The Little Manistee River

Watershed Management Plan

2020 – 2030

Plan Completed May 28, 2020

Acknowledgements

The Little Manistee Watershed Conservation Council gratefully acknowledges the contributions of the following organizations and individuals towards the development of the Little Manistee River Watershed Management Plan.

The Little Manistee Watershed Management Plan Steering Committee

"The undersigned believe that the health of the Little Manistee River Watershed is critical to the well-being and economic health of the area and that a plan should be created to ensure the wise use and management of the watershed – now and for future generations."

Eden Township
Elk Township
Ellsworth Township
Peacock Township
Newkirk Township
Norman Township
Meade Township
Village of Luther
Cadillac Area Land Conservancy
City of Manistee
Big Bass Lake and Little Bass Lake Association
Lake County River Property Owners Association
Manistee County Conservation District
Osceola/Lake Conservation District
Lake County Commissioners
Mason County Commissioners
Little River Band of Ottawa Indians
Michigan DEQ
Cool Lake Property Owners Association
Arcadia-Pierpoint Watershed
Bear Creek Watershed Council
Little Manistee Watershed Conservation Council
Great Start Collaborative
Launch Manistee
Drift Expeditions
Seng's Marina
Spicer Group
Manistee Watershed Partners
125 Individual Signatures

Major Financial Contributors:

Numerous Private Individuals
Little Manistee Watershed Cons. Council, Irons, MI
Jorgensen Family Foundation, Fort Wayne, IN
Little River Band of Ottawa Indians, Manistee, MI
Lake County Community Foundation, Baldwin, MI

2020

Supporting Advisory Organizations:

Little Manistee Watershed Conservation Council:
Armas Soorus, David Spruance, Jim Squier, Joyce Durdel, Tim Phillips, Steve Bishop, Greg Block, Gordon Lewis, Evelyn Furman, Dan Sernick, Dale Downes

Alliance for Economic Success:
Tim Ervin, Betsy Evans, Susan Hornkohl

Conservation Resource Alliance

Cool Lake Property Owners Association:
Len Trasciotti, Jackie and Dave McKellar

Grand Traverse Regional Land Conservancy:
Chris Sullivan

Lake County Economic Devevelopment:
Barbara Stenger

Lake County Economic Development Committee:
John Trimberger

Lake County Community Foundation

Little River Band of Ottawa Indians:
Shaughn Barnett

Manistee Conservation District:
Kayla Knoll, Susan Spencer, Josh Shields

Manistee WS Partners:
Mary Reed, Sharon Goble

Manistee County Community Foundation:
Laura Heintzelman

Manistee County Planning Department:
Rob Carson

Mason-Lake Conservation District:
Dani McGarry

Michigan DEQ:
Greg Goudy

Michigan DNR:
Mark Tonello

MSUE Educator Water Quality:
Christina Curell

MSUE (R) Educator:
Kurt Schindler, AICP

Natural Resources Conservation Service

North Country Cooperative Invasive Species Management Area:
Vicki Sawicki

Osceola-Lake Conservation District:
Dixie Ward

Big Sable River-Hamlin Lake Watershed:
Wayne Andersen

Trout Unlimited:
Jeremy Geist

United States Forest Service:
Chris Riley

United States Geological Survey:
Kevin Kincare

Prepared by:

Networks Northwest
Talent / Business / Community

Utilizing Consultants: **Ed Hoogterp & Scott Gest**

PO Box 506
Traverse City, MI 49685-0506
www.networksnorthwest.org

Administered by:

AES
Alliance for Economic Success

2141 Plett Rd C108
Cadillac, MI 49601
allianceforeconomicsuccess.com

2020

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Executive Summary

The 2020 Watershed Management Plan for the Little Manistee River Watershed is the result of a multi-year effort, conceived in 2014 and led by a Steering Committee formed under the auspices of the Little Manistee Watershed Conservation Council (LMWCC). The Plan is financed through local contributions, and supported by a broad range of partners who are listed along with Steering Committee members in the introductory material to this document.

The plan came about in response to a recognition that the high-quality waters of the Little Manistee River were vulnerable to degradation through changes in land use and/or inattention to such issues as streambank erosion and aging road stream crossings.

In its early meetings, the Steering Committee set a primary goal of creating a Watershed Management Plan that would protect the resource and earn approval under both state and national guidelines.

The Plan is intended to protect surface water quality by preventing or reducing non-point source pollution during the 10-year period from 2020 through 2030. It is a living document which may be amended – or extended into additional years – through action by the LMWCC and Steering Committee.

The Alliance for Economic Success, of Manistee, acted as fiscal agent for the project; Networks Northwest, of Traverse City, retained consultants for research and drafting of the Plan. Armas Soorus and Joyce Durdel, both of LMWCC, led the plan development team. Consultants contracted by Networks Northwest were Ed Hoogterp and Scott Gest.

The Steering Committee oversaw the planning process, meeting monthly for more than a year to provide input and to review and comment on early drafts. The Committee solicited public input throughout the process. All meetings were open to the public, a social indicators survey was publicized in local media. A near-final draft was presented to the public at two well-attended public meetings in 2019. The Plan document was formally submitted in 2020 to the Michigan Department of Environmental Quality (MDEQ) and the United States Environmental Protection Agency (USEPA).

Note: The state agency that oversees Michigan's pollution-prevention programs was renamed and given additional responsibilities in 2019, while this WMP was in the process of completion. The agency formerly known as the Department of Environmental Quality (MDEQ) became the Department of Environment, Great Lakes and Energy (EGLE). For purposes of this document, the authors have retained usage of "MDEQ" in references that predate the name change. By either name, the agency retains responsibility for Michigan's clean-water programs, including the non-point source (NPS) pollution program. For practical purposes, readers of this WMP may assume that the terms "MDEQ," "DEQ," and EGLE" are used interchangeably.

The Little Manistee Watershed encompasses approximately 135,000 acres in Manistee, Lake, Mason and Wexford counties in Michigan's Lower Peninsula. It is designated by the United States Geological Survey's 10-digit Hydrologic Unit Code (HUC), 0406010306.

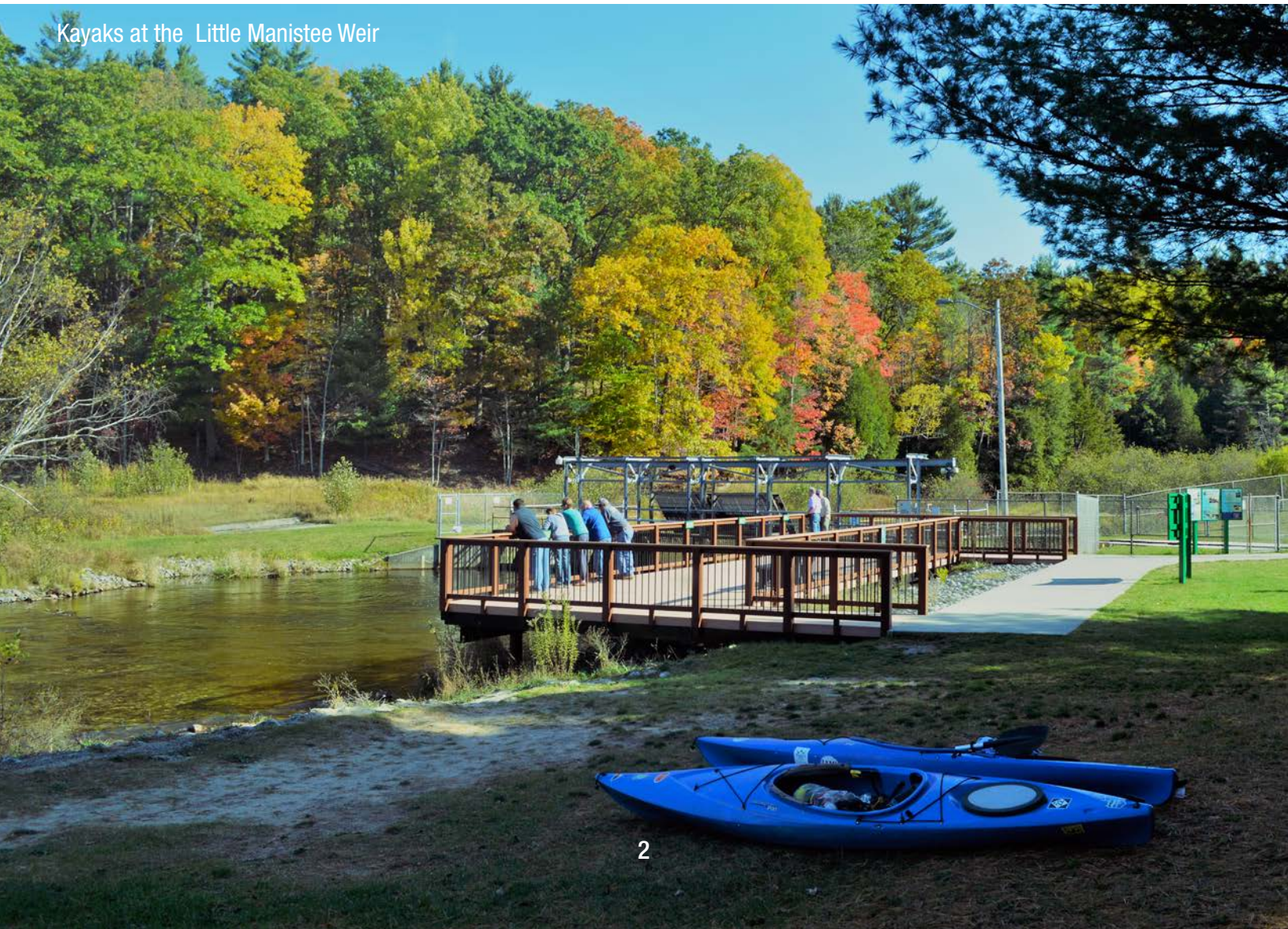
The Little Manistee River is recognized as an extremely high quality coldwater trout stream. Genetic material harvested annually from the river's population of wild steelhead trout supports a hatchery system that supplies waterways in Michigan and adjacent states.

In addition to the river and its tributaries, the Little Manistee Watershed includes 28 named lakes. Land cover data from 2016 shows that nearly 90 percent of the Watershed is in forest or other natural land covers.

Just over 50 percent of the Little Manistee Watershed is in public ownership through the United States Forest Service (USFS) or the Michigan Department of Natural Resources (MDNR). The river is not presently designated as a federal Wild and Scenic River or a Michigan Natural River, though it meets eligibility requirements for both. It is classified as a "Study River" under the national Wild and Scenic River System.

The Watershed is sparsely populated, with an estimated 3,100 residents distributed among one village and portions of 16 townships. Notably, seven of the 16 townships lack any zoning ordinance to regulate development in the watershed or river corridor.

The regional economy is dominated by outdoor recreation, including fishing, paddlesports, motorized and non-motorized trails, and generalized touring. Fewer than half the dwellings in the watershed are used for year-round occupation, with most of the remainder held for seasonal or occasional use, according to the 2010 United States Census.



Kayaks at the Little Manistee Weir

Soils in the watershed are primarily coarse sands and gravels. Those soils allow quick infiltration of rainfall and snowmelt, contributing to rapid recharge of groundwater aquifers. Since the coarse soils have limited filtering capacity, they also pose a concern that materials on the surface – including fertilizers, pesticides and petroleum products – could potentially leach deeply in the earth and contaminate the aquifers.

Groundwater is a key resource in this watershed: It maintains the temperature and flow rates of the prime coldwater streams; and residents rely entirely on groundwater for drinking water supplies.

The LMWCC was formed in 1996 as a public-private partnership to protect the water quality and natural character of the watershed. The organization has raised funds for habitat enhancement projects, and has sponsored volunteer water-quality monitoring since at least 2000.

At the onset of the Watershed planning process, the Steering Committee approved the following set of goals, which are presented in Chapter 5 of the document along with specific objectives related to each goal:

Goal 1: Develop an educational component to inform and engage the public in long-term water-quality protection efforts and the potential impacts of land use and development.

Goal 2: Ensure use of Best Management Practices (BMPs) to preserve and enhance the outstanding cold water resources in the Little Manistee River Watershed.

Goal 3: Preserve and improve water quality and the aquatic environment to score as well or better than all applicable state and federal standards and locally desired conditions, including the protection of public health.

Goal 4: Protect the natural character of the watershed, while maintaining the economic, lifestyle and public health benefits that accompany a high-quality natural environment.

Goal 5: Support efforts of governmental and citizen organizations to implement programs for protection and enjoyment of the watershed's natural features.

Most of the surface waters in this watershed are presently of such high quality that they score better than state and federal clean-water standards. Taken together, the goals are seen as an effort to preserve that status through a long-term program of educating the public, enabling Best Management Practices (BMP's) for land use, monitoring water quality indicators and responding rapidly to any emerging threats.

In an online survey conducted during the WMP process, most respondents gave high ratings to water quality in the Little Manistee watershed. Fishing, enjoying scenic beauty, and canoeing/kayaking were ranked as the most important activities related to the surface water resources. A majority of respondents in the non-scientific survey indicated support for some level of zoning and for designation of the Little Manistee as a Michigan Natural River, which would entail restrictions on development within the stream corridor.

The first two chapters of the document contain information about the planning process and the characteristics of the watershed.

Chapter 3 presents a general pollution inventory, including estimates of pollutants in stormwater runoff and on-site wastewater systems.

Chapter 4 describes the specific stressors of greatest concern in this watershed.

Potential threats include: Sediment; thermal issues; excess nutrients; invasive species; bacterial and parasitic pathogens; and to a lesser extent agricultural chemicals and oil and gas products. These potential pollutants must be monitored and in some cases managed or reduced in order to protect the water.

Local Volunteers and the Michigan Department of Environmental Quality have compiled a long record of monitoring water quality parameters. The Plan would continue those efforts, while adding thermal monitoring on the cold water streams, and instituting a system of groundwater monitoring.

Chapter 5 describes the applicable water quality standards, the status of state-designated surface water uses; and locally desired conditions in the watershed, along with a full listing of the plan's goals and objectives.

The Plan designates five critical sites where water quality is likely to be threatened by non-point source pollution in the near future. The critical areas described in Chapter 6 are: The Luther Dam area; Syers Lake and Creek; Cool Creek/Stronach Creek; road stream crossings; and streambank erosion sites.

These critical areas currently meet standards for the "designated uses" defined by MDEQ/EGLE. However the sites are considered to be at risk of deterioration unless careful management is applied.

Chapter 6 of the Plan also cites several priority locations or issues for protection and increased attention. They are: Stream ecology and habitat; the MDNR Little Manistee River Weir; inland lakes; groundwater; rustic and natural character of the watershed.

Chapter 7 of the document contains a multi-page table listing 12 categories of implementation tasks necessary to reach the goals and objectives of the plan.

The overall cost of implementation over the 10-year period is estimated to be approximately $6.5 million (Table 1). More than half of that total ($3.6 million) would be required to correct erosion and fish-passage issues that result from the aging infrastructure of bridges and culverts that carry roads across the Little Manistee and tributaries.

Other major anticipated costs include $540,000 to address shoreline and streambank issues and $1 million for long-term land protection activities. The listed costs are considered to be broad estimates. Accomplishing the tasks will require some combination of local funding and grant support.

Table 1 - Estimated 10-year WMP Implementation Cost

Category	Estimated Cost
A. Shoreline/Streambank Issues	$540,000
B. Stormwater and runoff	$74,000
C. Planning, Zoning and Land Use	$330,000
D. Road-Stream issues	$3,657,000
E. Land Protection and Management	$1,010,000
F. Habitat for Fish and Wildlife*	$280,000
G. Recreation, Safety, Navigation, Health*	(N/A)
H. Groundwater and Wetlands	$70,000
I. Water Quality Monitoring	$70,000
J. Invasive Species	$65,000
K. Wastewater and Septic Systems	$335,000
L. Information and Education	$81,000
TOTAL 10-year Cost	$6,512,000

*Cat. F cost est. does not include option for dam removal
*Cat. G costs are included in other line items

The WMP creates a long-term monitoring strategy with numerous sites to be sampled for water quality on a regular schedule (Chapter 8). As a respected and established steward of the watershed's natural resources, the LMWCC is given responsibility to coordinate monitoring and information sharing. The Plan recommends that the LMWCC seek grant funding to support a part-or full-time paid staff person to work with the implementation process, with a Conservation District or other project partner acting as employer of record.

