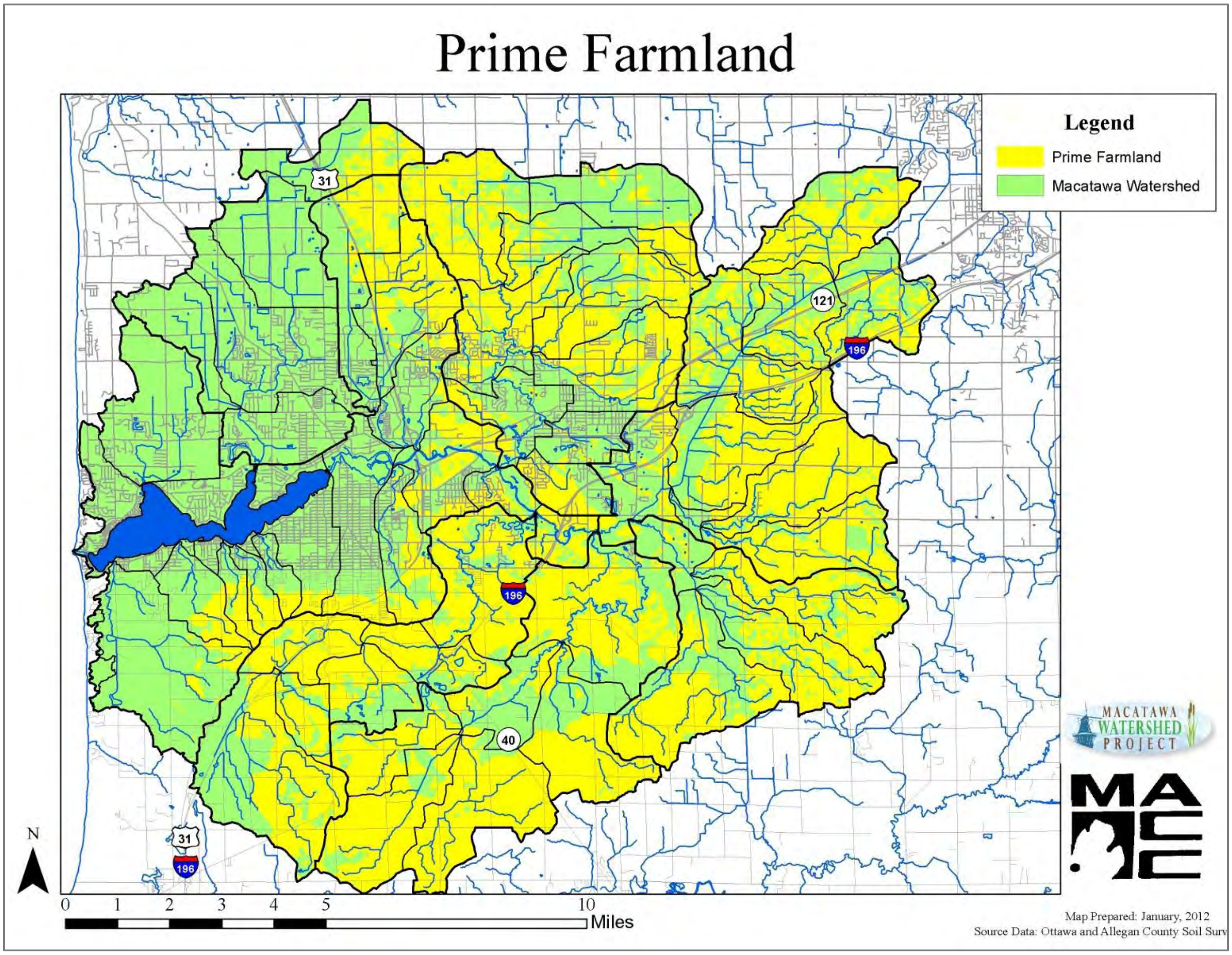


Figure 13. Extent of prime farmland in the Macatawa Watershed.

Of course, all of this prime farmland is a function of the widespread draining and clearing of the Macatawa Watershed during European settlement. Before the land was considered prime farmland it was covered with lush forest and wetlands. Some of the soil characteristics of those original wetlands remain today and are termed "hydric soils" which is a soil that formed under conditions of saturation, or flooding, long enough during the growing season to develop anaerobic conditions (Figure 14). Hydric soils are often well suited to support hydrophytic vegetation.

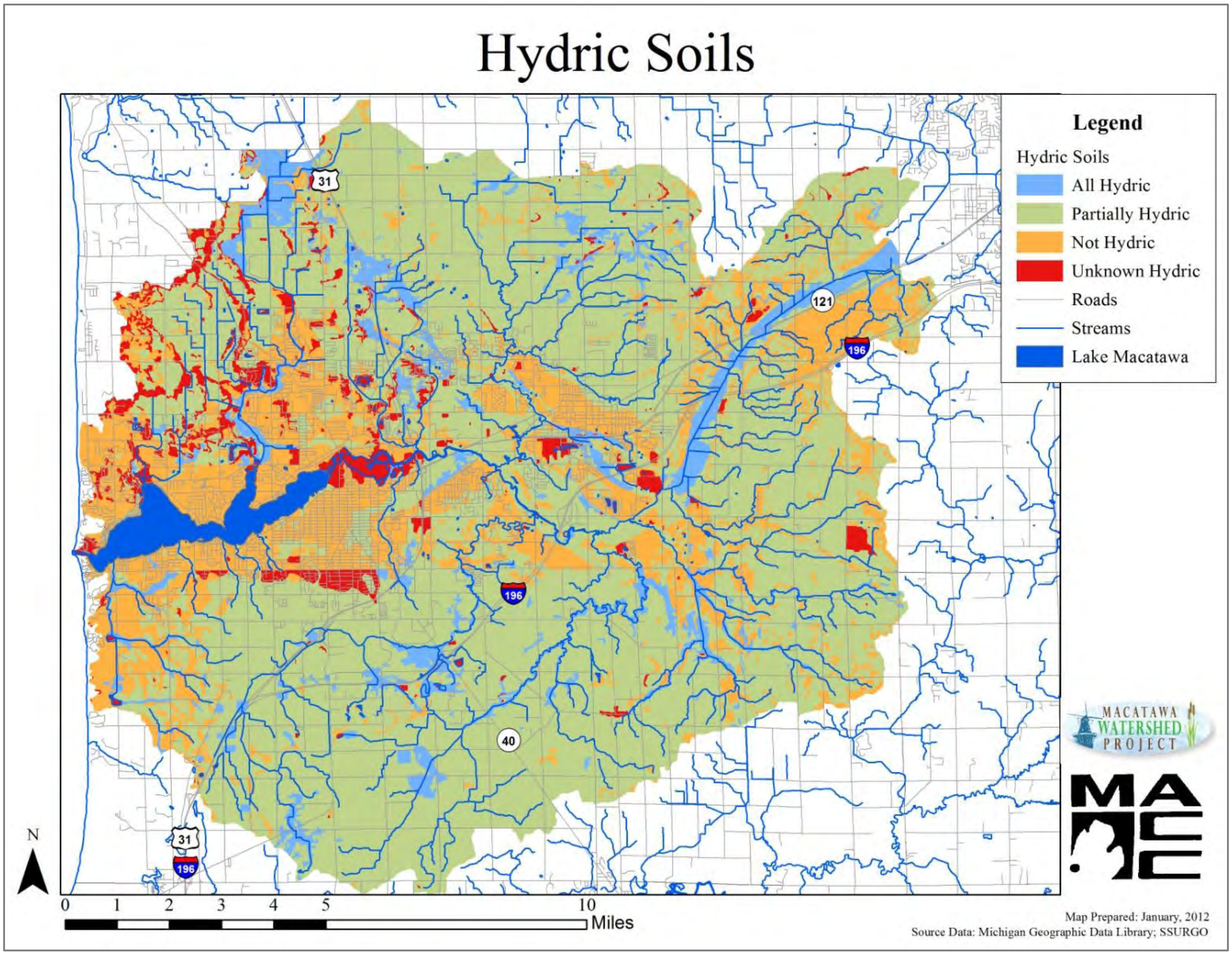


Figure 14. Hydric soils present in the Macatawa Watershed.

2.4 PRESETTLEMENT LAND COVER AND ECOLOGY

During presettlement times (before the area was settled by Europeans in 1847), historical records indicate that the area of the Macatawa Watershed was a densely forested region with trees six feet across and a hundred feet high (Figure 15). Forests contained mostly beech, sugar maple and hemlock, and lacked white pine (in contrast to other areas in Western Michigan). There were also significant expanses of wetlands including bogs, marshes and swamps (located near present day Windmill Island, south of the City of Zeeland and US-131 and James Street in Holland Township).

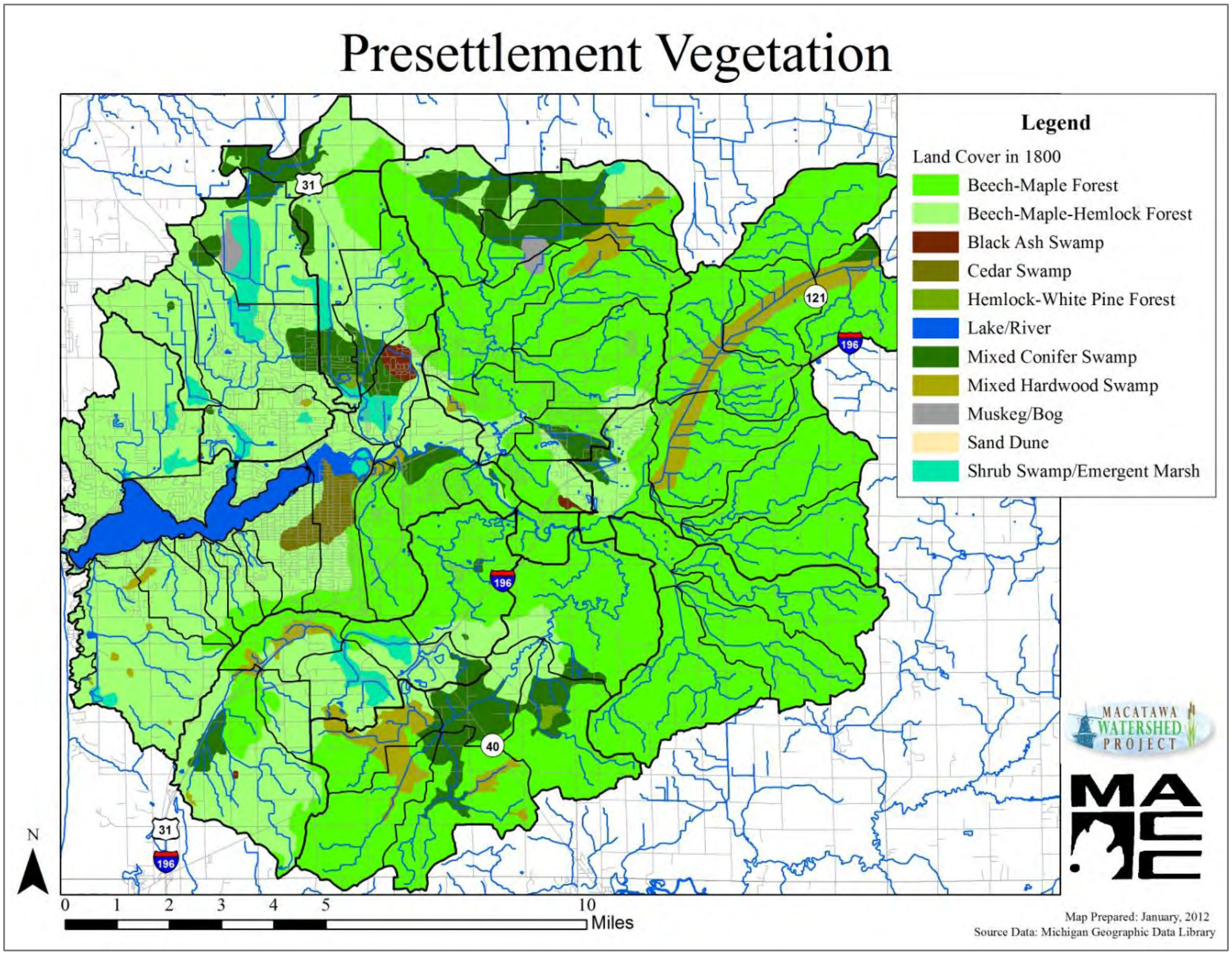


Figure 15. Presettlement vegetation present in the Macatawa Watershed.

The plants and animals of the region were varied and abundant and reflect the immense and diverse natural habitat of the area. Wolves, bobcats, bears, beaver, muskrat, mink, and otter were all abundant. Birds included a wide variety with bald eagles, hawks, owls, falcons, and overwhelming numbers of passenger pigeons. Early records indicate that the Eastern Massasauga snake was plentiful in the marshes. Walleye, pike, muskellunge, bass, perch were the main fisheries based on records indicating these species were harvested in huge numbers by early settlers.

The region's natural resources supported Native Americans for hundreds of years before European Settlement in the late 1800s. Native American tribes present in Michigan were the Chippewa, Potawatomi and Odawa (or Ottawa) as descendents of the Algonquins. The Ottawa Indians inhabited the present day Macatawa Watershed. Historical records indicate that the Ottawa Indians were nomadic hunter-gatherers who depended on trade with other tribes.

2.5 CULTURAL HISTORY

While it is true that the first Europeans came to the area in the 1600s when the region was primarily used to support the fur trade, the earliest "settlement" occurred on the north shore of Lake Macatawa in 1835. It was called Superior (present day Point Superior near Marigold Lodge) and faded away by 1839. In 1837 Michigan officially became a state and by 1847, the first Dutch Settlers arrived on the shores of Lake Macatawa.

The Dutch Settlers began clearing land and worked hard to drain the land for farming, traveling and to reduce the mosquito population. It took approximately ten years for them to significantly reduce the forested land within the watershed and by 1855 the native Ottawa Indians were driven from the area. Most of the early settlements were based on farming while some relied on burgeoning industries including tanneries and sawmills. By 1858, the settlers were working to open up and maintain a more permanent channel from Lake Macatawa to Lake Michigan. By 1885, the region was booming and tourism became important as the Macatawa Hotel was built on the south side of the lake, followed by Hotel Ottawa on the north side in 1886. However, by 1920 tourism was subsiding as train travel became outdated and the Ottawa Beach Hotel burned down. Agricultural production became the mainstay of the region and continues to be to this day.

Black Lake became Lake Macatawa in 1935

RANDY VANDE WATER

Since June 4, 1935, Holland's inland lake officially has been called Lake Macatawa, a moniker that aids in identifying Holland waterways, an integral part of the community's overall beauty and recently recognized by Keep Michigan Beautiful Inc.

Celebrating its 50th anniversary at Hope College on May 18, KMB chose this city because Holland was first in Michigan with a municipal beautification project, the 1929 origination of Tulip Time.

Working to change the lake's name in 1934 were the governing institutions in Holland, Ottawa County, State of Michigan and Holland Chamber of Commerce Managing Director William Connelly.

Final action concluded more than a year of negotiations. The Holland council, Ottawa County supervisors and the Michigan Historical Commission approved the change during 1934 and 1935.

On Saturday, June 8, 1935, The Sentinel announced Black Lake would be called Lake Macatawa.

The Sentinel said: "It was revealed today that Black Lake formally passed out of existence and Lake Macatawa came into being in action by the U.S. Department of Interior. The body of water connecting Holland with Lake Michigan will henceforth be known as Lake Macatawa. All maps and charts will carry that name."

Four days earlier, the official action was taken in Washington, D.C. John J. Cameron, Interior Department acting executive secretary, said the name was approved by the advisory committee of geographical names.

Black River Lake was the name given the waters in 1832 by surveyor Calvin Brittain. When the Dutch arrived in 1847, it was called Black River and, in 1849, Black Lake by the U.S. Army Corps of Engineers.

A literal translation of the Native American word meaning black is Macatawa. The word might have been used to describe the area following the Civil War. In 1881, City News newspaper editor Otto J. Doesburg wrote the body of water near the channel should have a more glamorous name. He suggested Macatawa Bay.

The first fishing event was Monday, June 24. Edward De Pree, 15, hooked a 10-pound, 37-inch muskellunge. At midnight, the bass and bluegill season opened. Don Lievense, 15, Stanley Lievense, 16 and Ken Deur, 15 caught 11 large black bass on opening day.

Superior 1935 Lake Macatawa fishing was because the Holland Fish and Game Club stocked the lake with 50,000 black bass and more than a million bluegills.

The Sentinel reported June 20, 1974, Black River was renamed Macatawa River. Ottawa County Commission Chairman William Winstrom said the DNR's Geological Survey Division change was effective immediately.

A DNR spokesman said the U.S. Geological Survey in Washington "approved the change recently." (Holland historian William Van Appledorn said approval was given by the U.S. Board of Geographic names.) In February 1974 commissioners petitioned for the change because "of too many black rivers."

"Both north and south branches are known as Macatawa River and will be listed as such on new maps," The Sentinel said.

Enhanced by the river is Window on the Waterfront, Windmill Island, Ottawa Discovery Center/Macatawa Greenway and Macatawa River Greenspace, former Holland Country Club, partnered by the Macatawa Area Coordinating Council.

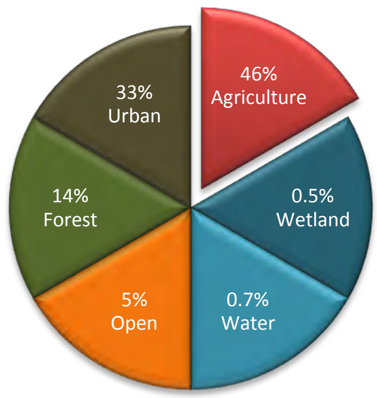
In 2009 Holland received the KMB president's award for its enlarged 24-acre Kollen Park Redevelopment and Expansion on Lake Macatawa with the Heinz Memorial Walkway, three more boat launches, six day slips and one-third increased park size.

— Contact Randy Vande at newsroom@hollandsentinel.com.

Excerpt from June 17, 2012 edition of the Holland Sentinel (Vandewater 2012)

2.6 CURRENT LAND USE, LAND COVER AND ECOLOGY

Over time, land use changes have permanently changed the landscape of the Macatawa Watershed. There has been a marked conversion of forest and wetlands to agricultural, suburban and urban land. Almost half of the watershed is intensively farmed (row crops and animal agricultural) and the majority of the farming is located in headwater areas (Figure 16 and Table 6). Overall the 2009 land use in the Macatawa Watershed consists of:



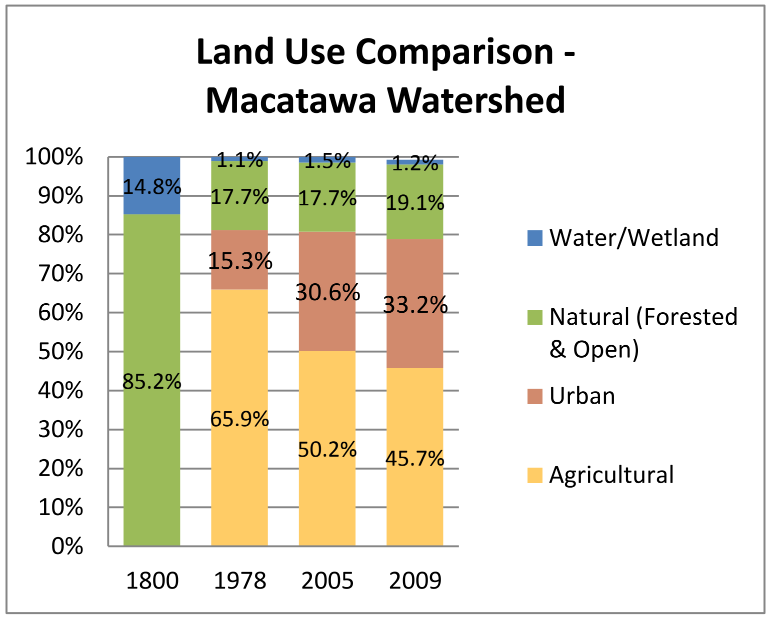


Table 6. Percentages of various land use categories in the Macatawa Watershed (2009).

No.	Name	Total Area (acres)	Agricul-ture (acres)	% Ag	Forest (acres)	% For	Open Land (acres)	% Open	Urban (acres)	% Urban	Water (acres)	% Water	Wetlands (acres)	%Wet
1	Beaver Dam Drain to Macatawa River	2492.8	1497.6	60.1%	288.1	11.6%	170.5	6.8%	509.6	20.4%	1.2	0.0%	25.7	1.0%
2	Macatawa River to Beaver Dam Drain	2045.7	1125.2	55.0%	403.2	19.7%	114.1	5.6%	362.0	17.7%	1.0	0.0%	18.9	0.9%
3	Macatawa River at 72nd Avenue	1712.6	1067.5	62.3%	292.0	17.1%	48.2	2.8%	291.3	17.0%	0.0	0.0%	13.6	0.8%
4	Macatawa River at I-196 Overpass	2901.6	1753.5	60.4%	192.3	6.6%	228.6	7.9%	707.5	24.4%	6.8	0.2%	13.0	0.4%
5	Macatawa River at Hunderman Creek	2697.7	1452.9	53.9%	207.4	7.7%	242.0	9.0%	779.2	28.9%	9.5	0.4%	6.7	0.2%
6	Big Creek to Hunderman Creek	2406.8	1919.0	79.7%	106.8	4.4%	54.8	2.3%	325.5	13.5%	0.6	0.0%	0.0	0.0%
7	Hunderman Creek to Big Creek	2297.5	1576.1	68.6%	217.7	9.5%	77.2	3.4%	411.4	17.9%	11.9	0.5%	3.3	0.1%
8	Hunderman Creek to Macatawa River	255.4	117.9	46.2%	38.7	15.1%	21.6	8.4%	74.8	29.3%	2.4	0.9%	0.0	0.0%
9	Macatawa River to the South Branch	1718.0	255.5	14.9%	336.0	19.6%	168.8	9.8%	910.2	53.0%	47.4	2.8%	0.0	0.0%
10	Unnamed tributary to Peters Drain	2326.1	2057.1	88.4%	116.6	5.0%	63.0	2.7%	78.4	3.4%	1.5	0.1%	9.4	0.4%
11	Peters Drain	3428.9	2831.1	82.6%	385.4	11.2%	43.9	1.3%	167.7	4.9%	0.8	0.0%	0.0	0.0%
12	Unnamed tributary to Peters Creek	2502.8	2070.0	82.7%	204.0	8.2%	97.6	3.9%	121.1	4.8%	7.9	0.3%	2.0	0.1%
13	Peters Creek to Macatawa River	844.4	355.9	42.2%	287.0	34.0%	71.3	8.4%	123.3	14.6%	6.8	0.8%	0.0	0.0%

No.	Name	Total Area (acres)	Agricul-ture (acres)	% Ag	Forest (acres)	% For	Open Land (acres)	% Open	Urban (acres)	% Urban	Water (acres)	% Water	Wetlands (acres)	%Wet
14	Kleinheksel Drain to South Branch	2868.3	2617.2	91.2%	45.3	1.6%	61.9	2.2%	139.7	4.9%	0.0	0.0%	4.3	0.1%
15	Jaarda Drain to South Branch	2412.8	2114.0	87.6%	50.9	2.1%	58.4	2.4%	189.5	7.9%	0	0.0%	0.0	0.0%
16	South Branch Macatawa River to Jaarda Drain	1652.1	1122.5	67.9%	201.7	12.2%	97.0	5.9%	187.2	11.3%	16.2	1.0%	27.4	1.7%
17	South Branch Macatawa River to Unnamed Tributary near 146th	1441.1	773.5	53.7%	353.1	24.5%	85.2	5.9%	221.0	15.3%	8.3	0.6%	0.0	0.0%
18	East Fillmore Drain (including Eskes Drain)	2605.1	2220.2	85.2%	206.4	7.9%	20.7	0.8%	151.0	5.8%	2.7	0.1%	4.2	0.2%
19	South Branch Macatawa River to Macatawa River	4013.9	2386.9	59.5%	749.0	18.7%	144.3	3.6%	694.6	17.3%	28.5	0.7%	10.8	0.3%
20	Uppermost North Branch Macatawa River	4072.9	2168.4	53.2%	796.4	19.6%	303.8	7.5%	743.1	18.2%	11.8	0.3%	49.5	1.2%
21	Vanderbie Drain and Rotman Drain	847.7	482.5	56.9%	102.7	12.1%	45.8	5.4%	213.5	25.2%	0.2	0.0%	3.1	0.4%
22	North Branch Macatawa River to Den Bleyker Drain	1290.4	499.2	38.7%	81.2	6.3%	97.8	7.6%	610.5	47.3%	1.1	0.1%	0.5	0.0%
23	Den Bleyker Drain	1415.4	455.2	32.2%	197.3	13.9%	108.6	7.7%	634.0	44.8%	14.7	1.0%	5.7	0.4%
24	North Branch Macatawa River at M-40	1314.1	399.3	30.4%	98.0	7.5%	194.4	14.8%	583.2	44.4%	17.7	1.3%	21.5	1.6%
25	North Branch Macatawa River to Macatawa River	3048.4	1367.3	44.9%	277.3	9.1%	299.9	9.8%	1074.6	35.3%	12.9	0.4%	16.3	0.5%
26	Bosch and Hulst Drain at 104th Avenue	1976.5	1156.6	58.5%	293.2	14.8%	209.1	10.6%	306.7	15.5%	10.5	0.5%	0.6	0.0%
27	Bosch and Hulst Drain to Noordeloos Creek	2727.1	2268.2	83.2%	136.6	5.0%	147.2	5.4%	175.1	6.4%	0.0	0.0%	0.0	0.0%
28	Tributary to Bosch and Hulst Drain	1754.1	1482.7	84.5%	37.9	2.2%	90.2	5.1%	134.8	7.7%	8.5	0.5%	0.0	0.0%
29	Hunters Creek to Brower Drain	2470.4	1648.8	66.7%	90.0	3.6%	136.8	5.5%	591.0	23.9%	3.9	0.2%	0.0	0.0%
30	Brower Drain to Hunters Creek	2470.4	660.9	26.8%	122.9	5.0%	207.0	8.4%	1503.4	60.9%	4.6	0.2%	0.0	0.0%
31	Noordeloos Creek to Drain #52	2227.1	987.7	44.4%	213.3	9.6%	146.9	6.6%	845.6	38.0%	33.6	1.5%	0.0	0.0%
32	Cedar Drain to Noordeloos Creek	931.9	82.1	8.8%	25.7	2.8%	55.4	5.9%	737.8	79.2%	30.9	3.3%	0.0	0.0%
33	Drain #4 and #43 to Noordeloos Creek	942.7	103.3	11.0%	91.3	9.7%	202.5	21.5%	517.2	54.9%	28.5	3.0%	0.0	0.0%
34	Noordeloos Creek to Macatawa River	1477.2	138.4	9.4%	290.2	19.6%	125.2	8.5%	904.7	61.2%	18.8	1.3%	0.0	0.0%
35	Macatawa River to the North Branch	732.1	206.1	28.2%	126.6	17.3%	85.0	11.6%	307.7	42.0%	6.8	0.9%	0.0	0.0%
36	Macatawa River to Noordeloos Creek	639.4	13.7	2.1%	175.7	27.5%	61.8	9.7%	387.7	60.6%	0.6	0.1%	0.0	0.0%
37	North Holland Creek to Drain #40	2476.6	1040.0	42.0%	252.7	10.2%	264.1	10.7%	888.1	35.9%	31.8	1.3%	0.0	0.0%
38	Drain #15 and #17 to Drain #40	2308.9	1124.1	48.7%	164.2	7.1%	156.0	6.8%	858.0	37.2%	6.6	0.3%	0.0	0.0%
39	Drain #40 to Macatawa River	1406.1	119.9	8.5%	150.6	10.7%	95.0	6.8%	1026.4	73.0%	14.3	1.0%	0.0	0.0%
40	Macatawa River to Windmill Island	1825.4	29.6	1.6%	290.3	15.9%	205.5	11.3%	1259.4	69.0%	18.7	1.0%	22.0	1.2%

No.	Name	Total Area (acres)	Agricul-ture (acres)	% Ag	Forest (acres)	% For	Open Land (acres)	% Open	Urban (acres)	% Urban	Water (acres)	% Water	Wetlands (acres)	%Wet
41	Maplewood Intercounty Drain to Macatawa River	1602.8	34.9	2.2%	114.4	7.1%	136.9	8.5%	1288.3	80.4%	0.0	0.0%	28.3	1.8%
42	Troost and Boven Dam Drains to Harlem Drain	1876.8	1146.2	61.1%	303.1	16.1%	27.6	1.5%	390.5	20.8%	0.8	0.0%	8.7	0.5%
43	Harlem Drain at Quincy St	2534.9	1053.5	41.6%	287.3	11.3%	126.5	5.0%	993.6	39.2%	63.2	2.5%	10.9	0.4%
44	Pine Creek to Drain #37	3516.6	490.7	14.0%	689.8	19.6%	174.8	5.0%	2117.7	60.2%	43.7	1.2%	0.0	0.0%
45	Drain #37 to Pine Creek	1508.0	671.7	44.5%	494.9	32.8%	60.5	4.0%	251.3	16.7%	29.6	2.0%	0.0	0.0%
46	Pine Creek to Lake Macatawa	1700.0	16.3	1.0%	295.3	17.4%	5.3	0.3%	1334.8	78.5%	28.5	1.7%	19.9	1.2%
47	Macatawa River marsh	2283.3	1.9	0.1%	70.4	3.1%	55.9	2.4%	1931.1	84.6%	70.7	3.1%	153.2	6.7%
48	Winstrom Creek and Drains #20A, #23, #53 to Lake Macatawa	3171.5	243.6	7.7%	1357.6	42.8%	146.7	4.6%	1335.3	42.1%	53.9	1.7%	31.5	1.0%
49	Old Lela Drain	445.9	15.9	3.6%	38.6	8.7%	8.7	2.0%	380.5	85.3%	2.2	0.5%	0.0	0.0%
50	Weller Drain	527.5	92.7	17.6%	26.3	5.0%	72.3	13.7%	336.3	63.7%	0.0	0.0%	0.0	0.0%
51	Arbor Creek	457.7	134.1	29.3%	49.4	10.8%	76.5	16.7%	197.7	43.2%	0.0	0.0%	0.0	0.0%
52	Ottogan Intercounty Drain	1135.4	212.3	18.7%	318.8	28.1%	133.7	11.8%	462.2	40.7%	8.5	0.7%	0.0	0.0%
53	Kelly Lake Drain	3922.8	308.0	7.9%	2081.2	53.1%	304.6	7.8%	1163.6	29.7%	29.4	0.7%	30.0	0.8%
54	East Lake Macatawa Direct Drainage	1968.5	11.7	0.6%	67.2	3.4%	23.5	1.2%	1853.8	94.2%	10.9	0.6%	1.5	0.1%
55	West Lake Macatawa Direct Drainage	2054.1	0.0	0.0%	371.4	18.1%	11.8	0.6%	1641.3	79.9%	15.1	0.7%	8.5	0.4%
Totals		109684.2	50181.0	45.8	15422.1	14.1	6472.2	5.9	36433.8	33.2	786.4	0.7	551.0	0.5

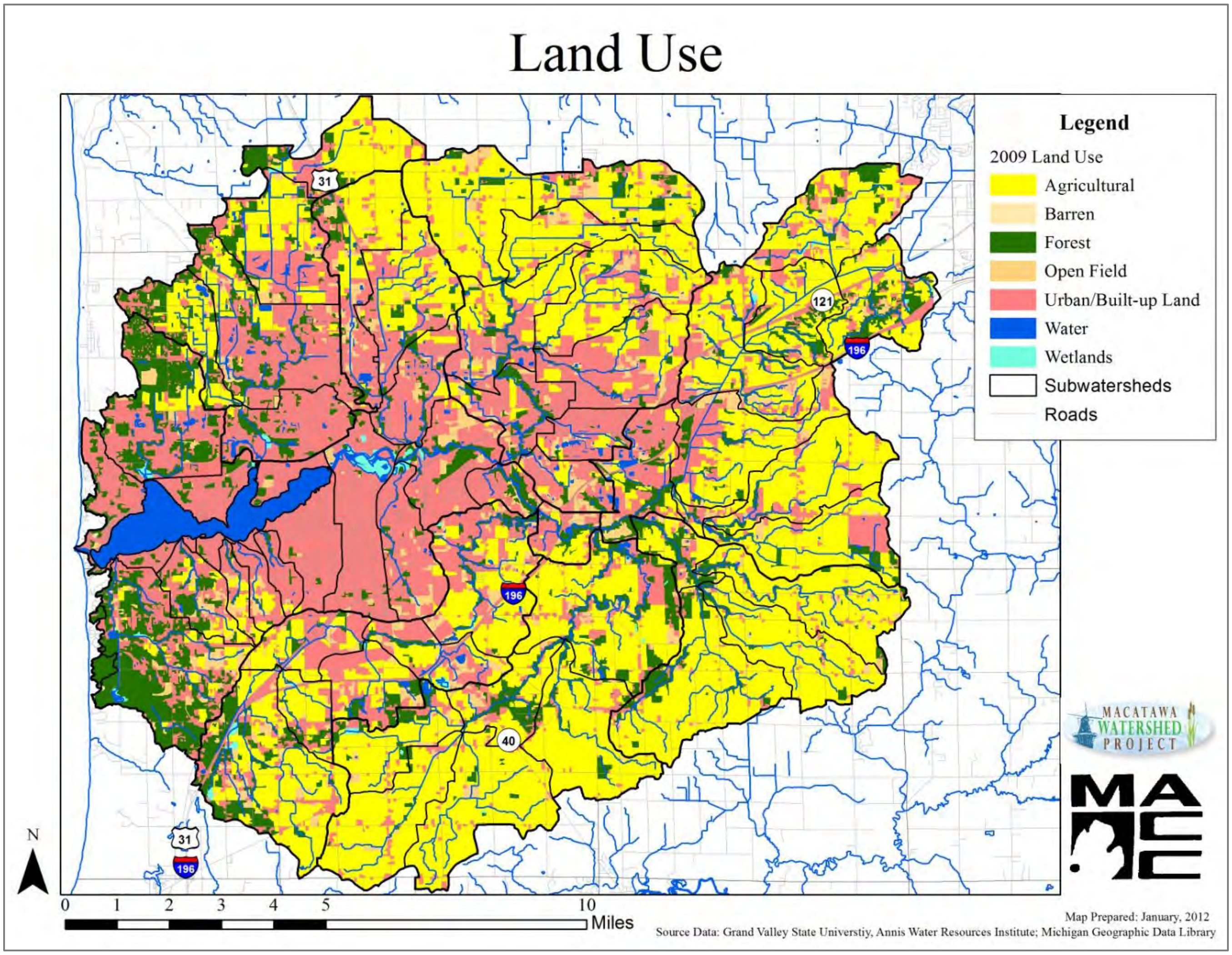


Figure 16. 2009 land use in the Macatawa Watershed.

Land cover percentages (by subwatershed) was important in calculating pollutant load reductions of various best management practices using EPA's STEPL Model (Spreadsheet Tool for Estimating Pollutant Loads) as described in Section 4.5.

While agriculture is still the prevailing land use, urban and suburban land is quickly changing due to growth and development pressures. There is very little high quality natural land still existing in the watershed. Currently, there exists approximately 551 acres of wetlands (Figure 17).

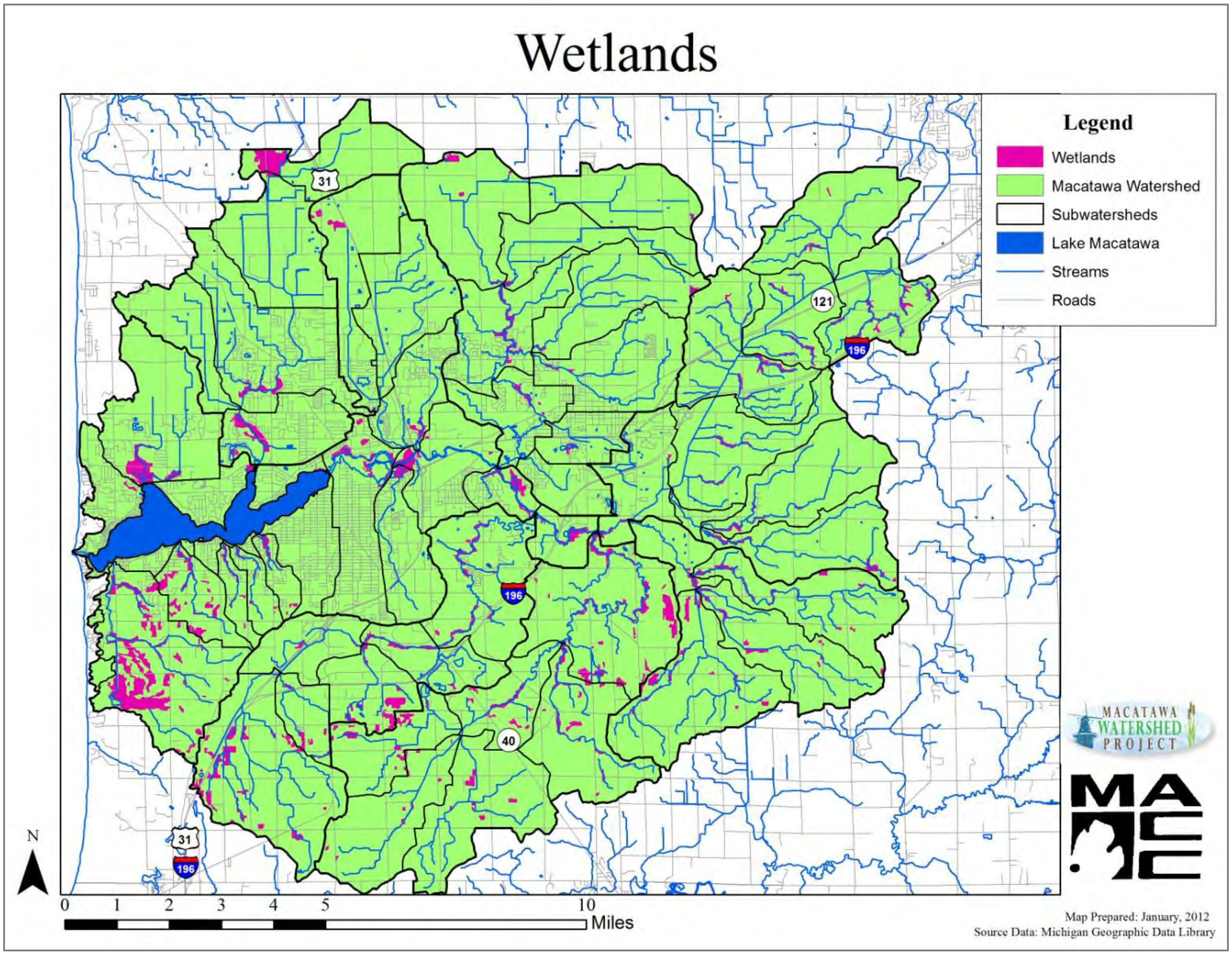


Figure 17. Current wetlands in the Macatawa Watershed.

The loss of natural land, especially wetlands, is an important historical factor affecting the current state of water quality in the watershed. There is no remaining virgin forest and according to the Landscape Level Functional Wetlands Assessment (Appendix Q) completed by MDEQ in 2010, approximately 86% of presettlement wetlands have been lost to agriculture and urban development (Figure 18 and Table 7). In fact, Windmill Island wetlands are less than half their original size.