The LMWCC Board of Directors is committed to review and update the plan each year at the organization's annual meeting and retreat.

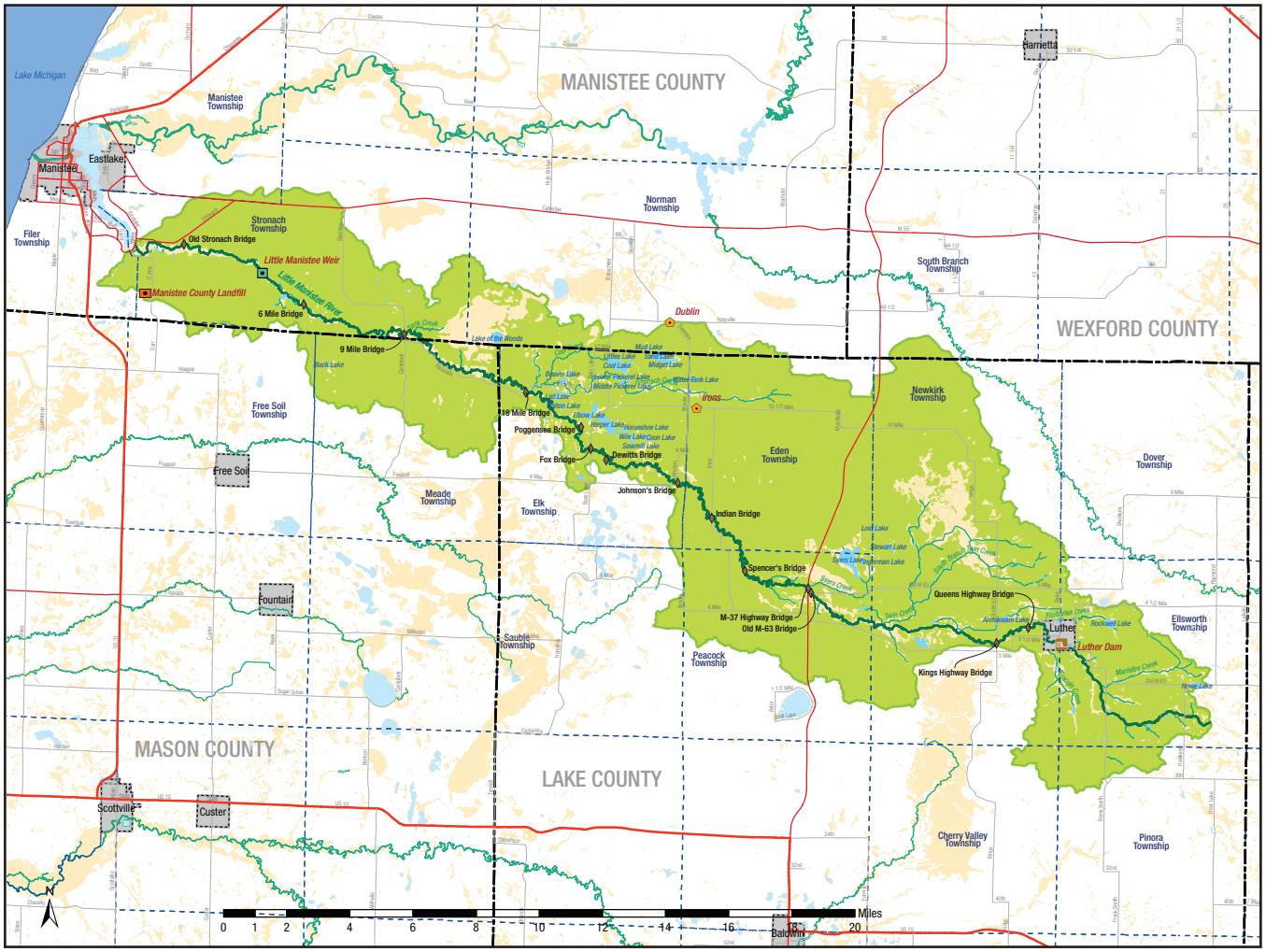
A vital element of the WMP is the continuing information and education component (Chapter 9). This plan focuses on three areas: Land use education to communicate options for protecting water quality and the area's natural character; limiting the introduction and spread of invasive species; and management of on-site wastewater treatment (septic and drain-field) systems.

The Little Manistee River Watershed is somewhat unusual in that its location extends across the service boundaries of counties, planning regions, conservation districts, land conservancies and invasive species networks. Because of that, it is essential that the

LMWCC and partners work diligently to coordinate planning and natural resource protection activities. That coordination has been well established through the public meetings and participation in the WMP process. It will be continued through implementation and monitoring of the plan. The stakeholders who have taken a role in creation of the WMP are committed to work together to preserve the Watershed's outstanding resources.

Stream Sand Loading at Chicago Boy Rollway

Map 1 - Little Manistee Watershed Reference Map



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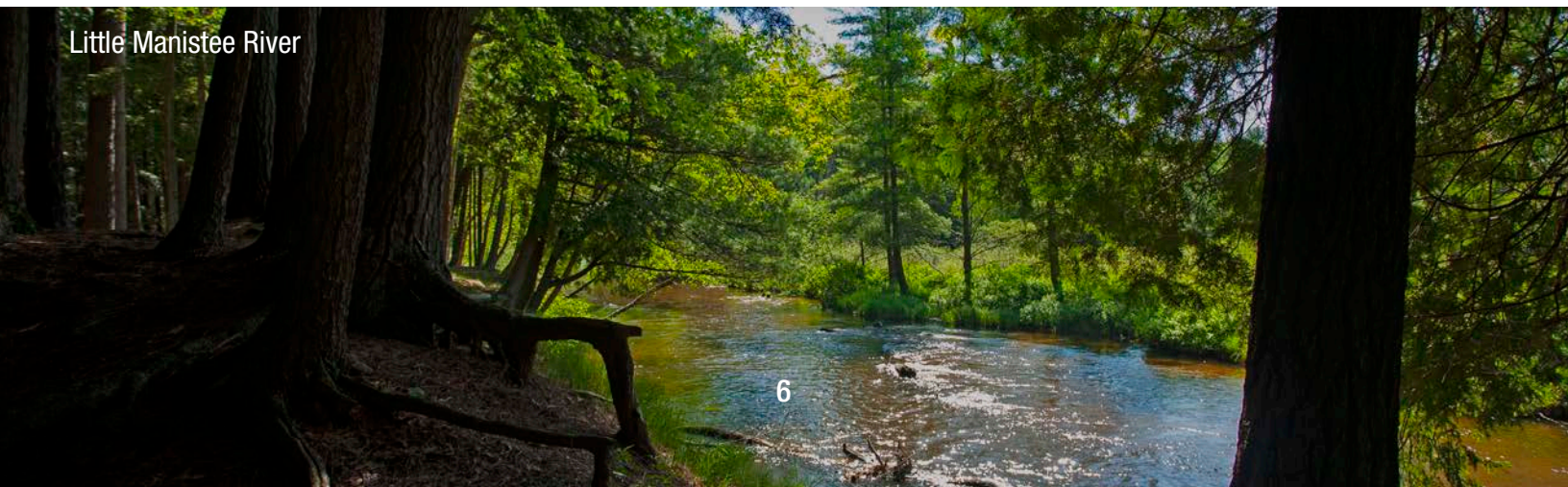
- Little Manistee River Bridges
- Dam
- Fish Weir
- Land Fill Facility
- Unincorporated Place
- Other Principal Arterial
- Minor Arterial
- Major Collector


Little Manistee River

Chapter 1

Background and introductory Information

The Little Manistee River Watershed encompasses about 210 square miles (546 square kilometers), primarily in the North Central Hardwoods ecoregion of Michigan's Lower Peninsula. Water resources include the Little Manistee River and several tributaries, along with numerous small lakes.

The river and all named tributaries are classed as coldwater streams by the Michigan Department of Natural Resources (MDNR). Monitoring, by volunteers and by the Michigan Department of Environmental Quality (MDEQ), indicates surface water quality is good to excellent at most locations. The Little Manistee River Weir, in operation since 1968, is the primary source of Steelhead trout broodstock in Michigan and surrounding states, (Tonello, 2008) and also serves as an egg-taking station for Chinook salmon hatchery operations.

The mainstream of the Little Manistee River stretches for approximately 60 miles, from its headwaters in Ellsworth Township of Lake County to the watershed's exit point at Manistee Lake in Manistee County (see: "Map 1 - Little Manistee Watershed Reference Map" on page 6 and "Map 2 - Little Manistee Watershed Satellite Image" on page 8). A dam at the village of Luther impounds a millpond of about eight acres. From there to the mouth – about 55 miles – the river is free-flowing.

More than 90 percent of the land cover in the watershed is in a natural state, primarily as forest that has regrown since the end of the Michigan logging era more than a century ago. Soils are mostly deep sands, which support forest growth but are less amenable to agriculture. Approximately 5 percent of the land area is in farm or pasture land covers.

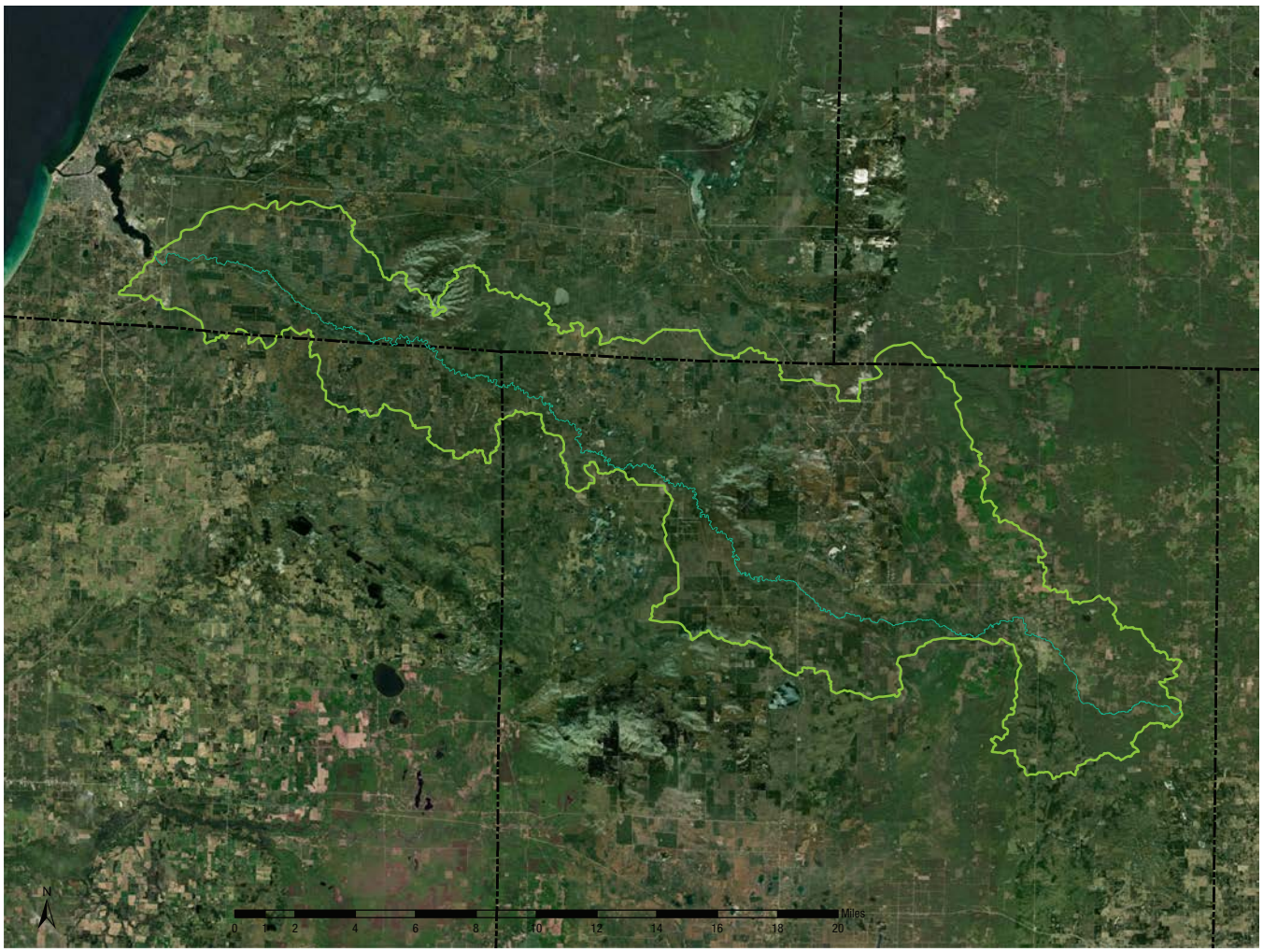
Slightly more than half of the watershed is in public ownership within the Huron-Manistee National Forest or the Michigan state forest system.

Nearly 30 groundwater-fed lakes are scattered across the watershed. Some lakes in the state and national forest ownership are completely undeveloped, while other water bodies – including Harper and Cool lakes – are ringed with seasonal cottages.

Population centers in the watershed include the unincorporated community of Irons and the village of Luther, both in Lake County. The overall area is sparsely populated, with a high percentage of dwellings, including many riparian properties, used on a seasonal basis.

Recreational pursuits include fishing, hunting, hiking, off-road vehicle use, canoeing and kayaking, observing wildlife, and general touring. The Little Manistee River Weir is open to the public and is a popular site for visitors during spring and fall egg-taking operations.

Map 2 - Little Manistee Watershed Satellite Image



Planning in this watershed is challenged by its location on the service-area boundaries of several administrative, governmental and environmental districts. The Watershed extends into Lake, Mason and Manistee counties, along with a small corner of Wexford County. Regional planning agencies, invasive species networks, conservation districts and regional land conservancies follow county lines. While these agencies have been supportive of the WMP, none has a service area which covers the entire watershed. The Conservation Resource Alliance (CRA), a non-profit river care organization based in Traverse City, does have a service area that encompasses all of the Little Manistee and adjacent watersheds.

Potential stressors to water quality include: sediment; thermal pollution; excess nutrients; invasive species; bacterial pathogens such as *Escherichia coli*; and to a lesser extent, runoff from impervious surfaces, agricultural runoff, and oil and gas products. These potential sources of environmental stress must be monitored and in some cases managed or reduced in order to protect the water.

Most of the surface waters in this watershed meet or are better than state and federal clean-water standards. Primary goals of the plan are to preserve – and potentially improve – that situation through land-use education, mitigation of known problems such as erosion sites, and a long-term program of monitoring water quality indicators for rapid response to any emerging threats.

Michigan Ecoregions

Michigan's geography is mapped into distinct "ecoregions," based upon the characteristics of land, vegetation and climate. And, much like watersheds themselves, the ecoregions are subdivided into smaller and more specific geographies, termed as levels. Michigan contains five Level III ecoregions and 31 Level IV ecoregions. Understanding the differences in these regions can assist in understanding the characteristics of the streams that flow through them.

Michigan's Level III ecoregions are described as follows in the MDEQ publication: "Water Quality and Pollution Control in Michigan 2016 Sections 303(d) 305 (b) and 314 Integrated Report:"

"Each of the five ecoregions in Michigan consists of areas that exhibit relatively similar geological landform characteristics. Factors used to delineate ecoregions include climate, soils, vegetation, land slope, and land use. This framework provides information on the environmental characteristics that tend to occur within each ecoregion. In order by size (largest to smallest area), the five ecoregions in Michigan are Northern Lakes and Forests, Southern Michigan/Northern Indiana Drift Plains, Huron-Erie Lake Plains, North Central Hardwood Forests, and Eastern Corn Belt Plains.

Rivers in the Northern Lakes and Forests and North Central Hardwood Forests ecoregions tend to support coldwater fish within at least a portion of their systems. These rivers commonly have relatively small watersheds, high relief topography, substantial groundwater inputs, and are naturally low in productivity. … In the North Central Hardwood Forests ecoregion, river flow is highly variable. Flow is entirely intermittent in some portions of the ecoregion and entirely perennial in other areas. These rivers typically drain soils with much poorer nutrient content than in bordering ecoregions to the south." (Integrated Report, 2016)

At Level III, the Little Manistee River Watershed is in the North Central Hardwood Forests Ecoregion, and the Northern Lakes and Forest Ecoregion. More specifically, it occupies parts of three Level IV regions (see: "Map 3 - Michigan Level IV Ecoregions" on page 10): The Cadillac Hummocky Moraines, and the Newaygo Barrens, which are part of the Northern Lakes and Forests region; and the Manistee-Leelanau Shore which is in the North Central Hardwood Forests region (Omernik, 2007).