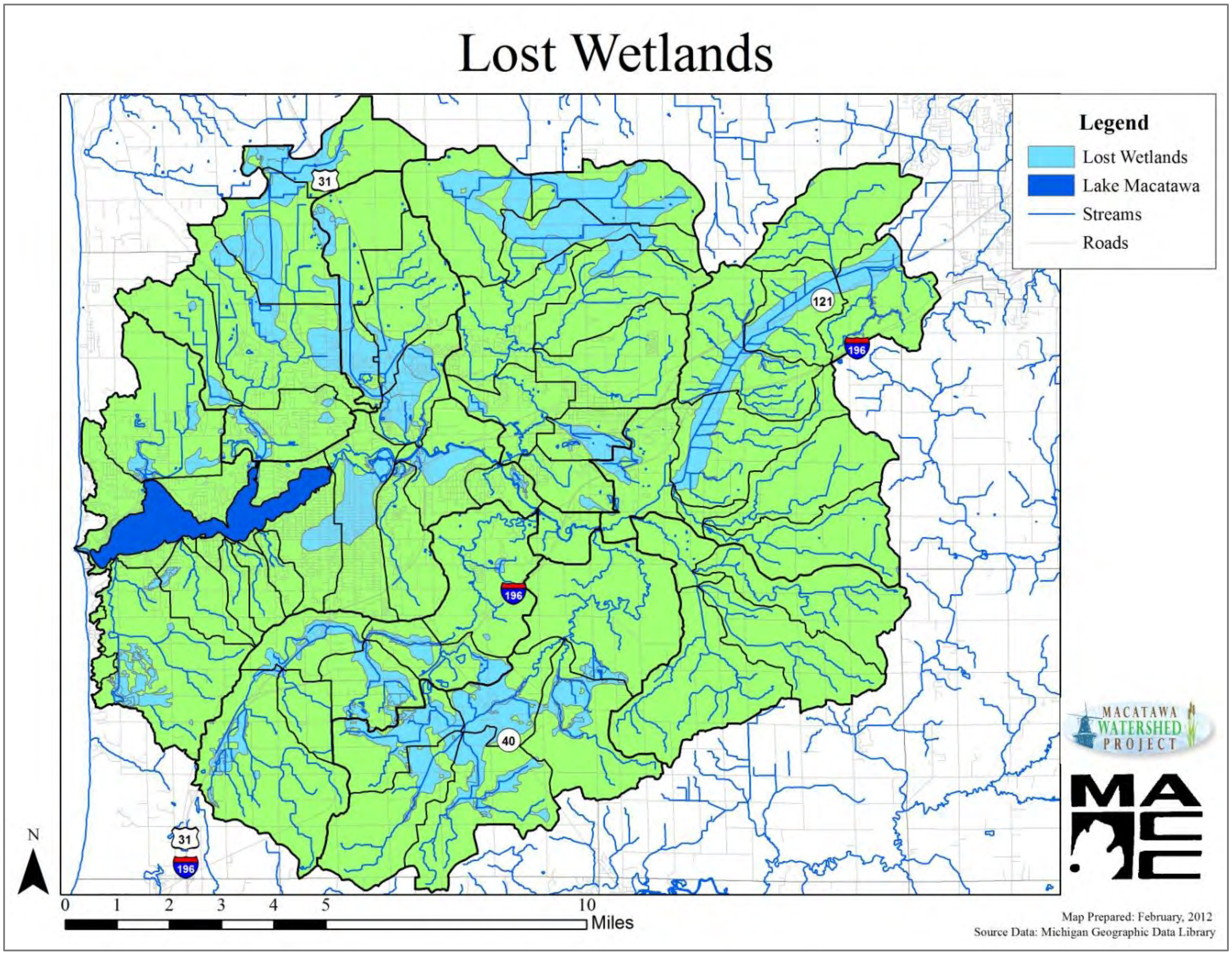


Figure 18. Historical wetland loss in the Macatawa Watershed.

Table 7. Total acres of wetland loss by subbasin.

	Upper Macatawa	Peters Creek	South Branch	North Branch	Noordeloos Creek	Lower Macatawa	Pine Creek	Lake Macatawa Direct Drainage	Totals
Total Wetland Loss (acres)	2,121	0	3,104	1,498	3,315	2,119	2,672	1,749	16,578
% of total wetland loss	12.8%	0	18.7%	9%	20%	12.8%	16.1%	10.6%	100%

As a result of the loss of natural habitat, wolves, bobcats, bears and beaver have all but been eradicated from the area (although there is evidence that at least one beaver has recently returned to the Windmill Island area). Bald eagles, hawks, waterfowl and owls still exist, however the once abundant Eastern Massassauga snake is currently a Species of Concern. There are various other plants, animal and fish species reported to be present within the watershed that are of special note (Table 8, Source: Michigan Natural Features Inventory).

Table 8. Summary of endangered and 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*	Special Concern	Direct Lake Macatawa Tributaries
Eastern Box Turtle	*Terrapene Carolina carolina*	Special Concern	Direct Lake Macatawa Tributaries
Plants			
Pitcher's Thistle	*Cirsium pitcheri*	Threatened	Direct Lake Macatawa Tributaries
Globe-fruited seedbox	*Ludwigia sphaerocarpa*	Threatened	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. Johns 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*	Special Concern	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*	Threatened	Direct Lake Macatawa Tributaries
Insects			
Frosted Elfin	*Incisalia irus*	Threatened	South Branch Macatawa River
Fish			
Bigmouth Shiner	*Notropis dorsalis*	Special Concern	Peters Creek

Although it is recognized that the species listed above are probably present somewhere in the Macatawa Watershed, the data is still vague and incomplete across large portions of the watershed (Figure 19). There are a few, very discrete areas thought to have the greatest probability of supporting threatened and rare species. However, the broad majority of the watershed is considered to have a low probability of housing these species or has no status at all.

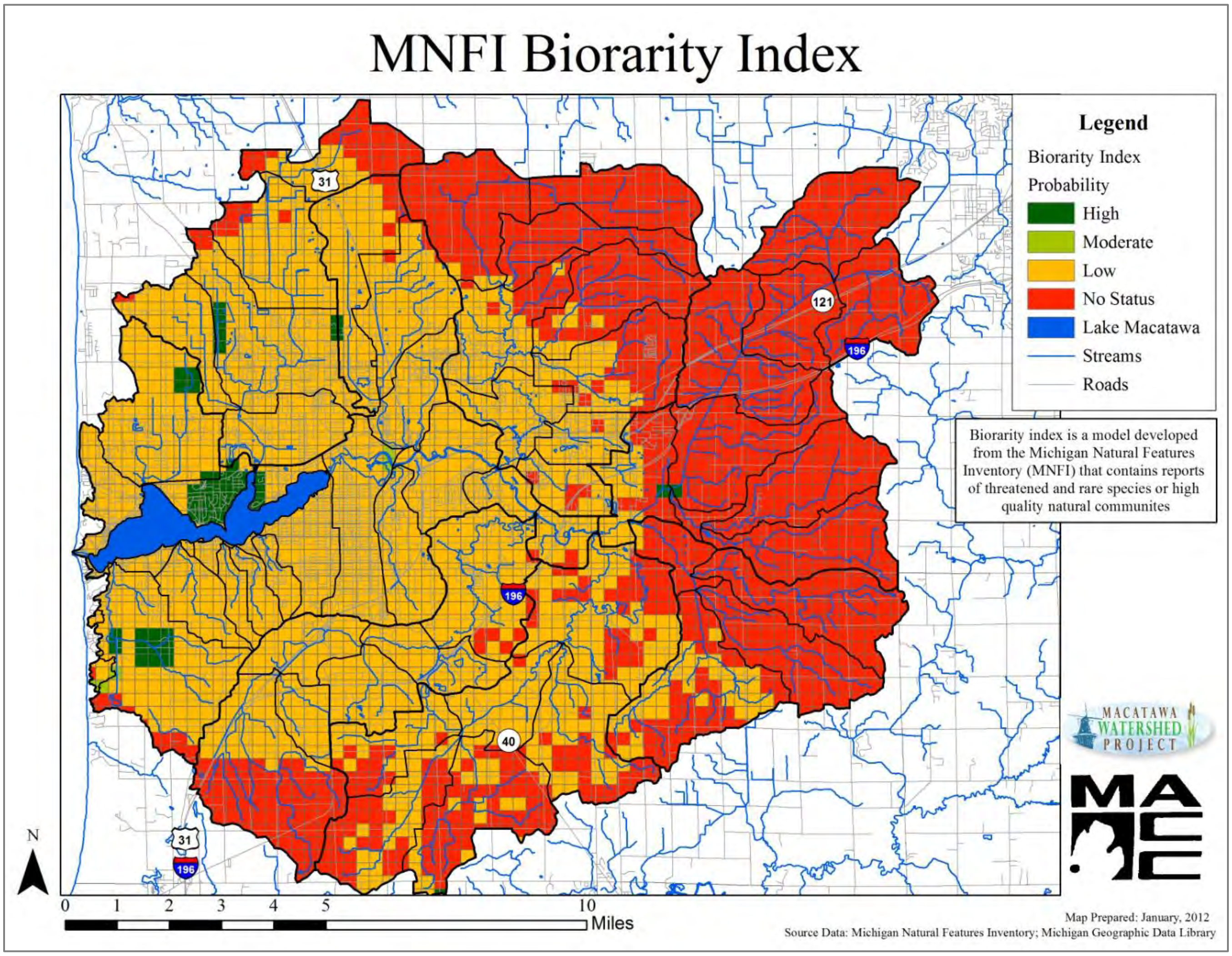


Figure 19. Biorarity Index scores for the Macatawa Watershed.

Throughout the watershed there are several areas that have undergone more intensive study including:

- Macatawa River Corridor between Windmill Island and Paw Paw Park Preserve (Subwatersheds #34 and #40, Martinus and Schaddelee 1998)
- Lower Pine Creek Area between Lakewood Boulevard and Ottawa Beach Road (Subwatershed #46, Martinus 2001).
- Upper Macatawa Conservation Area, Byron Road and I-196, Zeeland Township (Subwatershed #5, Resources Management Group et al. 2001)
- Outdoor Discovery Center- Macatawa Greenway property, 4214 56th Street, Fillmore Township, (Subbwatershed #23, Martinus 2004)

The natural features inventories conducted at these sites indicate that several notable additional species have been identified that have not been recognized by the Michigan Natural Features Inventory (Table 8). Those species include:

- Peregrine falcon (*Falco peregrines*), Endangered
- Short-eared owl (*Asio flammeus*), Endangered
- Caspian Tern (*Sterna caspia*), Threatened
- Common Tern (*Sterna hirundo*), Threatened
- Long-eared owl (*Asio otus*), Threatened
- Red-Shouldered Hawk (*Buteo lineatus*), Threatened
- Yellow-throated warbler (*Dendroica dominica*), Threatened
- American bittern (*Botaurus lentiginosus*), Special Concern
- Black Tern (*Chlidonias niger*), Special Concern
- Blandings Turtle (*Emydoidea blandingii*), Special Concern
- Northern Goshawk (*Accipiter gentilis*), Special Concern
- Northern Harrier, (*Circus cyaneus*), Special Concern
- Osprey (*Pandion haliaetus*), Special Concern

Invasive species in the Macatawa Watershed are abundant and wide spread to varying degrees. The known invasive species (as noted by the studies above and by personal observation) include purple loosestrife, multiflora rose, garlic mustard, nightshade, narrowleaved cattail, autumn olive, bull thistle, common teasel, common buckthorn, glossy buckthorn, Japanese barberry and phragmites.

The Michigan Department of Natural Resources has classified all waters in the State based on predominant water temperatures. Water temperatures determine suitable fish communities. The Macatawa Watershed is classified as a warm-water system that typically supports species that can handle temperature fluctuations up to 50° F and extreme variations in dissolved oxygen levels. Records indicate that in the mid-1900s there were up to 50 different species commonly found in Lake Macatawa. Current surveys indicate that only about 20 fish species were recorded in 2000 (MDNR 2000) including walleye, white bass, black bass, catfish, yellow perch, alewife, quillback, gizzard shad and common carp. The invasive species round goby is also growing rapidly in numbers.

2.7 LAKE MACATAWA

Figure 20. Aerial map of Lake Macatawa (source: Bing Maps).

Historically called Black Lake (named by the French in late 1700s), the lake was later renamed Lake Macatawa in 1935 after the Ottawa word for black (maw-kaw-te-waw). The water appeared, and was described as “black”, as a function of the surrounding landscape. Historically, the main river flowed slowly through a watershed that was heavily forested with predominantly deciduous trees. Over time, many of the leaves collected by the river ended up on the lake bottom. There they release dark colored pigments called tannins, which makes the water appear black when viewed from above. The lake water was actually clear and very clean based on all accounts from the historical records. It wasn’t until the watershed was largely drained and deforested after European Settlement that the water began appearing brown and murky.

The lake is approximately 5 miles long and slowly transports water from the Macatawa River to Lake Michigan. The lake was connected to Lake Michigan on the west end by a man-made channel built first by Dutch Settlers during the 1850s and historically maintained by Army Corps of Engineers starting in

1867 (dredged to 23 ft annually). The lake is 870 feet across at its narrowest point and 6,035 feet across at the widest point (Big Bay). With an average depth of 12 feet and a maximum depth of 38 (in Big Bay) the lake holds approximately 7 billion gallons of water at a time. Based on the average flow and volume of the lake, it is estimated that the water takes about 80 days to completely replace itself.

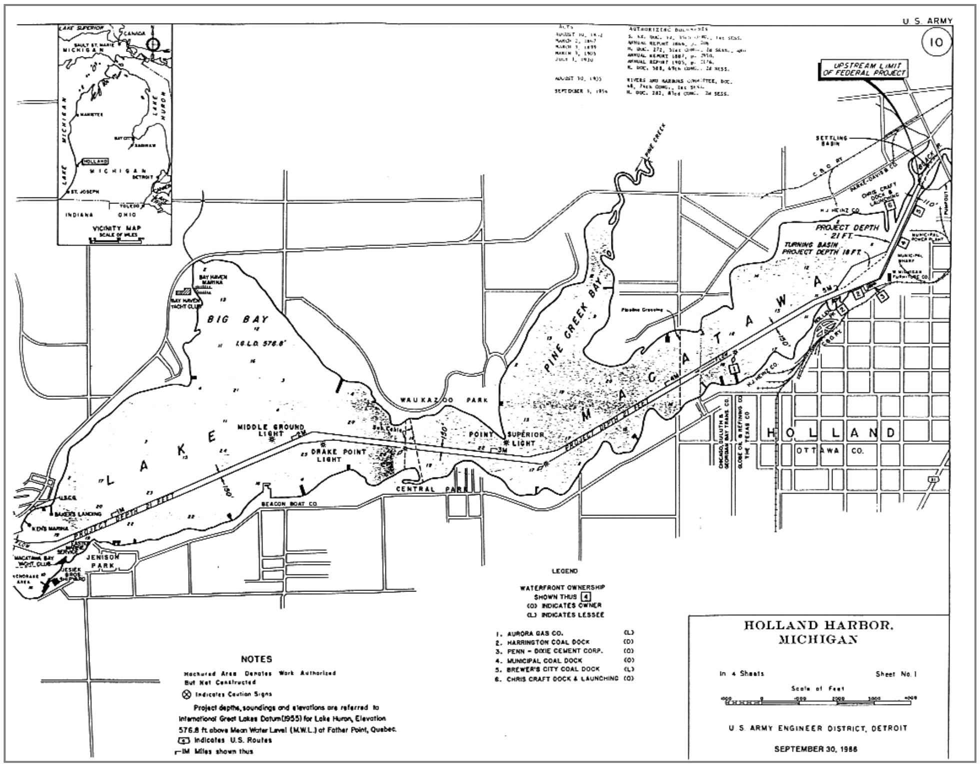


Figure 21. Diagram of the shipping channel of Lake Macatawa.

Lake Macatawa requires occasional dredging to maintain a shipping channel from the Lake Michigan inlet to the bridge at River Avenue (Figure 21). The Army Corps of Engineers oversees all dredging activities in Lake Macatawa. The Lake Michigan inlet is dredged once every year. The portion of Lake Macatawa from the River Avenue Bridge west to the "narrows" of Lake Macatawa requires dredging approximately once every two years. The western portion of the Lake (west of the "narrows") requires dredging approximately once every ten years in order to maintain depths necessary for the shipping channel.

The spoils from the in-lake dredging activities are currently deposited in a confined retention facility located near Lakewood and 120th Avenue. Historically, Windmill Island and the former sanitary landfill (currently part of the Window on the Waterfront Park) were locations where dredging spoils were deposited.

2.8 POPULATION AND DEMOGRAPHICS

Overall, the watershed area has a population of approximately 107,000 people according to the United State Census Bureau (2010, Figure 22). The City of Holland lies completely within the Macatawa Watershed, bordering Lake Macatawa, and contains approximately 31% of the watershed's population (about 33,000 people) while occupying only 10% of the total land area (population density 1,994 persons per square mile).

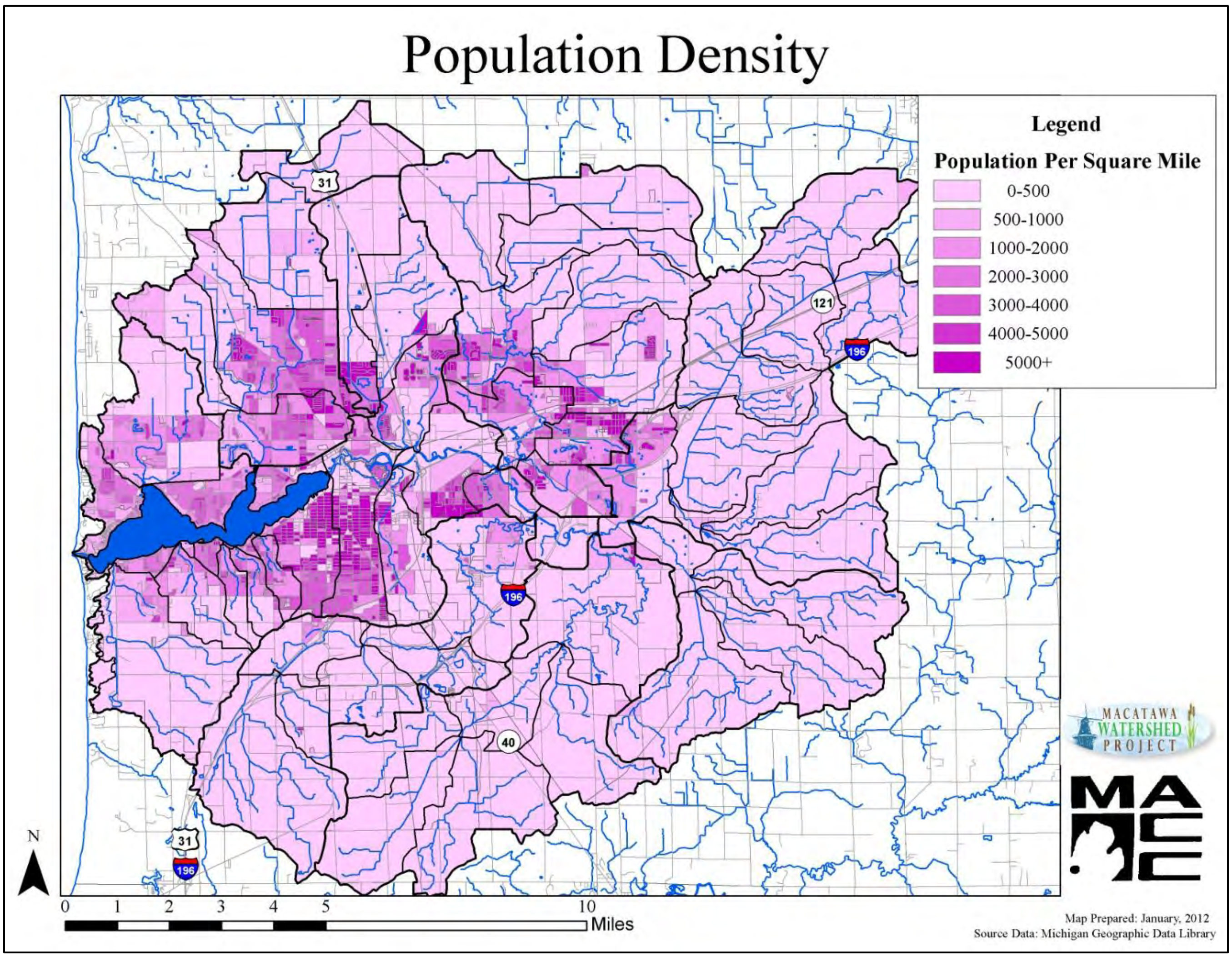


Figure 22. Population density in the Macatawa Watershed.

While a majority of the 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 tends to be centered in the urban areas, so a better characterization of the minority population is best displayed through examining City of Holland’s demographics. See the Information and Education Strategy (Appendix B) for a more complete description of community demographics.

The 2005-2009 American Community Survey and 2010 Census Data (City of Holland statistics) indicate that of the total population:

- 9.6% are foreign born (61% are not a U.S. Citizen, 57% are of Latin American origin and 25% are of Asian origin),
- 22.7% are Hispanic or Latino origin, 3.6% are African American, 3% are Asian,
- 20.8% speak a language other than English in the home,
- 16.5% of the population speaks English less than “very well”
- 13.2% are below the poverty level, 28% of families make less than $35,000 annually and
- 16.4% of those 25 years and older have not attained a high school diploma

2.9 TRANSPORTATION

The MACC area transportation system encompasses all modes of transportation with a general aviation airport, two Class A rail lines, a public transit system (8 fixed routes and demand response service), an extensive nonmotorized pathway network and commercial harbor serving business and recreational users.

The roadway network in the MACC includes segments of interstate (I-196), US routes (US 31) and numerous other state trunklines (M-121, M-40, BL-196). The MACC area also has approximately 147 miles of higher order, non-trunkline roadway network ranging from principal arterial to collector as well as several hundred miles of local streets.

The extensive transportation system in the Macatawa Watershed results in many places where roads cross waterways, referred to as road stream crossings. According to Figure 23, there are approximately 620 such crossings throughout the Macatawa Watershed (Fales 2009). Road stream crossings are usually constructed using several different varieties of culverts or bridges and can often cause localized restriction of flow, plunge pools, disconnectedness and erosion.

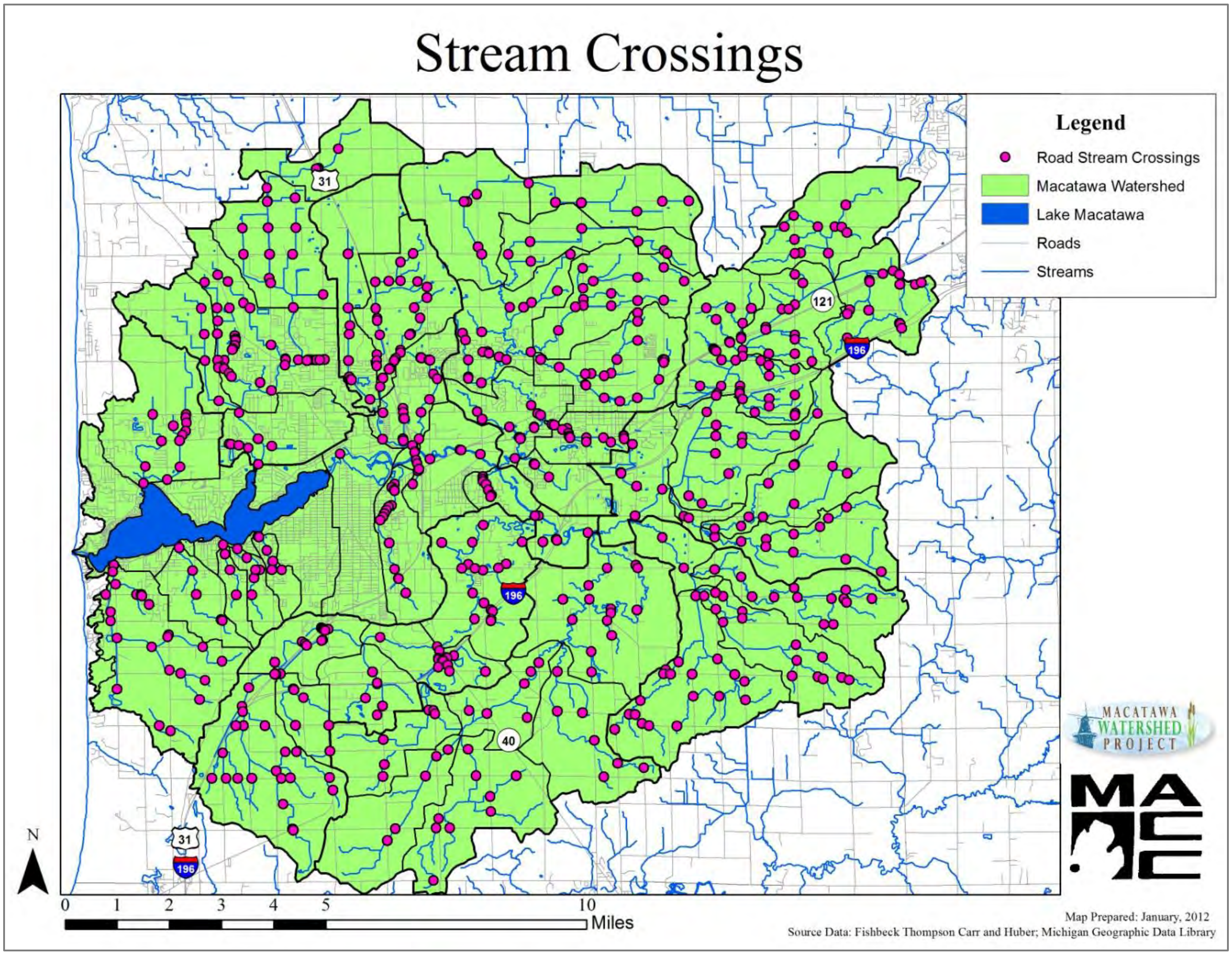


Figure 23. Road stream crossings in the Macatawa Watershed.

Since road stream crossings are often problematic for water quality, the crossings in the Macatawa Watershed have been periodically surveyed in 2004 (Cameron and Hall 2004) and 2008 (Fales 2009) for nonpoint source pollution issues and erosion risk using the standard Bank Erosion Hazard Index (Appendix C). The 2008 survey results indicate that of the 121 road stream crossings surveyed, 10% were considered high risk for erosion and 39% were considered a moderate risk for erosion (Figure 24 and Table 9). The narrative report in Appendix C details trends changes in conditions that were noted between the 2004 and 2008 surveys for each subbasin. In some cases the changes were significant (erosion issues were obviously getting worse). In other cases, conditions were relatively stable and unchanged.

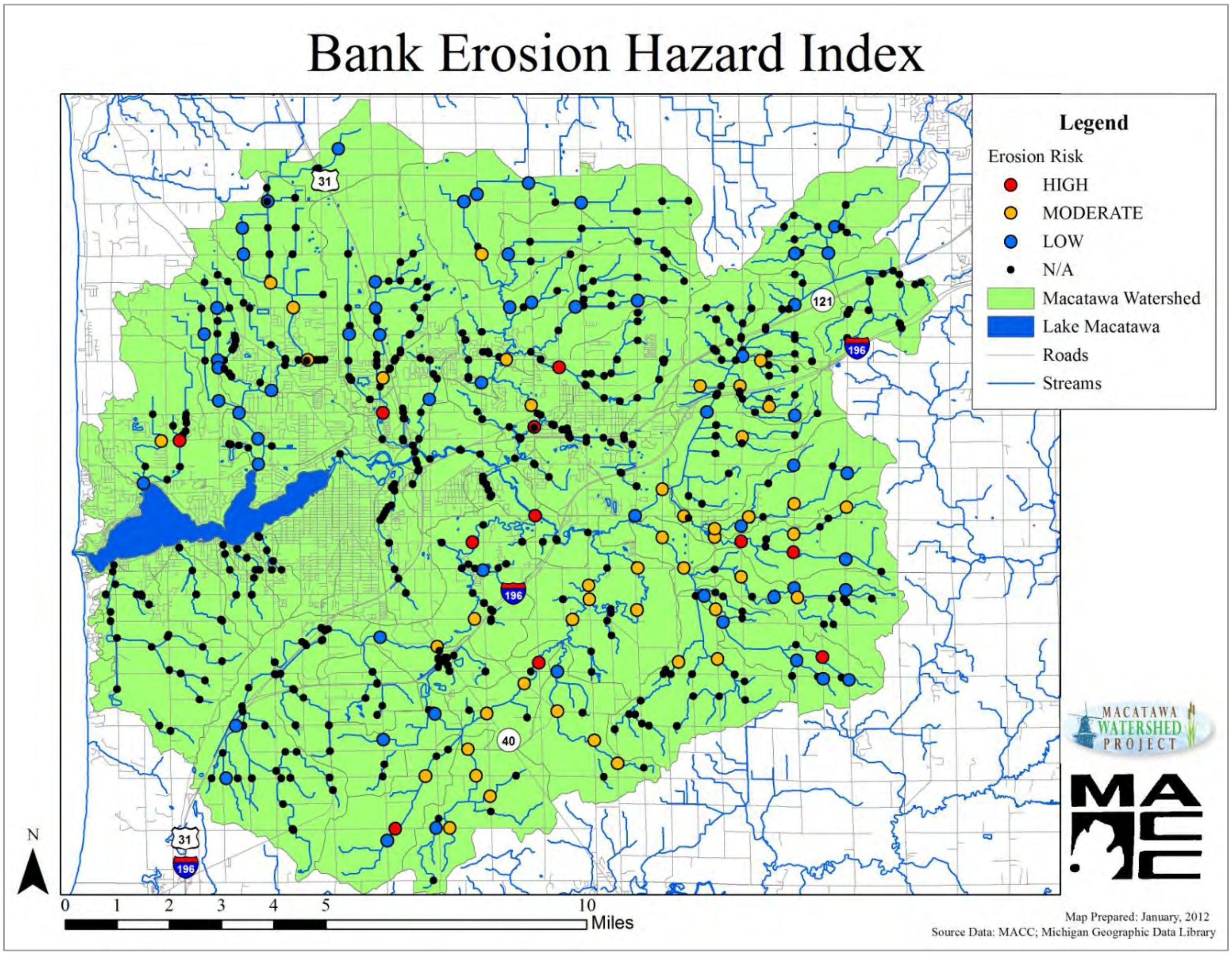


Figure 24. Bank erosion hazard scores for road stream crossings surveyed in 2008.

While the highest risk sites (red) are scattered throughout the watershed, the moderate risk sites (orange) seemed to be concentrated in the eastern two-thirds of the watershed.

Table 9. Erosion risk of road stream crossings in the Macatawa Watershed (Fales 2009).

Sub-watershed	Name	Total Road Crossings	High Erosion Risk	Moderate Risk	Low Risk	Unknown
1	Beaver Dam Drain to Macatawa River	11			3	8
2	Macatawa River to Beaver Dam Drain	15				15
3	Macatawa River at 72nd Avenue	13			2	11
4	Macatawa River at I-196 Overpass	34		4	2	28
5	Macatawa River at Hunderman Creek	14		1	1	12
6	Big Creek to Hunderman Creek	10		3	3	4
7	Hunderman Creek to Big Creek	11	2	3	1	5
8	Hunderman Creek to Macatawa River	2		1		1
9	Macatawa River to the South Branch	9		1	1	7

Sub-watershed	Name	Total Road Crossings	High Erosion Risk	Moderate Risk	Low Risk	Unknown
10	Unnamed tributary to Peters Drain	15	1	1	5	8
11	Peters Drain	21		2		19
12	Unnamed tributary to Peters Creek	13		2	5	6
13	Peters Creek to Macatawa River	2		2		
14	Kleinheksel Drain to South Branch	9		4	1	4
15	Jaarda Drain to South Branch	5	1	1	1	2
16	South Branch Macatawa River to Jaarda Drain	6			2	4
17	South Branch Macatawa River to Unnamed Tributary near 146th	6	1	2	0	3
18	East Fillmore Drain (including Eskes Drain)	7		3	1	3
19	South Branch Macatawa River to Macatawa River	14		5		9
20	Uppermost North Branch Macatawa River	24			2	22
21	Vanderbie Drain and Rotman Drain	7				7
22	North Branch Macatawa River to Den Bleyker Drain	13				13
23	Den Bleyker Drain	6			1	5
24	North Branch Macatawa River at M-40	15		1		14
25	North Branch Macatawa River to Macatawa River	18	3	2	1	12
26	Bosch and Hulst Drain at 104th Avenue	6			2	4
27	Bosch and Hulst Drain to Noordeloos Creek	6		1	3	2
28	Tributary to Bosch and Hulst Drain	7			1	6
29	Hunters Creek to Brower Drain	14		1	2	11
30	Brower Drain to Hunters Creek	20	1			19
31	Noordeloos Creek to Drain #52	18		1	3	14
32	Cedar Drain to Noordeloos Creek	12				12
33	Drain #4 and #43 to Noordeloos Creek	3				3
34	Noordeloos Creek to Macatawa River	13	1	1	0	11
35	Macatawa River to the North Branch	5				5
36	Macatawa River to Noordeloos Creek	7	0			7
37	North Holland Creek to Drain #40	9			1	8
38	Drain #15 and #17 to Drain #40	28		1	3	24
39	Drain #40 to Macatawa River	19	1	0	1	17
40	Macatawa River to Windmill Island	12				12
41	Maplewood Intercounty Drain to Macatawa River	15				15
42	Troost and Boven Dam Drains to Harlem Drain	4			1	3
43	Harlem Drain at Quincy St	13		1	3	9
44	Pine Creek to Drain #37	36		2	4	30
45	Drain #37 to Pine Creek	4			2	2
46	Pine Creek to Lake Macatawa	11			3	8
47	Macatawa River marsh	1				1
48	Winstrom Creek and Drains #20A, #23, #53	13	1	1	1	10
49	Old Lela Drain	6				6
50	Weller Drain	6				6
51	Arbor Creek	4				4
52	Ottogan Intercounty Drain	5				5
53	Kelly Lake Drain	24				24
54	East Lake Macatawa Direct Drainage	0				0
55	West Lake Macatawa Direct Drainage	0				0
Totals		621	12	47	62	500

2.10 STORM WATER

The storm water drainage system throughout the Macatawa Watershed is a separate storm sewer system that is owned and operated by a variety of entities including City of Holland, City of Zeeland, Allegan County Road Commission, Ottawa County Road Commission, Allegan County Drain Office and Ottawa County Drain Office. A separate storm sewer system (MS4) characterizes a drainage system in which wastewater and storm water is drained by separate pipes. The wastewater is carried to the local wastewater treatment plant while the storm water is discharged to the nearest surface water via storm water outfalls. These entities must operate their MS4 systems in accordance with their MS4 Storm Water General permit (NPDES Permit No. MIG619000) which is issued by the MDEQ. There are approximately 500 outfalls located in the Macatawa Watershed (Figure 25). Note that not all outfalls are depicted on the map (some outfalls are not formally owned or operated by any of the permittees).

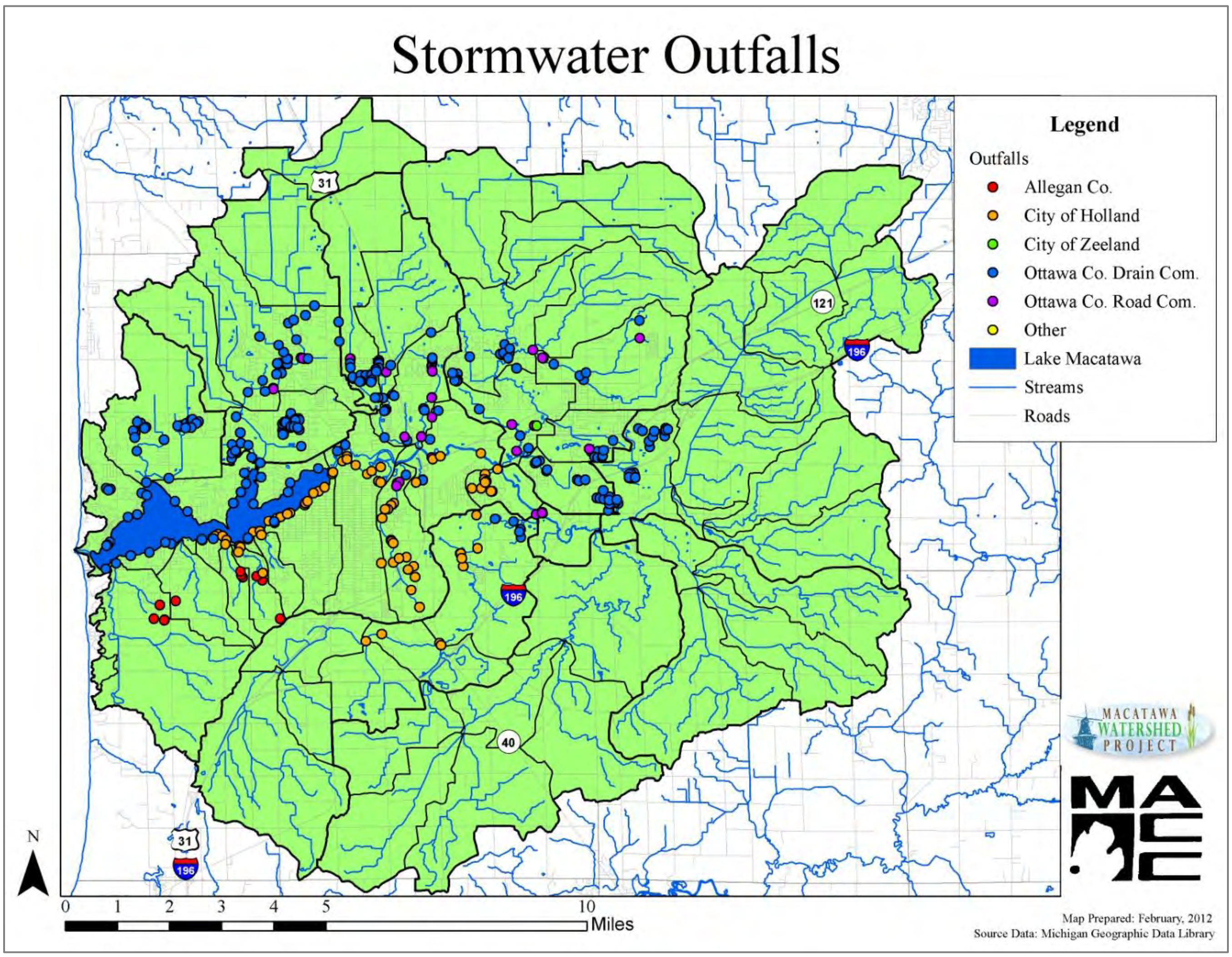


Figure 25. Storm water outfalls in the Macatawa Watershed.

The storm water system in the Macatawa Watershed drains storm water runoff from urban, suburban and rural land. Some land uses within the watershed have the potential to contribute contaminates to the drainage system. These land uses are typically regulated by the MDEQ and need to manage their runoff in accordance with their Industrial Storm Water Permits (Table 10).

Table 10. Summary of NPDES-permitted facilities in the Macatawa Watershed.

No.	Facility Name	Permit No	Address	City	County
1	**Acrofab Inc**	MIS210188	130 East Roosevelt	Zeeland	Ottawa
2	**Allen Extruders LLC**	MIS210514	1305 Lincoln Ave	Holland	Allegan
3	**Anchorage Boat Yard**	MIS210552	1895 Ottawa Beach Rd	Holland	Ottawa
4	**Autumn Hills Recycle-Disposal**	MIS210463	700 56th Ave	Zeeland	Ottawa
5	**BBI Enterprises-Holland**	MIS210132	13401 New Holland St	Holland	Ottawa
6	**Benteler Aluminium Systems**	MIS210720	365 West 24th St	Holland	Ottawa
7	**Big Dutchman-John Donnelly Dr**	MIS210894	3900 John F. Donnelly Dr	Holland	Ottawa
8	**Billco Products Inc-Holland**	MIS210919	1373 Lincoln Ave	Holland	Allegan
9	**Black River Pallet**	MIS210632	50 East Riley St	Zeeland	Ottawa
10	**Black River Recycling-Holland**	MIS210898	11531 Chicago Dr	Holland	Ottawa
11	**Bld Products Ltd-E 48th**	MIS210556	534 East 48th St	Holland	Allegan
12	**Boars Head Provisions Co**	MIS210604	284 Roost Ave	Holland	Ottawa
13	**Brewer Sand & Gravel Inc**	MIS210127	877 Chicago Dr	Holland	Ottawa
14	**Brewers City Dock-Holland**	MIS210150	24 Pine Ave	Holland	Ottawa
15	**Cardinal Buses-Holland**	MIS210658	11358 James St	Holland	Ottawa
16	**Con-way Freight-XHM**	MIS210124	3310 Windquest Dr	Holland	Ottawa
17	**Dr Pepper Snapple Group CSD**	MI0055352	777 Brooks Ave	Holland	Allegan
18	**Eldean Shipyard-Macatawa**	MIS210546	2223 South Shore Dr	Macatawa	Ottawa
19	**Eldean Yacht Basin-Holland**	MIS210548	1862 Ottawa Beach Rd	Holland	Ottawa
20	**Fleet Refinishing Works Inc**	MIS210605	13080 New Holland St	Holland	Ottawa
21	**Genzink Steel Supply**	MIS210745	40 East 64th St	Holland	Ottawa
22	**GLW Finishing**	MIS210929	741 Waverly Court	Holland	Allegan
23	**Gra-Bell Truck-Holland-144 Ave**	MIS210557	931 Interchange	Holland	Ottawa
24	**H J Heinz Co-Holland**	MI0001465	431 West 16th St	Holland	Ottawa
25	**Haworth Inc-Holland**	MIS220030	One Haworth Center	Holland	Allegan
26	**Herman Miller Inc-E Main**	MIS210169	855 East Main Ave	Zeeland	Ottawa
27	**Holland BPW-DeYoung Power Plt**	MI0001473	64 Pine Ave	Holland	Ottawa
28	**Holland BPW-Zeeland Landfill**	MIS210577	1130 56th Ave	Zeeland	Ottawa
29	**Holland Transplanter Co**	MIS210171	510 East 16th St	Holland	Ottawa
30	**Holland WWTP**	MI0023108	270 South River Ave	Holland	Ottawa
31	**Howard Miller Co-Zeeland**	MIS210558	860 East Main Ave	Zeeland	Ottawa
32	**ITW-Drawform**	MIS210462	500 North Fairview	Zeeland	Ottawa
33	**John A Van Den Bosch Co**	MIS210664	509 East Washington St	Zeeland	Ottawa
34	**Johnson Controls-Interior**	MIS210141	1776 Airport Park Court	Holland	Ottawa
35	**Johnson Controls-Southview**	MIS210702	1600 South Washington Ave	Holland	Allegan
36	**Kenowa Industries**	MIS210607	11405 East Lakewood Bvld	Holland	Ottawa
37	**Koks Woodgoods Inc**	MIS210541	423 North Centennial	Zeeland	Ottawa
38	**L&W Engineering Plt3-Holland**	MIS210770	808 East 32nd St	Holland	Allegan
39	**Liquid Industrial Waste**	MIS210717	11325 East Lakewood Bvld	Holland	Ottawa
40	**LKQ Self Service Auto Parts**	MIS210609	11475 and 11431 Chicago Dr	Holland	Ottawa

No.	Facility Name	Permit No	Address	City	County
41	**Louis Padnos Co-Holland**	MIS210945	185 West 8th St	Holland	Ottawa
42	**Meppelink Woods Inc**	MIS210549	260 East Roosevelt	Zeeland	Ottawa
43	**Mich Wood Pellet Fuel LLC**	MIS220051	1125 Industrial Ave	Holland	Allegan
44	**Nelson Steel Products Inc**	MIS210554	410 East 48th St	Holland	Allegan
45	**ODL Incorporated**	MIS210551	215 East Roosevelt	Zeeland	Ottawa
46	**Perrigo Holland Inc**	MIS210054	13925 Reflections Dr	Holland	Ottawa
47	**Plascore Inc**	MIS210506	615 North Fairview St	Zeeland	Ottawa
48	**Plascore Inc-Zeeland**	MIS210927	500 East Roosevelt	Zeeland	Ottawa
49	**Portercorp**	MIS210128	4240 North 136th Ave	Holland	Ottawa
50	**PQ Marine Holding Inc**	MIS210939	2385 112th Ave	Holland	Ottawa
51	**Repcolite Paints Inc**	MIS210516	473 West 17th St	Holland	Ottawa
52	**Rieth-Riley-Zeeland**	MIS220043	724 East Washington	Zeeland	Ottawa
53	**SAF-Holland USA-18th Street**	MIS210574	430 West 18th St	Holland	Ottawa
54	**Sara Lee Foods-Zeeland**	MI0037451	8300 96th Ave	Zeeland	Ottawa
55	**Sherwin Williams Co-Holland**	MI0055956	636 East 40th St	Holland	Allegan
56	**Siemens Water Technologies**	MIS210168	2155 112th Ave	Holland	Ottawa
57	**The Stow Co**	MIS210964	3311 Windquest Dr	Holland	Ottawa
58	**Tiara Yachts Inc**	MIS210536	725 East 40th St	Holland	Allegan
59	**Trendway Corp**	MIS210138	13467 Quincy St	Holland	Ottawa
60	**Tulip City Airport-Holland**	MIS210458	170 Geurink Blvd	Holland	Allegan
61	**Uniform Color Company**	MIS210891	942 Brooks Ave	Holland	Allegan
62	**Venturedyne-Thermotron**	MIS210513	836 Brooks Ave	Holland	Allegan
63	**Vertellus Health & Specialty**	MIS210008	215 North Centennial St	Zeeland	Ottawa
64	**Woodward FST Inc-Zeeland**	MIS220032	700 North Centennial St	Zeeland	Ottawa
65	**Zeeland Farm Services**	MIS220027	2468 84th Ave	Zeeland	Ottawa
66	**Zeeland Generating Station**	MIS220042	425 Fairview Rd	Zeeland	Ottawa
67	**Zeeland WWTP**	MI0020524	144 East Lincoln Ave	Zeeland	Ottawa

In addition to the facilities listed above, there are three facilities in the Macatawa Watershed that are considered major point sources of phosphorus and have direct wastewater discharges to the surface waters of the Macatawa Watershed. They include the Holland BPW Wastewater Treatment Plant, the City of Zeeland Clean Water Plant and Mead Johnson. These facilities are all regulated by the MDEQ and annually report to the Macatawa Watershed Project. See Appendix D for the most recent annual report (2010-2011).

2.11 SECTION 2.0 REFERENCES

Cameron, T. and T. Hall. 2004. Summary of Macatawa River Watershed Assessment, Ottawa and Allegan, Michigan. Michigan Department of Environmental Quality.

Fales, M. 2009. Summary of 2008 Bank Erosion Hazard Index and Road Stream Crossing Assessment, Macatawa Watershed. Macatawa Area Coordinating Council.

Fongers, D. 2009. Macatawa Watershed Hydrologic Study. Hydrologic Studies Unit. Land and Water Management Division. Michigan Department of Environment Quality.

Martinus, W. 2001. The Lower Pine Creek Area, a Natural Features Inventory.

Martinus, W. 2004. A Natural Features Inventory for the Outdoor Discovery Center.

Martinus, W. and L. Schaddelee. 1998. Macatawa Greenway overview for the Macatawa Greenway Partnership, Holland, Michigan.

MDNR (Michigan Department of Natural Resources). 2000. Lake Macatawa Fish Report. Accessed from the Fish Collection System on 6/20/2011. http://www.the-macc.org/wp-content/uploads/2009/04/History-of-Lake-Mactawa-and-Fish.pdf.

MNFI (Michigan Natural Features Inventory). 2012. Rare Species Explorer. (Allegan and Ottawa County). Accessed on 1/23/2012. http://mnfi.anr.msu.edu/explorer

Natural Resources Conservation Service, United States Department of Agriculture. Official Soil Series Descriptions. Available online at http://soils.usda.gov/technical/classification/osd/index.html. Accessed January 2012.

Resource Management Group and J.F. New & Associates. 2001. Upper Macatawa Conservation Area Feasibility Study. Prepared for the Ottawa County Parks & Recreation Commission.

U.S. Census Bureau. 2005-2009 American Community Survey. Available online at http://www.census.gov/acs/www/ Accessed January 2011.

Vandewater, R. 2012. Black Lake became Lake Macatawa in 1935. Holland Sentinel. June 17, 2012.

Van Faasen, C, J. Soukhome and G. Peaslee. 2008. An Environmental History of the Lake Macatawa Watershed. Holland Litho, Holland, Michigan.

3.0 WATER QUALITY CONDITIONS

IN THIS SECTION YOU WILL UNDERSTAND:

- HOW WATER QUALITY IS ASSESSED
- THE EXTENT OF IMPAIRED WATERWAYS IN THE WATERSHED
- THE HISTORIC, VOLUNTEER AND CURRENT MONITORING EFFORTS UNDERWAY
- THE PRIORITY POLLUTANTS, SOURCES AND CAUSES AFFECTING LAKE MACATAWA WATER QUALITY

3.1 ASSESSING WATER QUALITY

The Macatawa Watershed has undergone a myriad of studies, assessments and monitoring efforts over the last 15 years in an effort to assess and track water quality over time. Ultimately, the data collected by the MDEQ determines the official water quality status of the Macatawa Watershed. During the development of this management plan several more in-depth analyses were completed and are described below. In addition, the MACC involved a tremendous variety of stakeholders in the planning process. Many of these stakeholders contributed their invaluable personal watershed knowledge. All of these resources were pooled in an effort to develop the most complete and comprehensive management recommendations possible.

3.2 EARLY MONITORING AND RESEARCH

Researchers from Hope College, state and national 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 over a century. Research on biological communities, sediment quality, waste discharges, nutrients, and toxic measurements in the Macatawa Watershed have long signaled the presence of water quality impairments.

The majority of studies performed since the mid-1960's indicate that Lake Macatawa and its tributaries have struggled for decades with high levels of sediment and nutrients, indicating highly trophic (hypereutrophic) conditions (Van Fassen et al 2008).

As early as 1965, the Michigan Department of Conservation made various reports of fish kills. Each report suggests that the events were precipitated by low oxygen levels, caused by various waste discharges to the tributaries. The low oxygen levels again suggest hypereutrophic conditions. In 1971, the Michigan Water Resources Commission conducted a biological survey of the Black River and Lake Macatawa (Jackson 1971). Twelve sites were monitored and the results indicated poor water quality due to the number and types of aquatic life observed.

Don Williams, Ph.D., Hope College, submitted a report of water quality observations taken from 1966-1971. Williams worked with the Hope College Institute for Environmental Quality and volunteers from the Macatawa Bay Yacht Club to collect weekly lake water samples from June through September. One of the group's conclusions was that erosion and overabundance of organic matter was a problem, evidenced by high coliform counts (Williams 1975).

In 1996, the Clean Water Committee of the Lake Macatawa Shoreline Association assembled a document containing communications and background information on water quality studies performed on Lake Macatawa. Much of the information contained in that document points to excessive sediment and nutrients as sources of the Lake's historical problems (Lake Macatawa Shoreline Association 1996).

In 1995, the MDEQ performed a study of the waters in the East Basin of Lake Macatawa. The Department concluded that the dissolved oxygen levels in the lake were unsatisfactory, and that a probable cause of the low levels was nutrient overenrichment. This study by the MDEQ contained the findings that led to the development of the current Macatawa Watershed Project (Mustata 1996).

A consultant for The Lake Macatawa Shoreline Association, Water Quality Investigators, completed a study of the Lake Macatawa Watershed in 1999 (Fusilier and Fusilier 1999). The report includes historical information, water quality and sediment analyses, discussion and recommendations for remedial action in the Macatawa Watershed. A Water Quality Index was used to rank the overall water quality in Lake Macatawa. The Index was comprised of scores for temperature, dissolved oxygen, chlorophyll-a, secchi disk depth, nitrate, alkalinity, pH, specific conductivity, and total phosphorus.

Scores for the index follow an academic letter-grading scheme, A, B, C, D, and E, from highest quality to lowest. Lake Macatawa was tested over sixty times from 1993 to 1997. Scores for all dates, with the exception of five, were E (poorest water quality). The Water Quality Investigators found an average of 101 micrograms per liter phosphorus concentration over their five year sampling period.

3.3 WATER QUALITY STANDARDS, DESIGNATED USES AND P TMDL

The development of a Phosphorus Total Maximum Daily Load (TMDL) for the Macatawa Watershed is a direct result of the water quality impairments described above and violations of State Water Quality Standards, as described below.

The MDEQ routinely monitors waters of the State to determine compliance with State of Michigan water quality standards (WQS) of Part 4 (promulgated pursuant to Part 31 of the Natural Resources Environmental Protection Act, 1994 PA451, as amended known as NREPA).

Rule 323.1100 covers *Designated Uses* and states that at a minimum all surface waters of the state are designated for, and shall be protected for, all of the following uses:

a) Agriculture
b) Navigation
c) Industrial water supply
d) Warmwater fishery
e) Other indigenous aquatic wildlife
f) Partial body contact recreation
g) Fish consumption

In addition, all surface waters of the state are designated for and shall be protected for total body recreation from May 1 to October 31. Rule 323.1050 states that the waters of the state shall not have any of the following unnatural physical properties in quantities which 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. Complete definitions and specific water quality criteria for designated uses are included in Appendix E. According to the MDEQ's 2010 Integrated Report, the Macatawa Watershed has approximately 329 miles of waterways that are impaired and not meeting several designated uses (Table 11, Appendix F).

Table 11. Summary of attainment status of State Designated Uses for the Macatawa Watershed.

<table>
<tr><th rowspan="2">Subbasin Name</th><th rowspan="2">Subbasin HUC Code</th><th rowspan="2"># impaired stream miles from</th><th colspan="8">Designated Uses</th></tr>
<tr><th>Warmwater Fishery</th><th>Other Aquatic Life/Wildlife</th><th>Partial Body Contact</th><th>Total Body Contact</th><th>Fish Consumption</th><th>Agricultural Use</th><th>Industrial Water Supply</th><th>Navigation</th></tr>
<tr><td>Upper Macatawa</td><td>40500020401</td><td>50.2</td><td rowspan="8">Not supporting
(excessive sediment noted)</td><td rowspan="8">Not supporting
(excessive sediment and phosphorus noted)</td><td rowspan="8">Not assessed</td><td rowspan="8">Not assessed</td><td rowspan="8">Not assessed</td><td rowspan="12">Fully Supporting</td><td rowspan="12">Fully Supporting</td><td rowspan="12">Fully Supporting</td></tr>
<tr><td>South Branch Macatawa</td><td>40500020402</td><td>45.9</td></tr>
<tr><td>Middle Macatawa</td><td>40500020403</td><td>56.8</td></tr>
<tr><td>North Branch</td><td>40500020404</td><td>44.4</td></tr>
<tr><td>Noordeloos Creek</td><td>40500020405</td><td>52.1</td></tr>
<tr><td>Lower Macatawa</td><td>40500020406</td><td>32.1</td></tr>
<tr><td>Pine Creek</td><td>40500020407</td><td>26.2</td></tr>
<tr><td>Kelly Lake Drain</td><td>40500020408 -03</td><td>20.7</td></tr>
<tr><td>Lake Macatawa</td><td>40500020408 -01</td><td>1799 (acres)</td><td rowspan="4">Not Assessed</td><td rowspan="4">Not Assessed</td><td>Not Assessed</td><td>Not Assessed</td><td>Not Supporting (PCBs and mercury)</td></tr>
<tr><td>Dunton Park Beach</td><td>40500020408 -02</td><td>0.2</td><td>Not Supporting (E.coli bacteria)</td><td>Not Supporting (E.coli bacteria)</td><td>Not assessed</td></tr>
<tr><td>Huizenga Park Pond</td><td>40500020405 -02</td><td>0.2</td><td>Not Supporting (E.coli bacteria)</td><td>Not Supporting (E.coli bacteria)</td><td>Not assessed</td></tr>
<tr><td>Holland State Park Beach</td><td>40500020408 -03</td><td>NA</td><td>Fully Supporting</td><td>Fully Supporting</td><td>Not assessed</td></tr>
<tr><td>Total</td><td></td><td>328.8</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

According to the MDEQ, the waters of the Macatawa Watershed do not meet several water quality standards. Turbidity, color, settable solids, suspended solids, and deposits were all identified as properties which contributed to Lake Macatawa's non-attainment of designated uses (d) and (e) above. This formal designation of impaired water quality was first made in 1998. Almost every mile of waterway in the Macatawa Watershed is included on the State's 303(d) list for non attaining water quality due to nonpoint source pollution (Figure 26). While only the Dunton Park Beach area (north shore of Lake Macatawa) is failing to meet requirements for total and partial body contact due to elevated levels of *E.coli* bacteria. The fish consumption designated use is only impaired for Lake Macatawa (carp and walleye), as it was not assessed throughout the entire watershed. Note that the only waterway not included on this list is Winstrom Creek (subwatershed #48) which is a direct tributary to Lake Macatawa (northwest end of the lake).

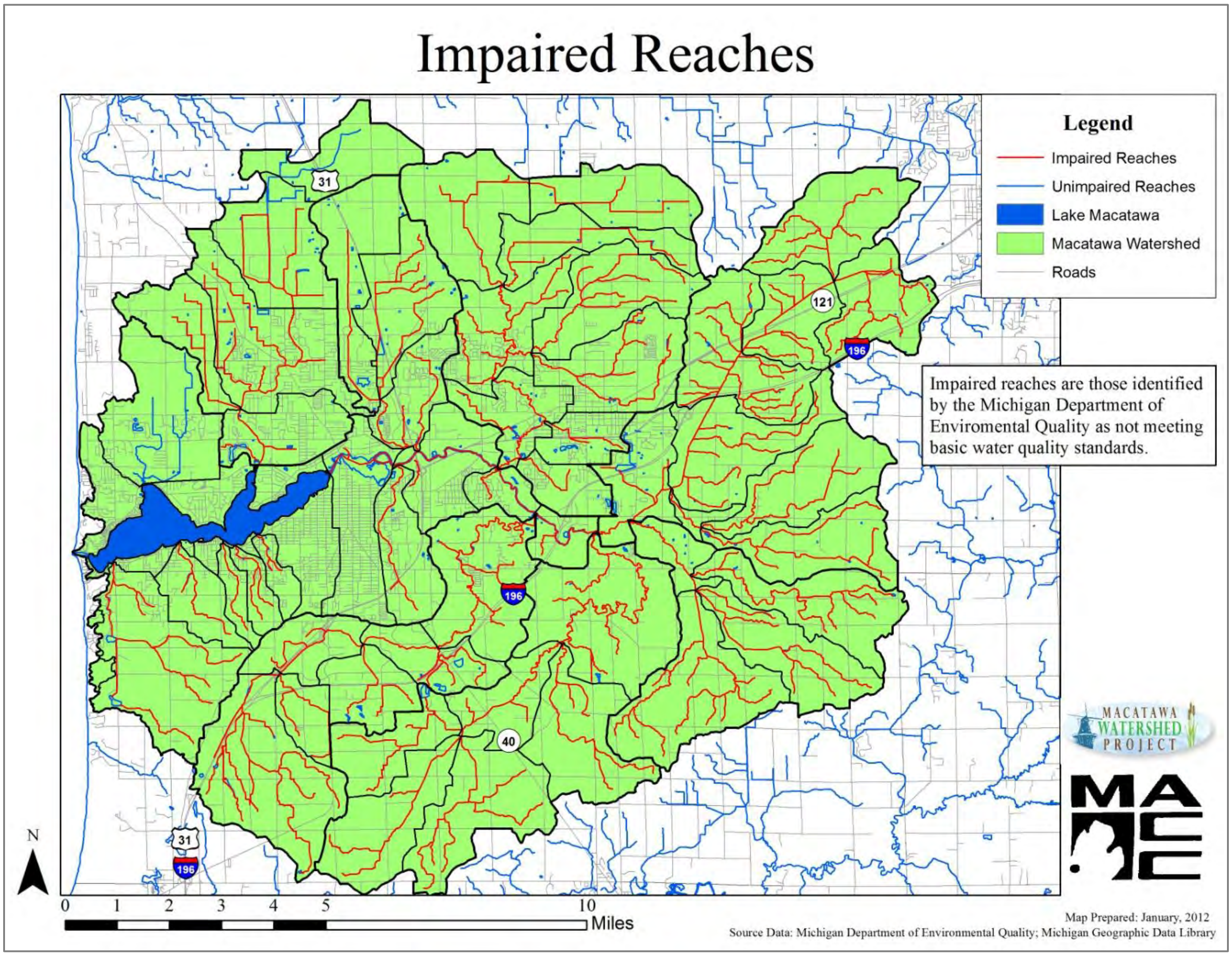


Figure 26. Impaired waterways within the Macatawa Watershed (MDEQ 2010). See Figure 5 to reference subbasin names.

- *"Excessive siltation requires annual dredging of the outer channel and way too frequent dredging of the inner channel. While the outer channel is certainly driven more by Lake Michigan currents, there is a contribution of many tons of sediment per day that is due to fluvial deposits there. The inner channel is entirely due to excess sediment from the Macatawa River, and causes the Army Core of Engineers to visit us regularly to keep commercial shipping channels open. I would argue that this is not meeting a designated use for navigation."*
- *"There are several segments of the Macatawa, Noordeloos Creek, and Pine Creek that could be navigable but are not because of sedimentation."*
- *"Canoes and kayaks, no problem. Large vessels that bring in coal and aggregate: the low water levels and silt accumulation combine to threaten safe passage. It is crucial that the USACE continue to fund inner and outer Holland Harbor maintenance so that commercial shipping activity thrives."*
- *"Lots of snags and places where canoeing is not viable"*

Comments from members of the Watershed Planning Committee regarding navigation

To review the complete set of listings see Appendix F for an excerpt from MDEQ's 2010 Integrated Report. Please note that MDEQ recently released a draft 2012 Integrated Report that has not yet been finalized. From preliminary review, it does not appear that there have been any changes to the listing of impaired waterbodies in the Macatawa Watershed.

The MDEQ does not conduct any specific monitoring to assess the agricultural, industrial water supply and navigation designated uses and makes the general assumption that they are being met statewide (unless data can be presented to the contrary). In the MACC's best professional judgment, we feel that the navigation designated use may be "threatened". In 2010, members of the Watershed Planning Committee submitted their comments about the issue (left).

To maintain navigation on Lake Macatawa and maintain a navigable connection to Lake Michigan, the Army Corps of Engineers (ACOE) must conduct frequent dredging. Without critical dredging projects, Lake Macatawa will remain inaccessible to large ships and recreational watercraft. Although the MDEQ does not recognize the navigation designated use as being threatened, the MACC feels it is a valid community concern. Therefore, we plan to address navigation and recreation issues as a "desired use". For more information, see Chapter 4, Watershed Action Plan.

Not Applicable	•Public Water Supply •Coldwater Fishery
Meeting Standards	•Agricultural Use •Industrial Water Supply •Navigation
Impaired	•Warmwater Fishery •Other Aquatic life/Wildlife •Total Body Contact •Partial Body Contact •Fish Consumption

The monitoring data and observations indicate that the watershed is being impaired by excessive levels of sediment and nutrients (especially phosphorus) which cause extremely low dissolved oxygen levels, turbidity and nuisance algae blooms. Small portions of the watershed are impaired by elevated levels of *E.coli* bacteria. The MDEQ continues to monitor the watershed, and as recently as 2010, biological communities and water quality parameters indicated poor conditions (Holden 2012).

In 1998, the MDEQ developed a Total Maximum Daily Load (TMDL) for phosphorus for Lake Macatawa, which was approved by EPA in 2000 (Walterhouse 1999). The MDEQ conducted monitoring to assess the total annual phosphorus load and estimated it to 138,000 pounds annually. The MDEQ also reported that the total amount of phosphorus contributed to the Macatawa Watershed by nonpoint sources was 91% of the total phosphorus load (approximately 126,000 lbs; Walterhouse 1998). They set an allowable phosphorus loading goal of 55,200 lbs annually with a phosphorus concentration in Lake Macatawa of 50 parts per billion (ppb). Major point source dischargers of phosphorus were allowed to use 20,000 lbs of that allotment. Therefore the nonpoint source portion of the 55,000 lbs of phosphorus is roughly 35,000 lbs annually, which indicates that the annual nonpoint source phosphorus load to Lake Macatawa must be reduced by 70% to meet water quality standards.

According to MDEQ's 2010 Integrated Report, there are two main areas in the watershed that are suffering from elevated levels of *E.coli* bacteria and are scheduled to have a TMDL developed in 2017. Those areas are Dunton Park Beach on the north shore of Lake Macatawa and Huizenga Park Pond which is a separate inland waterbody located within the City of Zeeland.

3.4 MORE WATER QUALITY INFORMATION

BIOSURVEYS AND WATER CHEMISTRY

One of the ways that the MDEQ assesses whether the State's waterbodies are meeting water quality standards is by performing regular monitoring. The MDEQ performs regular monitoring in the Macatawa Watershed via two methods including TMDL-related water quality monitoring every other year and biological monitoring every 5 years.

The MDEQ is committed to monitoring the Macatawa Watershed frequently to assess progress in relation to achieving the Phosphorus TMDL. Monitoring began in the late 1990s and continued annually until 2006 (Walterhouse 2007). Since 2006, the monitoring has been conducted every other year and was most recently conducted in 2008 and 2010 (Walterhouse 2009; Walterhouse 2011, Appendix G). The phosphorus concentration in Lake Macatawa has ranged from 127 µg/l in 1997, to 470 µg/l in 2000 and is strongly dependent on spring precipitation totals.

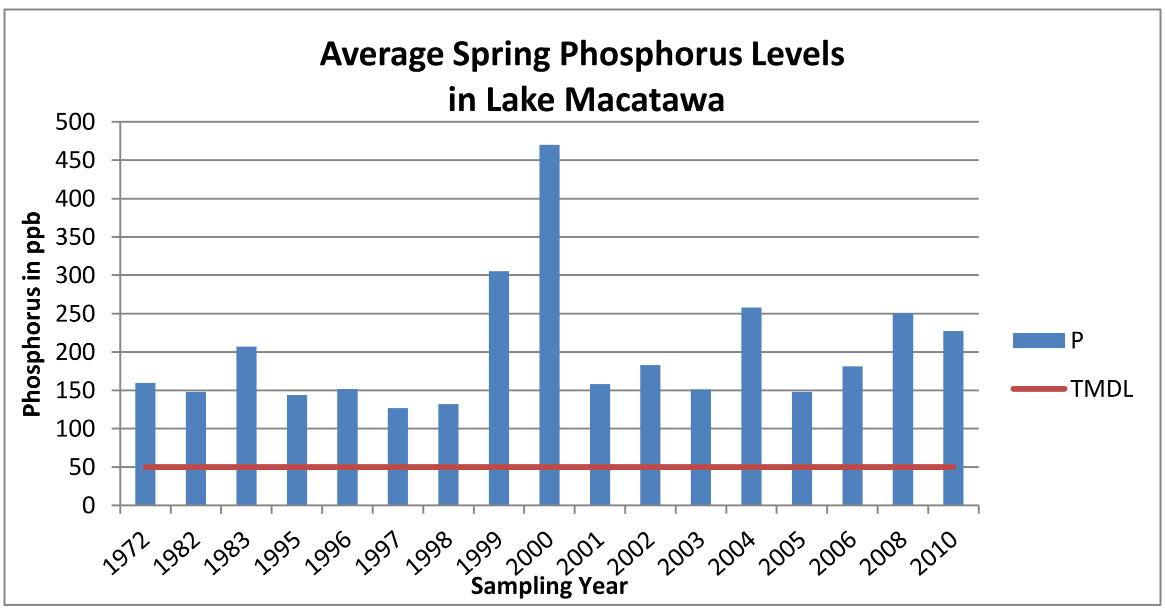


Figure 27. Historical average spring phosphorus levels in Lake Macatawa (MDEQ data, Walterhouse 2010).

The historical average spring phosphorus levels in Lake Macatawa vary widely (Figure 27). In 2010, the average spring phosphorus level was 227 parts per billion (ppb) which was lower than levels in 2008 but higher than levels in 2005 and 2006. The phosphorus levels in 2010 were 4 times greater than the TMDL goal of 50 ppb.

Regular biological and/or water chemistry monitoring is conducted in every watershed in the State on a 5-year rotating cycle. The MDEQ first began biological monitoring in the Macatawa Watershed 1990 and most recently monitored in 2010. During each monitoring period 7 to 16 sites have been assessed for habitat quality, fish community, aquatic macroinvertebrates and/or water chemistry (Table 12). Fish, habitat and invertebrates are categorized into four classifications including excellent, acceptable/good (slightly impaired), fair/marginal (moderately impaired) and poor (severely impaired). The data provides some basis for determining long term water quality trends. Refer to Figure 28 for the locations of each one of the sites referenced below identified on the map by the site number.

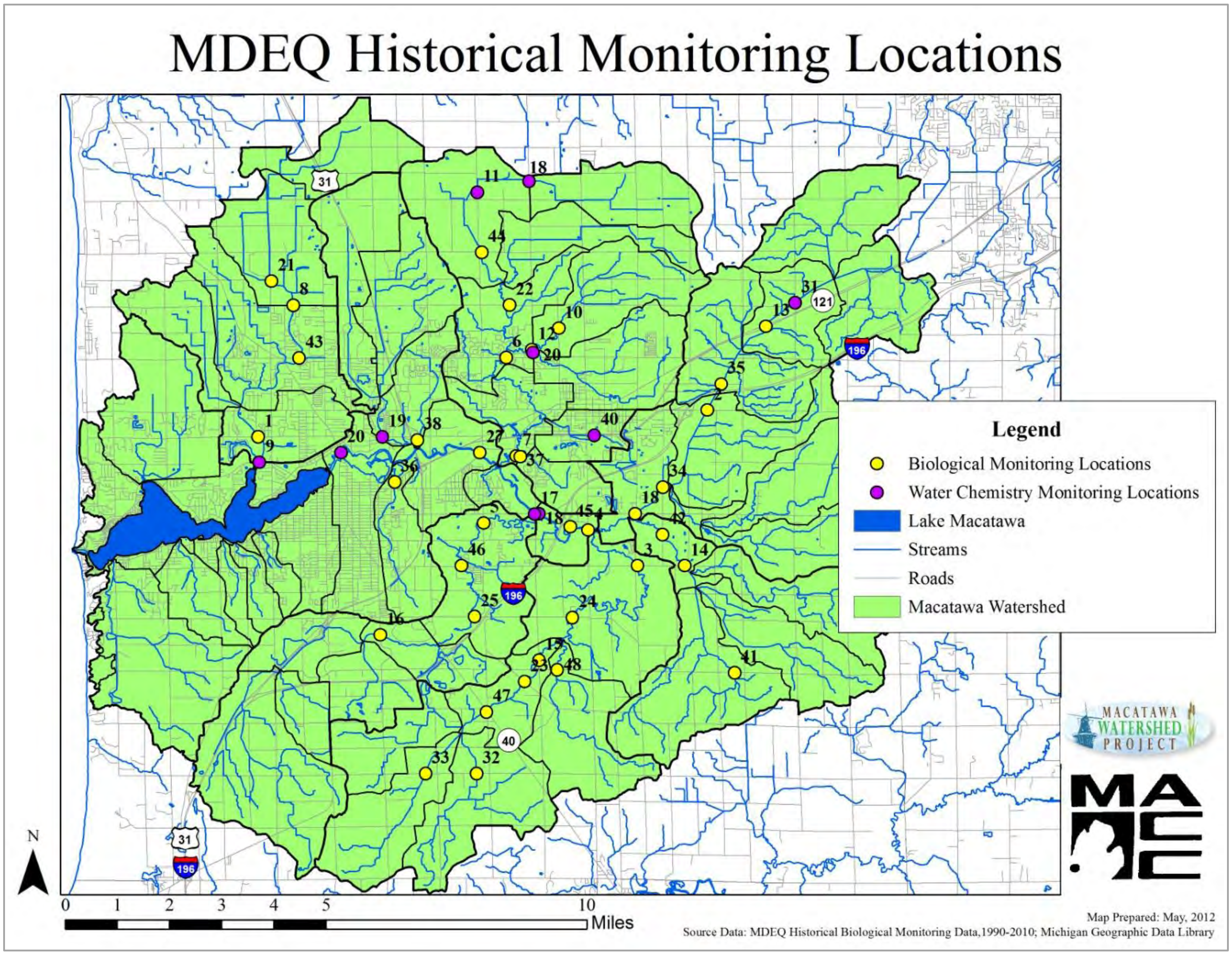


Figure 28. Locations of all historical monitoring locations sampling by the MDEQ since 1990 (see Table 12 for actual sampling data at each labeled site).

Table 12. History of biological surveys conducted by MDEQ in the Macatawa Watershed (TP=total phosphorus).

Site No.	Locations	Subbasin	Sampled For:	Prev site?	Fish	Inverts	Habitat	Water Temp	Total Phos (mg/l)	Trends
1990 (Wuycheck 1995)										
1	Pine Creek at Lakewood Blvd	Pine Creek	habitat, fish, bugs, temp		Good	Fair	Poor	59°F		
2	Macatawa River at Byron Road	Upper Macatawa	habitat, fish, bugs, temp		Fair	Fair	Poor	68°F		
3	South Branch of the Macatawa at Ottogan Road	South Branch	habitat, fish, bugs, temp		Good	Fair	Poor	72°F		
4	Macatawa River at 96th	Lower Macatawa	habitat, fish, bugs, temp		Fair	Fair	Poor	72°F		
5	North Branch of the Macatawa River at 112th Ave	North Branch	habitat, fish, bugs, temp		Good	Fair	Fair	76°F		
6	Noordeloos Creek at Riley Street	Noordeloos	habitat, fish, bugs, temp		Poor	Fair	Poor	66°F		
7	Noordeloos Creek at 106th Avenue	Noordeloos	habitat, fish, bugs, temp		Fair	Fair	Poor	73°F		
Aug-Oct 1995 (Walterhouse 1997)										
8	Pine Creek at Quincy Street	Pine Creek	habitat, bugs, water chemistry	No		Poor	Fair	67°F	0.136	
9	Pine Creek at Ottawa Beach Road	Pine Creek	water chemistry	No					0.105	
10	Brower Dr at 100th ave (Noordeloos Creek subshed)	Noordeloos	habitat, fish, bugs, water chemistry	No		Accept	Fair	72°F	0.139	
11	Noordeloos Creek at 112th	Noordeloos	water chemistry	No					1.2	
12	Noordeloos Creek at 104th	Noordeloos	water chemistry	No					0.095	
13	Macatawa River at M-21 (Chicago Drive)	Upper Macatawa	habitat, bugs, water chemistry	No		Accept	Poor	70°F	0.154	
14	Drenthe Creek/Drain at Ottogan Rd	Upper Macatawa	habitat, bugs, water chemistry	No		Accept	Fair	73°F	0.089	
15	South Branch of Macatawa at 50th Street	South Branch	habitat, bugs, water chemistry	No		Accept	Fair	75°F	0.35	
16	North Branch of Macatawa River at 56th Ave	North Branch	habitat, bugs, water chemistry	No		Poor	Fair	72°F	0.074	
17	North Branch Macatawa River at Adams	North Branch	water chemistry	No					0.119	
18	Macatawa River at Adams	Lower Macatawa	water chemistry	No					0.082	
19	North Holland Drain at Lakewood Blvd	Lower Macatawa	water chemistry	No					0.105	
20	Macatawa River at River Drive	Lower Macatawa	water chemistry	No					0.22	
August-September 2000 (Rockafellow 2002)										
21	Pine Creek at 144th Avenue	Pine Creek	habitat, bugs, water chemistry	No		Accept	Fair	68°F	0.05	
1	Pine Creek at Lakewood Blvd	Pine Creek	habitat, bugs, water chemistry	Yes		Accept	Fair	70°F	0.04	Scored better than 1990
22	Bosch and Hulst at Quincy (Noordeloos Subshed)	Noordeloos	habitat, bugs, water chemistry	No		Poor	Fair	74°F	0.28	
12	Noordeloos at 104th	Noordeloos	habitat, bugs, water chemistry	Yes		Accept	Fair	68°F	0.16	More phosphorus than 1995
2	Macatawa River at Byron Road	Upper Macatawa	habitat, bugs, water chemistry	Yes		Poor	Fair	62°F	0.138	Insects worse, better habitat than 1990
23	South Branch Macatawa River at Russcher Road	South Branch	habitat, bugs, water chemistry	No		Accept	Good	75°F	n/a	

Site No.	Locations	Subbasin	Sampled For:	Prev site?	Fish	Inverts	Habitat	Water Temp	Total Phos (mg/l)	Trends
24	South Branch Macatawa River at 146th	South Branch	habitat, bugs, water chemistry	No		Poor	Fair	76°F	0.18	
4	Macatawa River at 96th	Lower Macatawa	habitat, bugs, water chemistry	Yes		Accept	Fair	62°F	0.084	Scored better than 1990
25	North Branch Macatawa River at 146th	North Branch	habitat, bugs, water chemistry	No		Accept	Fair	72°F	0.08	
26	North Branch Macatawa River at 52nd	North Branch	habitat, bugs, water chemistry	No		Accept	Fair	72°F	0.08	
27	Macatawa River @ 112th (Paw Paw)	Lower Macatawa	habitat, bugs, water chemistry	No		Accept	Fair	70°F	0.1	
28	Bosch & Hulst @ 104th	Noordeloos	water chemistry	No					0.138	
10	Bosch & Hulst @ 100th	Noordeloos	water chemistry	No					0.5	
30	Bosch & Hulst Trib @104th	Noordeloos	water chemistry	No					0.83	
31	Macatawa River at 64th	Upper Macatawa?	water chemistry	No					0.146	
32	Kleinheksel Drain at 140th (trib to South Branch)	South Branch	water chemistry	No					0.16	
33	Jaarda Drain @140th (trib to South Branch)	South Branch	water chemistry	No					0.07	
16	North Branch Macatawa at 56th	North Branch	water chemistry	Yes					0.11	Higher phosphorus than 1995
June 2005 (Faivor and Hanshue2007)										
4	Macatawa River at 96th	Lower Macatawa	habitat, bugs, fish	Yes	Accept	Accept	Marginal	70°F		Scored better than 1990
34	Macatawa River at 84th	Upper Macatawa	habitat, bugs, fish	No	Poor	Poor	Poor	70°F		
35	Macatawa River at Riley	Upper Macatawa	habitat, fish	No	Poor		Marginal			
1	Pine Creek at Lakewood Blvd	Pine Creek	habitat, bugs, fish	Yes	Poor	Accept	Good	68°F		Fish getting worse, habitat getting better, insects about same
36	Maplewood Drain at 6th Street	Lower Macatawa	habitat, bugs, fish	No	Accept	Accept	Marginal	66°F		
3	South Branch Macatawa River at 108th (Ottogan)	South Branch	habitat, bugs, fish	Yes	Poor	Accept	Marginal	66°F		Fish getting worse , Habitat getting better
37	Noordeloos Creek at 107th	Noordeloos	habitat, bugs, fish	No	Poor	Accept	Good	73°F		
2	Macatawa River at Byron	Upper Macatawa	habitat, bugs	Yes		Poor	Marginal	69°F		About the same as 2000
12	Noordeloos Creek at 104th	Noordeloos	habitat, bugs, water chemistry	Yes		Accept	Marginal	70°F	0.15	Insects habitat about same, less phosphorus than 2000
38	Railroad Tributary	Lower Macatawa	habitat, fish, bugs	No	Accept	Accept	Good	70°F		
39	North Branch at 112th	North Branch	bugs, habitat	No		Accept	Good	64°F		
40	Zeeland Wastewater Treatment Plant	Noordeloos	water chemistry	No					0.36	
August 2010 (Holden 2012)										
35	Macatawa River at Riley St	Upper Macatawa	habitat, bugs	Yes		Accept	Marginal	68°F		About the same as 2005
41	Peters Creek at 144th	Peters Creek	habitat, bugs	No		Accept	Marginal	64°F		Better than 2005
42	Peters Creek at 84th	Peters Creek	habitat, bugs	No		Accept	Marginal	68°F		
34	Macatawa River at 84th	Upper Macatawa	habitat, bugs	Yes		Accept	Marginal	74°F		Habitat and insects better
18	Macatawa River at Adams	Lower Macatawa	habitat, bugs	Yes		Accept	Marginal	70°F		Not comparable data

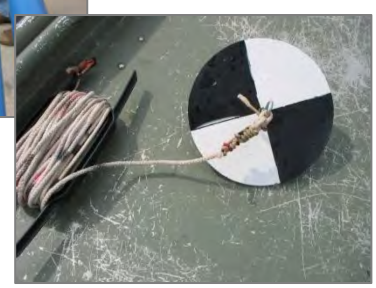
Site No.	Locations	Subbasin	Sampled For:	Prev site?	Fish	Inverts	Habitat	Water Temp	Total Phos (mg/l)	Trends
8	Pine Creek at Quincy	Pine Creek	habitat, bugs	Yes		Accept	Marginal			Insects better, habitat same as 1995
43	Pine Creek at Riley	Pine Creek	habitat, bugs	No		Accept	Marginal			
44	Noordeloos at New Holland (Bosch and Hulst)	Noordeloos	habitat, bugs	No		Accept	Poor			
45	Macatawa River at Black River Drive	Lower Macatawa	habitat, bugs	No		Accept	Marginal	74°F		
46	North Branch Macatawa River at Ottogan	North Branch	habitat, bugs	No		Accept	Marginal	68°F		
47	South Branch upstream of M-40	South Branch	habitat, bugs	No		Accept	Marginal	66°F		
33	Jaarda Drain at 140th	South Branch	habitat	Yes			Poor	71°F		Not comparable data
32	Kleinheksel Drain at 140th	South Branch	habitat	Yes			Poor	71°F		Not comparable data
48	East Fillmore Drain at 144th	South Branch	habitat	No			Marginal	71°F		

Most sites are selected randomly, although the MDEQ does make an effort to visit past sites and sites that might undergo restoration efforts in the future. In general, the data appears to indicate that:

- the diversity and abundance of the fish community may be declining,
- the diversity and abundance of aquatic macroinvertebrates are only acceptable (but this appears to be an overall improvement from historical conditions),
- the habitat quality seems to be relatively consistent over time at a level of only marginal.