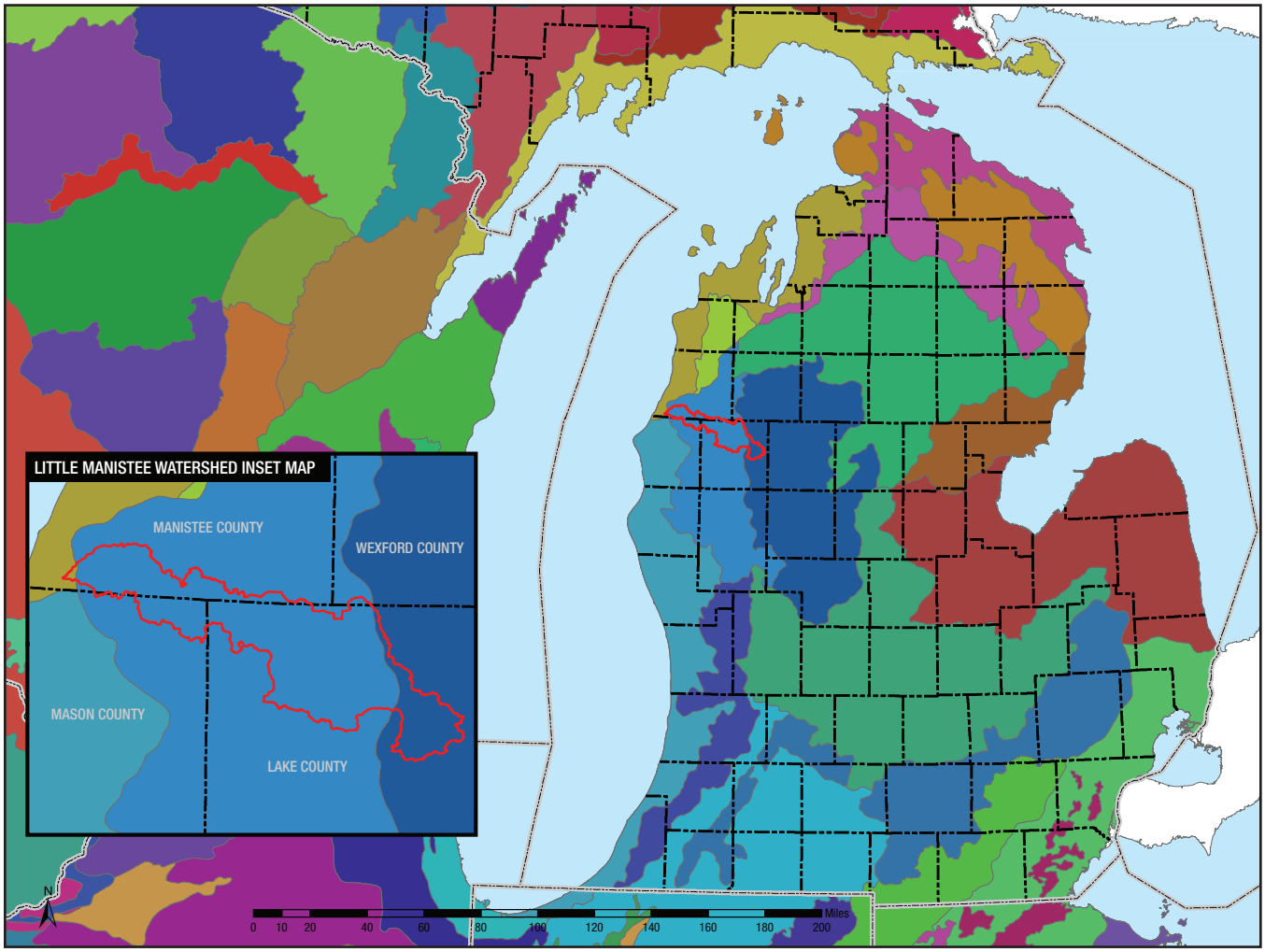
The easternmost segment of the Watershed, including the headwaters of the Little Manistee River, is in the Cadillac Hummocky Moraines region, which extends into a large swath of the Central Lower Peninsula. This area is characterized by deep, sandy soils and a rolling topography. It tends to be colder and somewhat drier than areas to the west. In pre-settlement times, the land cover was forest of American beech, sugar maple and northern red oak, with some eastern white pine.

West of the Cadillac Hummocky Moraines, and covering the majority of the Little Manistee Watershed, is the Newaygo Barrens region. This is a largely flat area with sandy, well-drained soils. The farthest inland areas of this ecoregion have a cold, continental climate, which is somewhat moderated in areas closer to Lake Michigan

Much of the Newaygo Barrens was originally covered with fire-adapted ecosystems including prairie, oak savanna, and stands of jack pine. Soils here are prone to erosion, drought and leaching of nutrients. The land was converted to agriculture after the native timber was cut, but most agricultural lands have reverted to forest or grassland. Considerable acreage in this region is protected by the Huron-Manistee National Forest.

The very western tip of the watershed extends into the Manistee-Leelanau Shore Level IV Ecoregion. Here, within about 15 miles of Lake Michigan, the climate is significantly modified by proximity to the lake, with cooler summers, less-cold winters and more precipitation.

Map 3 - Michigan Level IV Ecoregions



KEY | LEVEL IV ECOREGIONS

- Cadillac Hummocky Moraines
- Door Peninsula
- Lake Michigan Lacustrine Clay Plain
- Lake Michigan Moraines
- Lansing Loamy Plain
- Manistee-Leelanau Shore
- Michigan Lake Plain
- Mio Plateau
- Newaygo Barrens
- Platte River Outwash
- Saginaw Lake Plain
- Tawas Lake Plain
- Vanderbilt Moraines

Dominant tree species here are beech and sugar maple, with northern white cedar growing in forested wetlands in lowland areas of poorly drained soils (BPlant.Org).

Developing the Watershed Plan

The Little Manistee River Watershed Management Plan is a locally based effort led by the Little Manistee Watershed Steering Committee, which includes representatives from a number of active stakeholders. The Little Manistee Watershed Conservation Council (LMWCC) compiled water quality data and raised funds through local sources to develop the plan. The Alliance for Economic Success (AES), in Manistee, served as fiscal agent, while Networks Northwest, in its capacity as the Northwest Michigan regional planning agency, was contracted to help produce the plan.

The process of envisioning and creating the WMP involved more than 20 partners, and extended through more than 5 years, with plan development actually getting underway in 2017. (The list of project partners appears in the document acknowledgements section. A full report of committee meetings and actions is included as Appendix B.)

Recognizing a need to protect the Watershed's outstanding resources, in 2014 the Board of Directors of the Little Manistee Watershed Conservation Council identified the development of a Watershed Management Plan as an urgent priority.

The LMWCC initially reached out to the MDEQ and MDNR; Trout Unlimited; the United States Forest Service (USFS); the Alliance for Economic Success, conservation districts serving Lake, Mason and Manistee counties; and the Little River Band of Ottawa Indians (LRBOI) for assistance in creating and implementing a WMP. (Soorus, 2020)

In June 2015, the first meeting of what would become the Little Manistee River Watershed Steering Committee was held. This Steering Committee formed the central core of the outreach effort and brought in expertise from environmental agencies and interested stakeholders.

Among the founding members of the Steering Committee were representatives of: LMWCC; LRBOI; the Manistee County Planning Department; AES; MDEQ; Manistee County Community Foundation; The U.S. Department of Agriculture Farm Service Agency; and Trout Unlimited. The organizations then reached out to additional partners.

As part of the process, three funds were created within the Manistee County Community Foundation: a "Plan Fund" to develop the WMP; an "Implementation Fund" to implement and maintain the WMP; and an "LMWCC Fund" for money donated to the LMWCC to help ensure its long-term viability.

During these early stages of the planning process, the partners agreed that the end goal was to create a plan that would be eligible for approval under provisions of both the state Clean Michigan Initiative and the United States Environmental Protection Agency (USEPA) "nine-element" program under Section 319 of the Clean Water Act. LMWCC was designated as the organization to lead the effort.

Because the project relied on local funding, without outside grant support, it became apparent in 2017 that the Steering Committee would not have sufficient financial resources to contract with a single consultant for all the activities needed to administer the process and develop the plan.

Working with its partners, the Committee developed an alternative strategy in which volunteers with the LMWCC would share responsibilities with professional consultants retained by Networks Northwest (NNW).

Under this arrangement, the local volunteers retained certain tasks, including water sampling, coordination of public input, and scheduling of meetings. The consultants handled the mapping, data analysis and writing of the plan. In order to make best use of the limited funds, it was understood that the plan would rely largely on existing data provided by state and federal agencies, along with the extensive record of water monitoring by local volunteers.

This process resulted in an extraordinary level of public involvement, as stakeholders attended monthly or semi-monthly Steering Committee meetings in 2017, 2018 and 2019 to provide input and comment on drafts of the chapter narratives, goals and implementation tasks.

Among those who participated in plan development were: Armas Soorus, Joyce Durdel, David Spruance, Jim Squier, and Tim Phillips, all of LMWCC; Chris Riley of United States Forest Service; Mark Tonello of Michigan DNR; Jeremy Geist of Trout Unlimited; Kayla Knoll and Josh Shields of the Manistee Conservation District; Kurt Schindler of Norman Township; Kevin Kincare of the U.S. Geological Survey (USGS); Lou Fitz of Elk Township; Rob Carson, Manistee County Planning Director; Shaughn Barnett of the Little River Band of Ottawa Indians; Barbara Stenger, Lake County Commissioner; Paul Bigford of the Lake County Township Officers Association; Chris Sullivan of Grand Traverse Regional Land Conservancy. Shawn Middleton and Pat Bentley of the engineering firm Spicer Group, in Manistee, also provided valuable input. Tim Ervin of AES and Laura Heintzelman of the Manistee County Community Foundation were instrumental in initiating the project. Staff consultants for the project, working through Networks Northwest, were Scott Gest and Ed Hoogterp.

The Watershed Steering Committee met regularly with staff during the planning period. All Steering Committee meetings were held within the watershed, and were open to the public. In addition, staff provided periodic reports to lake associations and governmental bodies within the watershed.

This document includes the product of input from multiple sources.

The Michigan Department of Environmental Quality oversaw many technical details, with MDEQ water quality analyst Greg Goudy providing invaluable input, review and comments. The Conservation Resource Alliance contributed information from its inventories of road-stream crossings and Little Manistee River streambank conditions. Michigan Department of Natural Resources compiled fishery status reports and other wildlife information, while fishery biologist Mark Tonello attended many meetings and spoke directly to fishermen. The U.S. Forest Service shared

information on its projects and plans. Volunteers contributed water quality data that had been collected over the past two decades. And Watershed Steering Committee members gave of their time and expertise to propose, critique, and revise elements of the final plan.

As part of the public participation strategy, a social indicators survey was offered both on-line and at public meetings. In early 2019, a near-final draft of the document was presented to the public at two advertised meetings in Luther and Manistee. The draft was amended based on input from those well-attended meetings. It was submitted to MDEQ for review and comment in April of 2019. A final revision to reflect that input resulted in the present document.

Social Indicators Survey

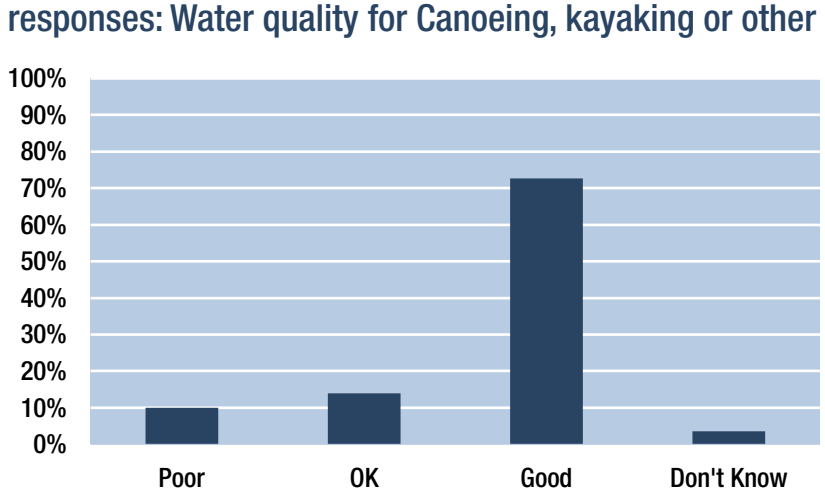
A social Indicators survey was developed and distributed in 2018, both as a paper document and as an online instrument through Survey Monkey. The survey contained questions designed to provide insight into respondents' opinions and knowledge of the watershed.

The survey instrument was advertised widely to the public, with a goal of receiving a minimum of 150 responses. While that threshold was met, with approximately 200 responses, the sample does reflect self-selection bias and is not truly random. Results are considered to be an indication of local opinion and knowledge, but confidence level and margin of error cannot be calculated.

Questions were selected from similar instruments used for watershed planning in this region (e.g. "Table 2 - Water Quality for Boating"); and from suggestions regarding locally desired information points (e.g. "Table 3 - Support for Natural River Designation").

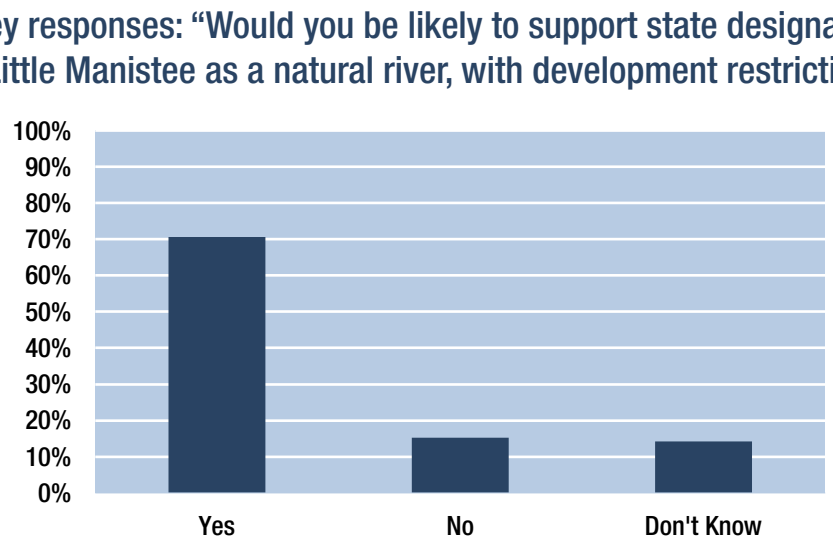
From a list of six water-related activities, respondents ranked "High quality fishing and fish habitat" as most important, followed in order by "Enjoying scenic beauty;" "Canoeing, kayaking and other boating;" "Eating locally caught fish;" "Picnicking and family activities;" and "Swimming." The environmental stressor ranked as most significant in this water-shed was "Sedimentation (dirt and soil) in the water."

Table 2 - Water Quality for Boating



Source: WMP Social Indicators Survey, 2019

Table 3 - Support for Natural River Designation



Source: WMP Social Indicators Survey, 2019

In addition, strong majorities indicated support for regulation of septic systems and for zoning requirements or natural river designation. Preliminary survey results played a role in the determination of WMP goals (Chapter 5).

The final tabulation was used to inform the plan's educational component. Survey results are included in relevant chapters of the WMP and the full survey is included as Appendix A.

Nonpoint Source Pollution

The federal Clean Water Act, adopted by Congress and signed into law in 1975, envisions watershed planning as a vital tool in controlling and reducing "nonpoint source" pollution of surface waters. The MDEQ defines nonpoint source (NPS) pollution as "pollution caused when rain, snowmelt, or wind carry pollutants off the land and into lakes, streams, wetlands, and other water bodies."