ONGOING VOLUNTEER MONITORING



Since the inception of the MWP in the late 1990s, volunteer monitoring efforts have played an important role in long-term data collection efforts. In 2002, the Secchi Disk Group was established and includes community members who collect weekly water quality data (seven months a year) including Secchi depth (a measure of water clarity, pictured at bottom right), temperature and water levels from several locations on Lake Macatawa. Currently, Dr. Graham Peaslee with the Chemistry Department at Hope College provides guidance for the group who has continuously collected data since 2002! Remaining group members, Bruce Panse and Allen Walters (pictured top right), each received the 2011 Watershed Stakeholder of the Year Award.

Since 2002, is appears that water clarity in Lake Macatawa, measured with the Secchi Disk, has been declining (Figure 29). In recent years, the best water clarity has occurred in the Channel connecting Lake Macatawa to Lake Michigan (4 feet of visibility). The worst water clarity has been consistently recorded at Paw Paw Park Preserve on the main branch of the Macatawa River. However, average visibility tends to be around 1 to 1.5 feet.

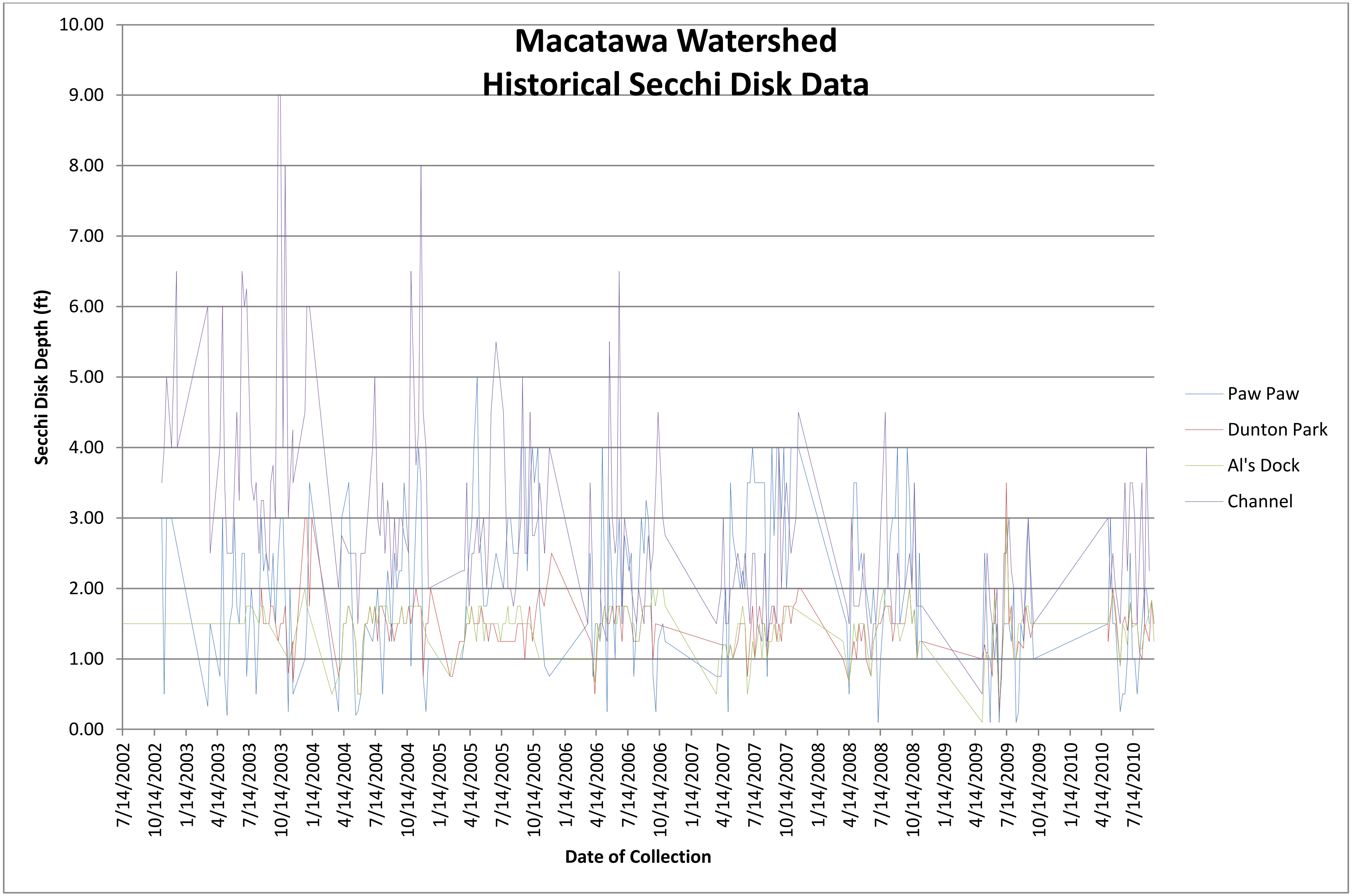


Figure 29. Historical Secchi Disk readings (water clarity) in Lake Macatawa based on Volunteer Monitoring Data.

Members of the Secchi Disk Group have recently started collecting water samples for the monitoring of harmful algal blooms in Lake Macatawa, in partnership with the Great Lakes Environmental Research Laboratory and Michigan Sea Grant . Harmful algal blooms are composed of cyanobacteria or blue-green algae that can release a toxin called microcystin. Microcystin can be toxic to some animals if ingested and can also cause skin rashes and other afflictions in humans. Harmful algal blooms are being studied throughout the Midwest and are a public health concern. Due to the excessive levels of phosphorus, Lake Macatawa frequently experiences intense blue-green algae blooms (leftmost bottle pictured above).

Monitoring for harmful algal blooms has occurred during the summers of 2009, 2010 and 2011. Results have indicated that although detectable levels of microcystin are found, most of the time the results are below the World Health Organization limits for public contact (Figure 30 and Table 13).

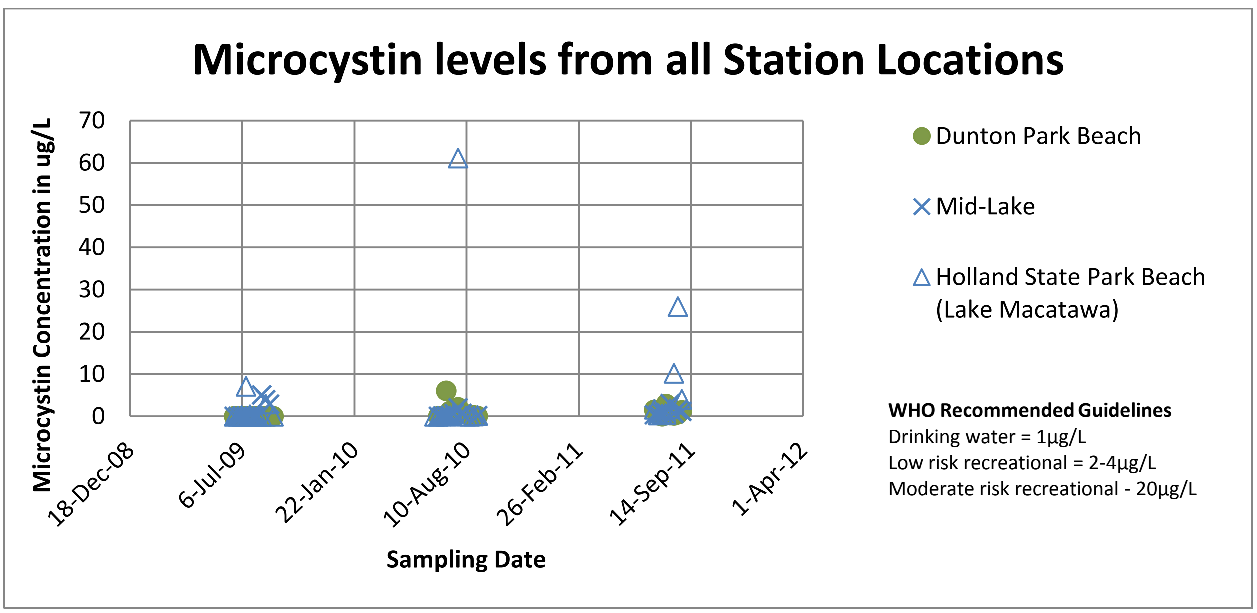


Figure 30. Harmful algal bloom sampling on Lake Macatawa based on Volunteer Monitoring Data analyzed by NOAA. Data can be accessed at http://www.glerl.noaa.gov/res/Centers/HABS/lake_macatawa.html

Table 13. Microcystin concentrations (ug/L) at sampling points on Lake Macatawa (bolded results exceed recreational standards for moderate risk).

Date	Dunton Park Beach	Mid Lake Macatawa	Holland State Park Beach on Lake Macatawa
22-Jun-09	0	0	0
29-Jun-09	0	0	0
6-Jul-09	0	0	0
13-Jul-09	0	0	7.10
20-Jul-09	0	0.24	0.39
27-Jul-09	0	0	0
3-Aug-09	0	0	0
10-Aug-09	0	5.06	0
17-Aug-09	0	3.96	2.90
24-Aug-09		2.87	
21-Jun-10	0	0	0
28-Jun-10	0	0	0
5-Jul-10	6.03	0.12	0.02
12-Jul-10	1.26	0.18	0.14
19-Jul-10	0.46	0.65	0.63
26-Jul-10	2.12	2.01	**61.12**
2-Aug-10	0.91	0.68	
9-Aug-10	0.44		0.02
16-Aug-10	0.22		0.02
23-Aug-10	0.21		0.37
30-Aug-10	0.05	0.19	
11-Jul-11	1.52	0.38	1.66
18-Jul-11	0.27	0.43	0.29
25-Jul-11	0.02	0.75	0.57
1-Aug-11	2.89	0.85	0.46
8-Aug-11	0.29	3.00	1.78
15-Aug-11	0.22	0.69	10.17
22-Aug-11	0.49	1.58	**25.98**
29-Aug-11	1.4	1.17	4.01

Results can be accessed at http://www.glerl.noaa.gov/res/Centers/HABS/habs.html.

Weekly sampling only occurred during the summer months on Lake Macatawa during 2009, 2010 and 2011. The most impacted site appears to be the swimming beach at the Holland State Park (on Lake Macatawa). Twice during the sampling period, levels of microcystin were detected at levels that posed a moderate risk to human health.

RECENT MONITORING AND RESEARCH

Over the course of three years, the MACC has worked to update the Macatawa Watershed Management Plan. This work was partially funded by a Section 319 grant from the MDEQ (Tracking Number 2008-0016). The following studies were completed during this time frame, specifically to aid in the development of the management plan including:

- Hydrology Study (MDEQ 2009)
- Pollutant Loading Report (MDEQ 2009)
- Bank Erosion Hazard Index (MACC 2009)
- Conservation Priority Map (Fraser 2010)
- Farmland Protection Priority Map (Fraser 2010)
- Septic System Priority Inventory (MACC 2010)
- 2010 Landscape Level Functional Wetlands Assessment (MDEQ 2010)
- Agricultural Survey (MACC 2010)
- 2011 Geomorphology Study (FTCH 2011)
- 2011 Critical Area Analysis (FTCH 2011)

This management plan will reference the above reports (contents, conclusions and recommendations) where appropriate.

In addition to the myriad of recent research studies and analyses, the MACC has also partnered with Hope College and the Outdoor Discovery Center Macatawa Greenway (ODCMG) to conduct watershed-wide sampling for suspended sediments and *E.coli* bacteria. This work is partially funded by the State of Michigan's Clean Michigan Initiative (via the Water Quality Monitoring grants) and other private donors.

The Suspended Sediment Sampling Project includes a network of 45 monitoring locations (Figure 31) throughout the Macatawa Watershed that allow us to measure the amount of fine sediment particles in our local waterways during rain events. In addition, once the samples are collected they are retained for forensic analysis which differentiates the soil based on a variety of physical, chemical, biological and radiological factors.

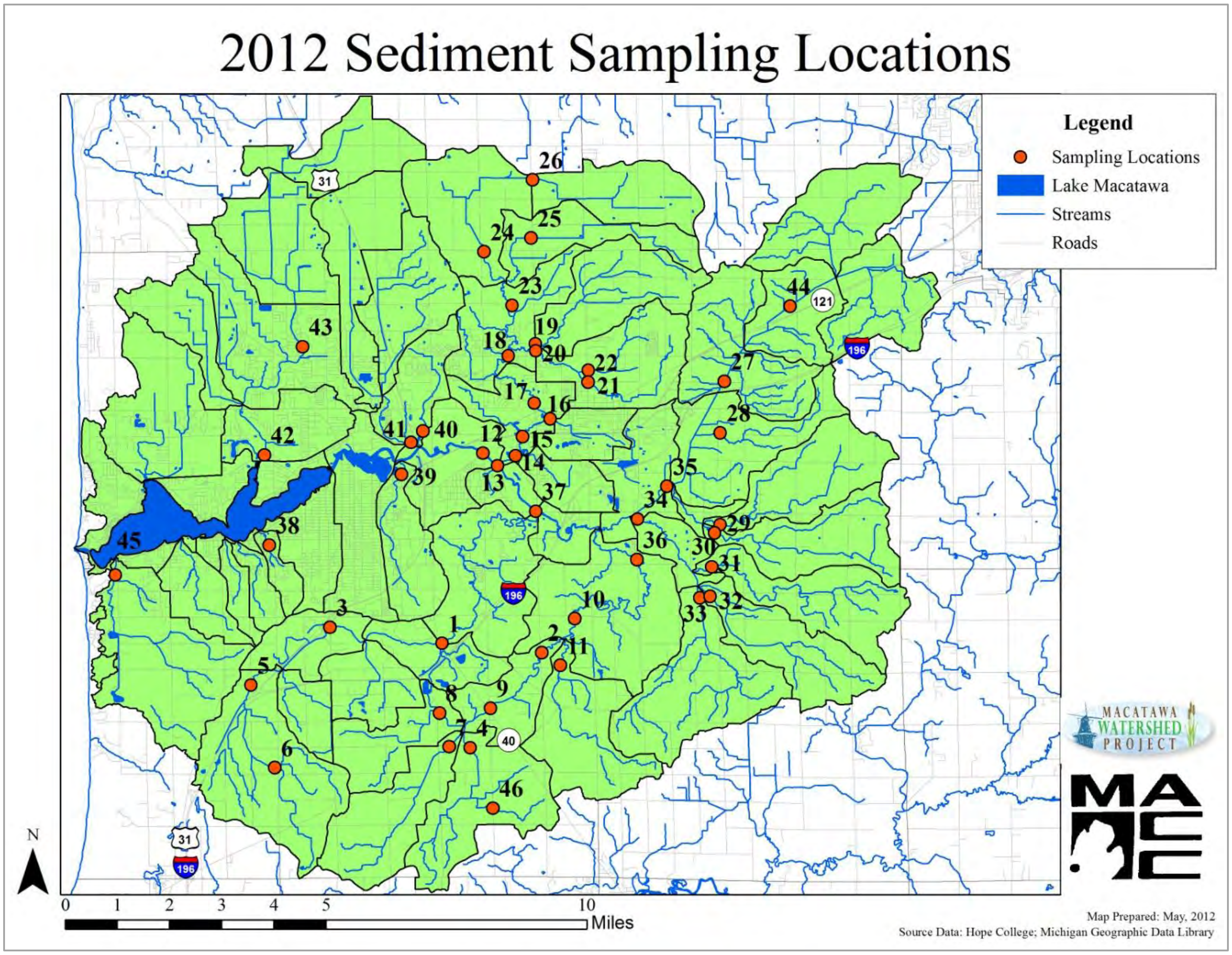


Figure 31. Suspended sediment sampling locations in the Macatawa Watershed.

Preliminary results indicate that a large quantity of suspended sediment is collected from locations around the outer ring of the watershed in predominantly agricultural areas (Figure 32). When normalized for the size of the contributing area for each sample site, the results are even more dramatic (sediment mass per total upstream area, Figure 33).

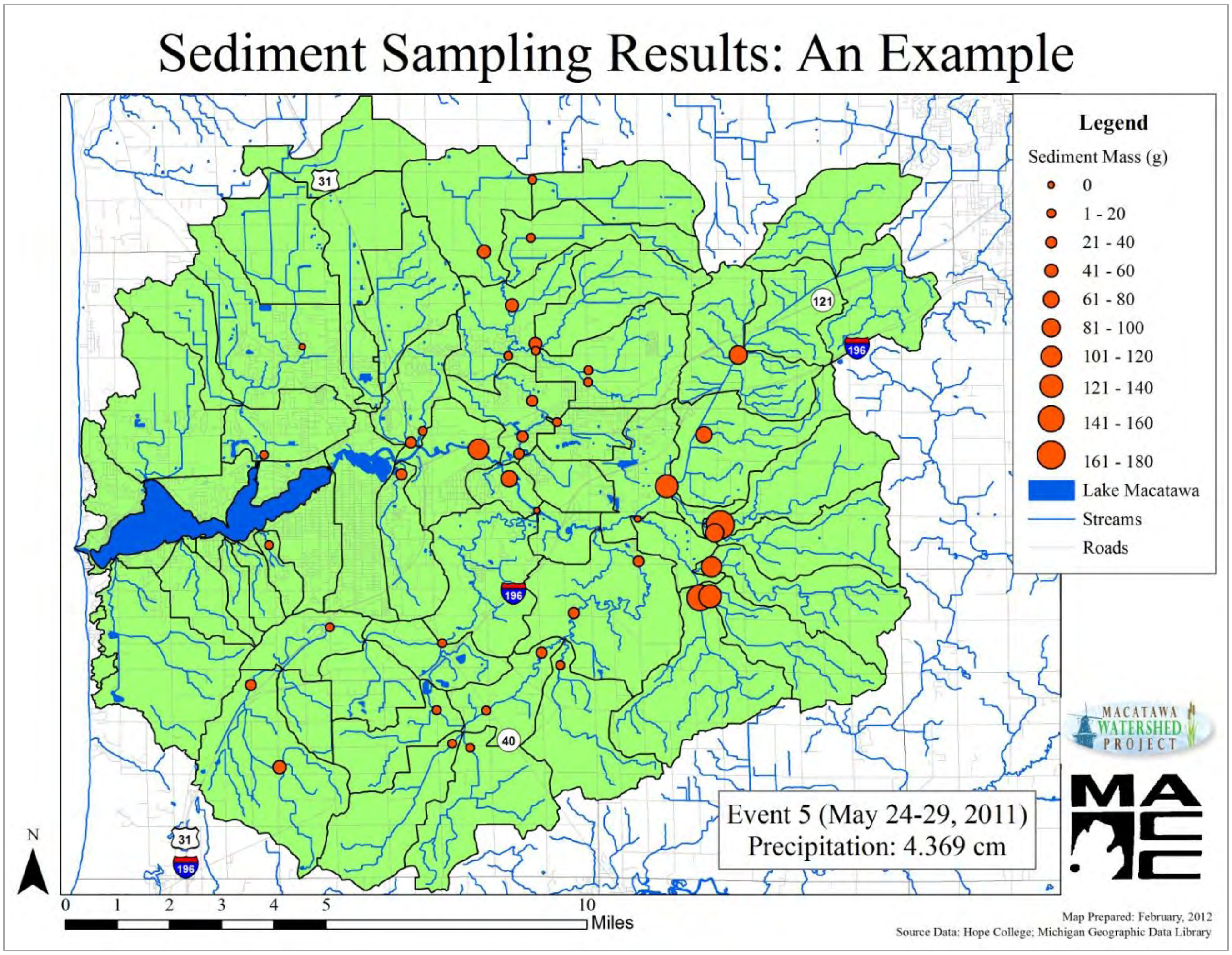


Figure 32. Sediment sampling results (mass) during a rain event in the Macatawa Watershed.

The data provides direct evidence that most of the suspended sediment originates from agricultural, headwater areas around the outer ring of the watershed. Sediment enters waterways via two main processes, surface runoff (overland flow) or streambank erosion. One of the forensic radiological techniques used to fingerprint the sediment samples, can differentiate sediment sources (surface runoff or streambank erosion) based on the presence of different radioisotopes. Preliminary analyses by Hope College have indicated that the vast majority of the suspended sediment in local waterways comes from surface runoff and overland flow (data is not yet published).

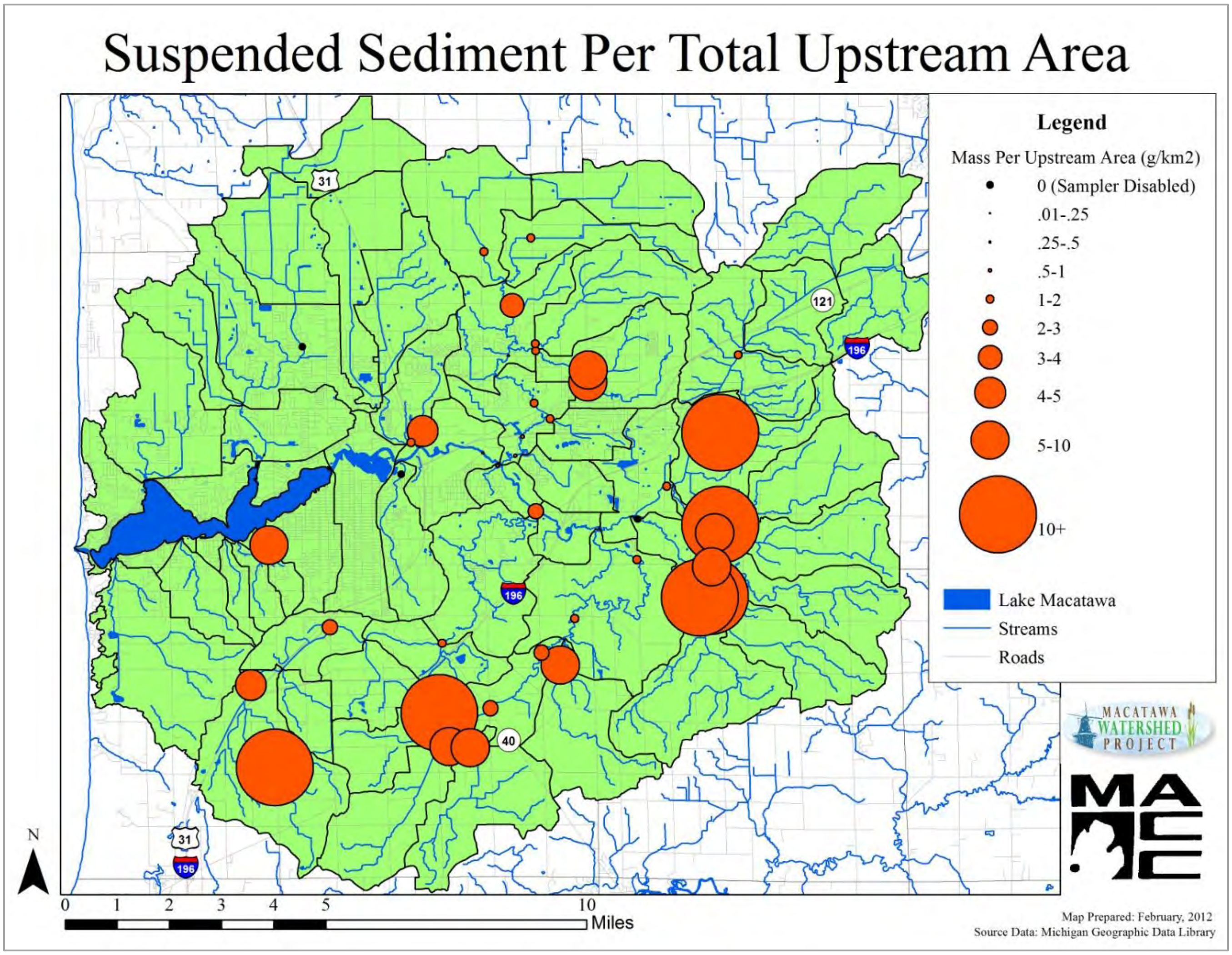


Figure 33. Sediment sampling results (mass per upstream area) for a typical rain event in the Macatawa Watershed.

In addition to the ongoing study of suspended sediment, Hope College, ODCMG and the MACC are also partnering to monitor the watershed for levels of *E.coli* bacteria. Finding high levels of *E.coli* bacteria in surface water samples can indicate the presence of other potentially harmful microorganisms that are associated with fecal contamination. Fecal contamination has certainly become a concern in Lake Macatawa as the number and length of beach closings has increased over the past 10 years. Identifying where the *E. coli* originates (point source or non-point source) is the first step in understanding the problem. Eleven sampling sites in the Macatawa Watershed were selected for microbial testing (Figure 34).

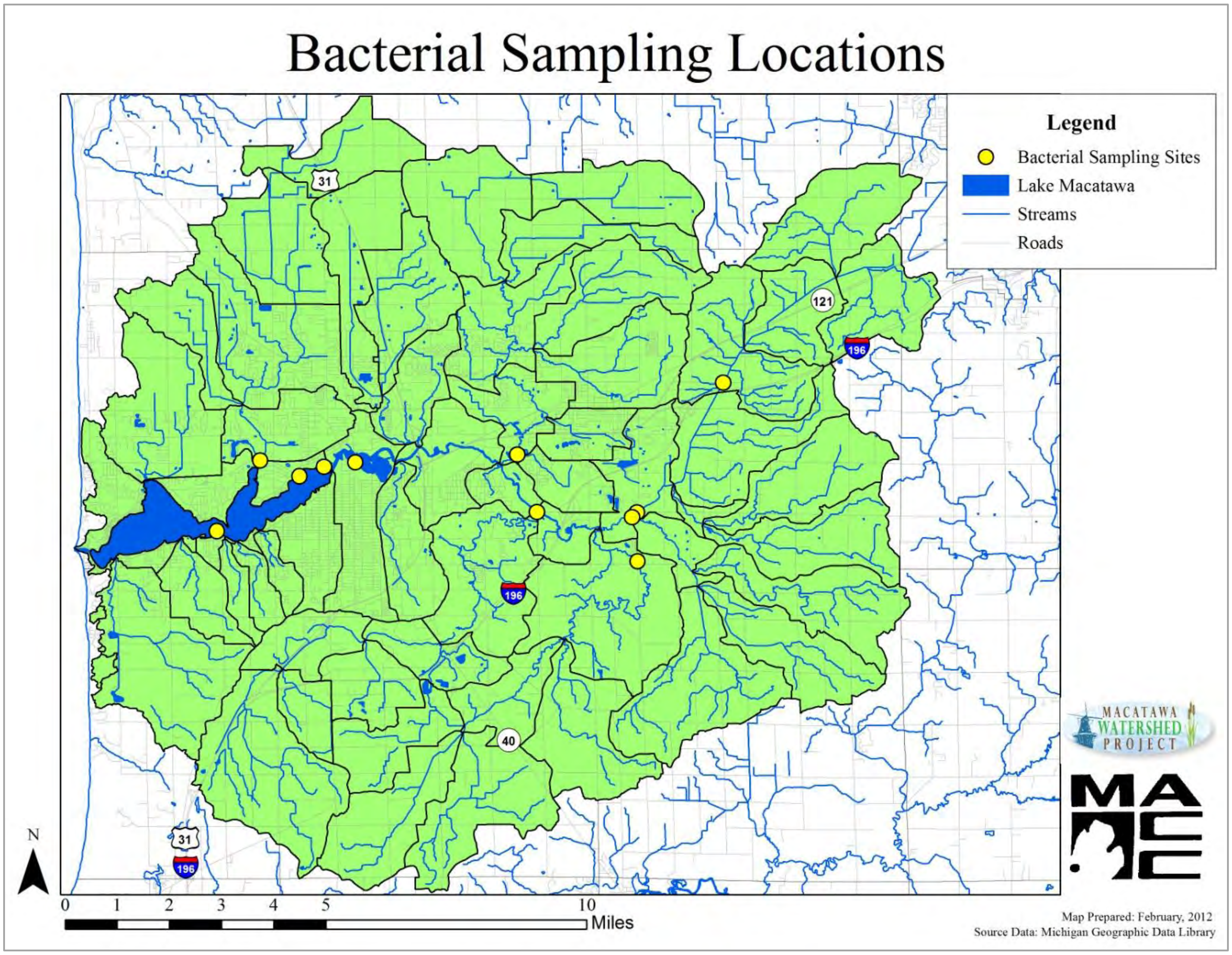


Figure 34. Bacteriological sampling locations in the Macatawa Watershed.

Preliminary results (in a study and analyses conducted by Hope College) show an interesting pattern of bacteria levels that differ drastically based on weather conditions (results not yet published). Dry sampling events (Figure 35) show very low *E. coli* counts that are generally below the level set for safe body contact by the State of Michigan (<300 cfu/ 100 ml of sample).

Wet sampling events (Figure 36) produce higher *E.coli* counts (sometimes even >10,000 cfu/100 ml of sample). The *E.coli* seem to be originating from widely distributed upstream sources whose presence is continually replenished and washed down during precipitation events.

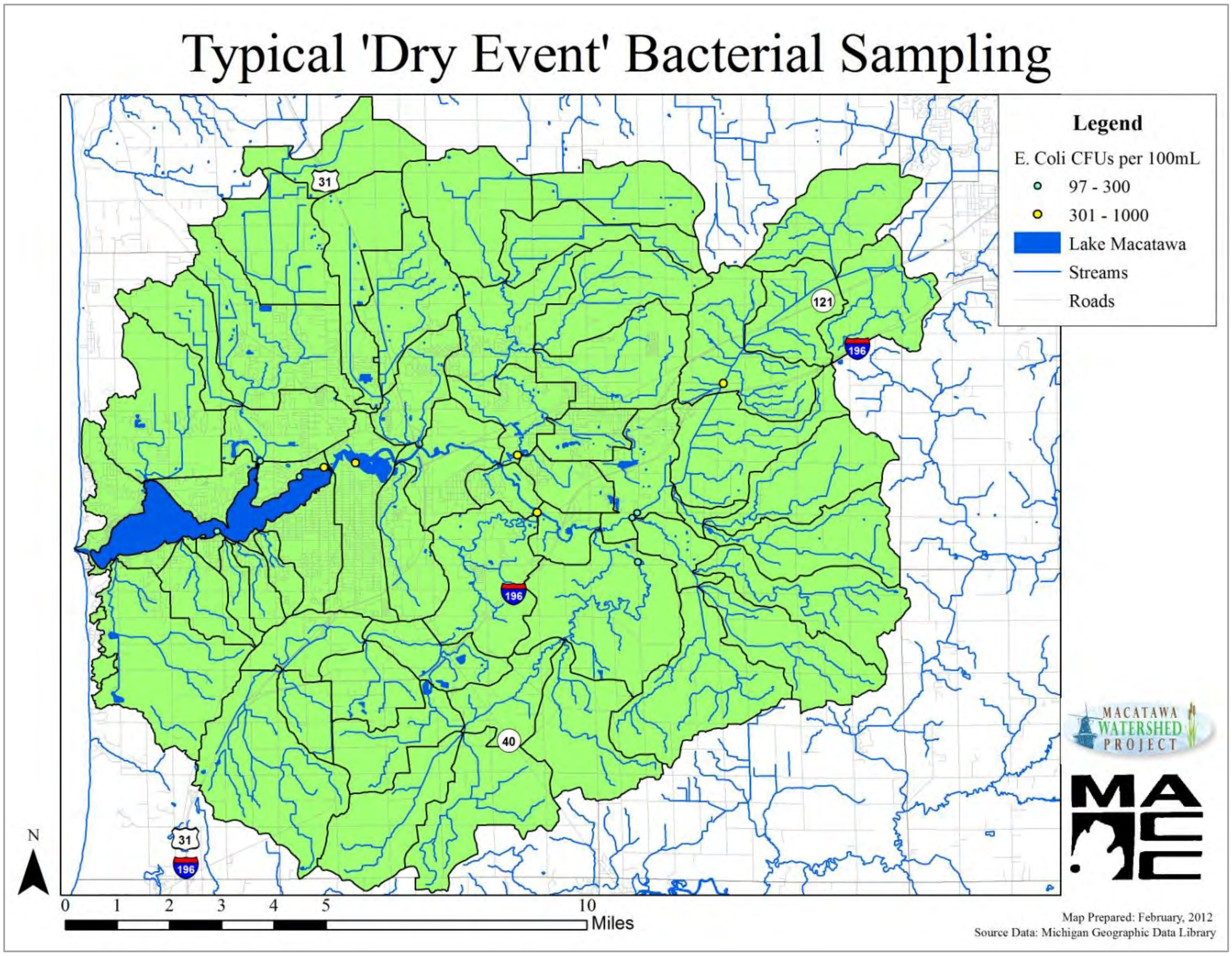


Figure 35. Typical levels of *E.coli* bacteria during dry weather conditions (sampling and analyses conducted by Hope College).

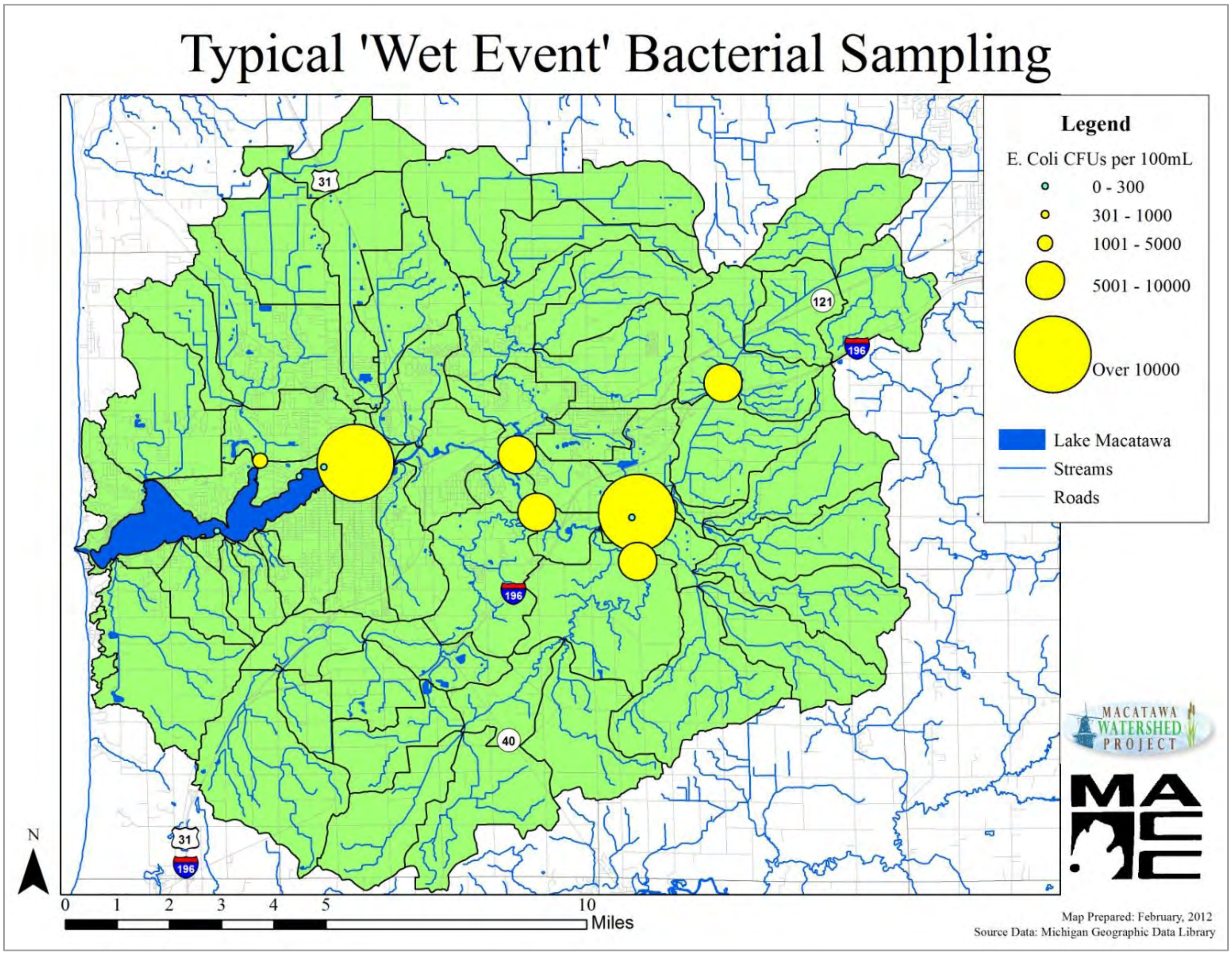
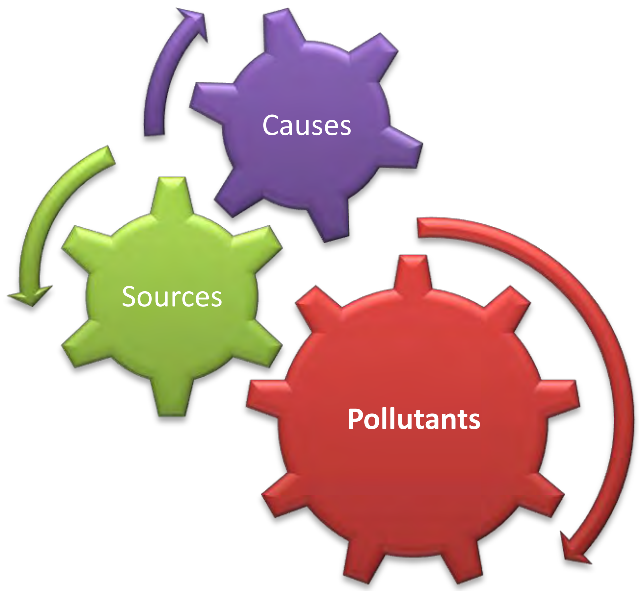


Figure 36. Typical levels of *E.coli* bacteria after a rain event (sampling and analyses conducted by Hope College).

The source of these bacteria may include leaking septic tanks, agricultural applications of manure, wildlife, or indigenously growing microorganisms within the watershed. Preliminary results of DNA source tracking indicate that human-specific markers are strongly present in raw municipal sewage, but only present in small quantities in environmental samples. Pig and cow-specific markers are almost completely absent in routine environmental samples which leaves a large percentage of *E. coli* that has not yet been attributed to a specific source. Further sampling and analysis is needed to determine the primary source of *E.coli* bacteria in the Macatawa Watershed.

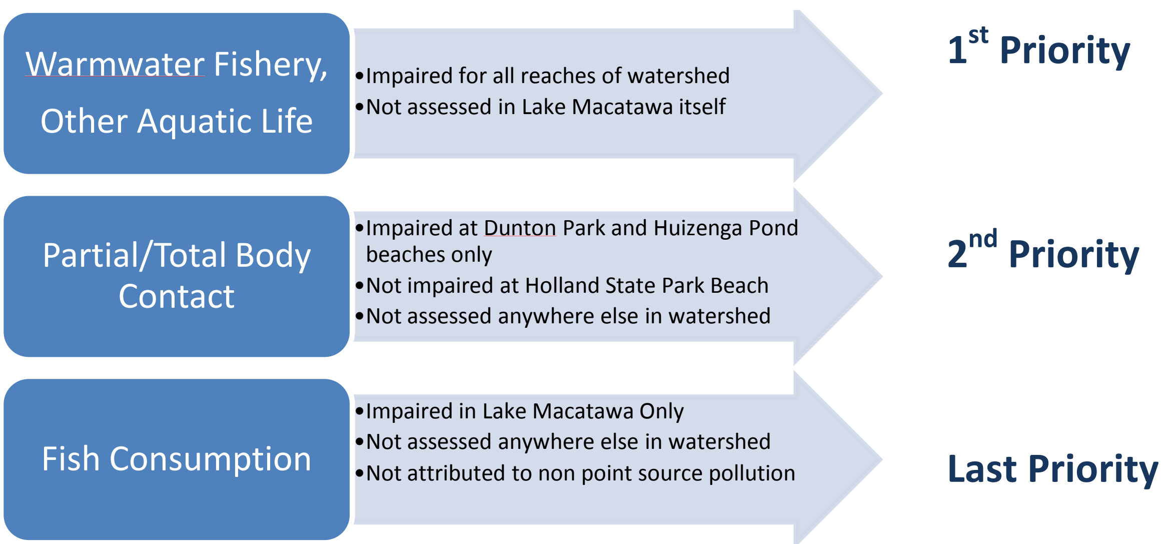
3.5 WATER QUALITY: POLLUTANTS, SOURCES AND CAUSES

The Macatawa Watershed faces a variety of challenges as described above. When considered together, the problems seem overwhelming. Prioritization of these water quality problems is a crucial part of the watershed planning process.



The ultimate goal of this watershed management plan is to improve water quality per State standards by restoring all required designated uses (as described above). To restore each impaired designated use, we must work to reduce the pollutants, sources and causes specific to that use.

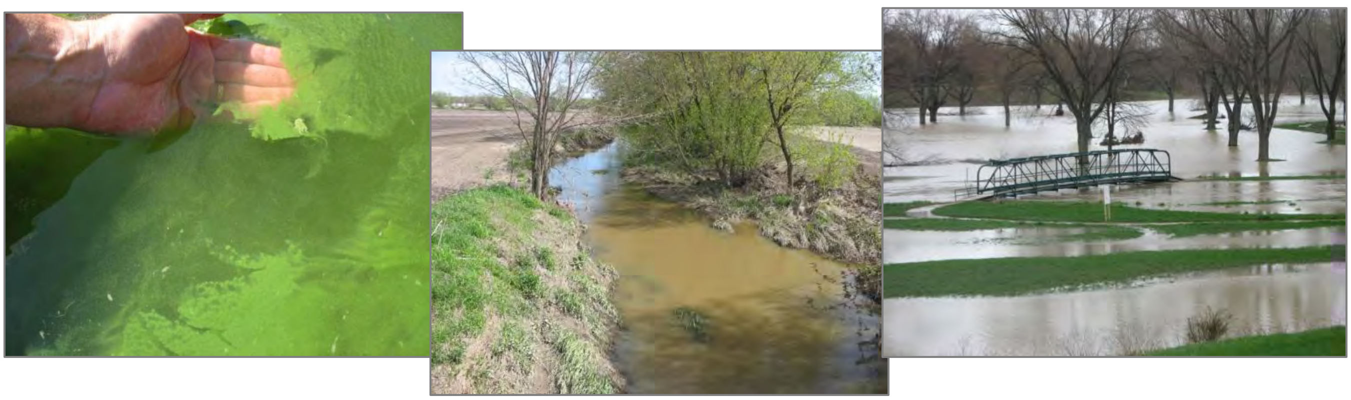
With the input from the members of the MACC's various committees, we have prioritized the designated uses and the pollutants affecting those uses (below).



PRIORITY POLLUTANTS

The ultimate goal of this watershed management plan is to improve water quality for a variety of reasons. Those reasons include meeting state water quality standards, meeting the goals of the Phosphorus TMDL, restoring designated uses, decreasing the number of beach closures and improving public perception, among others. To meet this goal we must reduce the pollutants entering the Macatawa Watershed annually. *But which pollutants do we focus on to achieve results quickly?*

The members of the various watershed committees considered the water quality impairments and the issues of community concern including algae blooms, flooding, beach closures and murky, brown water. They brainstormed a long list of all the possible pollutants of concern in the watershed. The pollutants were then ranked by the committee members individually. The preliminary results were discussed amongst multiple meetings until a final ranking system was created.



Designated use	Priority
Warmwater Fishery, Other Aquatic Life	• 1st Priority
Partial/Total Body Contact	• 2nd Priority: Partial Body • 3rd Priority: Total Body
Others	• Low Priority

Tier 1 Pollutants

- Nutrients
- Sediment
- Hydrology
- Temperature

Tier 2 Pollutant

- *E.coli* bacteria

Tier 3 Pollutants

- Other chemical contaminants
- Invasive Species
- Chloride
- Man-made debris (trash)

Please note that the *Fish Consumption* designated use will not be addressed by this plan. 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 is seen statewide in Michigan and is thought to be caused by atmospheric deposition. Since this designated use impairment is not caused by local nonpoint source pollution, the remediation of this designated use is outside the scope of this watershed management plan.

High Priority Pollutants: The first priority of this plan is to restore the *Warmwater Fishery* and *Other Aquatic Life* impaired designated uses. In addition, we must comply with the phosphorus TMDL that was developed by the MDEQ and approved by EPA (Walterhouse 1999). Therefore the two pollutants of highest concern are phosphorus and sediment. Other factors that contribute to the non-attainment of these designated uses are flashiness (extreme and sudden changes in water level and velocity) and excessive summer temperatures. Therefore, we will also focus on addressing hydrology and temperature. **Nutrients (mainly phosphorus), sediment, hydrology and temperature are the Tier 1 Pollutants.** These are also the pollutants that contribute to murky brown water, nuisance algae blooms, flooding and poor fish communities which are major concerns of the local community.

Moderate Priority Pollutants: The second priority of this plan is to restore the *Partial and Total Body Contact* impaired designated uses. In addition, an *E.coli* TMDL will be developed by the MDEQ in the future (2017). Therefore we must reduce the amount of *E.coli* bacteria in some parts of the watershed. ***E.coli* bacteria is considered a Tier 2 pollutant.** It is also the pollutant that causes frequent beach closures of Dunton Park Beach and a poor public health perception of Lake Macatawa which is a major concern of the local community.

Low Priority Pollutants: The secondary goals of this plan are to protect natural areas of the watershed and to enhance the watershed based on local community concerns, sometimes called *Desired Uses* (See Section 4.6 and 4.7). Desired Uses are not required by the State of Michigan and they are specific to each community. The members of the watershed committees decided that protecting open land and improving recreation, public access and native fish and wildlife habitat were desirable activities. The pollutants impacting desired uses and the pollutants with an unknown distribution and impact are included in the low priority category. **Tier 3 pollutants include other chemical contaminants (ex. pharmaceuticals, metals, volatile organic compounds etc), invasive species, chloride and man-made debris.** In general, the extent and impact of these pollutants is not readily understood, although many are of general concern to the local community. Note that this plan primarily addresses Tier 1 and Tier 2 pollutants.

PRIORITY SOURCES

Identifying the priority pollutants (above) is only the first step in crafting a restoration strategy. The Tier 1 and Tier 2 pollutants originate from a variety of different sources throughout the watershed. Different management techniques will be needed to address different sources. We used input from the members of the watershed committees, in conjunction with the results from the various studies listed in Section 3.4, to prioritize the sources of Tier 1 and Tier 2 pollutants (Table 14).

Table 14. Priority sources of the Tier 1 and Tier 2 pollutants.

Tier	Pollutant	Source	Priority Level
Tier 1	Nutrients	Agricultural sources/runoff	High
		Urban sources/runoff	Mod
		Streambanks	
		Untreated sewage	Low
	Sediment	Agricultural sources/runoff	High
		Urban storm water	
		Streambanks	Mod
		Road Stream Crossings	
	Hydrology	Agricultural runoff	High
		Urban/residential runoff	
		Road stream crossings	Mod/Low
	Temperature	Urban/residential runoff	High
		Agricultural runoff	Mod/Low
Tier 2	*E.coli* bacteria*	Agricultural sources/runoff	High
		Urban sources/runoff	Mod/Low
		Untreated sewage	Low
		Sediment	Unknown

*Please note that the watershed-wide monitoring program for *E.coli* bacteria is very recent. Preliminary data indicate that high levels of *E.coli* bacteria are recorded in the outer reaches of the watershed before elevated levels are then seen in Lake Macatawa. Hope College researchers hypothesize that the frequent and persistent beach closures at Dunton Park may be caused by a strain of *E.coli* bacteria able to grow in the sediment or in the biofilms of storm drains and agricultural drainage tiles. However, this phenomenon is unconfirmed.

In very generalized terms, it appears that evidence and public knowledge indicate that agricultural sources are of highest concern, urban and residential sources are of moderate to high concern and road stream crossings and untreated sewage are of lowest concern.

PRIORITY CAUSES

Once pollutants and sources are identified, the next important step is to accurately identify causes of the various pollutant sources. Tier 1 and Tier 2 pollutants are caused by a variety of different conditions or processes. Different management techniques will be needed to address these varying causes. We used input from the members of the watershed committees, in conjunction with the results from the various studies listed in Section 3.4, to prioritize the causes of Tier 1 and Tier 2 pollutants (Table 15). For a more detailed list of sources, causes, affected waterbodies and supporting evidence see Appendix H.

Table 15. Priority causes of Tier 1 and Tier 2 pollutants.

Pollutant and Source	Causes	Priority Level
Tier 1 Pollutant: Nutrients		
Agricultural sources/runoff	Loss of wetlands	High
	Lack of riparian buffers	
	Lack of BMPs (including excessive tillage and poor soil coverage)	
	Improper use or over application of manure	
Urban sources/runoff	Loss of wetlands	
	Improper use or over application of fertilizers	Mod
	Lack of riparian buffers	
	Poor Storm Water Management	
Streambanks	Erosion (loss of vegetation and logjams)	
Agricultural sources/runoff	Livestock Access	Low
Untreated sewage	Illicit Connections	
	Failing Septic Systems	
Urban sources/runoff	Marinas/Boating	
	Car washing	
Tier 1 Pollutant : Sediment		
Agricultural Runoff	Loss of wetlands	High
	Lack of riparian buffers	
	Lack of BMPs (including excessive tillage and poor soil coverage)	
Urban sources/runoff	Impervious surfaces	
	Storm drains	
Streambanks	Erosion (loss of vegetation and logjams)	Mod
Urban sources/runoff	Loss of wetlands	
Road Stream Crossings	Improper design, alignment, maintenance causing erosion	
	Erosion at private crossings with no road stream crossing structure	Low
Urban sources/runoff	Construction Sites	
Streambanks	Livestock access	
Tier 1 Pollutant : Hydrology		
Agricultural runoff	Drain tiles and other artificial drainage	High
	Wetland loss	
Urban sources/runoff	Impervious surfaces and Storm Drains	
	Wetland loss	
Road Stream Crossings	Improper design, alignment (hydraulics)	Mod
Tier 1 Pollutant : Temperature		
Urban sources/runoff	Impervious surfaces/storm drains	High
	Lack of riparian buffers	Mod
Agricultural sources/runoff	Lack of riparian buffers	
	Tiling and artificial drainage	Low
Tier 2 Pollutant: *E.coli* bacteria*		
Agricultural sources/runoff	Application of manure	High
	Biofilms in drain tiles and artificial drainage	
Urban sources/runoff	Biofilms in storm drains	
	Improper disposal of pet waste	Low

Pollutant and Source	Causes	Priority Level
	Birds and Animals	
Agricultural sources/runoff	Livestock Access	Low
Untreated Sewage	Sewer Overflows	
	Failing Septic Systems	
	Illicit Connections	
Sediment	Harbor and grow bacteria	

*Please note that the watershed-wide monitoring program for *E.coli* bacteria is very recent. Preliminary data indicate that high levels of *E.coli* bacteria are recorded in the outer reaches of the watershed before elevated levels are then seen in Lake Macatawa. In addition, preliminary source tracking indicates that a small amount of human-derived *E.coli* bacteria can be detected everywhere (which likely comes from illicit connections and failing septic systems). However, when high levels of *E.coli* are detected above state water quality standards, the human-derived portion is very small. The source tracking also indicated that the majority of the *E.coli* bacteria could not be traced to bovine or porcine sources. Hope College researchers hypothesize that the there may be a new strain of *E.coli* bacteria able to live in sediments or the biofilms in agricultural tile drains and urban storm drains. However, this phenomenon is unconfirmed.

3.6 QUANTIFICATION OF NUTRIENTS AND SEDIMENT

It is clear from the vast majority of historical and recent studies and analyses, that sediment, nutrients, temperature, hydrology and *E.coli* bacteria are pollutants of great concern in the Macatawa Watershed. These pollutants directly impact the ability of the Macatawa Watershed to meet State designated uses and water quality standards. *But how much of a problem are each of these pollutants?*

Determining the relative **pollutant loads** of each identified pollutant of concern is critical. In 2009, the MDEQ developed a Hydrology Study of the Macatawa Watershed (Appendix I) and used that information to create a Pollutant Loading Report (Fongers 2009a; Appendix J). Quantification of all high and moderate priority pollutants (by subbasin) is detailed in Appendix K.

The pollutant loading model first estimates annual runoff volumes (based on precipitation, land use and soil data) and then applies event mean concentrations for pollutants of concern including total phosphorus, total suspended solids and total nitrogen. Since this model is based on runoff it only estimates pollutants from overland flow (and not streambank erosion). This model does not contain loading information for temperature or *E.coli* bacteria. The pollutant load information is summarized in Tables 16 and 17.

Table 16. Summary of 1978 and 2005 sediment and nutrient pollutant loads for the Macatawa Watershed based on MDEQ Pollutant Loading Model (Fongers, 2009a).

Parameter	1978 Total (pounds)	2005 Total (pounds)	% Increase	Pounds per acre (2005)
Total Phosphorus (TP)	42,910	51,820	21	0.5
Total Suspended Solids (TSS)	14,394,694	15,676,877	9	145
Total Kjeldahl Nitrogen (TKN)	235,426	296,488	26	2.8

In 1978, the total volume of suspended solids would have filled about 554 ten-wheeler truck loads! In 2005, the total sediment load would have filled about 603 truck loads! Tables 17 and 18 also relate the total volume of sediment in terms of truck loads for each subbasin.

Table 17. Summary of 2005 sediment and nutrient pollutant loads by subbasin based on MDEQ Pollutant Loading Model.

Subbasin	Area (acres)	TP (lbs)	TP lbs/ acre	TSS (lbs)	Total truckloads (TSS)	TSS lbs/acre	TKN (lbs)	TKN (lbs/acre)
Pine Creek	11,136	4,185	0.4	990,697	38	88	25,416	2.2
Lower Macatawa	10,991	7,192	0.7	2,194,907	84	194	41,696	3.8
Noordeloos Creek	16,977	8,245	0.5	2,446,193	94	143	48,067	3.0
Upper Macatawa	18,528	8,196	0.4	2,686,070	103	138	44,885	2.4
Peters Creek	9,102	3,440	0.4	1,280,554	49	127	18,359	3.5
South Branch Macatawa	14,993	6,109	0.4	2,183,074	84	143	33,271	2.2
North Branch Macatawa	11,989	6,533	0.6	2,235,480	86	206	35,774	3.2
Lake Macatawa Direct Drainage	15,967	7,920	0.5	1,659,901	64	115	49,020	3.3

Sediment and pollutant loading generally occur one of two ways. The above tables depict the estimated amounts of sediment and nutrient loading resulting from overland flow during storm events. Sediment and nutrient loading can also occur from in-stream sources via streambank erosion. The 2011 Geomorphology Study (Appendix L) aimed to quantify the amount of sediment originating from these in-stream processes. Our consultant, Fishbeck, Thompson, Carr and Huber (FTCH) conducted a thorough field inventory of the three highest priority subbasins (Noordeloos Creek, South Branch Macatawa and North Branch Macatawa). They used the knowledge they learned during the in-depth field inventories to estimate sediment loading from in-stream processes in other subbasins (Table 18).

Table 18. Sediment and nutrient pollutant loading rates from streambank erosion processes by subbasin based on 2011 Geomorphology Study (FTCH).

Subbasin	Eroding streambank (ft)	TP (pounds)	TSS (tons)	Total truckloads (TSS)	Nitrogen (pounds)
South Branch Macatawa[1]	87,000	1,242	1,242	96	2,484
North Branch Macatawa[1]	63,000	1,235	1,235	95	2,470
Noordeloos Creek[1]	68,000	951	951	73	1,902
Pine Creek[2]	17,600	66	66	5	132
Lower Macatawa[2]	35,000	249	249	19	498
Upper Macatawa[2]	74,600	435	435	33	870
Peters Creek[2]	46,700	377	377	29	754
Lake Macatawa Direct Drainage[2]	77,150	1,016	1,016	78	2,031
Total	**469,050**	**5,571**	**5,571**	**429**	**11,141**

[1] Pollutant loading calculations based on in depth field inventory completed by FTCH field staff
[2] Pollutant loading calculation based on estimates, aerial photos, windshield survey and knowledge obtained by in depth field inventory of 3 other subbasins within the Macatawa Watershed.

3.7 LIMITATIONS AND ASSUMPTIONS

Our ultimate water quality goal is to meet the requirements of the Phosphorus TMDL, which means we have to significantly reduce nonpoint source phosphorus inputs to the watershed. The original TMDL work relied on a computer program called the Beale Ratio Estimator to estimate total nonpoint source phosphorus loadings (Walterhouse 1998). The results indicated that the annual nonpoint source phosphorus load was approximately 126,000 lbs. The MDEQ also calculated that to reach water quality standards, the annual phosphorus loading would have to be reduced to only 35,000 lbs annually. Therefore, through the TMDL, the MDEQ recommended that the nonpoint source phosphorus load be reduced by 91,100 lbs.

The methods used for estimating current pollutant loading (as described in Section 3.6) differ from the methods used in the original TMDL study. Nonpoint source pollution due to surface water runoff was estimated by the MDEQ using annual runoff estimates and pollutant loading by land cover, as defined in the Water Quality Trading Rules (Fongers 2009a). Nonpoint source pollution due to streambank erosion was documented in the 2011 Geomorphology Study and used the MDEQ's Pollutants

Controlled Calculations and Documentation for Section 319 Watersheds Training Manual (MDEQ 1999).

In addition, the pollutant loading reductions estimated for each of the proposed best management practices (described in Section 4.0) utilize a variety of other methods including EPA's Spreadsheet Tool for Estimating Pollutant Loads 4.1 (STEPL), MDEQ's Pollutants Controlled Calculations and Documentation for Section 319 Watersheds Training Manual (MDEQ 1999), Chesapeake Bay Model and the Simple Method.

The use of these different models to estimate pollutant loadings and reductions in the Macatawa Watershed does present a limitation to this management plan because the results cannot be compared directly. Each of these models relies on different parameters, equations, input data and assumptions. Therefore, the original TMDL goal of reducing 91,000 lbs of phosphorus is relevant only when using the original model. The comprehensive implementation actions described in Section 4.0 will result in reduction of phosphorus and sediment loading to the Macatawa Watershed; however the total reduction will not equal 91,000 lbs of phosphorus. The more applicable goal is to aim to meet the phosphorus concentration recommendations set forth in the TMDL, which was to reach an average phosphorus concentration of 50 ppm in Lake Macatawa.

It is also possible that *Designated Uses* may be restored prior to meeting the phosphorus concentration of 50 ppm. *Designated Uses* are measured via water quality and narrative standards (Appendix E). Regular monitoring of the Macatawa Watershed (as described in Section 5.0) will be the best method to determine if and when the *Designated Uses* are restored.

3.8 QUANTIFICATION OF HYDROLOGY AND TEMPERATURE

The total impervious area in the entire watershed would cover about 10,410 football fields (including the end zones). The total runoff volume would fill about 26,172 Olympic size swimming pools.

Runoff volumes and the amount of impervious surface in each subwatershed were calculated by the MDEQ as part of the 2009 Hydrology Study (Fongers 2009, Appendix I). They found that approximately half (27) of the 55 subwatersheds exceeds an estimated 10% imperviousness. Of these 27, almost half (12) exceeds an estimated 25% imperviousness. Runoff volumes and the amount of impervious surface are one part of the hydrology equation. Another important part is the peak flood flow yield, or the time it takes for runoff to flow through the drainage network. Taken together, annual runoff volumes, impervious surfaces, peak yields and total wetland loss can help estimate hydrology loads in the Macatawa Watershed (Table 19). The historical record of annual peak streamflow, measured at the United States Geological Survey Gage Station along the main branch of the Macatawa River near Adams Street, is shown in Figure 37.

Table 19. Runoff volumes, impervious surfaces, wetland loss and peak yield by subbasin based on the MDEQ Hydrology Study (Appendix I).

Subbasin	Total Impervious Area (Acres)	Impervious Area (%)	Total Wetland Loss (acres)	Total Runoff Volume (ft^3)	Runoff Volume per acre (ft^3/acre)	Average Peak Flood Flow Yield (ft^3/sec/acre)
Pine Creek	1,527	14	2,672	114 million	10,244	0.024
Lower Macatawa	3,130	28	2,119	276 million	25,106	0.057
Noordeloos Creek	2,265	13	3,315	443 million	26,105	0.048
Upper Macatawa	1,335	7	2,121	475 million	25,636	0.057
Peters Creek	98	1	0	97 million	10,634	0.048
South Branch Macatawa	356	2	3,104	273 million	18,203	0.048
North Branch Macatawa	1,908	16	1,498	256 million	21,368	0.063
Lake Macatawa Direct Drainage	3,145	20	1,749	372 million	23,266	0.089
Totals	13,765		16,578	2.31 billion		

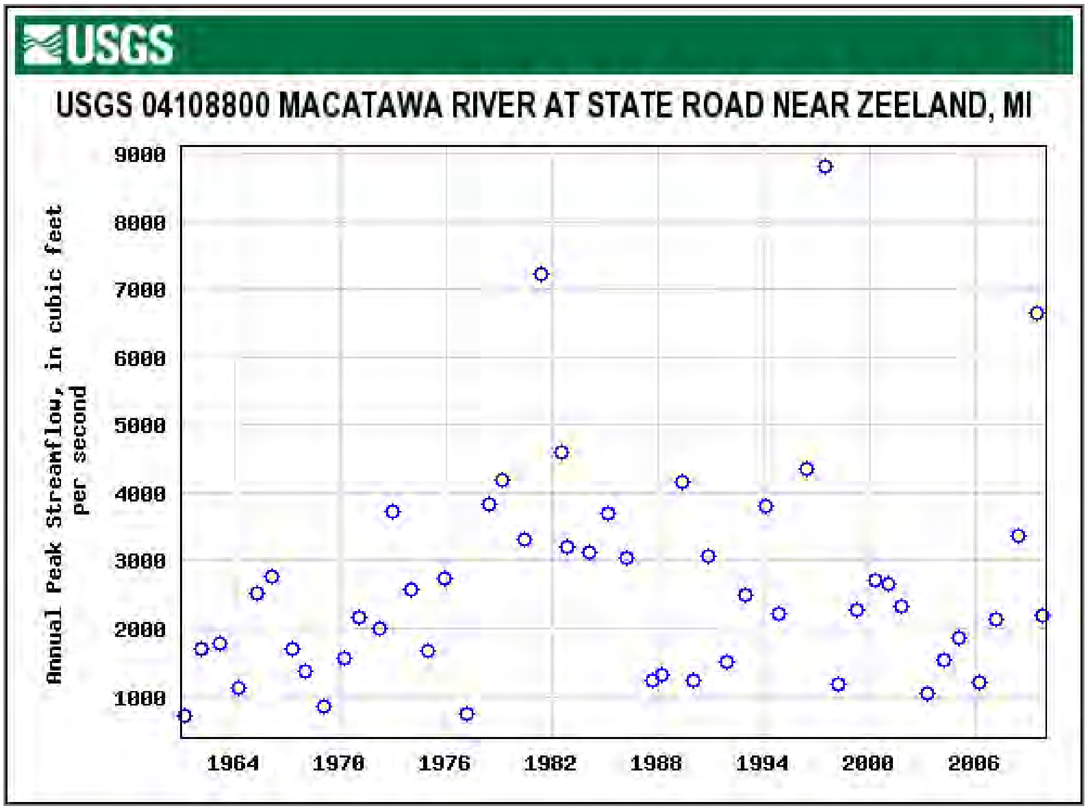


Figure 37. Historical record of annual peak streamflow at the USGS gage station.

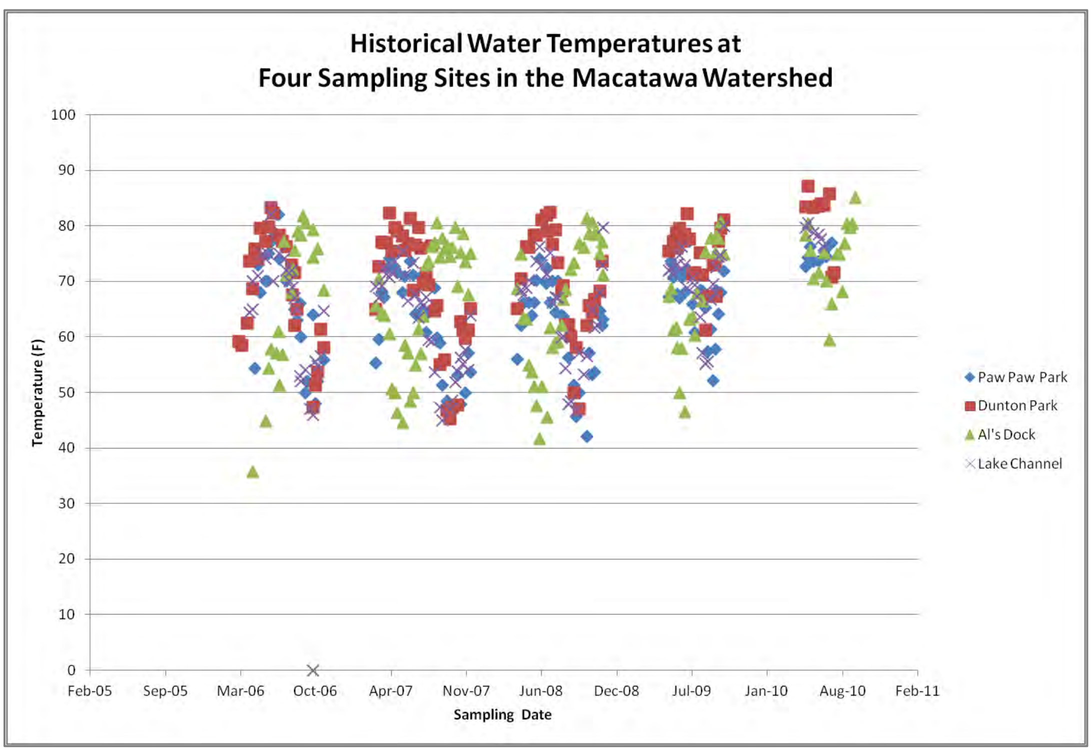


Figure 38. Historical water temperatures at four watershed locations collected by local volunteers.

Storm water runoff (characteristics described above) also contributes to the temperature load in Lake Macatawa. The MWP has several sources of historical temperature data including volunteer monitoring data (since 2006, Figure 38) and MDEQ biosurveys (since 1990, see Table 12). Refer to Section 3.4 to learn more about ongoing Monitoring Programs in the Macatawa Watershed. The MACC's temperature data can be accessed via the website at http://www.the-macc.org/watershed/water-quality/.

Three of the four sites sampled by volunteers are on Lake Macatawa (Paw Paw Park is on the main branch of the Macatawa River). The data shows that water near the Dunton Park and Al's Dock locations, on the north shore of Lake Macatawa, tends to undergo the warmest summer temperatures, sometimes near 85°F. The highest temperatures measured at each site are 87°F at Dunton Park, 83.5°F at Al's Dock, 82°F at the Channel, and 82°F at Paw Paw Park.

In the tributaries of the Macatawa River and Lake Macatawa, records indicate that the highest temperatures have been detected in the North Branch Macatawa River, South Branch Macatawa River and Noordeloos Creek. The lowest temperatures have been detected in Pine Creek and the upper portions of the Macatawa River. The historical data provides convincing evidence that temperature is indeed a pollutant of high priority in the Macatawa Watershed.

3.9 QUANTIFICATION OF E.COLI BACTERIA

As described in Section 3.3 and 3.4, *E.coli* bacteria is an emerging problem in the Macatawa Watershed that has caused frequent and persistent beach closures at Dunton Park Beach on the north side of Lake Macatawa. The Ottawa County Health Department is the agency responsible for monitoring Lake Macatawa beaches and they have provided sampling results from 2009, 2010 and 2011 (Table 20). The data can be requested directly from the Ottawa County Health Department at 616-738-4000 or http://www.miottawa.org/SwimmingAdvisory/beach.jsp.

Table 20. *E.coli* sampling results provided by Ottawa County Health Department (bolded results exceed standards for total body contact according to State of Michigan Water Quality Standards).

Sampling Date	Dunton Park	Holland State Park (on Lake Macatawa)	Type of Sample
7/7/2011	52	57.3	Individual Sample
7/7/2011	51	62.7	Individual Sample
7/7/2011	47	75.2	Individual Sample
07/12/2011	**345**	56.3	Individual Sample
07/12/2011	**328**	75.9	Individual Sample
07/12/2011	**308**	45	Individual Sample
07/20/2011	**1120**	41.4	Individual Sample
07/20/2011	**980**	32.7	Individual Sample
07/20/2011	**1046**	28.8	Individual Sample
7/26/2011	**649**	3.1	Individual Sample
7/26/2011	**579**	2	Individual Sample
7/26/2011	**436**	3	Individual Sample
8/2/2011	**2420**	39.7	Individual Sample
8/2/2011	**1986**	21.1	Individual Sample
8/2/2011	**1986**	30.9	Individual Sample
08/09/2011	**548**	23.1	Individual Sample
08/09/2011	**488**	26.5	Individual Sample
08/09/2011	**326**	28.8	Individual Sample
8/15/2011	**1414**	4.1	Individual Sample
8/15/2011	**1733**	16.9	Individual Sample
8/15/2011	**2420**	10.9	Individual Sample
8/24/2011	**575**	59.8	Individual Sample
8/24/2011	**388**	55.6	Individual Sample
8/24/2011	**549**	53.7	Individual Sample
8/29/2011	78	4.1	Individual Sample
8/29/2011	96	6.2	Individual Sample
8/29/2011	111	7.5	Individual Sample
6/1/2010	**>2419.6**	203	Daily Mean
6/7/2010	**1855**	42	Daily Mean
6/14/2010	110	5	Daily Mean
6/23/2010	**1800**	51	Daily Mean
6/30/2010	122	9	Daily Mean
7/7/2010	96	17	Daily Mean
7/14/2010	No sample collected	21	Daily Mean
7/21/2010	52	11	Daily Mean
7/28/2010	64	21	Daily Mean
8/4/2010	**294**	52	Daily Mean
8/13/2010	67	37	Daily Mean
8/18/2010	**846**	15	Daily Mean
8/25/2010	126	4	Daily Mean
5/27/2009	**>410.02**	4	Daily Mean
6/2/2009	66	1	Daily Mean
6/10/2009	82	297	Daily Mean

Sampling Date	Dunton Park	Holland State Park (on Lake Macatawa)	Type of Sample
6/15/2009	12	**337**	Daily Mean
6/23/2009	**625**	**352**	Daily Mean
6/24/2009	89	203	Daily Mean
6/29/2009	No sample collected	41	Daily Mean

It is clear from the monitoring data that Dunton Park beach, located near the mouth of the Macatawa River, is at higher risk for elevated levels of *E.coli* bacteria than the Holland State Park Beach (mid-lake on Lake Macatawa). Refer to Figure 39 for a map of the sampling locations.

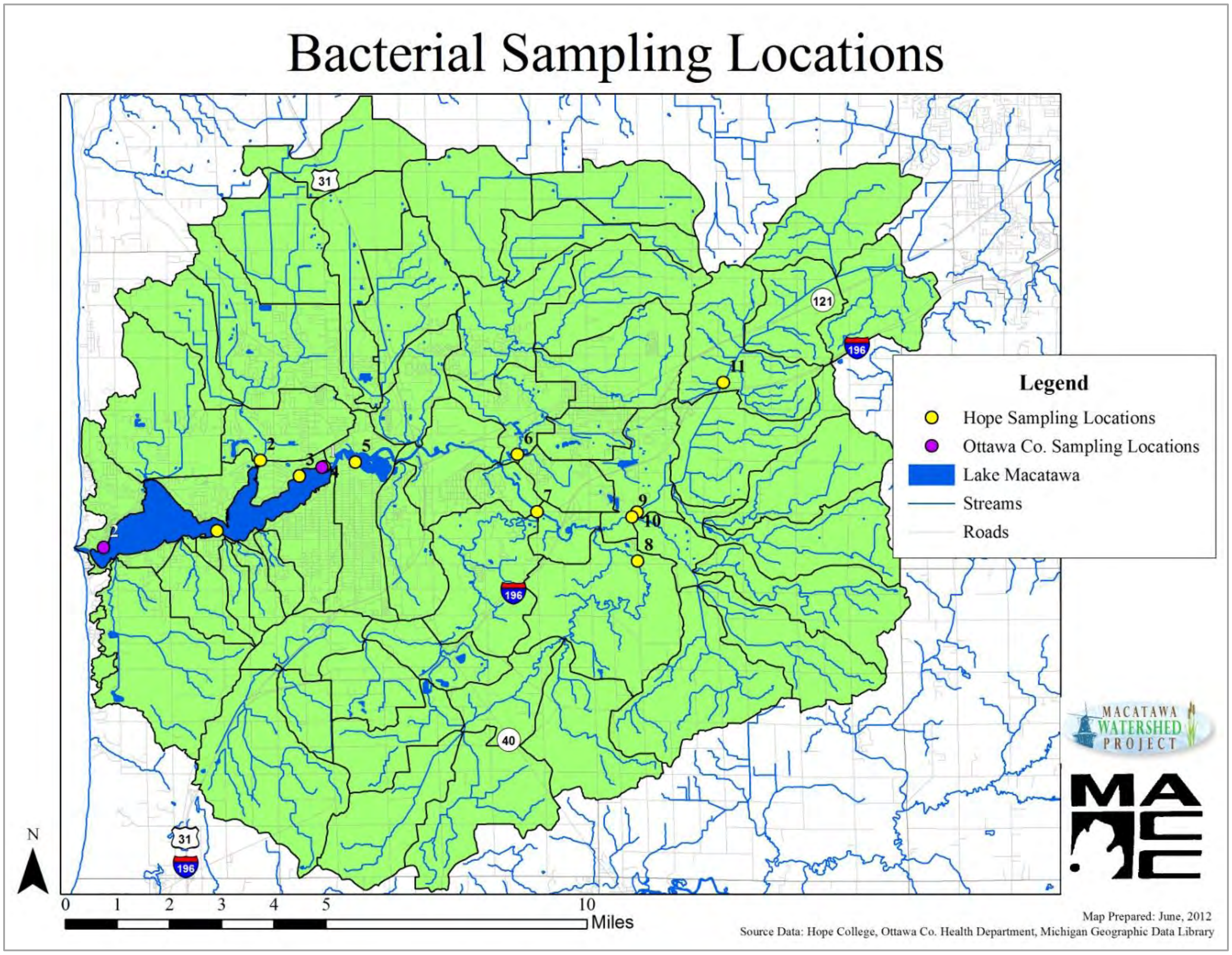


Figure 39. Map of bacterial sampling locations for Hope College and Ottawa County Health Department.

In addition to the two sites that are routinely sampled on Lake Macatawa (above), the MACC in partnership with Hope College and ODCMG, has recently begun monitoring *E.coli* levels throughout the watershed (Section 3.4, Figures 39). Table 21 shows results from the first year of sampling at eleven watershed locations.

Table 21. *E.coli* results from 2011 sampling study (Hope College) at eleven locations throughout the Macatawa Watershed (bolded results exceed standards for total body contact).

No. on Map	Sampling Location	2011 Sampling Dates							
		18-May	24-May	1-Jun	7-Jun	16-Jun	21-Jun	6-Jul	12-Jul
		Wet[1]	*Wet*[1]	*Dry*[2]	*Dry*[2]	*Dry*[2]	*Wet*[1]	*Dry*[2]	*Wet*[1]
		E.coli sample results (Colony Forming Units per 100 mL of sample)							
1	Fire Dock (south side Lake Macatawa)	**377**	60	157	17	37	not done	17	100
2	Pine Creek (north side Lake Macatawa)	220	**783**	97	223	**387**	**437**	**483**	**1,243**
3	Keizer Dock (north side Lake Macatawa)	**1,015**	**14,000**	210	53	7	150	3	57
4	Dunton Park (north side Lake Macatawa)	**1,000**	**14,000**	**550**	87	87	**377**	20	250
5	Window on Waterfront (Macatawa River marsh area)	**745**	**11,733**	**465**	**350**	260	**1,547**	**590**	**13,200**
6	Noordeloos Creek	285	**1,555**	**765**	**733**	**847**	**1,967**	**747**	**7,300**
7	North Branch Macatawa River	**385**	**2,133**	**350**	167	293	**8,867**	**463**	**6,300**
8	South Branch Macatawa River	235	**1,080**	285	**303**	**487**	**2,033**	**537**	**6,067**
9	Peters Creek	295	**963**	250	**783**	**477**	**1,067**	**1,867**	not done
10	Poppen Woods (Main Branch of the Macatawa River)	**867**	**2,700**	215	**460**	**463**	**8,333**	**940**	**15,933**
11	Felch Street (Upper Macatawa River)	**567**	**3,966**	**460**	**653**	**913**	**4,267**	**977**	**6,367**
	# of exceedances	7 sites exceed standards	10 sites exceed standards	5 sites exceed standards	6 sites exceed standards	6 sites exceed standards	9 sites exceed standards	8 sites exceed standards	7 sites exceed standards

1 Refers to a "wet" sampling condition during or just after a "wet" event or a rain event.

2 Refers to a "dry" sampling condition during normal, baseflow conditions during a period of time when it has not been raining for at least three days prior to sampling.