Note: The state agency that oversees Michigan's pollution-prevention programs was renamed and given additional responsibilities in 2019, while this WMP was in the review stage of development. The agency formerly known as the Michigan Department of Environmental Quality (MDEQ) is now the Department of Environment, Great Lakes and Energy (EGLE). For purposes of this document, authors have retained usage of "DEQ" or "MDEQ" in references that predate the name change. Under either name, the agency retains responsibility for Michigan's clean-water programs, including the non-point source (NPS) pollution program. For practical purposes, readers of this WMP may consider that the terms "MDEQ," "DEQ," and EGLE" are used interchangeably.

At the time the federal Clean Water Act was adopted, the majority of known pollution came from so-called point sources such as municipal wastewater plants and industrial discharges. Through regulation, compliance and technical advances, point source pollution has been reduced to the extent that today most pollution enters the water from nonpoint sources.

Michigan's Nonpoint Source Program, a section of MDEQ/EGLE, assists local units of government, non-profit entities, and numerous other state, federal, and local partners to reduce nonpoint source pollution statewide.

Hydrologic Unit Codes

Watersheds in the United States are identified through a unique set of numerical "Hydrologic Unit Codes," or HUC's, which are used by the United States Geological Survey to divide the nation's geography into successively smaller hydrological units.

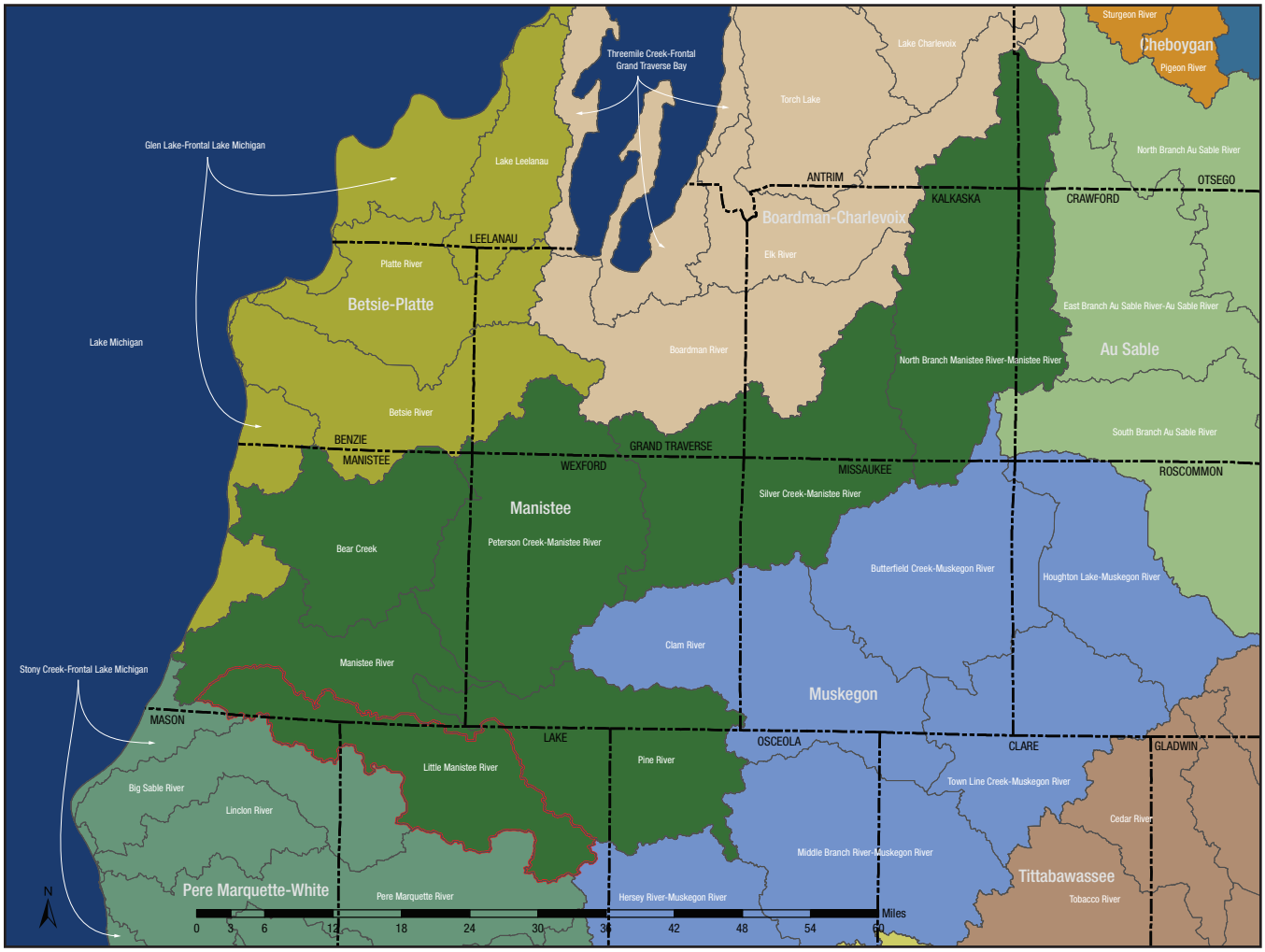
For example, the huge watershed that flows into the Great Lakes is designated by the two-digit code 04. That region is then subdivided into watersheds represented by four-digit codes, such as 0406 (which represents watersheds that flow into northeastern Lake Michigan) and so on up to 12 digit subwatersheds.

Under this system, the Manistee River Watershed in Northwest Lower Michigan is identified by the 8-digit HUC: 04060103. Adjacent geographic areas, identified by their own eight-digit codes, are: the Boardman River Watershed; the Platte-Betsie Watershed; the Au Sable River Watershed; the Muskegon River Watershed; and the Pere Marquette River Watershed (see: "Map 4 - Manistee and Adjacent Watersheds (HUC8)" on page 16).

The Manistee River system is divided into seven subwatersheds, including Bear Creek, the Pine River, the Little Manistee River and four segments of the Big Manistee River. Each of the subwatersheds is identified by a 10-digit HUC, consisting of the 8 digits for the overall Manistee system, plus 2 digits to designate the subwatershed. For the Little Manistee, the 10 digit code is 0406010306.

Winter on the Little Manistee River

Map 4 - Manistee and Adjacent Watersheds (HUC8)



KEY | SUBWATERSHEDS

- Au Sable
- Betsie-Platte
- Black
- Boardman-Charlevoix
- Cheboygan
- Lake Michigan
- Manistee
- Muskegon
- Pere Marquette-White
- Pine
- Tittabawassee
- County Boundary
- HUC 10 Watersheds
- Little Manistee Watershed Boundary

Finally, the Little Manistee is subdivided into six 12-digit units, each with the 10-digit code plus two additional digits, as follows (see: “Map 5 - Little Manistee River Subwatersheds (HUC12)” on page 17)

01—Twin Creek

02—Lincoln Creek – Little Manistee River

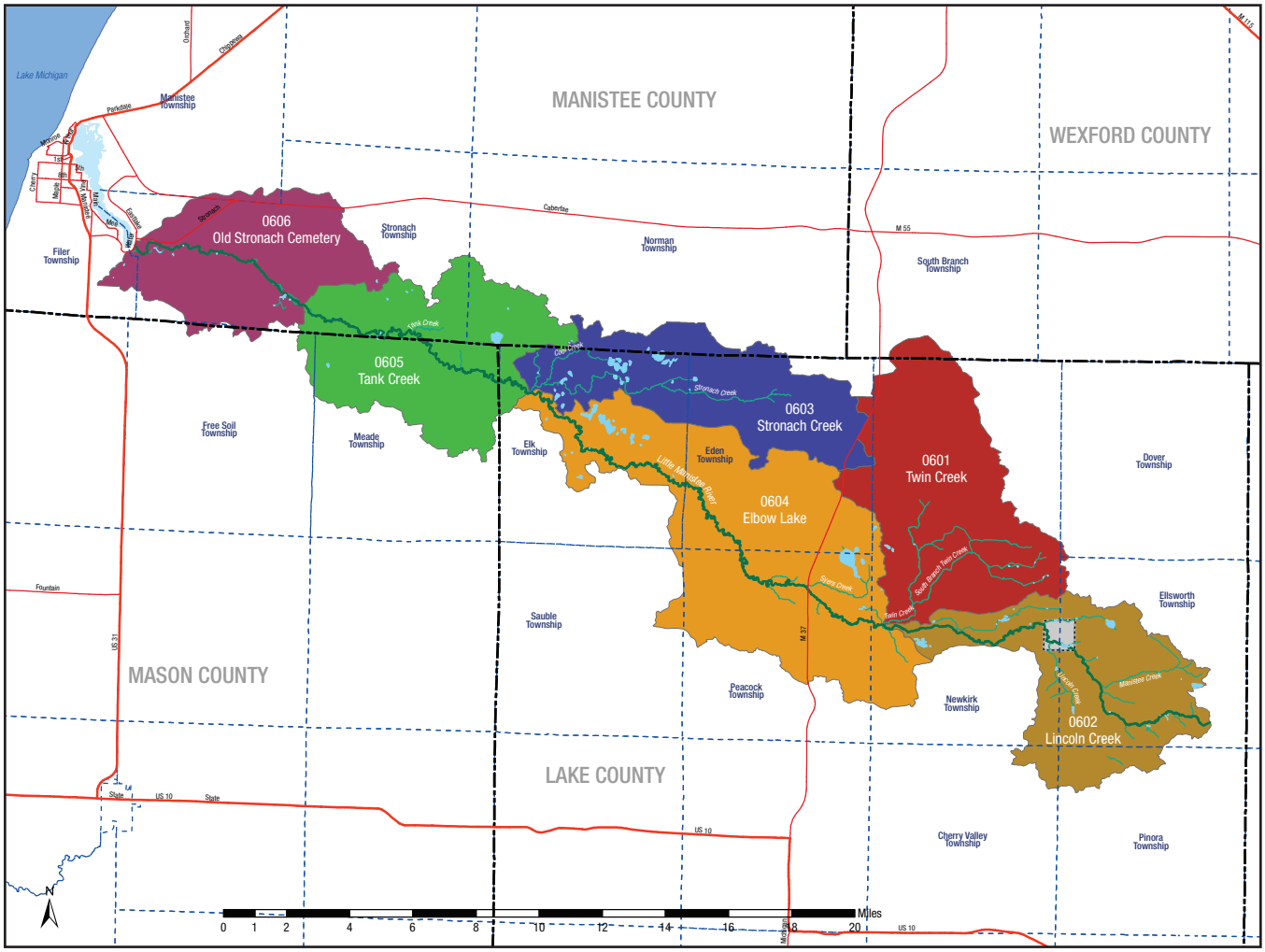
03—Stronach Creek

04—Elbow Lake – Little Manistee River

05—Tank Creek – Little Manistee River

06—Old Stronach Cemetery – Little Manistee River

Map 5 - Little Manistee River Subwatersheds (HUC12)



KEY | SUBWATERSHEDS

- Elbow Lake
- Lincoln Creek
- Old Stronach Cemetery
- Stronach Creek
- Tank Creek
- Twin Creek
- Little Manistee River
- LMW Tributaries
- Incorporated Cities & Villages
- LMW Lakes

This document focuses on the Little Manistee and its six subwatersheds.

Past and Ongoing Water Quality Efforts

Local and regional stakeholders have worked actively to improve aquatic habitat and reduce sediment loadings in the Little Manistee River for more than 40 years.

Those efforts were especially important in mitigating the impact of catastrophic failures of the Luther Millpond Dam, near the river's headwaters, in 1986 and 1993.

The Little Manistee Watershed Conservation Council (LMWCC) was formed in 1996 as a partnership of government and private stakeholder groups to provide the leadership for streambank and habitat improvement in the watershed.

The Council has led the effort to restore in-stream habitat through installation of woody debris. Conservation Resource Alliance (CRA), working through a partnership of river advocates, has completed inventories of road stream crossings and streambank erosion sites. CRA administers a Website, Northernmichiganstreams.org, with the complete inventory of sites on the Little Manistee.

Local road commissions, working with CRA and LMWCC, reduced sedimentation by improving or replacing several road crossings.

Property owners on Syers Lake have partnered with the LMWCC and CRA and others to remove an earthen dam from private property and restore streamflow, connectivity and spawning habitat on Syers Creek.

The Little Manistee's importance as a coldwater fishery and as the parent stream for steelhead throughout the Great Lakes region has been recognized by Trout Unlimited and the Little River Band of Ottawa Indians, both of which have contributed to habitat improvement projects in the Watershed..

LMWCC has performed annual monitoring of water quality parameters (*E. coli*, phosphorus, temperature, dissolved oxygen, etc.) at more than 20 sites in the watershed (see: "Table 4 - Volunteer Water Monitoring Summary" on page 19). Monitoring sites are mapped in Chapter 8. Descriptions and data from past and ongoing projects are included in the relevant sections of the WMP.

The Conservation Resource Alliance worked with The LMWCC and other groups in 2000 to develop the first Watershed Management Plan for the Little Manistee River.

This well-researched document was submitted and approved by MDEQ under the guidelines of the Clean Michigan Initiative. It was not submitted for review by USEPA.

The 2000 WMP focused on concerns with sediment, excess nutrients, thermal issues and *E. coli* in the river and tributaries – issues that continue to threaten the water quality in the watershed. The 2000 WMP is used as one of many resources in creating the present document.

Little Manistee River
Streambank Erosion

Table 4 - Volunteer Water Monitoring Summary

Site	Name	Test Parameter	2013	2014	2015	2016	2017	2018	2019
1	Below Luther Dam	*E. coli* (Col/100ml)	156.5	59.1	119.0	85.7	93.3	201.4	57.3
		Phosphorus (mg/L)	0.200	0.030	0.081	0.050	0.063	0.210	0.050
		Diss. Oxygen (mg/L)	7.8	9.8	8.1	8.3	8.2	8.7	9.4
2	Above Fairbanks Creek	*E. coli* (Col/100ml)	248.1	195.6	144.0	178.5	228.2	133.3	155.3
		Phosphorus (mg/L)	0.028	0.023	0.110	0.063	0.046	0.100	0.040
		Diss. Oxygen (mg/L)	7.8	9.9	8.2	8.2	8.2	8.9	9.2
6	Above Syers Creek	*E. coli* (Col/100ml)	178.2	65.0	96.0	137.6	275.5	98.8	NP
		Phosphorus (mg/L)	0.150	0.017	0.057	0.097	0.034	0.050	NP
		Diss. Oxygen (mg/L)	7.7	9.8	8.5	8.4	8.1	9.5	NP
8	Spencer Bridge	*E. coli* (Col/100ml)	201.4	122.3	140.0	104.3	231.0	99.0	135.4
		Phosphorus (mg/L)	0.069	0.048	0.293	0.030	0.022	0.050	0.100
		Diss. Oxygen (mg/L)	7.6	9.6	8.2	8.4	8.0	9.4	9.2
9	Johnson Bridge	*E. coli* (Col/100ml)	121.1	90.8	77.0	104.6	193.5	96.0	114.5
		Phosphorus (mg/L)	0.430	0.218	0.078	0.035	0.015	0.050	0.040
		Diss. Oxygen (mg/L)	7.8	9.5	8.5	8.4	8.3	9.4	9.3
11	Poggensee Bridge	*E. coli* (Col/100ml)	461.1	81.3	81.0	178.5	261.3	56.3	65.0
		Phosphorus (mg/L)	0.020	0.030	0.091	0.016	0.021	0.050	0.050
		Diss. Oxygen (mg/L)	7.7	9.4	8.4	8.3	8.1	9.3	9.2
12	Above Cool Creek	*E. coli* (Col/100ml)	160.7	72.7	52.0	146.7	105.0	59.4	59.1
		Phosphorus (mg/L)	0.036	0.026	0.042	0.042	0.011	0.050	0.050
		Diss. Oxygen (mg/L)	7.8	9.2	8.1	8.3	8.1	9.4	9.0
19	Nine Mile Bridge	*E. coli* (Col/100ml)	1119.9	57.3	184.0	77.1	56.3	57.6	80.5
		Phosphorus (mg/L)	0.038	0.076	0.243	0.024	0.021	0.080	0.060
		Diss. Oxygen (mg/L)	7.8	9.4	8.2	8.1	7.8	9.2	9.2
20	Six Mile Bridge	*E. coli* (Col/100ml)	816.4	38.4	72.0	93.2	49.6	24.3	40.8
		Phosphorus (mg/L)	0.074	0.056	0.069	<0.005	0.011	0.050	0.040
		Diss. Oxygen (mg/L)	7.7	9.6	8.2	8.3	8.1	9.2	9.1
21	DNR Weir	*E. coli* (Col/100ml)	727.0	28.2	55.0	81.6	53.8	37.3	66.3
		Phosphorus (mg/L)	<0.002	0.122	0.109	<0.005	<0.005	0.450	0.170
		Diss. Oxygen (mg/L)	7.7	9.6	8.4	8.3	8.3	9.4	9.3
22	Stronach Road	*E. coli* (Col/100ml)	579.4	34.1	49.0	117.8	48.7	78.9	79.8
		Phosphorus (mg/L)	0.049	0.062	0.117	<0.005	<0.005	0.080	0.120
		Diss. Oxygen (mg/L)	7.8	9.5	8.8	8.3	8.3	9.5	9.3

Source: Little Manistee Watershed Conservation Council
See: “Map 17 - Monitoring Sites” on page 114 for location of sampling sites

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Chapter 2

Watershed Overview

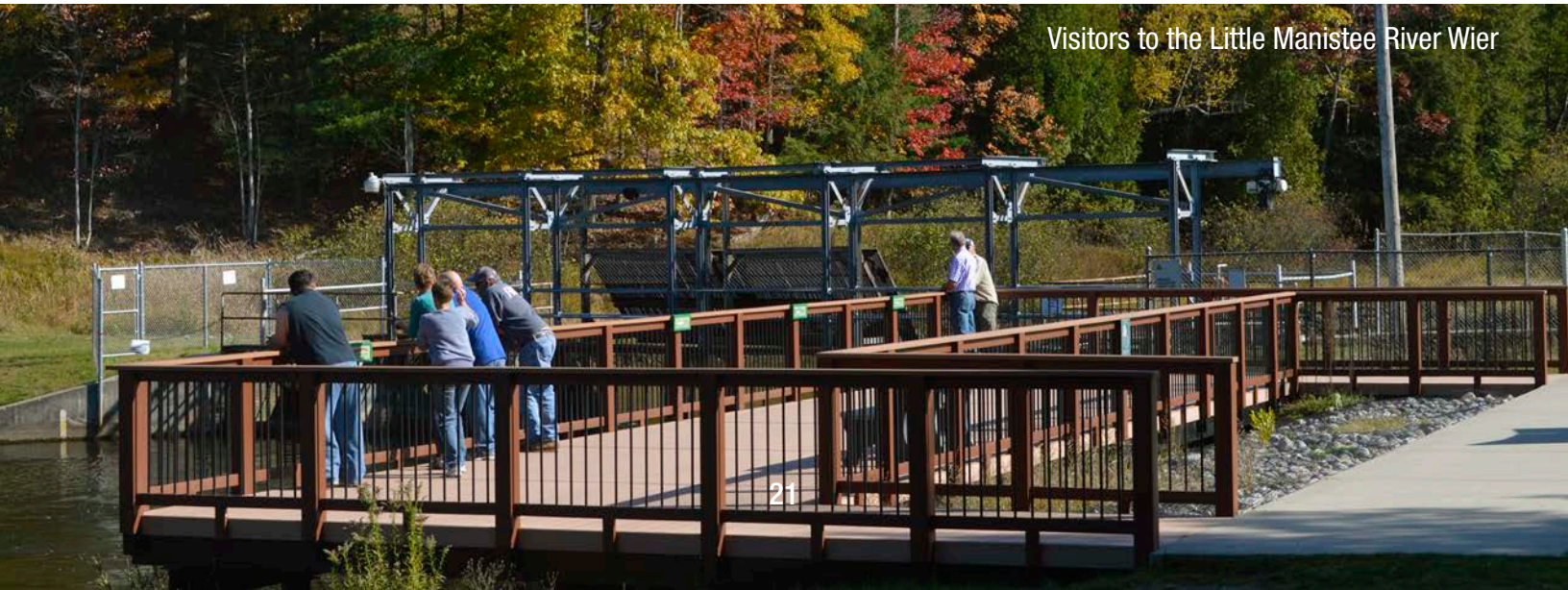
The Little Manistee River Watershed, a subwatershed of the Manistee River system, encompasses 135,000 acres (210 square miles) in Lake, Mason, Manistee and a small corner of Wexford counties in Michigan's northwestern Lower Peninsula.

Significant surface water features include the Little Manistee River and tributaries as well as more than two dozen small lakes. The river and tributaries are fed year-round by stable groundwater aquifers and are all designated as coldwater trout streams.

The Little Manistee is one of several high-quality streams – including the White, Pere Marquette, Big Sable, Pine, Big Manistee, Betsie and Platte rivers – which flow east to west into Lake Michigan, draining an extensive, forested area of the Lower Peninsula between the Muskegon River and Grand Traverse Bay watersheds.

Among those rivers, the Little Manistee is distinguished by its stable flow and cold water temperatures. Those features make it an ideal habitat for coldwater fish, including migratory steelhead trout. A Michigan Department of Natural Resources (MDNR) weir on the river is the site of an egg-taking operation that provides stock for hatchery operations that supply Little Manistee strain steelhead to streams throughout the Great Lakes region.

The weir is open to the public and is a popular stop for visitors during the egg-taking seasons. The only fish stocked in the Little Manistee are Chinook salmon, of which 150,000 were stocked into the river at or below the weir in 2016 (Tonello, 2016).



Visitors to the Little Manistee River Wier

Portions of 16 townships and one incorporated village lie within the watershed, as follows (See: “Map 1 - Little Manistee Watershed Reference Map” on page 6):

In Lake County: parts of the townships of Cherry Valley, Dover, Eden, Elk, Ellsworth, Newkirk, Peacock, Pinora and Sauble, and the entire village of Luther.

In Manistee County: portions of the townships of Filer, Manistee, Norman and Stronach.

In Mason County: portions of Meade Township and Free Soil Township

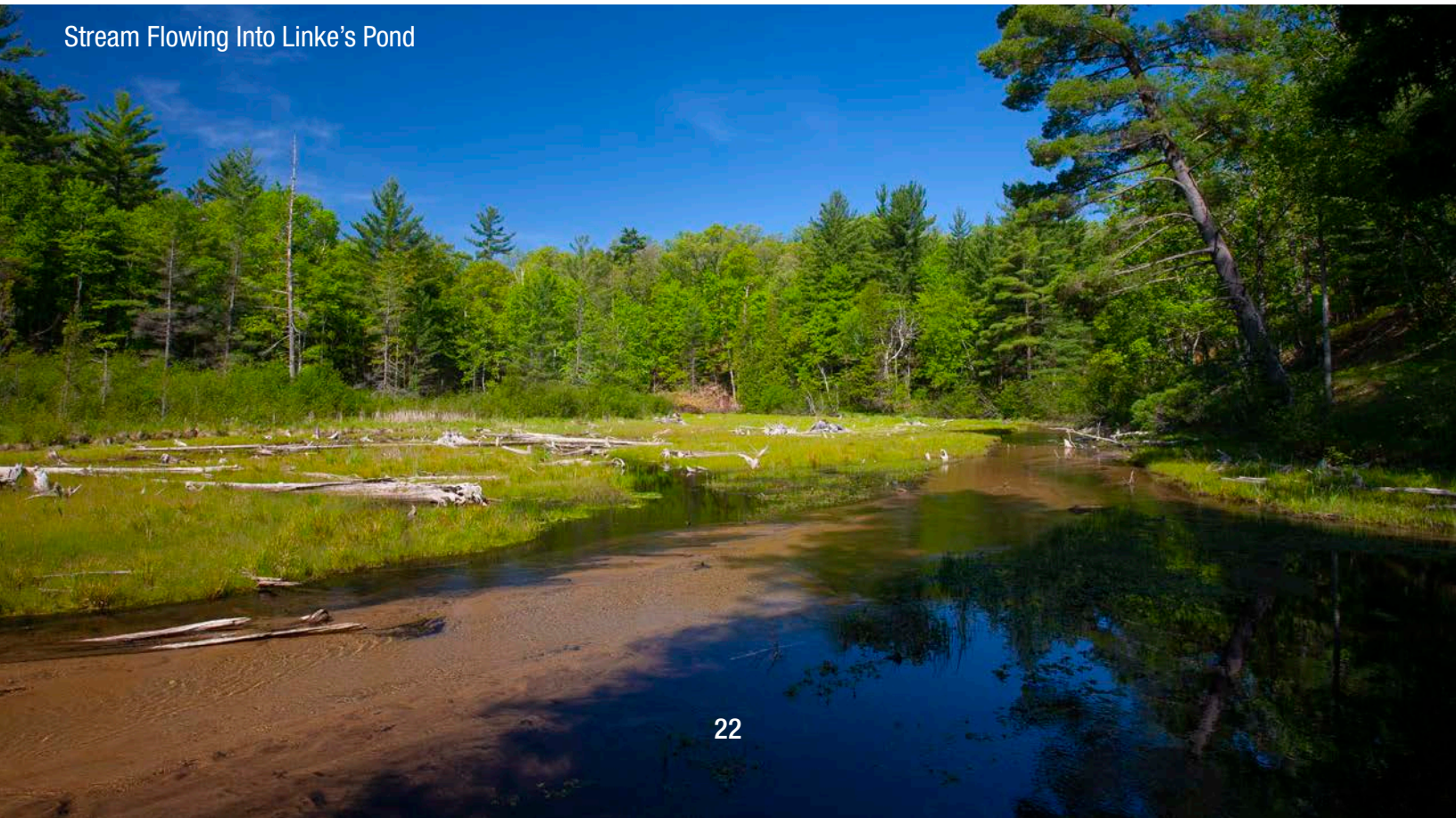
In Wexford County: part of South Branch Township.

The watershed arises from wetlands in Lake County’s Ellsworth Township, east of the village of Luther, and extends westward just over 60 miles before discharging into Manistee Lake near the community of Stronach in Manistee County.

The Little Manistee River and the “Big” Manistee River flow into separate arms of Manistee Lake, which in turn is connected by a deep-water channel to Lake Michigan. While Manistee Lake is not included in the Little Manistee Watershed, it does provide a link for migratory fish to move between the Great Lakes and the river. The Little Manistee (HUC 0406010306) is a subwatershed of the Manistee River system.

From the watershed’s eastern margin in Lake County to the exit point at Manistee Lake, the drop in altitude is approximately 600 feet. Soil types are primarily well-drained sands and gravels, which provide high rates of groundwater infiltration.

Public lands in the Pere Marquette State Forest and the Huron-Manistee National Forest make up more than half of the total acreage within the watershed. The Village of Luther and the community of Irons each have populations of several hundred persons within the watershed. Services are provided in and around the city of Manistee, just west of the watershed.



Stream Flowing Into Linke’s Pond

Private lands are largely forested, and sparsely populated. The 2010 census shows a majority of the dwellings in the watershed are used as cottages or seasonal recreation properties.

Nearly 90 percent of the Watershed is in forest or other natural land covers, according to the 2016 National Land Cover Database (See: "Table 5 - Little Manistee Watershed Land Cover 2016" on page 23 and "Map 6 - Land Cover (NLCD 2016)" on page 24). Agricultural land uses, primarily row crops and small livestock operations, occupy about 7 percent of the watershed's acreage. The largest farm area is in Ellsworth and Newkirk townships, near the headwaters.

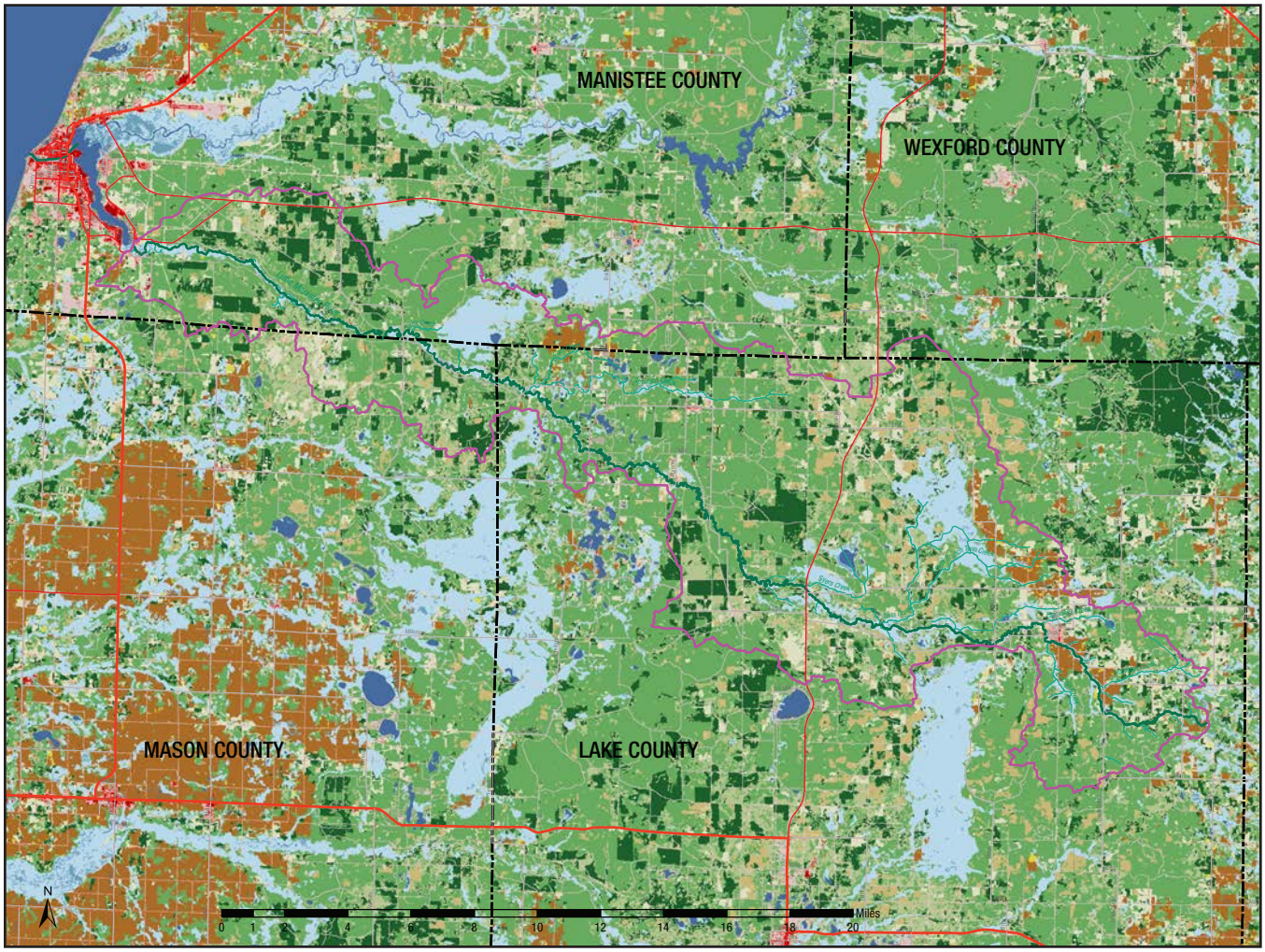
Table 5 - Little Manistee Watershed Land Cover 2016

Land Cover Type	Total Acres	Percent of Watershed
Open Water	1,704	1.26%
Developed, Open Space	5,655	4.19%
Developed, Low Intensity	1,222	0.91%
Developed, Medium Intensity	232	0.17%
Developed, High Intensity	84	0.06%
Barren Land	114	0.08%
Deciduous Forest	55,248	40.93%
Evergreen Forest	14,478	10.73%
Mixed Forest	13,493	10.00%
Shrub/Scrub	5,299	3.93%
Herbaceuous	8,335	6.17%
Hay/Pasture	222	0.16%
Cultivated Crops	9,701	7.19%
Woody Wetlands	18,443	13.66%
Emergent Herbaceuous Wetlands	765	0.57%

Source: National Land Cover Database, 2016

Hiking Trail Below the Little Manistee Weir

Map 6 - Land Cover (NLCD 2016)



KEY | LAND COVER CLASS

- Barren Land
- Cultivated Crops
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Emergent Herbaceuous Wetlands
- Evergreen Forest
- Hay/Pasture
- Herbaceuous
- Mixed Forest
- Open Water
- Perennial Snow/Ice
- Shrub/Scrub
- Unclassified
- Woody Wetlands

Anderson Level II Classification System

FEATURES

- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Little Manistee River
- LMW Tributaries
- Little Manistee Watershed Boundary

The Little Manistee mainstream has one dam, at the village of Luther, which impounds a millpond of about 8 acres. The Luther Dam was rebuilt after failing in 1986 and 1993. The dam failures contributed significant sediment into the river below. From Luther to the mouth – a distance of about 55 miles – the river is free-flowing. A smaller dam on United States Forest Service (USFS) property in Stronach Township impounds a small tributary to form a water body known as Linke's Pond. That impoundment has been shown to increase water temperature in

the stream, and the Forest Service is studying possible changes in management of the site. (Because of its small size, and because USFS is working to mitigate issues there, Linke's Pond is not considered as a Critical Site in Chapter 6 of the WMP)

The lower section of the river – from the weir to the mouth – is popular with canoeists and kayakers. Upper segments are narrow and considered more difficult except for experienced paddlers.