Sampling sites cover almost all of the major subbasins except for the Lower Macatawa and several direct tributaries of Lake Macatawa. Surprisingly, elevated levels of *E.coli* bacteria are present throughout the sampling season at all eleven sampling sites. Results from sampling sites located highest up in the watershed (Felch St, Poppen Woods, and Peters Creek) indicate that *E.coli* bacteria are present in significant quantities even in mostly agricultural areas of the watershed.

As stated previously, preliminary source tracking indicates that a small amount of human-derived *E.coli* bacteria can be detected everywhere (which likely comes from illicit connections and failing septic systems). The MACC has created a map that indicates where septic systems, at high risk for failure, are most likely located (Figure 40). Parcels were categorized as being at high risk for septic system failure if they were not serviced by municipal sewer system and were located within 30 meters of a waterway on poorly infiltrating soils (soils in Hydrologic Groups C, C/D or D).

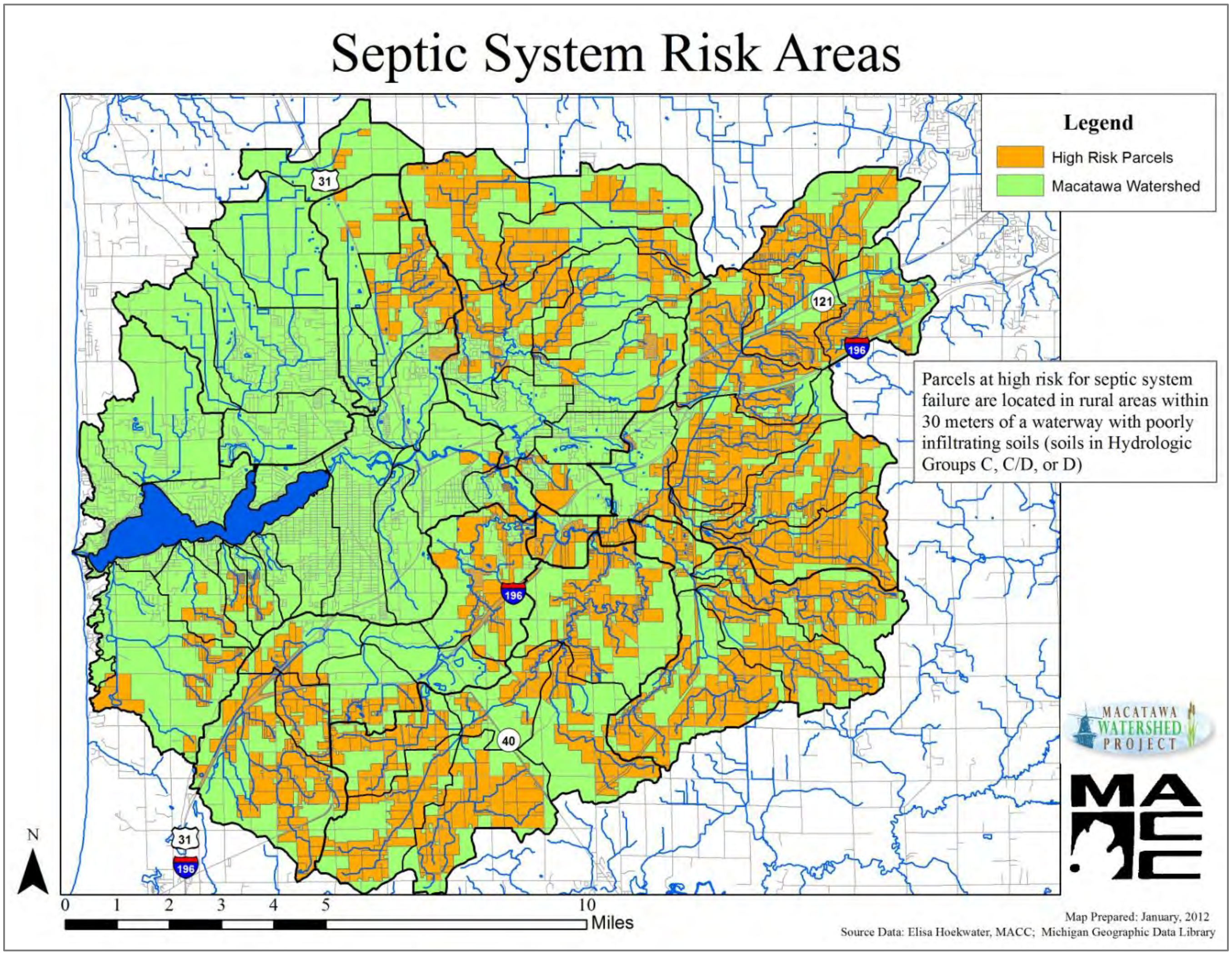


Figure 40. Areas at high risk for septic system failure in the Macatawa Watershed, based on soil characteristics and proximity to waterways.

However, when high levels of *E.coli* are detected above state water quality standards, the human-derived portion is very small. The source tracking also indicates that the majority of the *E.coli* bacteria could not be traced to bovine or porcine sources either. Local scientists hypothesize that the there may be a new strain of *E.coli* bacteria able to live in sediments or the biofilms in agricultural tile drains and/or urban storm drains.

The information presented above is intended to provide a detailed description of the level of data we currently have available about the extent, sources and causes of *E.coli* bacteria in the Macatawa Watershed. Due to the extensive beach closures experienced at Dunton Park every summer and the high level of concern for public health, *E.coli* bacteria is a pollutant of high priority for the Macatawa Watershed. However, the problem is not adequately characterized at this time and further study of the issue is certainly warranted.

3.10 SECTION 3.0 REFERENCES

Faivor, L. and S. Hanshue. 2007. A biological survey in the Lake Macatawa Watershed Allegan and Ottawa Counties, Michigan, June 2005. Report No. Mi/DEQ/WB-07/014.

Fongers, D. 2009. Macatawa Watershed Hydrologic Study. Hydrologic Studies Unit. Land and Water Management Division. Michigan Department of Environment Quality.

Fongers, D. 2009a. Macatawa Watershed Modeled Pollutant Loads. Hydrologic Studies Unit. Land and Water Management Division. Michigan Department of Environmental Quality.

Fusilier, W.E. and B.M. Fusilier. 1999. Lake Macatawa Holland and Park Townships Ottawa County, Michigan: A Water Quality and Watershed Management Study. Water Quality Investigators, The Lake Macatawa Shoreline Association, Holland, Michigan.

Holden, S. 2012. A biological survey of Macatawa River, Pigeon River, and the Little Pigeon River Watersheds, Allegan and Ottawa Counties, Michigan, August 2010. Report No. MI/DEQ/WRD-12-016.

Jackson, G. 1971. A biological survey of the Black River and Lake Macatawa, Vicinity of Holland, Michigan. Michigan Water Resources Commission, Bureau of Water Management, Michigan Department of Natural Resources.

Lake Macatawa Shoreline Association. 1996. Toward a Cleaner Lake 1988-1996. Clean Water Committee, Lake Macatawa Shoreline Association, Holland, Michigan.

MDEQ (Michigan Department of Environmental Quality). 1999. Pollutants controlled calculation and documentation for Section 319 watersheds training manual.

MDEQ (Michigan Department of Environmental Quality). 2010. Water quality and pollution control in Michigan 2010 Sections 303(d), 305(b), and 314. Integrated Report. Report No. MI/DEQ/WB-10/001.

Mustata, E. 1996. Dissolved Oxygen Study of Lake Macatawa's Eastern-Basin, Ottawa County, Michigan, June-August, 1995. Michigan Department of Environmental Quality, Surface Water Quality Division, Report No. MI/DEQ/SWQ-96/043.

Rockafellow, D. 2002. A biological survey of the Lake Macatawa Watershed and selected tributaries, Ottawa and Allegan Counties, Michigan, August and September 2000. Michigan Department of Environmental Quality. Report No. MI/DEQ/SWQ-02/026.

Walterhouse, M. 1997. A survey of the macroinvertebrate communities and water chemistry at sites in the Lake Macatawa Watershed Allegan and Ottawa Counties, Michigan, August 24 and October 13, 1995. Report No. MI/DEQ/SWQ-97/067.

Walterhouse, M. 1998. Phosphorus loading assessment for Lake Macatawa, 1995 through 1997. Report No. MI/DEQ/SWQ-98/015.

Walterhouse, M.1999. Total maximum daily load (TMDL) for phosphorus in Lake Macatawa. Michigan Department of Environmental Quality.

Walterhouse, M. 2007. Monthly water quality assessment of Lake Macatawa and its tributaries 2006. Michigan Department of Environmental Quality. Report No. MI/DEQ/WB-07/086.

Walterhouse, M. 2009. Monthly water quality assessment of Lake Macatawa and its tributaries 2008. Michigan Department of Environmental Quality. Report No. MI/DEQ/WB-09/076.

Walterhouse, M. 2011. Monthly water quality assessment of Lake Macatawa and its tributaries 2010. Michigan Department of Environmental Quality. Report No. MI/DEQ/WRD-11/018.

Walterhouse, M. 2012. Monthly water quality assessment of Lake Macatawa and its tributaries 2008. Michigan Department of Environmental Quality. Report No. MI/DEQ/WB-09/076.

Williams, D.H. 1975. A Study of the Water Quality of Lake Macatawa (1966-1974). Hope College, Institute for Environmental Quality for the Macatawa Bay Yacht Club Volunteer Samplers and Concerned Agencies and Groups.

Wuycheck, J. 1995. Biological survey of the Macatawa River, its tributaries and Pine Creek, a triburtary to Lake Macatawa, Ottawa and Allegan Counties, Michigan. July 10-11 1990. Michigan Department of Natural Resources. Report No. MI/DNR/SWQ-95/044.

4.0 WATERSHED ACTION PLAN

IN THIS SECTION YOU WILL UNDERSTAND:

- THE WATER QUALITY GOALS AND OBJECTIVES
- HOW CRITICAL AREAS OF THE WATERSHED HAVE BEEN IDENTIFIED
- THE RANGE OF BEST MANAGEMENT PRACTICES RECOMMENDED
- THE INFORMATION AND EDUCATION STRATEGY
- HOW THIS PLAN IS COORDINATED WITH STATE STORM WATER PERMIT REQUIREMENTS

4.1 WATER QUALITY GOALS AND OBJECTIVES

The watershed management plan provides a detailed outline of the strategy that will be employed as we strive to meet the plan goals of restoration, protection and enhancement. In general, the implementation plan can be summarized by the following set of objectives and desired outcomes (Table 22).

Table 22. Summary of watershed management plan goals and objectives.

GOAL 1 Restore water quality to meet state water quality standards and the Phosphorus Total Maximum Daily Load	
OBJECTIVES	**DESIRED OUTCOMES**
1A: Implement practices in critical areas of the watershed to reduce nutrient and sediment loading to local waterways.	Soil erosion decreases resulting in less sediment and nutrient loading to waterways
1B: Implement practices in critical areas of the watershed to reduce storm water runoff to local waterways.	Storm water volumes remain stable and preferably decrease over time, peak flows are less "flashy", peak flow water velocities decrease.
1C: Implement practices in critical areas of the watershed to reduce temperature stress in local waterways.	The quality and extent of riparian buffers increases
1D: Implement practices to reduce levels of *E.coli* bacteria in local waterways.	The source of *E.coli* bacteria is determined, a plan is developed to address identified sources, the number of beach closures decreases.
1E: Conduct water quality monitoring to track and detect changes in water quality.	Nutrient and turbidity levels decline, water appears clearer and algae blooms are decreased.
1F: Investigate potential for Tier 3 pollutants to impact water quality.	Pollutants are reduced enough to meet water quality standards
GOAL 2 Protect remaining natural areas (forests and wetlands) for water quality improvement	
OBJECTIVES	**DESIRED OUTCOMES**
2A: Provide Conservation Priority Map to appropriate stakeholders to target Tier 1 areas for protection opportunities.	Amount of natural lands (forests and wetlands) remains stable or increases in the future.
2B: Work with local units of government to integrate recommendations from the Conservation Priority Map into master plans.	Local governments enact measures to protect natural lands via master planning.
2C: Work with private landowners to implement conservation easements to protect high quality natural areas.	Increased amount of natural lands protected in conservation easements.
2D: Identify unique and valuable protection sites that are not reflected in the Tier 1 locations identified in the Conservation Priority Map.	A list of target sites is generated and added to the conservation priority map

GOAL 3 Enhance watershed for desired uses that are of community importance	
OBJECTIVES	**DESIRED OUTCOMES**
3A: Develop a committee of appropriate stakeholders to address enhancement concerns.	Contact list of appropriate stakeholders is identified and the MACC facilitates a committee meeting, stakeholders work to identify goals for enhancement concerns.
3B: Enhance opportunities for recreational uses of Lake Macatawa and its tributaries.	Increase number of canoeing, kayaking, fishing and swimming amenities and non-motorized trails in riparian areas.
3C: Increase public access to Lake Macatawa and its tributaries.	Increase and create awareness of public access points along local waterways.
3D: Enhance, protect and/or restore important areas of fish and wildlife habitat.	Completion of habitat improvement projects and control of key invasive species in critical areas, reduction of invasive species impacts and increase in diversity and quality of fish and wildlife communities.
3E: Preserve and protect remaining open space within the watershed (including prime farmland).	Prime farmland protected and the region's green infrastructure remains stable or increases.

4.2 CRITICAL AREAS OF THE WATERSHED

One of the last steps of prioritizing implementation activities is to spatially identify areas of critical importance in relation to the goals of the watershed management plan (restoration, protection and enhancement). The restoration and protection goals are most closely tied to water quality and restoring designated uses in the Macatawa Watershed. A critical area analysis was completed to identify critical restoration areas and critical protection areas.

FOR RESTORATION

The Macatawa Watershed is composed of relatively distinct urban and agricultural areas. Since the best management practices that can typically be implemented in urban areas are very different from those implemented in agricultural areas, two separate analyses were performed. The MACC, in consultation with the various watershed committees, identified a host of variables to help identify the most critical *urban* areas for restoration and the most critical *agricultural* areas for restoration. In general the following factors were used to determine critical areas by calculating a score for each of the 55 subwatersheds:

- Percent (urban or agricultural) land
- Percent (urban or agricultural) land within 200 ft of a waterway[1]
- Percent impervious surface[2]
- Percent soils with high potential for erosion[1]
- Percent land with high risk for septic system failure[1]
- Priority level for in-stream BMPs
- Priority level for upland BMPs[1]
- Runoff volume (inches)[2]
- Percent increase in runoff volume from 1978-2005
- Number of high risk road stream crossings
- Total suspended solids loading (lbs/acre)
- Percent wetland loss[2]
- Percent poor riparian buffer[1]

[1] Factors that were double-weighted in the agricultural critical area analysis

[2] Factors that were double-weighted in the urban critical area analysis

For a complete description of the methodology of the critical areas analysis see Appendix M (FTCH 2011a). The resulting maps indicate high priority (red) and moderate priority (orange) zones for both the critical agricultural areas (Figure 41) and the critical urban areas (Figure 42).

Critical Agricultural Areas

- High Priority
  - 30,681 acres
  - 28%
- Mod Priority
  - 40,052 acres
  - 36.5%
- Low Priority
  - 38,981 acres
  - 35.5%

Critical Urban Areas

- High Priority
  - 18,846 acres
  - 17%
- Mod Priority
  - 15,976 acres
  - 15%
- Low Priority
  - 74,891 acres
  - 68%

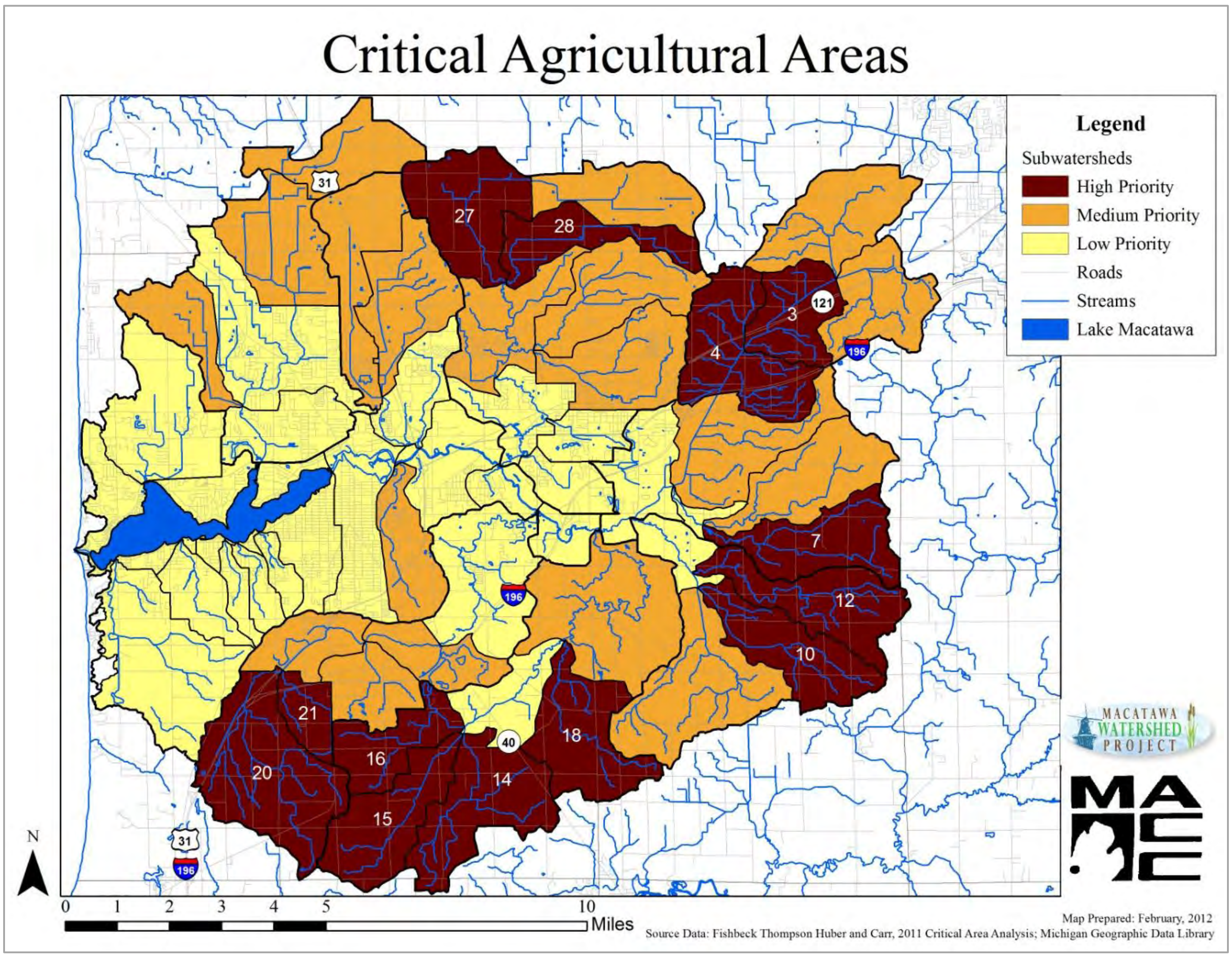


Figure 41. Critical agricultural areas of the Macatawa Watershed (FTCH 2011a).

The most critical *agricultural* areas are scattered around the outside ring of the watershed in the Upper Macatawa River subbasin and in the headwater areas of Noordeloos Creek, Peters Creek, the South Branch of the Macatawa River and the North Branch of the Macatawa River (Table 23). In general these areas are characterized by highly erodible soils, a large amount of cultivated land within 200 ft of waterways, poor riparian buffers, elevated risk of septic system failure and a significant amount of historical wetland loss.

Table 23. Summary of critical agricultural areas in the Macatawa Watershed.

No.	Subwatershed	Subbasin	Area (acres)
3	Macatawa River at 72nd Avenue	Upper Macatawa	1,713
4	Macatawa River at I-196 Overpass		2,902
7	Hunderman Creek to Big Creek		2,298
10	Unnamed tributary to Peters Drain	Peters Creek	2,326
12	Unnamed tributary to Peters Creek		2,503
14	Kleinheksel Drain to South Branch	South Branch Macatawa	2,868
15	Jaarda Drain to South Branch		2,413
16	South Branch Macatawa River to Jaarda Drain		1,652
18	East Fillmore Drain (including Eskes Drain)		2,605
20	Uppermost North Branch Macatawa River	North Branch Macatawa	4,073
21	Vanderbie Drain and Rotman Drain		848
27	Bosch and Hulst Drain to Noordeloos Creek	Noordeloos Creek	2,727
28	Tributary to Bosch and Hulst Drain (Southwest of Blendon Drain)		1,754
		Total	30,681

Table 24. Summary of critical urban areas in the Macatawa Watershed.

No.	Subwatershed	Subbasin	Area (acres)
22	North Branch Macatawa River to Den Bleyker Drain	North Brach Macatawa	1,290
23	Den Bleyker Drain		1,415
24	North Branch Macatawa River at M-40		1,314
30	Brower Drain to Hunters Creek	Noordeloos	2,499
32	Cedar Drain to Noordeloos Creek		932
38	Drain #15 and #17 to Drain #40	Lower Macatawa	2,309
39	Drain #40 to Macatawa River		1,406
40	Macatawa River to Windmill Island		1,825
41	Maplewood Intercounty Drain to Macatawa River		1,603
47	Macatawa River marsh	Lake Macatawa Direct Drainage	2,283
54	East Lake Macatawa Direct Drainage		1,969
		Total	18,846

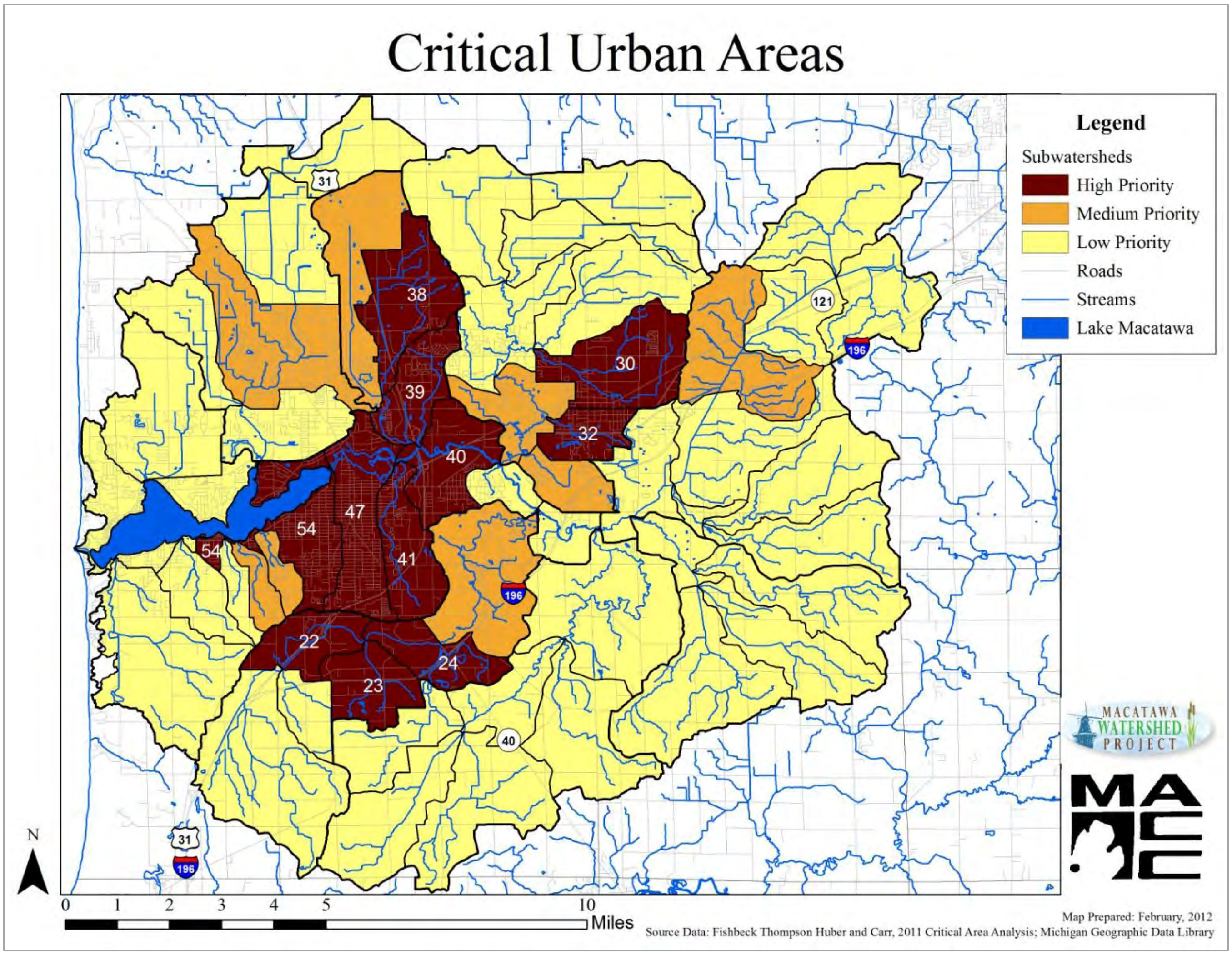


Figure 42. Critical urban areas of the Macatawa Watershed (FTCH 2011a).

The most critical *urban* areas are centrally located in the watershed and include almost the entire land area of the City of Holland and City of Zeeland as well as parts of the Lower Macatawa, Noordeloos Creek, and the North Branch of the Macatawa River (Table 24). In addition, about half of the total Lake Macatawa Direct Drainage area is included in the highly critical urban areas. In general these areas are characterized by large runoff volumes, vast amounts of impervious surfaces and a significant amount of historical wetland loss.

FOR PROTECTION

The Macatawa Watershed has very few natural areas, including forest and wetland, remaining compared to presettlement times. In fact, only about 15,422 acres of forested land and 551 acres of wetlands remain (based on 2009 land use). Forests and wetlands have immense water quality benefits because they can reduce storm water runoff and take up nutrients. Therefore, it is crucial that we protect the remaining natural lands in the Macatawa Watershed.

The MACC, in consultation with the various watershed committees, identified a host of variables to help identify the most critical areas for protection. In general the following factors were used to determine critical protection areas by calculating a score for each quarter-quarter section of land in the watershed (40 acre blocks):

- Type of land cover (forest and wetland areas were scored highest)
- Presence of a waterway
- Potential presence of rare species (Biorarity index)
- Development pressure
- Proximity to already protected land
- Groundwater recharge
- Presence of prime farmland[1]

[1] The presence of prime farmland decreased the value of land for protection

For a complete description of the methodology of the protection area analysis see Appendix N (Fraser 2010). The resulting map (Figure 43 and Table 25) indicates a range of recommended protection priorities (from Tier 1 to Tier 5).

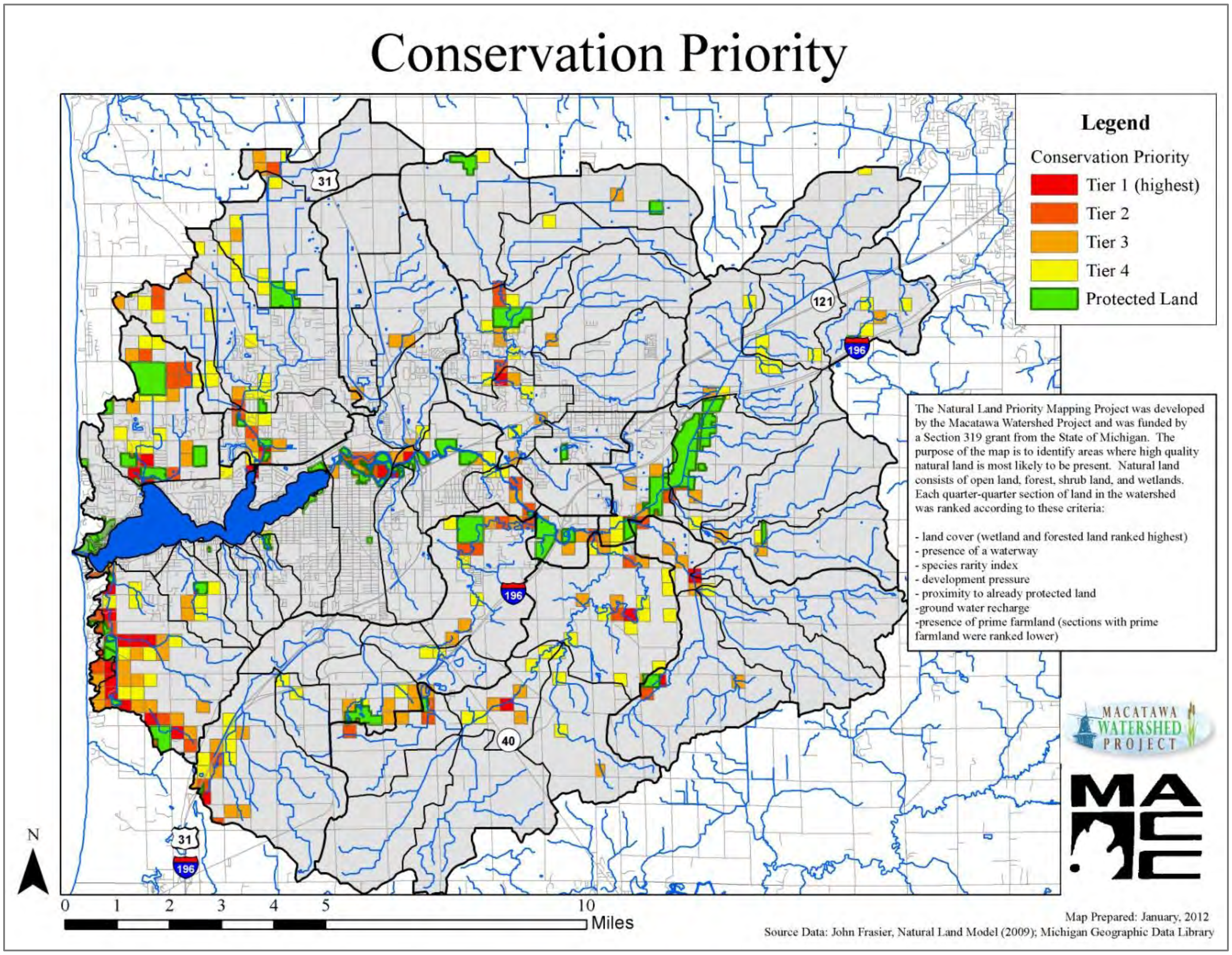


Figure 43. Natural land protection priority map (Fraser 2010).

Table 25. Summary of Tier 1 and Tier 2 natural land recommended for protection in the Macatawa Watershed.

Subwatershed	Subbasins	Tier 1 (acres)	Total Tier 1 (acres)	Tier 2 (acres)	Total Tier 2 (acres)
1					
2					
3					
4					
5	Upper Macatawa		68	63	173
6					
7					
8				15	
9		68		96	
10					
11	Peters Creek	41	100	40	69
12		18			
13		41		29	
14					
15					
16				123	
17	South Branch	41	81		217
18					
19		40		94	
20		30		96	
21					
22					
23	North Branch		30	40	328
24					
25				192	
26					
27				14	
28				2	
29					
30	Noordeloos Creek		80		120
31		46		98	
32					
33					
34		35		6	
35				14	
36				89	
37					
38	Lower Macatawa		77		142
39					
40		43		40	
41		34			
42				40	
43				6	
44	Pine Creek		40	20	282
45				86	
46		40		130	
47		43		199	
48		129		314	
49					
50					
51	Lake Macatawa Direct Drainage		689		758
52		40			
53		442		224	
54		9		1	
55		26		20	
Totals		1,166	1,166	2,089	2,089

4.3 RESTORATION ACTIONS

In Chapter 3 we detailed how pollutants, pollutant sources and pollutant causes were identified and prioritized (Table 14 and 15). Restoration efforts to address the *high priority* and *moderate priority* causes are summarized here. Recommendations are categorized as either structural or non-structural practices (managerial).

Objective 1A: Implement practices in critical areas of the watershed to reduce nutrient and sediment loading to local waterways.

There are a variety of implementation actions recommended to reduce nutrient and sediment loading to the Macatawa Watershed (Table 26). While there are some best management practices (BMPs) that are common to several types of nonpoint source pollution, recommendations will vary depending on the source and cause of the pollutants. In general, the BMPs described below are intended to promote wise use of nutrients, protect bare soil and prevent nutrients and sediment from leaving the land via surface water runoff. These BMPs should be implemented in highly critical areas first and moderately critical areas second (as described in Section 4.2).

Table 26. Summary of implementation actions recommended to reduce nutrient and sediment loading (red indicates highest priority items, orange indicates moderate priority items).

Pollutant/Source	Causes	Recommendations	
		Structural	Non-Structural
Nutrients			
Agricultural Runoff	Loss of wetlands	Wetland restoration	Wetland protection ordinances
	Lack of riparian buffers	Increase and improve buffers	Riparian Overlays/Zoning
	Lack of BMPs	Cover crops, reduced tillage, gypsum amendments, grassed waterways, grade stabilization structures, drainage water management, two stage ditch design	Verification in MAEAP[1] program
	Improper use or over application of manure		Nutrient management plans, manure management plans, refraining from winter applications
Urban Residential Runoff	Loss of wetlands		Wetland protection ordinances
	Improper use or over application of fertilizers		Homeowners use Lawn Care Seal of Approval companies
	Lack of riparian buffers	Increase and improve buffers	Riparian Overlays/Zoning
	Poor Storm Water Management	Rain gardens, native vegetation, rain barrels, porous pavement, buffer strips, storm water retrofits	Storm water ordinances, improved site plan review
Streambanks	Erosion (loss of vegetation and logjams)	Streambank stabilization, buffer zones, native vegetation, removal of log jams	Revised maintenance procedures at county drain offices
Sediment			
Agricultural Runoff	Loss of wetlands	Wetland Restoration	Wetland protection Ordinances
	Lack of riparian buffers	Increase and improve buffers	Riparian Overlays/Zoning
	Lack of BMPs	Cover crops, reduced tillage, gypsum amendments, grassed waterways, grade stabilization structures, drainage water management, two-stage ditch design	Verification in MAEAP[1] program
Urban Residential Runoff	Impervious surfaces	Porous pavement, bioretention	Regular street sweeping program
	Storm drains		Catch basin cleaning program, Illicit Discharge Elimination Program

Pollutant/Source	Causes	Recommendations	
		Structural	Non-Structural
	Loss of wetlands		Wetland protection Ordinances
Streambanks	Erosion (loss of vegetation and logjams)	Streambank stabilization, buffer zones, native vegetation, removal of log jams	Revised maintenance procedures at county drain offices
Road Stream Crossings	Improper design, alignment, maintenance causing erosion	Replacement or correction of problem road stream crossings	

[1] MAEAP: Michigan Agricultural Environmental Assurance Program

Objective 1B: Implement practices in critical areas of the watershed to reduce storm water runoff to local waterways.

There are a variety of implementation actions recommended to reduce storm water runoff and reduce the harmful effects of extreme hydrology on the Macatawa Watershed (Table 27). While there are some best management practices (BMPs) that are common to several types of nonpoint source pollution, recommendations will vary depending on the source and cause of the pollutants. In general, the BMPs described below are intended to promote infiltration of storm water on land, reduce storm water velocities and remove "pinch points" along the stream channel. These BMPs should be implemented in highly critical areas first and moderately critical areas second (as described in Section 4.2).

Table 27. Summary of implementation actions recommended to address hydrology (red indicates highest priority items, orange indicates moderate priority items).

Source	Causes	Recommendations	
		Structural	Non-Structural
Hydrology			
Agricultural Sources	Drain tiles and other artificial drainage	Two stage ditch design, drainage water management, gypsum amendments	
	Wetland loss	Wetland restoration	Wetland protection ordinances
Urban/Residential Sources	Impervious surfaces and Storm Drains Wetland loss	Porous pavement, storm water detention/retention, conversion to native vegetation	Storm water ordinances Wetland protection ordinances
Road Stream Crossings	Improper design, alignment (hydraulics)	Replacement or correction of problem road stream crossings	

Objective 1C: Implement practices in critical areas of the watershed to reduce temperature stress in local waterways.

There are a variety of implementation actions recommended to reduce temperature stress on the waterways of the Macatawa Watershed (Table 28). In general, the BMPs described below are intended to increase the length of stream that is protected by vegetation canopy cover and reduce storm water runoff by promoting infiltration of storm water on land. These BMPs should be implemented in highly critical areas first and moderately critical areas second (as described in Section 4.2).

Table 28. Summary of implementation actions recommended to address temperature stress (red indicates highest priority items, orange indicates moderate priority items).

Source	Causes	Recommendations	
		Structural	Non-Structural
Temperature			
Urban/Residential Sources	Impervious surfaces and Storm Drains	Porous pavement, storm water detention/retention, conversion to native vegetation	Storm water ordinances
	Lack of riparian buffer	Increase and improve buffers	Riparian Overlays/Zoning
Agricultural Sources	Lack of riparian buffer	Increase and improve buffers	Riparian Overlays/Zoning

Objective 1D: Implement practices to reduce levels of *E.coli* bacteria in local waterways.

There are a variety of implementation actions recommended to reduce levels of *E.coli* bacteria throughout the Macatawa Watershed and specifically at the Dunton Park Beach area (Table 29). In general, there is a need to further investigate the sources of *E.coli* bacteria and determine if it can live and thrive in the biofilms of storm drain and agricultural drainage tiles. In general, the BMPs described below are intended to decrease the potential impact of manure application and improper disposal of pet waste on downstream *E.coli* bacteria levels. As indicated above, the impact of these sources and causes has not yet been verified. Pending further study, it is likely that these BMPs should be implemented in highly critical areas first and moderately critical areas second (as described in Section 4.2). However, future studies may reveal unknown sources or causes of *E.coli* bacteria and may reveal other critical focus areas not described here.

Table 29. Summary of implementation actions recommended to reduce levels of *E.coli* bacteria (red indicates highest priority items, orange indicates moderate priority items).

Source	Causes	Recommendations	
		Structural	Non-Structural
E.coli Bacteria			
Agricultural Sources	Application of manure	UNKNOWN-FURTHER STUDY REQUIRED	
		Buffer strips, cover crops, drainage water management	Nutrient management plans, manure management plans
	Biofilms in drain tiles and artificial drainage	UNKNOWN-FURTHER STUDY REQUIRED	
Urban/Residential sources	Biofilms in storm drains	UNKNOWN-FURTHER STUDY REQUIRED	

Objective 1E: Conduct water quality monitoring to track and detect changes in water quality.

Monitoring is an important component of the watershed management plan implementation. A complete monitoring program is described in Section 5.0.

Objective 1F: Investigate potential for Tier 3 pollutants to impact water quality.

As stated above, this watershed management plan is designed to address Tier 1 (nutrients, sediment, hydrology, and temperature) and Tier 2 pollutants (*E.coli* bacteria) because these pollutants directly impact impaired *Designated Uses*. There were a variety of other pollutants that were of concern, as identified by members of the watershed committees. These Tier 3 pollutants include:

- Invasive Species (KNOWN POLLUTANT)
- Other chemical contaminants
- Chloride
- Man-made debris (trash)

Invasive species, which include both non-native plants and aquatic wildlife, are known to impact water quality and habitat in the Macatawa Watershed. Invasive species were not listed as a Tier 1 or 2 pollutant because it is unlikely that invasive species are impacting attainment of *Designated Uses* in the Macatawa Watershed. However, the control of invasive species is a desired goal of the watershed management plan and will be addressed under Objectives 3D and 3E below. The extent and severity of invasive species in the Macatawa Watershed is not fully documented and deserves further study.