Off Road Vehicle trails crisscross much of the public land, and are well used. A segment of the North Country Scenic Trail passes through the watershed. The public and private forest land is also popular with deer hunters. The Bear Track campground on U.S. Forest Service land offers rustic tent and R.V. camping on the river. The Watershed also has several private campgrounds and a USFS recreation area on Sand Lake.

The Watershed was heavily logged beginning as early as the 1840s, when a sawmill was built at Old Stronach on the lower river. Historical records indicate that virtually all the native timber had been removed from the Little Manistee and adjoining watersheds by the early 20th century.

The ecosystem was dramatically altered by removal of vegetation, coupled with "log drives" on the river. Banks were eroded; gravel beds were covered with sand; the stream became wider and slower; and woody debris was scoured from the water course. Among the negative impacts was the eradication of the native grayling, which had thrived in the river's natural condition.

River habitat restoration began in the 1930s with Civilian Conservation Corps members who built campgrounds, stabilized streambanks and planted trees, helping to create what would become the Manistee National Forest.

Two overlapping local groups – the Little Manistee Watershed Conservation Council and the Little Manistee River Restoration Committee – have continued that work to the present time.

The Little Manistee River meets eligibility criteria for state and national natural river or Wild and Scenic River programs. For that reason, public lands in the river corridor are managed to prevent any degradation of those conditions. For example, managed timber cutting is generally allowed on Manistee National Forest land, but is restricted within a quarter mile of the river.

The USFS describes the river's status as follows: "The Little Manistee River is a Congressionally Authorized, 5(a), Study River in the National Wild and Scenic River system. As a result, it is subject to the protections afforded by Section 7(b) of the Wild and Scenic Rivers Act. The designated reach is 42 miles in length and is within National Forest System Lands. Water resources projects proposed within, below, above or on a stream tributary to the study river will be evaluated as to whether the study river is invaded or the scenic values of the Little Manistee River are diminished."

Climate (and Climate Change)

The Little Manistee River Watershed is located in a temperate "four-season" region of the Northwest Lower Peninsula of Michigan. Daily average high temperatures are 75 to 80 degrees in July and August; nightly average lows are in the teens in January and February.

Climate in this watershed is significantly moderated by proximity to Lake Michigan. Western sectors of the Watershed, near the Great Lake, are generally snowier than the eastern sectors, with warmer winters and cooler summers. The lake water acts as a heat "sink" in warm weather, and releases some of that warmth in winter.

There are no long-term climate monitoring sites within the watershed. Watershed climate records may be approximated from data collected at nearby stations in Manistee and Baldwin.

Table 6 - Temperature and Precipitation

Manistee Climate Normals (1981-2010)												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average daily highs (F)	30°	33°	42°	56°	67°	76°	80°	78°	71°	59°	46°	34°
Average daily lows (F)	18°	19°	25°	35°	44°	53°	59°	58°	51°	41°	33°|	23°
Monthly Avg Precip. (In)	1.73	1.26	2.13	3.03	3.23	3.66	3.15	3.62	3.54	3.39	3.23	2.76

Annual Average Precipitation: 34.73 inches
Annual Average Snowfall: 106 inches

Baldwin Climate Normals (1981-2010)												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average daily highs (F)	30°	33°	44°	58°	69°	78°	83°	81°	73°	60°	46°	34°
Average daily lows (F)	13°	13°	20°	32°	42°	52°	56°	54°	46°	36°	28°	19°
Monthly Avg Precip. (In)	2.17	1.73	2.09	2.91	3.15	3.62	3.03	3.35	3.82	3.50	3.23	1.93

Annual Average Precipitation: 34.53 inches
Annual Average Snowfall: 77 inches

Snowfall averages more than 100 inches per winter in Manistee, near Lake Michigan, but about 25 percent less than that at the inland site of Baldwin in Lake County. Much of the snowfall is related to the "lake effect," which results when cold winter winds absorb moisture while crossing Lake Michigan, and then release that moisture as snow over land.

The four-season climate is important to the local economy. While summer is clearly the busiest tourist time, the region also draws visitors for skiing, snowmobiling and ice fishing in winter; steelhead fishing in spring; leaf-color viewing, deer hunting and salmon runs in autumn, and general touring year round.

In planning for future water quality, it is important to consider the potential impacts of climate change. "Greenhouse gases" such as carbon dioxide have the physical effect of trapping a portion of the sun's heat in the atmosphere. Global data indicate that increases in atmospheric CO2 have been occurring in line with burning of fossil fuels since the beginning of the industrial revolution. Impacts such as rising sea levels, decreasing arctic ice cover and higher average global temperatures have been documented over recent decades, lending strong support to models that show a link between atmospheric CO2 levels and increasing climate change.

While the global issue seems clear, climate predictions are considerably more difficult for a small area such as the Little Manistee Watershed. As the earth retains more of the sun's heat energy, it is likely that air and sea currents will be impacted, making some areas wetter, some dryer, and possibly even pushing cold air into some areas.

Specific local impacts of those complex interactions remain very much in doubt. There is no consensus, for example, on the question of Great Lakes water levels. Warmer air holds more moisture, so precipitation may increase, potentially raising lake levels. On the other hand, more warmth also means more evaporation, which could result in lower levels. Add those opposing forces to the natural variability of Lake Michigan, and it's impossible, given our current knowledge, to accurately forecast lake level changes.

There does, however, appear to be high probability of several local impacts resulting from climate change.

A 2014 report by the Rocky Mountain Climate Organization found that the probability of severe rainstorms – defined in the report as a rainfall of 2 inches or more in a single day – increased by 89 percent in Michigan from 1965 to 2010. (Saunders, 2014)

The finding comports with most climate models, since warmer air holds more energy and more moisture and is thus capable of producing stronger storms.

In another 2014 study, the United States Geological Survey found that over the next 30 years, Northern Michigan will likely see an increasing percentage of winter precipitation in the form of rain, rather than snow. That, combined with a higher likelihood of midwinter thaws, will have the dual effect of reducing the size of the late winter snowpack, and decreasing the number of days each year when the ground is snow-covered. (Christiansen, 2014)

That will tend to moderately increase stream flows during the normally low-flow winter months, and decrease the rise of streams in the spring. While the change may appear to be modest, the USGS report stated, it may "appreciably alter ecosystem functions … that depend on seasonal dynamics at subannual time periods, such as fish spawning."

The USGS report further notes that a decrease in days of snow cover would be expected to increase rates of evapo-transpiration which could lead to drier soils in late summer and increased reliance on groundwater for irrigation.

These potential changes reinforce the desirability of meeting the central goals of this Watershed Management Plan.

Best management practices such as native plantings, properly sized stream culverts, stormwater catchment, maintaining forest cover and preserving wetlands are all important to protecting water quality under present climate conditions. They become even more vital as climate changes.

Likewise, as climate uncertainty rises, the need for consistent monitoring of water parameters also increases.

Hydrology

The Little Manistee Watershed has no large lakes to serve as reservoirs, and there are no "upstream" watersheds that contribute surface water flow.

As such, the watershed hydrology is dependent entirely on precipitation and groundwater flow within its 210 square mile area. Deep, sandy soils allow rapid infiltration of rainwater, recharging aquifers that provide a consistent base flow to the stream.

The river's width and depth grow significantly over the 60-mile course from its headwaters near Luther to its discharge point at Manistee Lake.

Measurements by the Conservation Resource Alliance show the stream to be 14 feet wide and less than a foot deep in the village of Luther at the first road crossing below the Luther Millpond dam. (CRA Road-Stream Inventory, 2019)

At the Old Stronach Road Bridge, two miles above the watershed exit point, the river is 60 feet wide with a depth of approximately 3 feet. The gradual increase in stream size is due almost entirely to infusion of groundwater.

Throughout its length, most of the mainstream is less than 40 inches deep. Those wadeable depths – and the stable flow rates and cold water temperature that result from groundwater infusion – are among factors that make the Little Manistee a Blue Ribbon trout stream.

The United States Geological Survey (USGS) maintained a flow gage at Six-Mile Bridge on the Little Manistee from 1956 to 1975 (see: "Table 7 - Stream Flow [1956-1975]" on page 28). USGS records also show estimated peak annual stream flows from 1957 to 1982.

Table 7 - Stream Flow [1956-1975]

Little Manistee River												
Average Flow By Month (cfs) 1956-1975												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Avg
158	159	191	242	205	183	160	148	153	155	170	170	174.5
Maximum Monthly Avg: 353 cfs; April 1959												
Minimum Monthly Avg: 123 cfs; Feb and May, 1958												

Source: USGS Monthly Streamflow Statistics

The USGS data show average flow over the period of record was 175 cubic feet per second (cfs). The monthly low average was in August, with an average 148 cfs over the 19-year period of record. The highest average flow month was April, at 242 cfs. The maximum peak flow estimated by USGS was 595 cfs on March 30, 1976.

While the lack of continuous flow monitoring over the past 30-plus years is a major concern – addressed as a high priority in the WMP Implementation tasks in Chapter 7 – periodic estimates by volunteers and state biologists indicate that flows in the Little Manistee likely remain in the range shown by the period of record.

For example, DEQ biologists in June of 2004 estimated the Little Manistee's flow at 277 cfs in the Linke's Pond area of the lower river. And, in May of 2010, LMWCC volunteers measured stream width, depth and velocity to calculate flow rates of 35 cfs at Queens Highway near the headwaters and 263 cfs at Old Stronach, two miles above the mouth.

While those estimates are helpful, they provide no more than snapshots of conditions at a specific day in time. They cannot reveal trends that might be associated with factors such as climate change or alterations in land use.

To fill that gap, the LMWCC approved a plan in 2020 to install and maintain up to seven automated sensors that will monitor stream depth and temperature at points to be determined on the river. Trout Unlimited will contribute funding to that effort.

Over a 30-year period, the Watershed has averaged approximately 35 inches of precipitation annually, with the highest amounts in September-October and the lowest in late winter. A significant share of the total falls as snow, especially in western sectors of the watershed, near Lake Michigan. (see: "Table 6 - Temperature and Precipitation" on page 26)

Because of the watershed's forested land cover and sandy, permeable soils, most of the precipitation can be expected to infiltrate into the ground, with only a relatively small amount becoming surface runoff. This is reflected in the character of the Little Manistee River, in which a stable flow of cold groundwater creates ideal conditions for coldwater fish species (Tonello, 2008).

A 2014 report by Lee, Selle and Swanson for the Inter-Fluve company found that the watershed's coarse soil types allowed rapid infiltration and reduced the amount of surface runoff into the stream.

"The Little Manistee is a stable system due to the low gradient of the valley and the base-flow driven hydrologic regime," The report stated "…The sandy sediments allow a large portion of precipitation and snowpack to infiltrate the ground surface. Consequently, peak discharges do not increase drastically during rainfall events and the base flow remains high throughout the year." (Lee, Selle, Swanson, P. 3)

Soil types, land covers, impervious surfaces, topography and related factors all have an impact on hydraulic response and peak water flows that result from storm runoff and/or snowmelt.

In this watershed, land cover is generally similar to what existed before European settlers and loggers arrived in Northern Michigan.

The pre-settlement vegetation in this Watershed was primarily forest. That was almost completely cut between 1840 and 1910. Some cutover areas were farmed briefly, but agriculture proved a difficult proposition in the region's sandy soils and harsh climate. Today, 87 percent of the watershed is again in forest and other natural land covers.

The Watershed has more than 20 named lakes. Among the largest are Syers Lake, at 130 acres, and Cool Lake at 83 acres. Most are fed by groundwater and natural springs, though Stronach Creek flows through several small lakes in Elk Township before its confluence with Cool Creek (Tonello, 2002).

The largest tributary stream in the Watershed is Cool Creek, with an estimated flow of up to 16 cfs. It flows from Cool Lake and enters the river in Elk Township. Other tributary streams are Syers Creek, which forms the outlet of Syers Lake, and the Twin Creeks, which drain a large wetland complex in Newkirk Township.

The Stroud Water Research Center employs stormwater models, including the Source Loading and Management Model (SLAMM) and the U.S. Department of Agriculture's Technical Release 55 (TR-55) to estimate volumes of surface runoff, infiltration and evapo-transpiration expected to occur within a watershed from a given size of storm event.

Those models were applied to the Little Manistee Watershed and each of its six subwatersheds to estimate the hydraulic response to a 50-percent probability rain event, that is, a storm event which, based on past climate records, can be expected to occur on average once every two years. For this region of Michigan, that is a rainfall of 2.09 inches in a 24-hour span.

The model results (see: "Table 8 - Storm Runoff Modeling") predict that only about 3 percent of precipitation falling on the Watershed in such a storm is converted to surface runoff. The rest is accounted for by infiltration into soils, evapo-transpiration, and direct contributions to water bodies.

Table 8 - Storm Runoff Modeling

Subwatershed Name	Subwatershed Acres	Total Rain Volume (1,000 cf)	Soil Infiltration		Evapotranspiration		Surface Runoff	
			(1,000 cf)	% of total	(1,000 cf)	% of total	(1,000 cf)	% of total
Twin Creek LMR	23,969	179,000	155,000	86.5%	18,000	10.2%	6,000	3.3%
Lincoln Creek LMR	19,768	148,000	126,000	85.3%	15,000	10.2%	7,000	4.4%
Stronach Creek LMR	17,792	134,000	116,000	86.5%	13,000	10.0%	5,000	3.5%
Elbow Lake LMR	35,583	268,000	235,000	87.6%	27,000	10.0%	6,000	2.3%
Tank Creek LMR	21,004	158,000	138,000	87.5%	16,000	10.3%	3,000	2.2%
Old Stronach Cem LMR	16,803	126,000	111,000	88.3%	13,000	10.1%	2,000	1.6%
Little Manistee River	134,919	1,013,000	881,000	87.0%	103,000	10.1%	29,000	2.9%

Note: Runoff Modeling by Subwatershed used 24-hour rainfall of 2.09 inches
Source: SLAMM and TR55 modeling, via Stroud Water Research Center

The calculated runoff volumes were also utilized with the USEPA's Software Tool for Estimating Pollutant Loads (STEPL) to estimate sediment and nutrient loads. Those estimates are reported as part of the pollution Source Inventory in Chapter 3 of this WMP.

Another measure of the stability of a stream is "flashiness," or how rapidly the flow changes in response to storms. Streams that rise and fall quickly are considered flashier than those that maintain a steadier flow, and an increase in flashiness in often associated with streambank erosion and stream channel instability. The Richards-

Baker Flashiness Index (R-B Index) uses data from USGS gaging stations to quantify the frequency and rapidity of short-term changes in stream flow.

The MDEQ Nonpoint Source (NPS) Program staff has calculated R-B Index values for 308 USGS gages in Michigan watersheds. (Fongers, 2012)

The MDEQ analysis included 75 watersheds in the size range of 100-300 square miles, including the Little Manistee. R-B index scores from those watersheds ranged from 0.029 to 0.429, with the higher values indicating more flashiness. Based on analysis of 19 years of data, from 1957-75, the Little Manistee scored 0.037, placing it in the lowest 25 percent of similarly sized watersheds in terms of flashiness.

High soil permeability can be considered a positive attribute, in that it tends to reduce volumes of stormwater runoff. On the other hand, the well-drained sands that dominate in the watershed have less filtering capacity than clay or loam. That increases the chance that contaminants such as pesticides, used motor oil or fertilizers may leach into the groundwater.

The WMP envisions an education program to inform local residents and government agencies of proper use and disposal of potential contaminants, as well as general strategies (local zoning, green infrastructure plans, on-site wastewater system inspections, etc.) to protect the public health and water quality benefits of the area's natural hydrology.

Fishery

The Little Manistee River is the "parent stream" for steelhead trout planted throughout the Great Lakes region according to fishery status reports by MDNR biologist Mark Tonello. Hatchery fish raised from steelhead eggs taken at the Little Manistee Weir have been stocked in streams throughout Michigan and in nine other states (Tonello, 2008).

The clean, cold, free-flowing stream supports populations of brook trout, brown trout, and Coho and Chinook salmon, in addition to the steelhead, which are a migratory variant of rainbow trout.

The Little Manistee River is nationally renowned for its fishing for both potomadromous steelhead and salmon and resident brown trout. Fishing pressure is extremely heavy in the spring for steelhead, and also in the summer for Chinook salmon (Tonello, 2008). The Little Manistee is designated as a Blue Ribbon trout stream, reflecting both its fish populations and the fact that it is shallow enough to be wadeable by anglers.

An unusual aspect of the Little Manistee fishery is that migratory species, including steelhead and Coho salmon, have developed significant reproduction as result of "off-season" runs, perhaps due to the operation of the weir during the primary spawning seasons.

A major goal of the WMP is to protect and enhance the fishery, which is important to the region as a recreational option, an economic driver and an indicator of environmental quality.

Arctic grayling were most likely the only trout or salmon species native to the Little Manistee. Grayling were abundant in the stream before 1880, but were gone by 1900. Possible causes of the species demise are habitat destruction due to the active logging, and competition from other trout species which were introduced to the stream in the same time period.

Brook trout are native to some Michigan watersheds, but not to the Little Manistee, according to the MDNR data. Reports indicate three trout species – brook, brown and steelhead – were introduced to the watershed in the

1890s or earlier. As biologist Mark Tonello noted: “Certainly, by the turn of the century (1900) brook trout, steelhead, and brown trout had all become naturalized residents of the Little Manistee River, and the Arctic grayling were gone.” (Tonello, 2008)

Attempts to reintroduce grayling to Michigan rivers have thus far been unsuccessful. The MDNR and tribal biologists are engaged in planning a new reintroduction of grayling from Western states, perhaps in an upper segment of the Big Manistee River. The Little Manistee is not among streams being considered for that effort at this time.

Pacific salmon were first introduced to Michigan rivers in the 1960s as an effort to recreate a Great Lakes sport fishery that had been decimated by sea lampreys, habitat deterioration and overfishing.

The egg-taking station at the Little Manistee River Weir has been in operation since 1968 (see: “Table 9 - Fish Counts at Little Manistee Weir” on page 32). It provides the primary broodstock for hatchery-raised steelhead in Michigan and adjacent states. Chinook salmon eggs are also harvested at the Weir during the fall salmon run.

Little Manistee River Wier Fish Harvest

Table 9 - Fish Counts at Little Manistee Weir

Year	Spring Steelhead	Fall Chinook	Fall Coho	Fall Steelhead	Fall Brown Trout
1968	1,640	11,230	60,248	1,322	28
1969	996	26,288	25,186	3,043	36
1970	1,405	34,190	108,400	7,411	123
1971	5,031	21,213	59,123	7,622	69
1972	7,403	24,994	2,314	3,561	5
1973	6,588	16,476	11,872	1,926	48
1974	3,684	24,156	6,129	3,488	161
1975	7,183	29,228	15,863	6,121	238
1976	1,874	16,159	24,505	578	106
1977	10,480	11,136	25,255	2,031	98
1978	7,240	20,230	23,696	320	51
1979	3,540	22,925	27,925	640	100
1980	4,505	15,761	50,004	1,111	28
1981	6,307	11,811	14,656	849	101
1982	4,100	14,358	18,458	347	62
1983	5,091	39,359	26,968	3,100	43
1984	7,950	32,632	33,982	1,909	141
1985	6,517	34,006	15,256	6,356	177
1986	7,036	22,131	16,724	4,720	99
1987	6,315	31,841	15,101	1,450	48
1988	8,432	12,519	4,467	1,050	27
1989	5,102	18,338	14,023	1,130	29
1990	4,411	19,499	10,030	1,521	55
1991	6,109	21,067	12,300	3,666	113
1992	4,597	15,866	13,441	3,054	104
1993	6,156	12,911	18,096	1,702	118
1994	4,411	11,886	562	2,849	126
1995	3,553	13,004	394	351	31
1996	9,057	17,090	2,572	5,249	174
1997	7,096	15,433	781	915	123
1998	4,005	7,170	1,463	888	28
1999	4,484	18,621	519	662	39
2000	4,236	13,029	600	319	74
2001	7,029	18,279	911	2,262	59
2002	6,290	19,385	538	120	38
2003	3,209	14,419	616	1,404	43
2004	2,571	15,618	1,102	1,074	60
2005	3,483	11,075	2,100	665	53
2006	2,949	12,772	238	417	56
2007	2,880	10,946	303	738	50
2008	3,441	5,169	172	406	58
2009	4,191	8,274	126	343	86
2010	1,961	5,776	203	91	32
2011	3,196	14,124	1,815	901	40
2012	4,818	12,327	1,333	283	103
2013	3,667	6,427	1,021	988	80
2014	2,767	2,781	760	392	79
2015	2,857	654	259	51	65
2016	1,834	1,379	528	310	44
2017	2,827	1,768	3,606	487	44
2018	2,565	1,300	1,100	411	95
TOTAL	239,069	819,030	677,644	92,604	3,888
Avg.	4,688	16,059	13,287	1,816	76

Source: Michigan DNR

In addition to the egg-taking function, the river weir serves as a barrier to stop sea lamprey from moving upriver to spawn. The MDNR, in cooperation with the U.S. Army Corps of Engineers, is in process of studying possible changes to improve the weir's effectiveness against lamprey. Any such changes must comport with the Little Manistee's status as a study river in the U.S. Wild and Scenic Rivers program.

The Little Manistee weir is one of two Chinook egg-take stations in Michigan. Chinook salmon eggs from the Little Manistee weir are also raised and stocked into Lake Michigan by Indiana and Illinois.

Steelhead intercepted at the weir are passed upstream after sufficient eggs have been taken. Salmon are harvested at the site and marketed by a private company. Some Chinook and Coho salmon do make it upriver – especially when the weir is not in operation – and the Little Manistee has some natural reproduction of both.

In recent years, there has been no planting of steelhead or Coho in the Little Manistee. Chinook continue to be stocked at or below the weir, though the numbers have been reduced in recent years as part of an ongoing effort to balance the prey/predator ratio in the Great Lakes.

The Little Manistee Weir is open to the public during Chinook salmon and steelhead egg takes, and is heavily visited. During the autumn Chinook salmon egg take, many school groups are given tours of the facility by MDNR personnel. The children get a close up view of weir personnel taking and fertilizing the eggs and performing autopsies on Chinook salmon.

Geology and Soils

The surface geology of the watershed is dominated by glacial features, including moraines, outwash plains and kettle lakes (see: "Map 7 - Quaternary Geology" on page 34). Soils are primarily well-drained sands and sandy loams, (see: "Map 8 - Soil Types" on page 35) with some more productive soils in eastern Lake County, upstream of Luther.

The Natural Resource Conservation Service (NRCS), an agency of the U.S. Department of Agriculture, has created a national soil database that classifies various soil types on the basis of such characteristics as color, permeability, subsurface layers and mineral and organic content. Predominant soil types in this watershed include the Rubicon, Grayling, Montcalm and Graycalm soil series, each of which covers thousands of acres. These soils are deep, coarse sands that formed on glacial features such as outwash plains and moraines. According to the Official Soil Series Descriptions published by NRCS, Rubicon sands are "very deep, excessively drained soils" formed in glacial drift areas. Native vegetation on these soils was mostly evergreen forest, with some hardwoods. Some of these soils were cleared and used for cropland or pasture after the native timber was removed. Many of these lands have reverted to woodland over time.

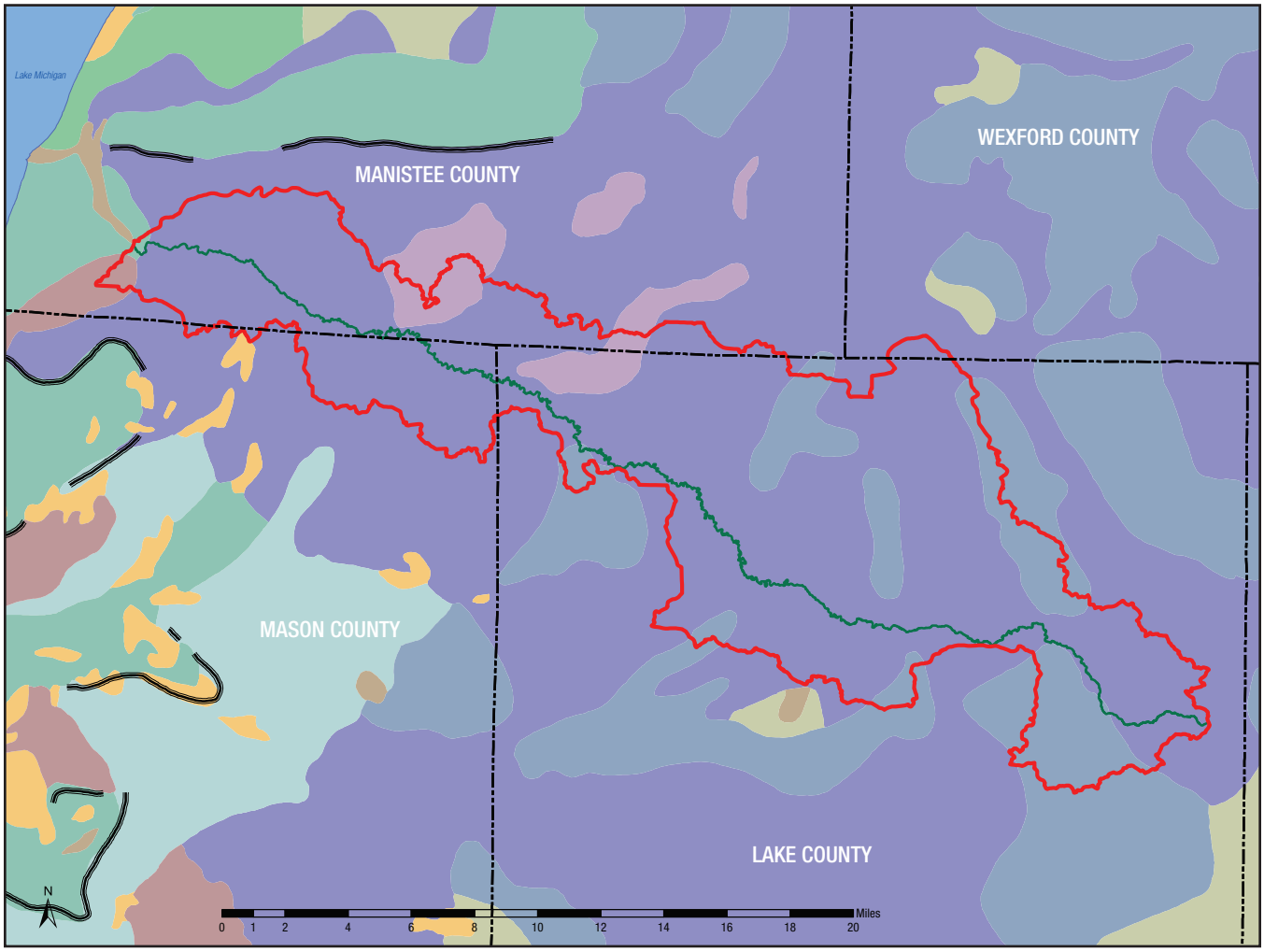
Grayling and Graycalm soils are similar. None of these soils are considered to be "prime" agricultural soils, though some have been used for hay or pasture over the years.

All of the coarse sands are highly permeable to water. They are considered to be at low risk for flooding or for excessive storm runoff because water sinks in so rapidly. For the same reason, these soils often require irrigation if they are used for crop production.

Several historic wetlands in low-lying areas of the watershed have deep, hydric or muck soils.

There are no surface outcroppings of bedrock in the watershed. Elevation in the headwaters area of eastern Lake County reaches approximately 1,200 feet above sea level. That drops to below 600 feet at the watershed's exit point at Manistee Lake (see: "Map 9 - Elevation" on page 36).

Map 7 - Quaternary Geology



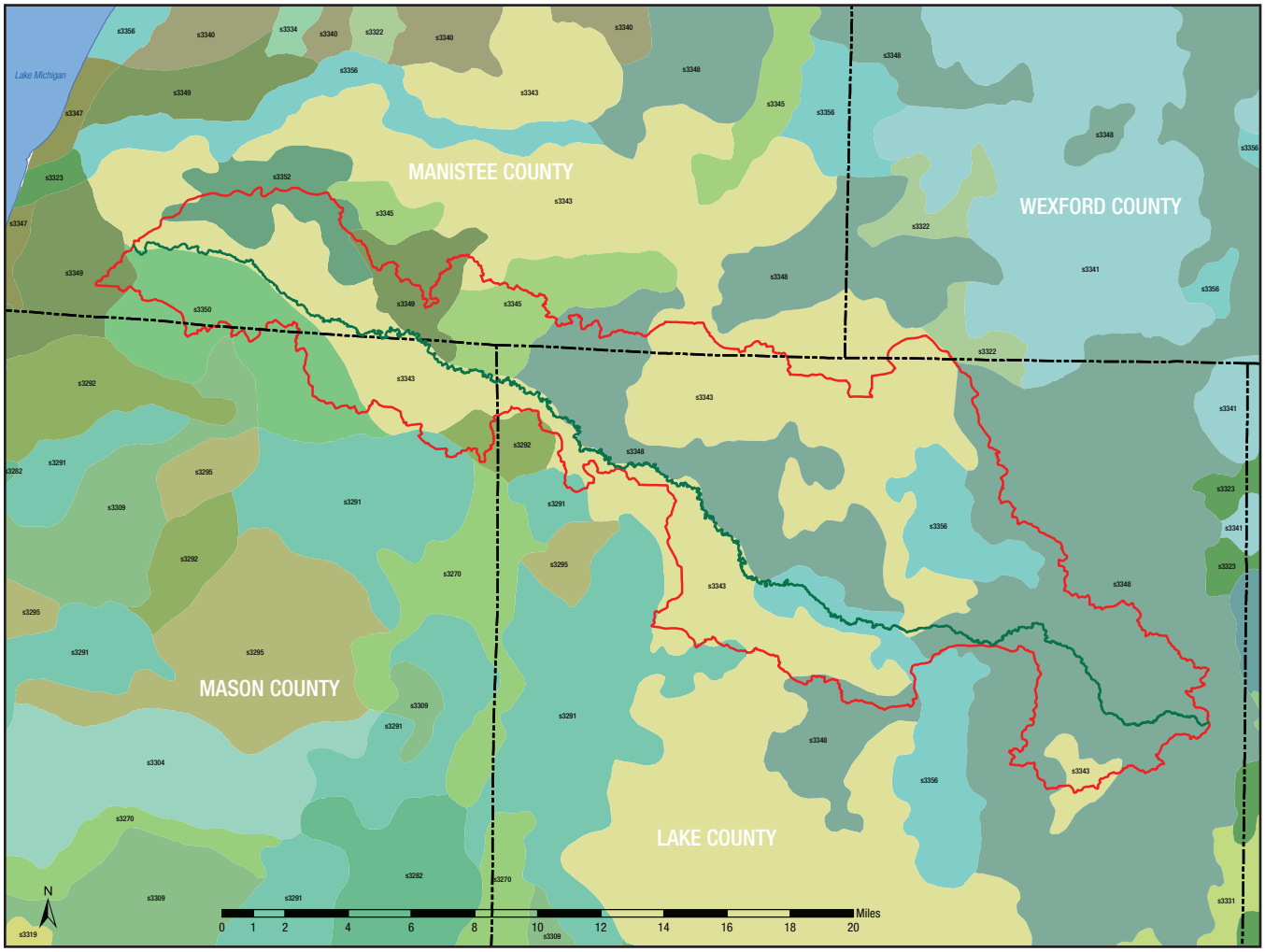
KEY | QUATERNARY TYPE

- Coarse-textured glacial till
- Dune sand
- End moraines of coarse-textured till
- End moraines of fine-textured till
- End moraines of medium-textured till
- Fine-textured glacial till
- Glacial outwash sand and gravel and postglacial alluvium
- Ice-contact outwash sand and gravel
- Lacustrine sand and gravel
- Water