The remaining Tier 3 pollutants (chemical contaminants, chloride and trash) may be problems in the Macatawa Watershed. There is very little data concerning these pollutants. At this time, there are no other pollutants that are known to be impacting attainment of *Designated Uses*. The extent and severity of these potential pollutants in the Macatawa Watershed is not fully documented and deserves further study.

This objective will be addressed in the long-term and is a secondary priority to the restoration actions detailed for Objectives 1A-1D.

4.4 IMPLEMENTATION OF BEST MANAGEMENT PRACTICES

The success of the watershed management plan depends upon implementation of many structural and non-structural BMPs. In the previous section, a range of BMPs were prioritized and tied to specific pollutant sources and causes. These BMPs are intended to help meet the first goal of the watershed management plan which is restoration of water quality. Refer to Appendix O for detailed pollutant load reductions for each recommended practice. Refer to Appendix P for a proposed implementation schedule of restoration activities, interim measurable milestones and estimated implementation costs.

WETLAND RESTORATION

The MDEQ conducted a Landscape Level Functional Wetlands Assessment for the Macatawa Watershed in 2009 (Appendix Q). The study indicated that the Macatawa Watershed has lost 86% of its original wetlands. The water quality benefits of wetlands are numerous and well documented. Wetland restoration has been shown to be an effective practice for reducing storm water flows, reducing water velocities and capturing nutrients and sediment. In addition, wetlands provide crucial habitat to birds, fish and other wildlife. This practice should be very applicable in the Macatawa Watershed because of the high capacity for wetland restoration and the presence of an estimated 21,070 acres suitable for restoration (Table 30). The land areas with the highest potential for successful wetland restoration projects were wetlands in presettlement times and are still characterized by hydric soils today (Figure 44).

Table 30. Summary of potential wetland restoration in the Macatawa Watershed.

Subbasin	High Potential for Restoration (acres)	Moderate Potential for Restoration (acres)	Total Restoration Potential (acres)
Noordeloos Creek	2,036	2,580	4,616
Upper Macatawa	1,583	1,091	2,674
South Branch Macatawa	1,582	1,502	3,084
Pine Creek	1,503	2,336	3,839
Lower Macatawa	659	1,628	2,287
North Branch Macatawa	645	2,024	2,669
Lake Macatawa Direct Drainage	85	921	1,006
Peters Creek	0	896	1,080
Totals	8,093	12,977	21,070

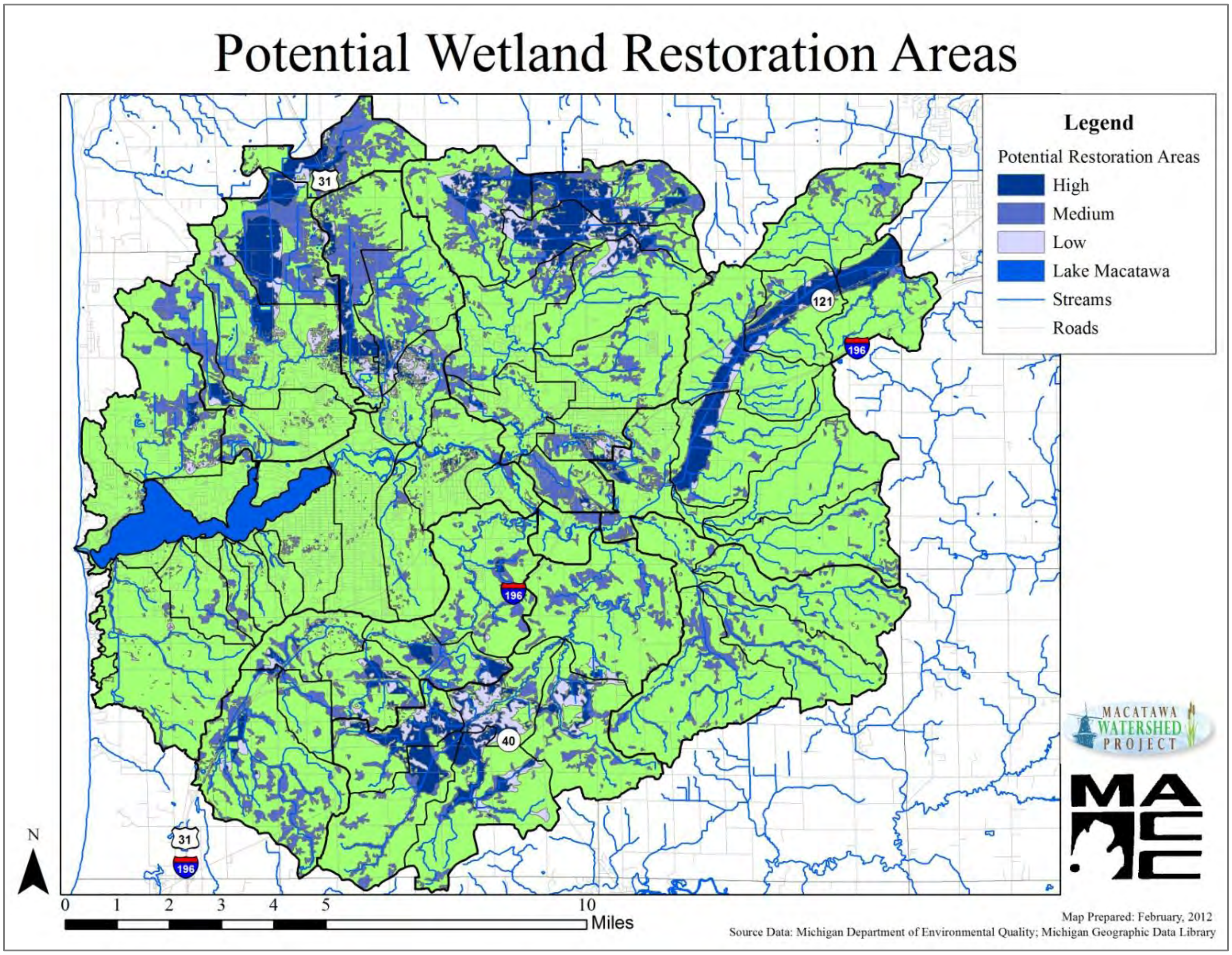


Figure 44. Potential wetland restoration in the Macatawa Watershed.

Wetland restoration is most feasible in critical agricultural areas that are currently undeveloped. With the help of MDEQ, we estimated that we should aim to restore approximately 50% of the total high potential acres in the most critical agricultural areas (4,050 acres). One of the biggest obstacles to implementing wetland restoration is acquiring land or landowner permission. Therefore wetland restoration in critical urban areas is likely prohibitive. If wetland restoration opportunities arise in critical urban areas or moderately critical agricultural areas, we would certainly support such a project and consider it a high priority for implementation.

ESTIMATED ANNUAL LOAD REDUCTION*: 3,755 lbs P, 13,285 lbs N, 1,927 tons Sediment

* Load reductions were calculated using the EPA's STEPL Model (Appendix O).

TRADITIONAL AGRICULTURAL BEST MANAGEMENT PRACTICES

The Macatawa Watershed is predominantly agricultural with an expansive amount of land categorized as prime farmland (Figure 13). Farmland has the potential to contribute a significant amount of nutrients and sediment via overland flow, depending on its soil type, slope and management practices. There are many traditional agricultural BMPs that are effective for reducing soil erosion and surface water runoff. These BMPs include grassed waterways, buffer strips, cover crops, reduced or conservation tillage, grade stabilization structures, and critical area plantings among others. Several agricultural areas of the watershed were evaluated for BMP needs by the Allegan Conservation District by conducting in-depth field inventory (Allegan Conservation District 2011). The Allegan Conservation district used these field inventories to extrapolate recommendations to other areas of the watershed. The focus area for agricultural BMPs is in highly and moderately critical agricultural areas. See Appendix R for a copy of the agricultural inventory reports conducted by the Allegan Conservation District in 2002 and 2010. Refer to Appendix O for a detailed list of pollutant load reductions for traditional agricultural BMPs as described here.

ESTIMATED ANNUAL LOAD REDUCTION*: 66,184 lbs P, 137,909 lbs N, 48,909 tons Sediment

* Load reductions were calculated by Allegan Conservation District using RUSLE and MDEQ's Pollutant Loading Spreadsheet (Appendix O).

NON-TRADITIONAL AGRICULTURAL BEST MANAGEMENT PRACTICES

In this predominantly agricultural watershed it is important to consider non-traditional agricultural BMPs to maximize the possibility of successful implementation. Therefore, under this plan we will consider implementation of drainage water management, gypsum amendments and two stage ditch design in addition to the BMPs described above. Furthermore, we intend to remain flexible in our implementation strategy and will consider other new and emerging technologies that are effective in reducing nonpoint source pollutants as they become available in the future. The focus area for non-traditional agricultural BMPs is in highly and moderately critical agricultural areas. Refer to Appendix O for a detailed list of pollutant load reductions for non-traditional agricultural BMPs as described here.

Drainage Water Management

Agricultural *drainage water management* can be used with traditional agricultural systems and is somewhat of a retrofit for heavily tiled areas. It reduces surface and subsurface runoff by reducing flow from agricultural drainage tiles during times of the year when drainage is not necessary (Agricultural Drainage Management Coalition 2006). In-line control structures can be inserted into drainage pipes to allow the farmer to periodically adjust the height at which the water table triggers drainage. The ability to control drainage height enables the farmer to respond to crop needs and reduces the amount of nitrate and phosphorus (and possibly *E.coli* bacteria) that escape from the field (Fertilizer Institute 2012, LaLonde et al. 1996).

The water table level may be set high during winter or other periods when crops are not growing, decreasing the loss of water and nutrients from the field. In spring, the water level may be lowered enough for planting, while during the growing season farmers are able to make adjustments for weather conditions. It's effectiveness at intercepting nutrients is related to the reduced flow and the amount of dissolved nutrients available for transport. Nitrogen is readily transportable and research indicates that a general reduction expectation of 16 pounds of nitrate nitrogen can be retained per acre per year in a typical system (based on retaining 40% of the typical season's drainage water in the soil profile). Reduction in the loss of soluble phosphorus has not been sufficiently studied. However, given the high levels of phosphorus in typical soils in the Macatawa Watershed, some degree of reduction should be expected. Research indicates that nitrogen and phosphorus may be reduced by 30-50% (Evans et al. 1995).

The goal of this plan is to implement drainage water management systems on approximately 50% of the drained acres in highly critical subwatersheds (5,298 acres). We assumed a conservative reduction of nutrients of 30% and a negligible removal of sediment.

ESTIMATED ANNUAL LOAD REDUCTION*: 2,103 lbs P and 9,050 lbs N

* Load reductions were calculated using EPA's STEPL Model (Appendix O).

Gypsum Amendments

Gypsum or calcium sulfate dehydrate, is a mineral that can be added to heavy soils as a soil conditioner. It has been shown to improve plant growth and crop yields while reducing phosphorus losses by directly reducing solubility of phosphorus and by reducing losses of soils containing bound phosphorus (Fisher 2011). The material also substantially increases infiltration which should reduce secondary erosion losses due to flowing water by reducing peak stream flows if the material was used on a substantial proportion of agricultural land in a watershed. The calcium in gypsum also helps clay particles aggregate together by displacing less favorable cations which cause the particles to repel each other (Chen and Dick 2011, Favoretto et al. 2006, Fisher 2011, Norton 2006). This improves soil stability and drainage.

Therefore, gypsum amendments may be effective at reducing runoff, and therefore sediment and phosphorus loading from agricultural land within the Macatawa Watershed. The goal of this plan is to treat approximately 50% of the agricultural land in highly critical subwatersheds (10,465 acres). We assumed a conservative reduction of phosphorus and sediment of 30% (Stout et al. 1999). However, we were unable to confirm any research to estimate nitrogen reductions.

ESTIMATED ANNUAL LOAD REDUCTION*: 3,381 lbs P and 1,595 tons sediment

* Load reductions were calculated using EPA's STEPL Model (Appendix O).

Two Stage Ditch Design

The Macatawa Watershed is a heavily drained basin, which has made available an abundant amount of prime farmland. Many of the waterways that make up the drainage system of the Macatawa Watershed are artificially constructed county-owned or private drains. These drains are typically constructed in deep trapezoid-shaped channels characterized by steep banks (Dierks 2010). Much of the time water flow is low to non-existent in some places. However, during storm events water runs off the land quickly and water velocities in these straight, confined channels is intense with the potential to cause great destruction. Bank erosion, scouring, sediment build-up and periodic flooding are prevalent and indicate that water drainage is a problem. The two-stage ditch design describes an alternative method for constructing artificial drainage systems in primarily agricultural settings.

The design of a two-stage ditch incorporates a floodplain zone, called benches, into the ditch by significantly widening stream banks and creating a low-flow channel in the bottom center. This allows the water to have more area to spread out on and decreases the velocity of the water flowing in the main channel. This not only improves the water quality, but also improves the biological conditions of the ditches where this is located. Research has shown that two-stage ditches can remove between 3% and 27% of sediment, 10% to 40% of total phosphorus and 1% to 45% of nitrogen (Dierks 2010). The two-stage design improves ditch stability by reducing water flow and the need for maintenance, saving both labor and money.

The goal of this plan is to reconstruct approximately 20% of the current traditional county-owned and private drains in highly critical subwatersheds (10,465 acres). We assumed a median reduction of sediment (15%), phosphorus (25%) and nitrogen (23%) respectively. We also assumed that two-stage ditches will reduce pollutant loading from streambank erosion and surface runoff.

ESTIMATED ANNUAL LOAD REDUCTION*: 9,191 lbs P, 43,432 lbs N and 1,448 tons sediment

* Load reductions were calculated using EPA's STEPL Model (Appendix O).

URBAN STORM WATER PRACTICES

Approximately 33% of the Macatawa Watershed is characterized as urban or built-up land which includes the urban city center as well as the less densely populated suburban areas. Urban areas have a high percentage of impervious surfaces including roads, parking lots, sidewalks, driveways and roofs, which create a large volume of storm water runoff. There are many urban BMPs that are effective for reducing storm water runoff and its associated nutrient and sediment load. Some of these BMPs can be used in storm water retrofitting (implementing storm water practices where previous practices were non-existent or ineffective). These urban BMPs include bioretention (such as rain gardens), extended detention, wet ponds, infiltration practices (such as infiltration trenches), rain barrels, native vegetation, highly engineered filtration practices, buffer strips, porous pavement, and increasing the urban tree canopy. These practices and others are considered effective low impact development practices and they can be implemented in a variety of ways in municipal, commercial, industrial and residential land uses. The focus area for urban BMPs is in highly critical urban areas. All of the above practices will be considered as feasible and prudent goals of the watershed management plan. Pollutant load reduction estimates will be calculated on a site-specific basis as projects become available for practices that are highly site-specific (such as extended detention, wet ponds, infiltration trenches, highly engineered filtration practices). Pollutant load reduction estimates for other, more broadly applicable practices are included below (Table 31).

Table 31. Estimated pollutant reduction goals for urban best management practices.

BMP	Targeted Pollutants	Goals	Total Acres	Calculated	Pollutant Load Reductions		
					Sediment (tons/yr)	P (lbs/yr)	N (lbs/yr)
Rain Gardens	Nutrients Hydrology Temperature	25% SF (1058 ac) 25% INST (231 ac) 25% COMM (539 ac) 25% MF (222 ac) Of land in highly critical urban areas	2,050	STEPL MODEL (using bioretention BMP)	0	866	3,204
Turf Grass Converted to Native Vegetation	Nutrients Hydrology	10% COMM (215 ac) 10% IND (264 ac) 10% INST (81 ac) 25% SF (1058 ac) 25% MF (223 ac Of land In highly critical urban areas	1,841	STEPL MODEL (using vegetated filter strip BMP)	106	474	2,626
Porous Pavement	Nutrients Sediment Hydrology	10% INST (81 acres) 10% IND 9265 acres) Of land in highly critical urban areas	345	STEPL MODEL (using porous pavement BMP)	43	215	1,744
Rain Barrels	Nutrients Hydrology	5,000 barrels In highly critical urban areas	NA	Chesapeake Bay Model[1]	Negligible	50	500
Buffer Strips (see Figure 45) ** includes natural shoreline projects	Nutrient Sediment Hydrology Temperature *E.coli* bacteria	100% COMM (11.9 ac) 100% IND (8.1 ac) 100% INST (1.9 ac) 100% MF (3.1 ac) 100% SF (12 ac) Of identified poor buffers in highly critical urban areas[2]	31.5	STEPL MODEL (using filter/buffer strip BMP)	2	7	46
Increase Urban Tree Canopy[3]	Nutrients Sediment Hydrology Temperature	6,000 tree planted In highly critical urban areas	NA	Chesapeake Bay Model[4] and EPA STEPL Model	11	180 (over a 20 year period)	1,200 (over a 20 year period)
Totals					162	1,792	9,320

SF: single family residential land use
INST: institutional land use
COMM: commercial land use
MF: multi-family residential land use
IND: industrial land use
1: Chesapeake Bay Model assumes 0.1 pounds of phosphorus is removed annually by a single rain barrel, negligible phosphorus removal
2: Assumed 20 ft wide buffers on one side of the waterway only
3: Estimates should be refined after a tree canopy analysis is completed
4: Chesapeake Bay Model assumes one tree can reduce 30,000 gallons of water over the first 20 years of its life and reduce 0.03 lbs of P and 0.2 lbs N over that time period

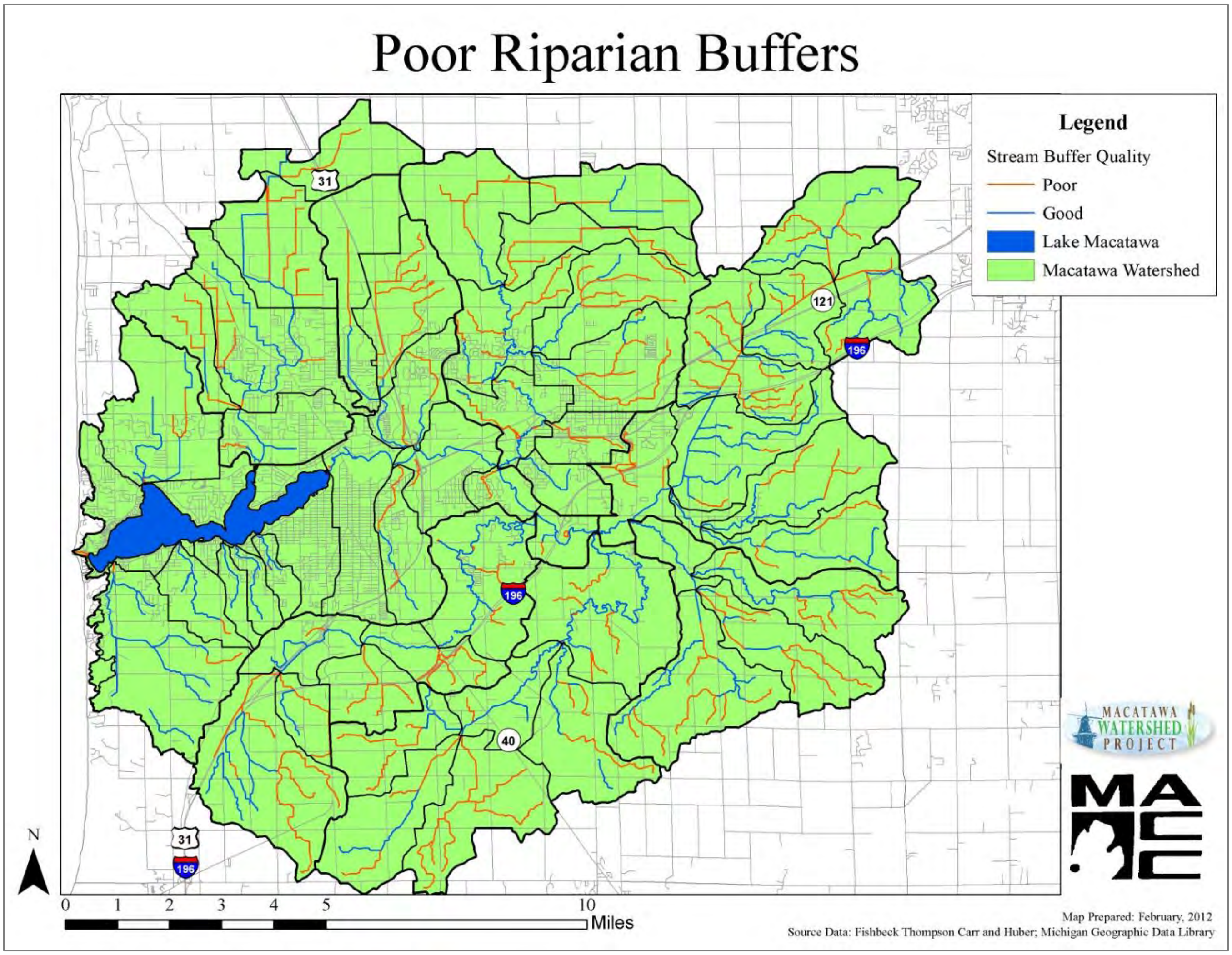


Figure 45. Poor riparian buffers in the Macatawa Watershed (FTCH 2011).

The figure above denotes the location of waterways within the Macatawa Watershed that suffer from inadequate or "poor" riparian buffers (FTCH 2011). These areas would be prime candidates for buffer strip projects and/or conservation easements.

STREAMBANK STABILIZATION

There is a total of 1,716,912 ft of waterway in the Macatawa Watershed and data that shows that approximately 27% (469,050 ft) is eroding (FTCH 2011, Table 32). Best professional judgement was used to develop a goal to stabilize 35% of the total eroding streambank (79,503 ft) in three of the most critical subbasins for instream erosion (South Branch Macatawa, North Branch Macatawa and Lake Macatawa Direct Drainage) and 15% of the total eroding streambank (21,390 ft) in other subbasins of lesser concern (Noordeloos Creek, the Upper Macatawa and Peters Creek). Streambank stabilization projects may include repair of problem road stream crossings and removal of large log jams. There is a total of 622 road stream crossings in the Macatawa Watershed and we have data that shows that approximately 10% (62) likely show a high risk for bank erosion and 39% (243) likely show a moderate risk of bank erosion (MACC 2009; Bank Erosion Hazard Index). The goal is to repair at least 30% of the total high risk road stream crossings (19) and 10% (24) of the moderate risk crossings with a special focus on those located in critical agricultural and urban subwatersheds.

Table 32. Estimated pollutant load reductions for streambank stabilization projects.

			Estimated Load Reduction		
Subbasin	**Eroding streambank (ft)**	**Restoration Goal**	**TP (pounds)**	**TSS (tons)**	**Nitrogen (pounds)**
South Branch Macatawa[1]	87,000	30,450 (35%)	435	435	870
North Branch Macatawa[1]	63,000	22,050 (35%)	395	395	865
Lake Macatawa Direct Drainage[2]	77,150	27,003 (35%)	356	356	711
Noordeloos Creek[1]	68,000	10,200 (15%)	143	143	285
Upper Macatawa[2]	74,600	11,190 (15%)	65	65	131
Peters Creek[2]	46,700	7,005 (15%)	57	57	113
Total	**469,050**	**107,898**	**1,451**	**1,451**	**2,975**

See Appendix L for a copy of the Geomorphology Report and for a description of several highly critical streambank erosion sites recommended for immediate stabilization. See Appendix C for a copy of the 2009 Back Erosion Hazard Risk Study.

NON-STRUCTURAL BMPS

The following non-structural BMPs are proposed to support implementation of the structural BMPs. Pollutant load reductions from these practices are difficult, if not impossible to estimate. We believe that it is not prudent and/or feasible to calculate pollutant load reductions from such practices (SWMPC 2008). Instead, pollutant load reductions should be calculated on a case by case basis when project specific details become available. Consult Appendix P for a schedule of implementation.

Wetland protection ordinances:

Very little wetlands remain in the Macatawa Watershed compared to presettlement times. Wetlands are primarily threatened by development so one way to ensure long term wetland protection is by enacting wetland ordinances. These ordinances should be implemented by local units of government to protect and preserve wetlands by changing the way development is permitted in these areas and by disallowing certain destructive activities. These rules keep wetlands from being destroyed and help developers to work around wetlands so they can continue to filter and improve water quality (SEMCOG 2008). Wetland protection ordinances should be enacted throughout the Macatawa Watershed because all remaining wetlands are critical for water quality, due to historic losses. The focus will be to implement wetland protection ordinances in local units of government that contain highly critical urban and/or agricultural areas.

Riparian zoning overlays/conservation easements:

Riparian zones include land that directly borders waterways. Land practices in riparian zones are important because of their proximity to the water and potential to directly impact (or protect) water quality. Conservation easements enhance water quality protection via permanent protection of these sensitive areas, increasing greenbelts along waterways and limiting future development or destruction that can occur in these areas. Riparian zoning overlays enhance protection of waterways and water quality by encouraging greenbelts along stream corridors by implementing building setbacks and open space requirements along the water's edge (SEMCOG 2008). These types of best management practices provide local waterways with protection from nonpoint source pollution by reducing runoff, providing room for flooding, protecting streambanks from erosion, and allowing for adequate tree canopy or other natural plant cover. These practices would be most useful in the riparian zones of the watershed. The focus will be to implement riparian zoning overlays or ordinances, or purchase conservation easements, in areas located in highly critical urban and/or agricultural areas.

Storm water ordinances:

Planning for storm water treatment is usually conducted during the beginning phases of new development projects. However, one of the most important aspects of storm water treatment and ensuring long term effectiveness of BMPs is proper operation and maintenance. Storm water ordinances can be enacted by local units of government to guide proper design and installation of storm water practices and to mandate that these practices are properly maintained. Ordinances focus on the design, construction, maintenance, and inspections of storm water BMPs. The focus will be to implement storm water ordinances in local units of government that contain highly critical urban and/or agricultural areas.

Site Plan review/Development criteria:

Development of natural areas such as forest, wetlands and open lands increase impervious surfaces. Unless mitigating designs and practices are employed, storm water runoff and peak flows are increased. Development plans are typically reviewed and approved at the local unit of government. Site plan review is highly dependent on the strength of the development and zoning ordinances in a particular municipality. One goal of this watershed management plan is to review and make recommendations for improving the strength of the ordinances and development criteria that protect natural lands and limit storm water runoff (discussed above) in the Macatawa Watershed. Improving the site plan review process is a complimentary task.

Effective site plan review should include efforts to minimize soil compaction, minimize total disturbed area, protect natural flow pathways, protect riparian buffers and sensitive areas, reduce impervious surfaces and disconnect storm water by routing it to natural infiltration areas (SEMCOG 2008).

Street Sweeping and Catch Basin Cleaning:

Street sweeping and catch basin cleaning are pollution prevention activities currently being conducted by local units of government that are regulated by NPDES Storm Water Permits. Regular street sweeping along paved roads collects litter, sediment, and pollutants that build up on the road ways and prevents it from running off into nearby waterways. Catch basins are used in storm drains inlets to catch debris, chemicals, trash, sediment, leaves, and other pollutants in order to keep the material out of waterways. The goal of this watershed management plan is to support continued implementation of these important pollution prevention activities while evaluating and improving the timing, frequency and location of such practices. The focus will be to implement improved street sweeping and catch basin activities in local units of government that contain highly and moderately critical urban areas.

Illicit Discharge Elimination Program:

Eliminating illicit discharges to storm drains is a pollution prevention activity that is currently being conducted by local units of government that are regulated by NPDES Storm Water Permits. Storm drains and storm drain outfalls are periodically monitored for indicators of pollutants including wastewater, septic system drainage, illegal dumping, sump pumps and/or grey water discharge. Conducting a regular screening process for illicit discharges leads to prompt remediation which can reduce input of nonpoint source pollutants into the Macatawa Watershed. The goal of this watershed management plan is to support continued implementation of local Illicit Discharge Elimination Programs (IDEP) while evaluating and improving the timing, frequency and location of such practices. The focus will be to implement improved IDEP activities in local units of government that contain highly critical urban and agricultural areas.

Lawn Care Seal of Approval Companies:

Urban and suburban areas in the Macatawa Watershed are usually characterized by high amounts of impervious surfaces and turf grass. Turf grass (lawns) is a high maintenance land cover that requires regular cutting, fertilizing and irrigation. All of these practices have the potential for negative water quality impacts via improper disposal of grass cuttings, over-fertilization and over watering. There are several ways to reduce impacts from the vast amount of turf grass in the Macatawa Watershed. A long term goal should be improving soil health in turf grass settings to improve infiltration, water holding capacity and plant health in order to reduce fertilizer, pesticide and irrigation inputs. Conversion of turf grass to native vegetation is a structural practice discussed above, and educating homeowners on proper lawn care is a goal of the Information and Education Strategy (Appendix B). Another goal of this watershed management plan is to encourage landowners to employ lawn care and landscaping businesses that use watershed-friendly practices. The MACC operates a Lawn Care Seal of Approval Program which certifies such companies and works to continually educate these companies on water quality concerns. Most importantly, these companies have agreed to abide by the applicable county Phosphorus Fertilizer Ordinances, conduct soil tests, keep grass clippings out of the waterways, mow grass no shorter than 3 inches to encourage good root development and refrain from fertilizing a three foot buffer along waterways. The focus will be to promote and increase use of Lawn Care Seal of Approval Companies in highly and moderately critical urban areas.

MAEAP Verification:

The Macatawa Watershed is predominantly agricultural with many large row crop and livestock operations. The State of Michigan operates a program that helps farmers reduce environmental risks on their farms. It’s called Michigan’s Agriculture Environmental Assurance Program (MAEAP) and it’s a voluntary program meant to promote conservation and reduce agricultural pollution. Interested farmers go through an extensive farm review with technical assistance from local conservation district staff. The review process results in a list of actions that the farmer needs to implement in order to become MAEAP-verified. Producers are provided with a plan that will maintain a productive farming system while reducing pollution. Depending on each specific case, there is potential for significant reductions in sediment and nutrient runoff resulting from MAEAP-verification (Department of Agricultural & Rural Development). The focus will be to promote and increase participation in MAEAP in all agricultural areas.

Manure Management

Research has shown that the Macatawa Watershed is a storm event and snow melt-driven system (Fongers 2009 Hydrology Report, Appendix I), which indicates that most nonpoint source pollutants are carried to waterways via overland flow from rain events and during snowmelt. Since the Macatawa Watershed has abundant livestock operations there is a constant need to dispose of animal manure by spreading it on cropland. The constant spreading of manure presents a significant risk of nutrient runoff to, and possibly bacterial contamination of, local surface waters. At a minimum, we recommend that farmers follow conventional standards outlined in GAAMPs (Generally Accepted Agricultural Management Practices, MDARD 2012) and CAFO (Confined Animal Feeding Operations) permits. There are several other ways to reduce pollution risks from manure application including developing nutrient or manure management plans and refraining from spreading manure in the winter altogether. We believe these actions are crucial to properly managing the effects of manure application in the Macatawa Watershed. The focus will be to increase development of nutrient/manure management plans and limit winter application in all agricultural areas.

Drain Maintenance Procedures

We estimate that approximately 50% of waterways in the Macatawa Watershed are designated as county drains. County drains are actively managed and maintained by County Drain Commissioners to facilitate drainage and reduce flooding. Typical maintenance activities include periodically removing riparian vegetation and accumulated sediment. Sediment removal is accomplished with heavy machinery that scoops out these deep, steep channels, often leaving bare stream bottoms and bare streambanks behind. Removal of in-stream and riparian vegetation has the potential to increase erosion and downstream sedimentation while elevating water temperatures. The goal of this plan will be to work cooperatively with County Drain Commissioners to revise maintenance procedures in a way that will be less harmful to downstream surface water quality. The focus will be to implement revised maintenance procedures first in highly critical agricultural and urban areas.

4.5 PROTECTION ACTIONS

The ultimate goal of the watershed management plan is restoration of water quality (described above). A secondary goal is protection of current natural land in the watershed including forest and wetlands. This section describes the actions that will be taken to meet Protection Objectives 2A through 2D. Refer to Appendix P for a description of interim milestones and estimated costs.

Objective 2A: Provide Conservation Priority Map to appropriate stakeholders to target Tier 1 areas for protection opportunities.

The MACC commissioned the development of a Conservation Priority Analysis (see Section 4.2) in 2009 (Fraser 2010, Appendix N) which identifies and prioritizes land for protection. There is approximately 1,200 acres of natural land that is a high priority (Tier 1) for protection. The MACC will identify appropriate stakeholders and convene an informational meeting to distribute copies of the Conservation Priority Map.

Potential partners include the local units of government, churches, schools, commercial and industrial businesses, the Land Conservancy of West Michigan, Outdoor Discovery Center Macatawa Greenway and DeGraaf Nature Center.

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Increased awareness of the Conservation Priority Analysis and high quality natural land.
- No net loss of wetlands and forested land areas.
- Increase in permanently protected natural land.

Objective 2B: Work with local units of government to integrate recommendations from the Conservation Priority Map into master plans.

Local units of government have a large influence on land cover and land use through the implementation of zoning ordinances and master plans. Under Objective 2A all local units of government will receive a copy of the Conservation Priority Analysis. The focus of Objective 2B will be to inventory current protection efforts through the watershed and improve protection efforts in areas where Tier 1 and Tier 2 land has been identified by the Conservation Priority Map. This will require the help of local experts who can provide technical assistance to local units of government to revise planning standards and criteria.

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Increased number of local units of government with formal protection efforts in effect.

Objective 2C: Work with private landowners to implement conservation easements to protect high quality natural areas.

Many of the high quality natural areas in the Macatawa Watershed are privately owned. Landowners should be made aware of the presence and value of natural land and the protection methods that can be utilized to permanently preserve these areas. This will require widespread distribution of informational material relating to the value of natural land and how to implement conservation easements. The MACC will partner will appropriate local stakeholders to hold informational meetings for targeted landowners and provide technical assistance to interested individuals. Technical assistance will likely take the form of targeted mailings with specially developed informational pieces, followed by phone calls and then personal, confidential visits.

Potential partners include the Land Conservancy of West Michigan, conservation districts, local units of government and the Outdoor Discovery Center Macatawa Greenway.

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Increase in the number of conservation easements achieved within the watershed

Conservation easements will be used to permanently protect high quality natural areas (as identified by Fraser 2010 in Appendix N) in highly and moderately critical urban and agricultural areas (see Section 4.2).

Objective 2D: Identify unique and valuable protection sites that are not reflected in the Tier 1 locations identified in the Conservation Priority Map.

The Conservation Priority Analysis was completed by a private consultant using the mapping capabilities of a Geographic Information System (Fraser 2010). Only land characteristics that could be readily mapped where considered in this analysis. Larger expanses of natural land inherently earned more points and are more likely to be captured in Tier 1 and Tier 2 protection areas than smaller areas. We recognize that some high quality, unique natural areas may not be identified on the Conservation Priority Map but may still be important to protect. It is important to identify these areas and implement protection efforts when the opportunity arises. The MACC will work to identify other unique and valuable protection sites that may occur throughout the Macatawa Watershed.

Potential partners include knowledgeable community members, local units of government, Hope College, Outdoor Discovery Center Macatawa Greenway, DeGraaf Nature Center and the Land Conservancy of West Michigan.

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Number of specific new sites identified and prioritized for protection
- Creation of an updated Conservation Priority Map

4.6 ENHANCEMENT ACTIONS

The third goal of the watershed management plan is enhancing the watershed for recreation, open space, public access and fish and wildlife habitat. This section describes the actions that will be taken to meet Enhancement Objectives 3A through 3E. Refer to Appendix P for a description of interim milestones and estimated costs.

Objective 3A: Develop a committee of appropriate stakeholders to address enhancement concerns.

The main goal of this watershed management plan is to restore water quality to meet state water quality standards. However, there are many other watershed issues of community concern that do not directly relate to water quality. These include recreational activities, public access, open space and fish and wildlife habitat and are commonly referred to as Desired Uses. The Macatawa Watershed Project is partially supported by funds from local units of government and we feel that is important to address these concerns, in addition to traditional water quality issues.

Accomplishing this objective will require input from a broad range of partners and development of an action plan. Potential partners include the Outdoor Discovery Center Macatawa Greenway, DeGraaf Nature Center, Macatawa Watershed Association, Ottawa and Allegan County Parks, local units of government, marinas, and local fishing/canoeing outfitters.

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Development of an action plan
- Development of an Enhancement Committee

The Enhancement Committee will develop a way to track implementation of the following objectives and create a list of Indicators of Success (to be added to Appendix U) to track success of Enhancement Actions over time.

Objective 3B: Enhance opportunities for recreational uses of Lake Macatawa and its tributaries.

Local residents and visitors to the Macatawa Watershed undoubtedly connect with water quality the most through recreational activities including swimming, boating, fishing, hiking, bird watching, kayaking and canoeing. Although many of these recreational activities do not require that local water quality standards are met (which is the primary goal of this plan), we feel it is important to enhance recreational experiences to increase community stewardship for, and interaction with, Lake Macatawa. The more recreation is emphasized, promoted, and expanded, the more people will enjoy the watershed.


Photo contributed by Greg Holcombe

Accomplishing this objective will require input directly from community members and visitors. We propose conducting a survey of these target audiences to help craft the action plan (as described above).

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Increased recreational use of Lake Macatawa
- Increase in positive perception of Lake Macatawa

Objective 3C: Increase public access to Lake Macatawa and its tributaries.

To engage in a variety of recreational activities (described above) the public needs to be able to access Lake Macatawa and its tributaries. Access points typically include public boat launches, swimming beaches, fishing docks and trails and walkways. An important aspect of enhancing recreational activities (Objective 3B) is to increase the number and quality of public access points.

Accomplishing this objective will require a thorough inventory of current public access locations and the amenities that are provided. We can then work with local stakeholders to identify and prioritize areas that need to be addressed. Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Increased number of public access points
- Increased number of amenities available at public access points
- Increased usage frequency of public access locations

Objective 3D: Enhance, protect and/or restore important areas of fish and wildlife habitat.

Water quality and natural lands are not only important to the residents of the Macatawa Watershed, they are critically important to maintaining diverse and high quality fish and wildlife species. The ecology of the Macatawa Watershed has been severely compromised by decades of development and destruction of natural lands. We recognize that it is important to protect the high quality habitat we currently have and work towards restoring high quality habitat that we have lost. Protection efforts (Goal 2, Objectives 2A-2D), habitat improvement projects and controlling the growth and expansion of invasive species will contribute greatly to the enhancement of fish and wildlife habitat.

Accomplishing this objective will require the expert help of naturalists and biologists to assess current conditions, identify important restoration areas and craft an invasive species action strategy (Higman and Campbell 2009) which may include policy and regulations, information and education, research and monitoring and early detection and rapid response (Office of the Great Lakes 2002).

Potential partners include MDEQ, MDNR, Outdoor Discovery Center Macatawa Greenway, Ottawa and Allegan County Parks, Degraaf Nature Center, Macatawa Watershed Association, Ducks Unlimited, Holland Fish and Game Club and Land Conservancy of West Michigan.

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Identified areas of high quality habitat
- Acres of restored or enhanced habitat
- Acres of controlled invasive species
- Improved diversity and quality of fish and wildlife communities

Objective 3E: Preserve and protect remaining open space within the watershed (including prime farmland).

As the Macatawa Watershed continues to become increasingly developed, it is important to protect and preserve remaining open space to combat the effects of an increasing amount of impervious surface. Wetlands and forested land are considered open space and have been addressed under Protection Goal 2 (Objectives 2A-2D). Much of the remaining open land in the Macatawa Watershed is in agricultural use. While agricultural land use does pose a risk to downstream water quality (via erosion and overland runoff) this open space provides significantly more infiltration than impervious surfaces. In addition, agricultural land use is a main economic driver in the area and the land base supports a variety of other industries. Accomplishing this task may include many of the protection measures described previously (wetland, riparian ordinances, conservation easements etc) in addition to implementation of farmland protection programs.

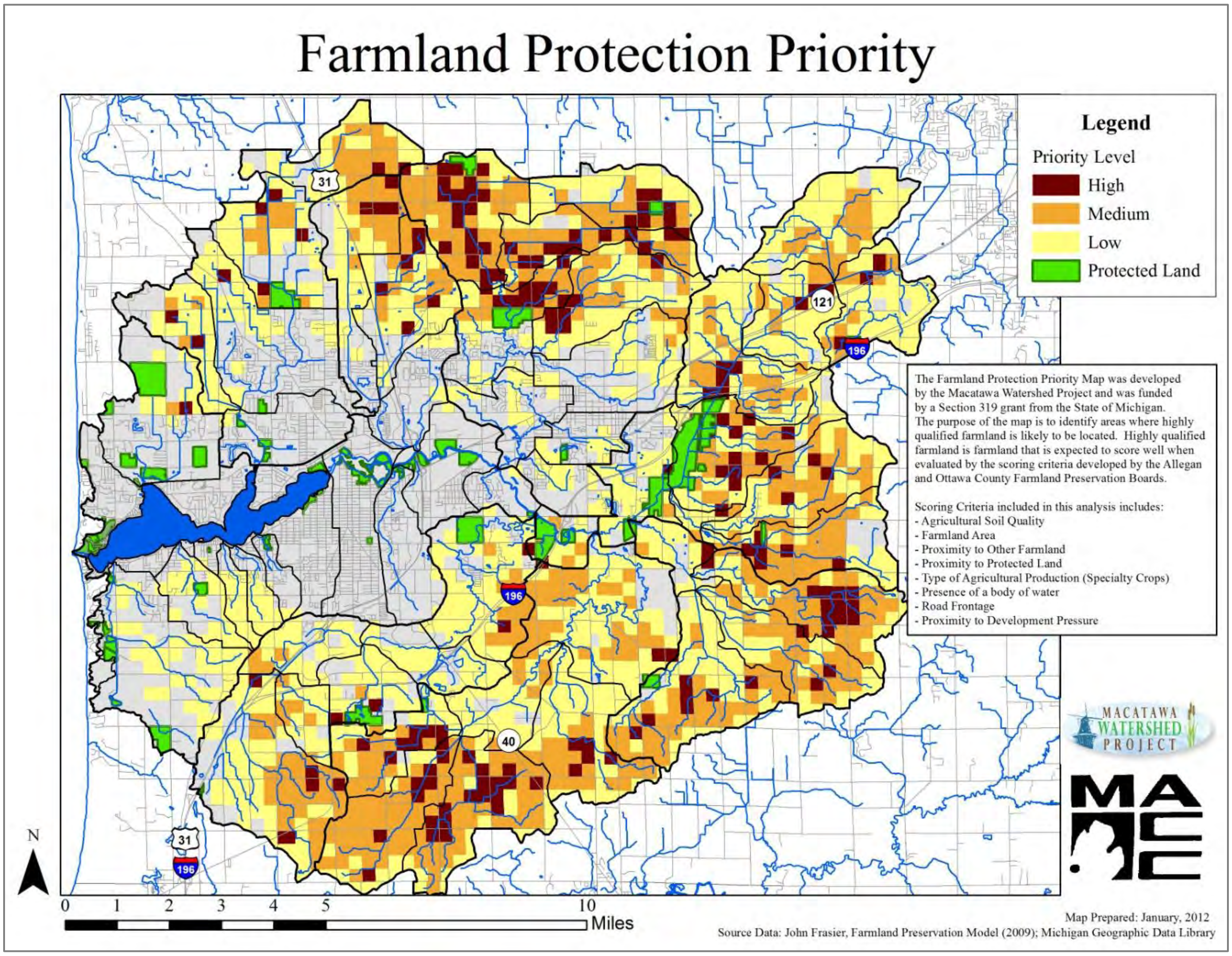


Figure 46. Farmland protection priority map (Fraser 2010a).

In 2009, the MACC commissioned the development of a Farmland Protection Study (Fraser 2010a, Appendix S). The resulting map (Figure 46) depicts farmland that would likely score well when evaluated by Ottawa and Allegan County Farmland Preservation Programs. These programs work to provide funding to purchase the development rights of high quality farmland to ensure the land remains undeveloped and available for farming in perpetuity.

The MACC will identify appropriate stakeholders and convene an informational meeting to distribute copies of the Farmland Protection Priority Map. The MACC will also work to generate awareness and participation in the Healthy Waters Rural Pride Initiative (HWRP), a developing program that provides funding for purchasing developing rights in return for *permanent* buffer strips and conservation plans on participating farms. More information about HWRP can be found at http://www.wix.com/hwrpinitiative/hwrp.

Potential partners include the county farmland preservation boards, the Natural Resources Conservation Service, local conservation districts, Michigan State University Extension, Michigan Farm Bureau, Hamilton Farm Bureau, other Farm Services Agencies and local units of government.

Progress towards meeting this objective will be measured by timely completion of the interim milestones (Appendix P) and the following indicators:

- Increase participation in the county farmland preservation programs
- Increase participation with Healthy Waters Rural Pride
- Number of permanently preserved acres

4.7 INFORMATION AND EDUCATION STRATEGY

A strong Information and Education Strategy (I & E) will be paramount to accomplishing all of the watershed management plan goals and objectives. Since the MWP was created in the late 1990s, outreach and public education has been an important focus. The MWP already employs a variety of I & E techniques to create awareness of local water quality issues and encourage stewardship. These techniques include:

- Maintaining a recognizable brand via the creation of a Macatawa Watershed Project Logo
- Administering the Lawn Care Seal of Approval Program
- Distributing informational material including:
  - Three Children's Books (A Day at the Farm, The Lake I Didn't Remember and Springwater Rain)
  - General Watershed Brochure
  - Lawn Care Brochure
  - Award – winning *Into the Watershed* DVD
  - Homeowner's Handbook
  - Project Specific Fact Sheets
  - *An Environmental History of the Macatawa Watershed* Book
  - Quarterly newsletters
  - Watershed Maps
- Attending and supporting watershed-related events:
  - River Cleanups
  - Kayak Tours
  - Watershed Festival
- Bestowing the Annual Watershed Stakeholder of the Year Award
- Conducting community presentation accompanied by two tabletop displays and Enviroscapes
- Managing a storm drain stenciling program for the community
- Maintaining a Facebook Page and website

An updated I & E Strategy has been created that specifically supports the goals and objectives of this plan, including the recommended management measures. The plan includes milestones, a timeline for implementation and estimated implementation costs. For a copy of I & E Strategy refer to Appendix B.

4.8 COORDINATION WITH MS4 PERMITTEES

Six of the local units of government in the Macatawa Watershed are regulated by NPDES Phase II MS4 Storm Water Permits. They are the City of Holland, City of Zeeland, Ottawa County Drain Office, Allegan County Drain Office, Ottawa County Road Commission and Allegan County Road Commission. Currently, these local units of government are operating under the General Storm Water Permit No. MIG619000 (Appendix T) until 2017 (at which time they will be required to apply for a new permit).

The 2003 Storm Water Permit requires permittees to address both the quality and quantity of storm water discharged to the Macatawa Watershed. Required activities are categorized under the Six Minimum Measures:

1. Public Education and Outreach
2. Public Participation and Involvement
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post Construction Runoff Control
6. Pollution Prevention and Good Housekeeping

In addition, the permit requires permittees to participate in the development and implementation of a watershed management plan and to develop a SWPPI (Storm Water Pollution Prevention Initiative) based on the watershed management plan.

As described in Section 1.3 all of the storm water permittees were intricately involved in the development of this watershed management plan. It is assumed that storm water permittees will take active roles in implementing this watershed management plan and fulfilling the requirements of the storm water permit. Specific commitments will be itemized and described by each permittee during the development of their SWPPI (which will be updated when this plan becomes approved). Some specific commitments have already been described in the Information and Education Strategy (Appendix B, Table 11).

4.9 SECTION 4.0 REFERENCES

Agricultural Drainage Management Coalition. 2006. Benefits and Costs of a Subsurface Agricultural Drainage Water Management System to Improve Water Quality and Increase Crop Production in a Public-Private Partnership.

Allegan Conservation District, 2011. Agricultural priority area inventory and best management practices recommendations for selected areas in the Macatawa Watershed.

Chen, L. and W. Dick. 2011. Gypsum as an Agricultural Amendment: General Use Guidelines. The Ohio State University Bulletin 945.

Dierks, S. 2010. Two-stage ditches and water quality solutions for agricultural NPS. Pipeline 19 (1): 32-35.

Evans, R.O., R.W. Skaggs and J.W. Gilliam. 1995. Controlled versus conventional drainage effects on water quality. Journal of Irrigation and Drainage Engineering121 (4): 127-133.

Favaretto, N., L. D. Norton, B. C. Joern, and S. M. Brouder. 2006. Gypsum amendment and exchangeable calcium and magnesium affecting phosphorus and nitrogen in runoff. Soil Science Society of America Journal 70:1788–1796.

Fertilizer Institute. Subsurface tile drainage management. Accessed in 2012 at http://www.nutrientstewardship.com/implement-4rs/article/subsurface-tile-drainage-management#print

Fisher, M. 2011. Amending soils with gypsum. Crop and Soils Magazine, American Society of Agronomy. Pg 4-9.

Fraser, J. 2010. Land protection priorities in the Macatawa Watershed. Part 1: Natural Land. Prepared for the Macatawa Area Coordinating Council.

Fraser, J. 2010a. Land protection priorities in the Macatawa Watershed. Part 2: Farmland. Prepared for the Macatawa Area Coordinating Council.

FTCH (Fishbeck, Thompson, Carr and Huber). 2011. Geomorphic Assessment using the watershed assessment of river stability and sediment supply (WARSSS). Macatawa Watershed, Ottawa and Allegan Counties, Michigan.

FTCH (Fishbeck, Thompson, Carr and Huber). 2011a. Macatawa Watershed Critical Area Analysis for Restoration. Prepared for the Macatawa Area Coordinating Council.

Higman, P. and S. Campbell, Michigan Natural Feature Inventory. 2009. Meeting the challenge of invasive plants: A framework for action. Prepared for the Michigan Department of Natural Resources.

Lalonde, V., C.A. Madramootoo, L. Trenholm and R.S. Broughton. 1996. Effects of controlled drainage on nitrate concentrations in subsurface drain discharge. Agricultural Water Management 29 (2:187-199.

MDARD (Michigan Department of Agricultural and Rural Development). 2012. Generally Accepted Agricultural and Management Practices for Manure Management and Utilization. http://www.michigan.gov/gaamps

Norton, L.D. 2006. Reducing runoff volume and concentrations of phosphorus and atrazine with gypsum amendment. National Soil Erosion Research Laboratory. Findings presented at 9th Biennial Conference on Storm Water Research and Watershed Management.

Office of the Great Lakes. 2002. Michigan's Aquatic Nuisance Species State Management Plan. Michigan Department of Environmental Quality. http://michigan.gov/documents/deq/deq-ogl-ANSPlan2002_249062_7.pdf

SEMCOG (Southeast Michigan Council of Governments). 2008. Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers.

Stout, W.L., A.N. Sharpley, W.J. Gburek and H.B. pionke. 1999. Reducing phosphorus export from croplands with FBC fly ash and FGD gypsum. Fuel (78): 175-178.

SWMPC (Southwestern Michigan Planning Commission). 2008. Paw Paw River Watershed Management Plan.

5.0 EVALUATION METHODS

IN THIS SECTION YOU WILL UNDERSTAND:

- HOW THE IMPLEMENTATION EFFORTS WILL BE MONITORED
- HOW EFFECTIVENESS OF THESE EFFORTS WILL BE ASSESSED

5.1 EVALUATION

A critical aspect of watershed management planning process is tracking progress over time and measuring water quality improvement. Many resources will be dedicated to implementing the actions described in this plan. It is important to institute an effective plan to measure the success of these efforts over time. Results of the evaluation process will play a key role in adaptive watershed management and will help the MACC and its partners identify strategies that are working and those that are not. This information will be used to periodically update the watershed management plan as needed.

The MACC will employ a variety of evaluation techniques to monitor the progress towards implementing this management plan including water quality monitoring, tracking social indicators and annual reporting.

5.2 MONITORING

Another method that the MACC will use to evaluate watershed management plan effectiveness is by directly monitoring water quality. Monitoring will be accomplished via State of Michigan programs, volunteer efforts, and partnerships with local universities and regional organizations as described below.

State of Michigan Programs

According to the State of Michigan "environmental monitoring is an essential component of the MDEQ mission" (MDEQ 2010 Integrated Report) and that "water quality monitoring of Lake Macatawa and its tributaries is planned, as resources allow, through 2020 to document the effectiveness of phosphorus reduction efforts (Walterhouse 2011). We expect that Lake Macatawa will continue to be regularly assessed by MDEQ via at least two monitoring programs:

- Water chemistry sampling, approximately every other year, at five locations on Lake Macatawa and six locations throughout the watershed (Figure 27).

- Biological and water chemistry monitoring based on a 5-year rotating cycle (Lake Macatawa was assessed in 2005 and 2010 and we expect that monitoring will continue in 2015 and 2020). Typically monitoring occurs at 10-12 sites throughout the watershed (Table 12).

Volunteer Monitoring

Currently, the MACC organizes a volunteer monitoring program for the weekly collection of Secchi Disk depths and water temperatures at four sites throughout the watershed (Section 3.4, Figure 29). This data is crucial for assessing the impact of thermal pollution and sedimentation on Lake Macatawa.

The MACC will initiate a new volunteer monitoring program in 2012 under Michigan's MiCorps Program. Seven sites will be monitored twice a year (Figure 47) for stream habitat and aquatic macroinvertebrates. This type of sampling should provide direct measurements of the diversity and abundance of aquatic wildlife which is directly related to *Designated Uses* and required water quality standards (Section 3.3). The monitoring will be conducted in accordance with a Quality Assurance Project Plan approved by the Great Lakes Commission via the MiCorps Program. This information is important to measure long term trends in water quality, habitat characteristics, species diversity, abundance and sensitivity. The data will be evaluated according to a scoring system and each site will be scored based on the number and diversity of taxa found at the site and will be rated as poor, good, fair or excellent.

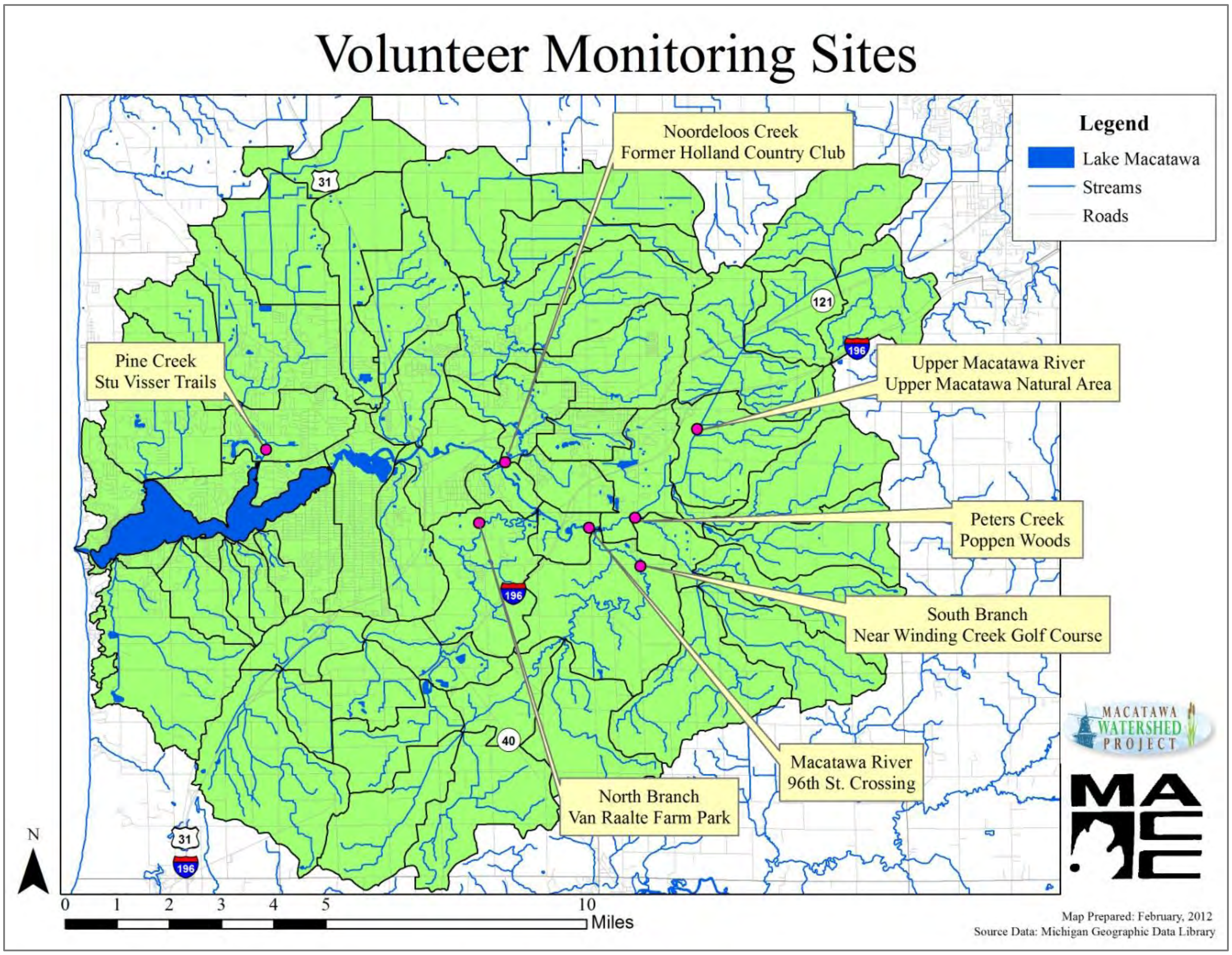


Figure 47. Proposed volunteer monitoring sites in the Macatawa Watershed.

Partnership Programs

As described in Section 3.4, the MACC partners with several outside agencies to facilitate monitoring of harmful algal blooms (Figure 30, Table 13), suspended sediment (Figure 31-33) and levels of *E.coli* bacteria (Figure 34 – 36). The MACC will make every effort to continue facilitating these sampling programs. Sampling will be conducted in accordance with applicable Quality Assurance Projects Plans as approved by the Michigan Department of Environmental Quality.

The quantitative data collected from these monitoring efforts will result in a wealth of information that will help us measure level of progress towards meeting Goal 1 of this watershed management plan. The following data will be used to determine compliance with water quality standards:

- Average water temperature (F)
- Highest water temperature (F)
- Total phosphorus (mg/L)
- Average spring phosphorus levels (mg/L)
- Suspended Sediment Mass and Loading Estimates (mg/L)
- *E.coli* Bacteria (cfu/100 ml)
- Habitat rating
- Fish community rating
- Aquatic Macroinvertebrate rating
- Average Secchi Disk Depth
- Microcystin Concentration
- Highest Peak Stream Flow (ft^3/sec)
- Average Peak Stream Flow (ft^3/sec)

This monitoring data will used to measure compliance with water quality standards to evaluate achievement of *Designated Uses* (Appendix E). The MACC will use the following guidance to determine appropriate water quality monitoring targets:

<u>Nutrients</u>

The Macatawa Watershed is regulated by a Phosphorus Total Maximum Daily Load (TMDL). The TMDL Document (Appendix A) specifies that the goal for phosphorus concentrations is 0.05 mg/l (as measured from grab samples in Lake Macatawa). The State of Michigan provides an additional narrative standard (Appendix E). This information will be used to determine the target goals for nutrients in the Macatawa Watershed, with a special focus on phosphorus since the Macatawa Watershed is under a Phosphorus TMDL.

Sediment

State of Michigan water quality standards provide a narrative standard for sediment (Appendix E) with some additional water quality benchmarks. Excessive sediment is also one of the pollutants that negatively impact fish and wildlife habitat. The MACC will use the narrative standard to qualitatively assess sedimentation impacts in the Macatawa Watershed. This assessment will be supported by water quality data collected via the Suspended Sediment Sampling program (mg/L), Secchi Disk volunteer monitoring (water clarity in ft) and fish, habitat and insect ratings. Initial baseline estimates are not yet available for suspended sediment, therefore the MACC aims to show a decreasing sediment load on an annual basis. The goal for Secchi Disk readings will be to increase water clarity (water depth readings) by 25%. The goal for fish, habitat and insect ratings will be to increase quality scores of each sampling site to “acceptable”.

Hydrology

The State of Michigan provides only a very vague narrative standard to assess hydrology (Appendix E). The MACC proposes to access hydrology impacts by monitoring highest peak flow and average annual peak stream flow using data from the USGS gauge stations (Figure 37). In addition, extreme hydrology has significant potential to negatively impact fish and wildlife habitat. The goal for fish, habitat and insect ratings will be to increase quality scores of each sampling site to “acceptable”.

Temperature

State of Michigan water quality standards provide specific parameters for temperature requirements (Appendix E). The goal will be to use monitoring data (from State of Michigan and volunteer monitoring) to determine that lake and river temperatures do not exceed these standards. In addition, temperature stress is a factor that has the potential to negatively impact fish and wildlife habitat by decreasing levels of dissolved oxygen. The goal will be to use State of Michigan monitoring data for dissolved oxygen to show that levels in Lake Macatawa do not decrease below 5 mg/L. In addition, the goal for fish, habitat and insect ratings will be to increase quality scores of each sampling site to “acceptable”.

E.coli bacteria

State of Michigan water quality standards provide specific parameters for acceptable levels of *E.coli* Bacteria (Appendix E). The MACC will obtain sampling data collected by the Ottawa County health Department and Hope College to monitor *E.coli* levels. The goal is show a decreasing annual trend in *E.coli* levels and to stay below water quality standards to protect partial and total body contact designated uses.

5.3 SURVEYS

The implementation strategy described in this watershed management plan depends largely on actions taken by private landowners, local units of government and businesses to install best management practices and associated management measures. The MACC will take an active role in advocating these practices, increasing awareness, pursuing funding and providing technical assistance however, many of the practices will be privately implemented. To adequately track these actions and changes in community knowledge, awareness, values and behaviors, the MACC will rely on qualitative means of assessment, namely surveys.

The MACC has a long history of conducting surveys of local residents, farmers and local units of government. By continuing to conduct surveys of these target groups we hope to document increased levels of knowledge and awareness of water quality issues, and increase adoption of recommended best management practices. See the Information and Education Strategy in Appendix B for a more complete description of survey goals and objectives. Large formal surveys will be conducted in accordance with a MDEQ-approved Quality Assurance Plan.

5.4 REPORTING

The MACC will produce an annual report which will document watershed activities accomplished during the previous year. The report will specifically reference management measures and the implementation schedule as described in Appendix P and those described in the Information and Education Strategy (Appendix B per Section IX). The purpose of the report will be to track implementation efforts, water quality monitoring activities and survey results including:

- Number of tasks accomplished
- Number of presentations made
- Number of documents distributed
- Number of committee meetings held
- Number of newsletters distributed
- Number of workshops, tours, events
- Number of participants at workshops, events
- Number of newspaper articles
- Number of best management practices implemented
- Number of ordinances enacted
- Acres of land restored, protected or enhanced

Most importantly, the annual report will compare accomplishments to the management indicators as described in Appendix U. Protection and enhancement indicators are described in Section 4.5 and 4.6. The annual report will be made available on the MACC's website at www.the-macc.org.

5.5 SECTION 5.0 REFERENCES

Creal, W., Hanshue, S., Kosek, S., Oemke, M. and M. Walterhouse. 1996. Update of GLEAS Procedure 51 Metric Scoring and Interpretation. Michigan Department of Environmental Quality. MI/DEQ/SWQ-96/068.

MDEQ (Michigan Department of Environmental Quality). 2010. Water quality and pollution control in Michigan 2010 Sections 303(d), 305(b), and 314. Integrated Report. Report No. MI/DEQ/WB-10/001.

Walterhouse, M. 2011. Monthly water quality assessment of Lake Macatawa and its tributaries, 2010. MDEQ Report No. MI/DEQ/WRD-11/018.

6.0 SUMMARY AND CONCLUSION

THIS SECTION WILL PROVIDE:

- A SYNOPSIS OF WATER QUALITY POLLUTANTS, SOURCES AND CAUSES
- A SUMMARY OF CRITICAL IMPLEMENTATION AREAS AND PRACTICES
- A PRIORITIZED LIST OF IMPLEMENTATION EFFORTS
- ITEMS THAT NEED FURTHER STUDY
- FUTURE STEPS AND WATERSHED PLANNING

6.1 WHAT ARE THE MAIN CONCERNS?

The Environmental Protection Agency, the Michigan Department of Environmental Quality and local researchers all agree that Lake Macatawa suffers from too much **nutrients**, too much **sediment, flooding, thermal pollution** and too much ***E.coli*** bacteria. These conditions result in extreme erosion, brown muddy water, odors, algae blooms, fish kills, beach closures and road failures.

Tier 1	Tier 2	Tier 3
• Nutrients • Sediment • Temperature • Hydrology	• *E.Coli* bacteria	• Chemical Contaminants • Invasive Species • Chloride • Man-made debris • Mercury/PCBs

These pollutants travel to local waterways via storm water runoff which comes primarily from nonpoint sources like roads, parking lots, rooftops, driveways, lawns and agricultural fields. This is a major concern because Lake Macatawa and all its tributaries are not meeting the state's basic water quality criteria and we have been instructed that we need to reduce phosphorus inputs by 70% to start improving water quality.

The goal of this watershed management plan is to restore water quality (*Designated Uses*), protect remaining natural land and enhance the watershed (*Desired Uses*).

6.2 WHERE ARE THE CRITICAL AREAS?

The Macatawa Watershed is a mix of urban, suburban and agricultural land uses that pose unique threats to water quality. Storm water runoff, combined with certain land characteristics makes certain parts of the watershed more likely to contribute pollutants. These areas have been identified as critical areas(Figures 48 and 49). Approximately 28% of the watershed is designated as critical agricultural area while 17% is designated as critical urban area.

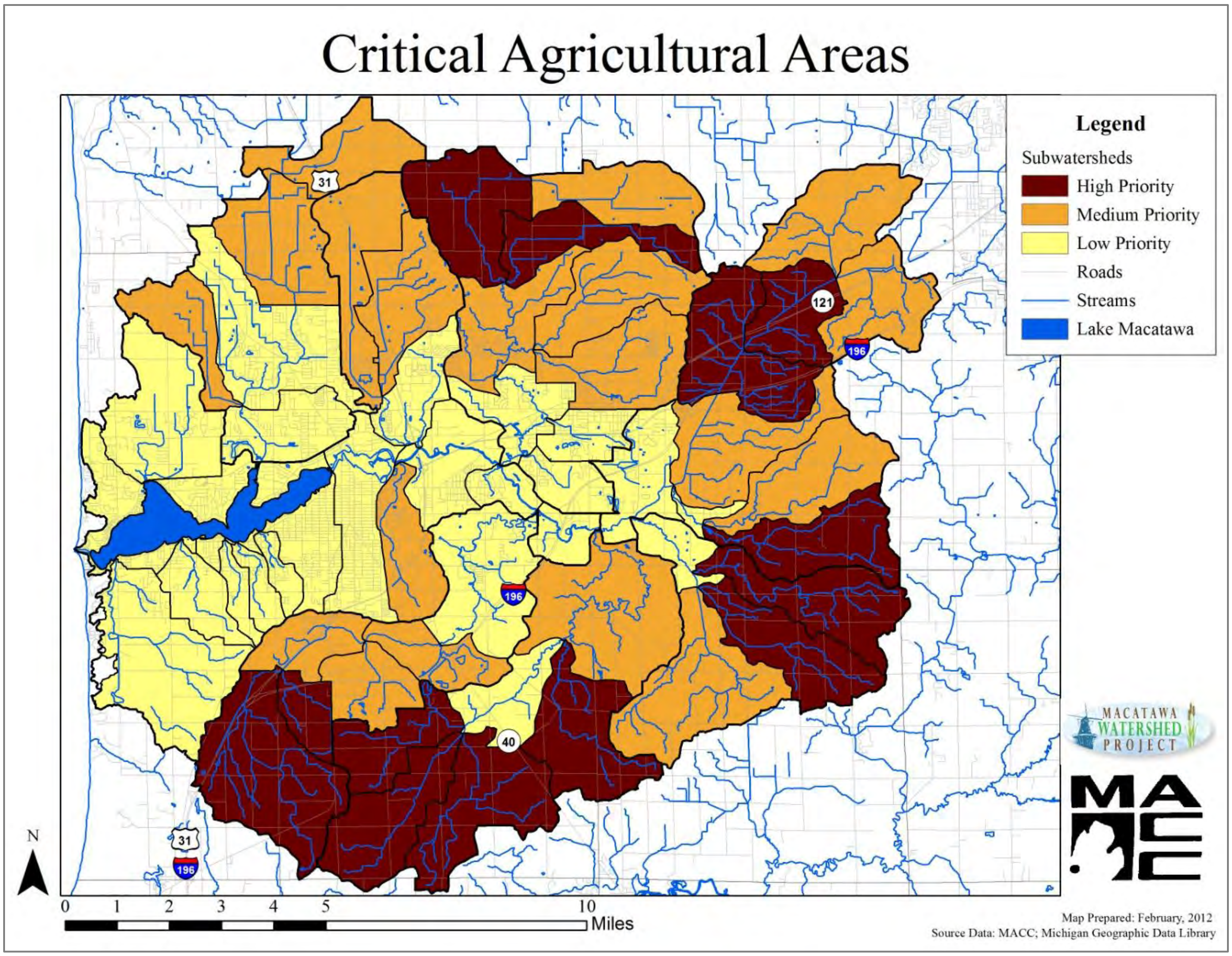


Figure 48. Critical agricultural areas of the watershed.

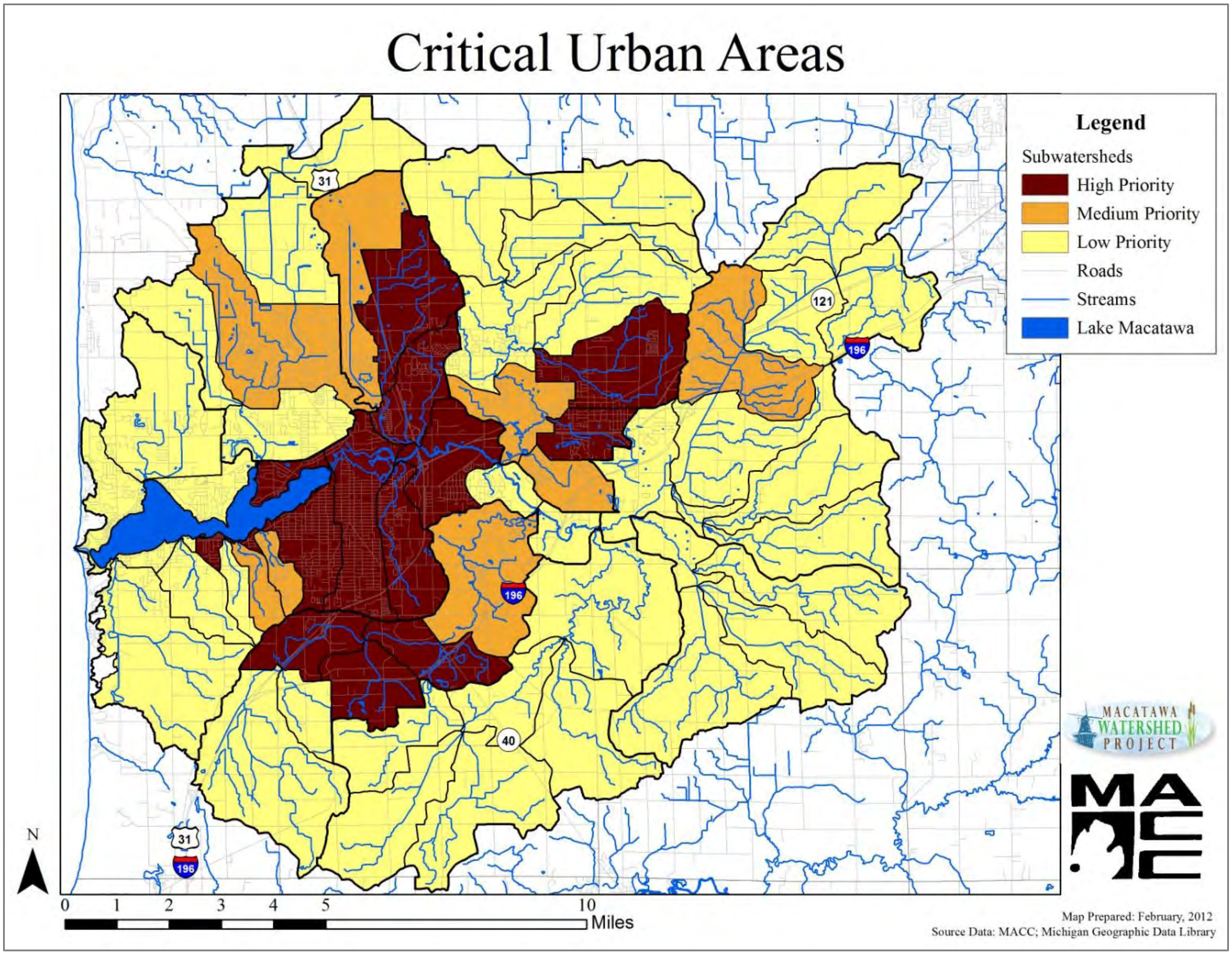


Figure 49. Critical urban areas in the watershed.

6.3 WHAT ACTIONS SHOULD BE IMPLEMENTED?

In general terms, this document presents a three-pronged action plan including an Information and Education Strategy, and recommendations for structural best management practices and managerial (non-structural) best management practices (Figure 46). The main focus of this action plan is to **restore water quality** by targeting high and moderate priority pollutant sources and associated causes.

Information and Education

- Farmers
- Residents
- Local Government
- Institutions
- Environmental Advocacy Groups
- Schools

Structural BMPs

- Wetland Restoration
- Agricultural BMPs
  - Cover Crops
  - Reduced Tillage
  - Gyspum Amendments
  - Two Stage Ditch
  - Buffer Strips
  - Grassed Waterways
  - Drainage Water Management
- Urban BMPs
  - Native Vegetation
  - Rain Gardens
  - Porous Pavement
  - Buffer Strips
  - Tree Planting
  - Rain barrels
- Streambank Stabilization
- Road Stream Crossings

Managerial BMPs

- Wetland Protection
- Riparian Overlays/Zoning
- Conservation Easements
- Storm Water Ordinance
- Improved Site Plan Review
- MAEAP verification
- Nutrient/Manure Management Plans
- Lawn Care Seal of Approval Program
- Street Sweeping/Catch Basin Cleaning
- Illicit Discharge Elimination Program
- Revised Drain Maintenance Procedures

Figure 50. Summary of recommended implementation actions included in this plan.

All of the recommended action items outlined in the plan are listed above, however an important element of this plan is prioritizing these items to create the most effective strategy for water quality restoration. Therefore, using best professional judgment and input from members of the various watershed committees, the various action items were prioritized into the following lists.

Note that the following prioritization only addresses the primary focus of this plan which is the water quality restoration actions. The secondary goals of the plan, protection and enhancement actions, have not been included.

High Priority Restoration Actions

Information and Education Strategy

- *General Awareness Messages to*:
  - Farmers, Riparian Residents, School and Local Government
- *Taking Action Messages to:*
  - Row Crop and Riparian Farmers
  - Pork/Dairy Producers
  - Elected Officials/Managers
  - Department Engineers
  - Planning/Zoning Commision
  - Drains/Road Commissions
  - Riparian Landowners
  - Suburban Residents

Urban BMPs

- Low Impact Development (LID Practices) and/or Green Infrastructure Practices
  - Examples include Rain Barrels, Rain Gardens, Bioretention, Infiltration practices etc
- Streambank Stabilization

Agricultural BMPs

- Wetland Restoration
- Buffer Strips
- Cover Crops
- Conservation Tillage

Managerial BMPs

- Wetland Protection
- Storm Water Ordinance
- MAEAP Verification
- Improved Site Plan Review
- Conservation Easements

Moderate Priority Restoration Actions

Information and Education Strategy

- *General Awareness Messages To*:
  - Institutional and Environmental Advocacy Groups
- *Taking Actions Messages To:*
  - Poultry Farmers
  - Vegetable Farmers
  - Parks Departments
  - Urban Residents
  - Rural Residents

Urban BMPs

- Porous Pavement
- Urban Tree Canopy
- Buffer Strips (and/or natural shorelines)
- Conservation Easements

Agricultural BMPs

- Drainage Water Management
- Two Stage Ditch
- Grade Stabilization Structures
- Critical Area Plantings
- Conservation Easements

Managerial BMPs

- Riparian Zoning/Overlays
- Improved Drain Maintenance Procedures
- Nutrient/Manure Management Plans
- Street Sweeping/Catch Basin Cleaning

Low Priority Restoration Actions

Information and Education Strategy

- *Taking Action Messages to*:
  - Blueberry Farmers
  - Environmental Advocacy Groups
  - Institutions

Urban BMPs

- Road Crossings
- Native Vegetation

Agricultural BMPs

- Gypsum Amendments
- Grassed Waterway

Managerial BMPs

- Lawn Care Seal of Approval Program
- Illicit Discharge Elimination Program

Implementation of the Information and Education Strategy (Appendix B) is of the utmost importance because it fundamentally supports all other water quality restoration recommendations of this plan. It is estimated that implementation of the above actions will result in a reductions of approximately 87,857, lbs of phosphorus, 215,971 lbs of nitrogen and 55,492 tons of sediment annually.

6.4 WHAT NEEDS FURTHER STUDY?

The water quality of Lake Macatawa and the Macatawa Watershed is complex. This plan was possible due to the wealth of information available about the most pressing pollutants of concern. However, some water quality issues are in need of further study including the sources and causes of *E.coli* bacteria (and applicable remediation activities) and the possible impacts of Tier 3 pollutants.

6.5 HOW WILL PROGRESS BE MEASURED?

Progress will be *measured* periodically via water quality monitoring and community surveys. Progress will be *reported* to community stakeholders annually in the form of an annual report. The annual report will summarize monitoring activities and results, implementation status of all management plan tasks and objectives and results of social surveys. Surveys will ultimately be the most effective tool for measuring changes in awareness, values and behavior.

6.6 WHAT WILL HAPPEN IN THE FUTURE?

This plan presents an ambitious work plan and is intended to guide watershed management activities over the next ten years (until 2022). However, the water quality problems in the Macatawa Watershed are very serious and successful restoration of water quality will depend on many actions taken by many community members over the next several decades. The annual reports and associated water quality monitoring will provide a periodic assessment tool to determine the effectiveness of watershed activities. The watershed management plan is meant to be an adaptive tool and may be updated with new information periodically.

The MACC intends to start implementation of the watershed management plan immediately and will continue to involve as many local stakeholders as possible to achieve our vision for Lake Macatawa. It is our understanding from the Michigan Department of Environmental Quality that the Phosphorus TMDL goals will not be revised and that an *E.coli* TMDL will be developed in approximately 2017.


MACATAWA
WATERSHED
PROJECT
The Macatawa Watershed
Healthy, clean and safe
Reflecting a vibrant and sustainable community