FEATURES

- Quaternary Feature: Shoreline
- County Boundary
- Little Manistee Watershed Boundary
- Little Manistee River
- Lake Michigan

Map 8 - Soil Types



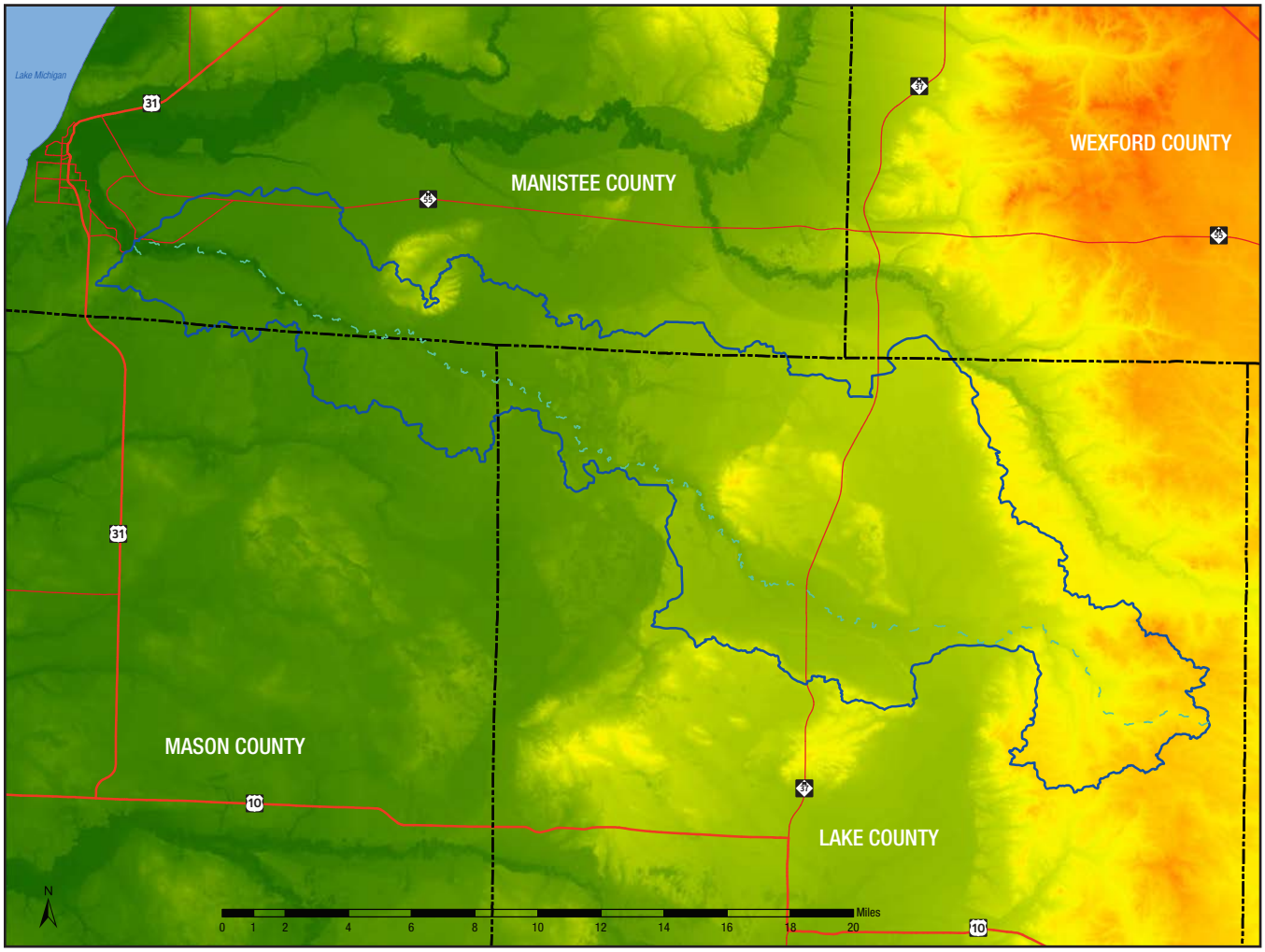
KEY || SOIL TYPE

- Grayling (s3352)
- Grayling-Graycalm (s3343)
- Houghton-Carlisle-Adrian (s3270)
- Kalkaska (s3341)
- Kingsville-Granby (s3292)
- Leelanau-Kalkaska-Emmet (s3340)
- Menominee-Markey (s3334)
- Montcalm-Emmet (s3331)
- Montcalm-Kalkaska-Graycalm (s3339)
- Nester (s3323)
- Nester-Kawkawlin (s3322)
- Perrinton-Ithaca-Coloma (s3295)
- Pipestone-Grattan (s3291)
- Rubicon-Croswell-Au Gres (s3351)
- Rubicon-East Lake (s3349)
- Rubicon-Grayling (s3350)
- Rubicon-Montcalm-Graycalm (s3348)
- Spinks-Perrinton-Miami-Metea (s3319)
- Spinks-Plainfield-Metea-Chelsea (s3282)
- Spinks-Remus-Coloma (s3309)
- Tawas-Roscommon-Au Gres (s3345)
- Tawas-Roscommon-Cathro (s3356)
- Udipsamments-Eastport-Deer Park (s3347)
- Wixom-Tappan-Londo-Avoca (s3304)

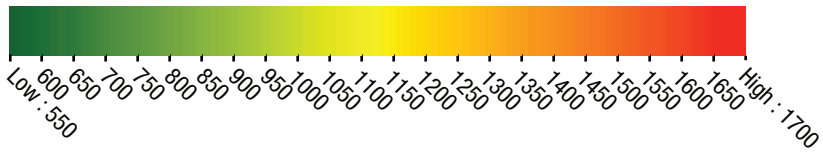
FEATURES

- Little Manistee River
- County Boundary
- Lake Michigan
- Little Manistee Watershed Boundary

Map 9 - Elevation



KEY | ELEVATION (Feet)



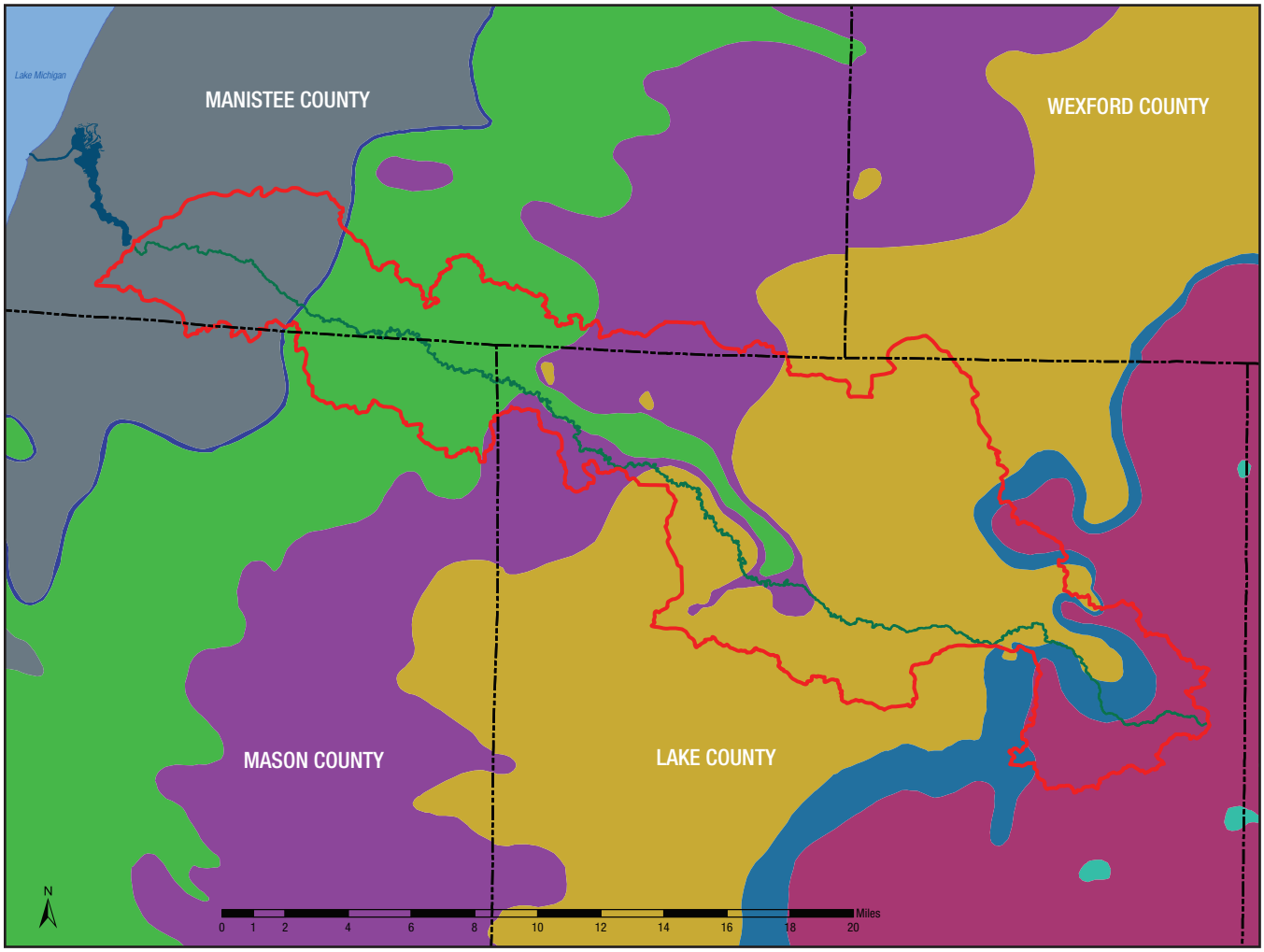
FEATURES

- Little Manistee River
- County Boundary
- Roads - Other Principal Arterial
- Roads - Minor Arterial
- Lake Michigan
- Little Manistee Watershed Boundary

The Udell Hills, located in Stronach Township on the boundary between the Big and Little Manistee watersheds, contain slopes large enough to have operated in the past as the Big M downhill ski area. Today, the site is part of the Manistee National Forest and is managed as a public area for cross country skiing and mountain biking.

The bedrock geology (see: “Map 10 - Bedrock Geology” on page 37) is made up of sedimentary layers, including the Antrim Shale, formed at times when the Michigan Basin was covered by shallow seas. Deep salt and mineral formations that underlie part of the region are reached through solution mining along Manistee Lake just west of the Watershed.

Map 10 - Bedrock Geology



KEY | BEDROCK TYPE

- BAYPORT LIMESTONE
- COLDWATER SHALE
- ELLSWORTH SHALE
- MARSHALL FORMATION
- MICHIGAN FORMATION
- RED BEDS
- SAGINAW FORMATION
- SUNBURY SHALE

FEATURES

- Manistee Lake
- Lake Michigan
- County Boundary
- Little Manistee Watershed Boundary
- Little Manistee River
- Manistee River

Wetlands

Wetlands provide vital ecological services, including flood mitigation, filtration and groundwater recharge, sediment retention, and wildlife habitat. It is an objective of the WMP to protect and restore wetlands within the watershed.

The National Land Cover Database (NLCD) data from 2016 classifies just over 9 percent of the Little Manistee Watershed as Wetland – including 10,370 acres of woody wetlands and 1,900 acres of emergent herbaceous

wetlands (see: "Map 6 - Land Cover (NLCD 2016)" on page 24 and "Table 5 - Little Manistee Watershed Land Cover 2016" on page 23).

One notable wetland complex is the large Baylor Swamp, which feeds both branches of Twin Creek in Newkirk Township. Much of the upper reach of the river flows through lowland conifer swamp.

While the majority of soils in the watershed are well-drained coarse mineral sands, hydric soils in these wetlands often contain thick layers of organic materials, accumulated over the centuries.

Wetland regulations have been a source of political controversy and have been subject to proposed changes in recent years. At the time the WMP effort was initiated, federal and state agencies had authority to regulate wetlands which have any of the following characteristics:

- Connected to one of the Great Lakes or Lake St. Clair.
- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river or stream.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, but more than 5 acres in size.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but determined by MDEQ (with notification to the property owner) to be essential to the preservation of the state's natural resources.

Many of the Little Manistee wetlands are protected from development through public ownership as part of the state and federal forest systems.

Demographics

The year-round population of the watershed is estimated at 3,700, including 2,300 in Lake County, 1,300 in Manistee County and fewer than 100 in Mason and Wexford counties combined (see: "Table 10 - 2010 Census of Population and Housing" on page 39).

Precise demographic calculations are impossible, since the watershed boundary does not follow census block lines as it meanders into parts of 16 townships. The watershed occupies less than 1 percent of Dover and more than 95 percent of Eden Township in Lake County.

Census estimates show overall population in the 16 townships fell by about 1 percent from 2010 to 2016.

Of an estimated 4,500 housing units in the watershed, 2,500, or 57 percent, were vacant during the 2010 census count and categorized as being used for seasonal or occasional occupancy. That result is unsurprising, given the region's well-known recreational and seasonal attractions. Many of the seasonal dwellings are cottages located on waterfront properties on the river or lakes.

The sparse population leaves local government with few resources for planning. Of the 16 townships, seven have fewer than 500 residents. Only three of the townships, all near the city of Manistee, have populations in excess of 1,000.

Table 10 - 2010 Census of Population and Housing

Township	Entire Township			Portion of Township in Watershed		
	Total Population	Total Housing Units	Total Seasonal Housing Units	Watershed Population	Watershed Housing Units	Watershed Seasonal Housing Units
Cherry Valley	396	522	318	2	6	5
Dover	395	370	184	0	0	0
Eden	487	793	544	442	701	476
Elk	985	1,589	1029	710	1123	749
Ellsworth	817	622	237	351	285	111
Newkirk	632	860	502	562	726	412
Peacock	492	1,132	841	244	508	377
Pinora	717	461	147	24	40	23
Sauble	333	688	481	2	7	6
Filer	2,325	1,188	125	40	19	1
Manistee	4,084	1,598	202	24	14	1
Norman	1,553	1,633	803	220	207	110
Stronach	821	581	184	379	281	104
Free Soil	822	566	177	18	14	6
Meade	181	208	116	77	126	83
South Branch	383	455	268	4	9	7
Total	15,423	13,266	6,158	3,099	4,065	2,471

Note: The Portion of Township in Watershed calculations utilized 2010 Census Block data adjusted for the percentage of the Block contained within the Little Manistee Watershed in relation to the total Block area.

The Local Economy

The Little Manistee River area is known primarily as a destination for outdoor recreation, fishing, boating and general tourism. There are few if any large employers directly in the Watershed, with residents more likely to seek employment in the surrounding towns of Baldwin, Manistee, Reed City and Cadillac.

There is a significant population of retirees, who live in the area either year-round or seasonally. Public and private campgrounds help to swell the summer population and provide some seasonal employment.

Fishing is an important component of the economy. A number of fishing guides run trips on the Little Manistee. Out-of-town anglers visiting the area during salmon and steelhead runs support campgrounds, hotels, restaurants and other businesses in and near the Watershed.

Businesses within the watershed tend to be small and oriented toward retail or the outdoor tourism economy. The Dublin Store at the northern extremity of the watershed has a statewide following for its store-made products, including countless varieties of jerky made from beef, venison and exotic animals. Both Irons and Luther have small business districts that cater to local and tourist trade.

Public and private woodlands provide some timber harvest employment, though milling and processing are done outside the watershed.

Fast food outlets, chain branded motels and other highway services for travelers are non-existent. Only one state highway, M37, transects the watershed and that is in a generally remote segment of Lake County.

The agricultural economy is limited to a few small row crop or pasture operations. In general, soils at the eastern end of the Watershed, in the area around Luther, are more amenable to agriculture.

Land Use Regulation: Master Plan & Zoning Review

Land use is known to have a significant impact on water quality and non-point source pollution. For example agricultural operations, residential on-site waste water systems, impervious surfaces and open space areas all have differing effects on groundwater and lakes and streams throughout the Watershed.

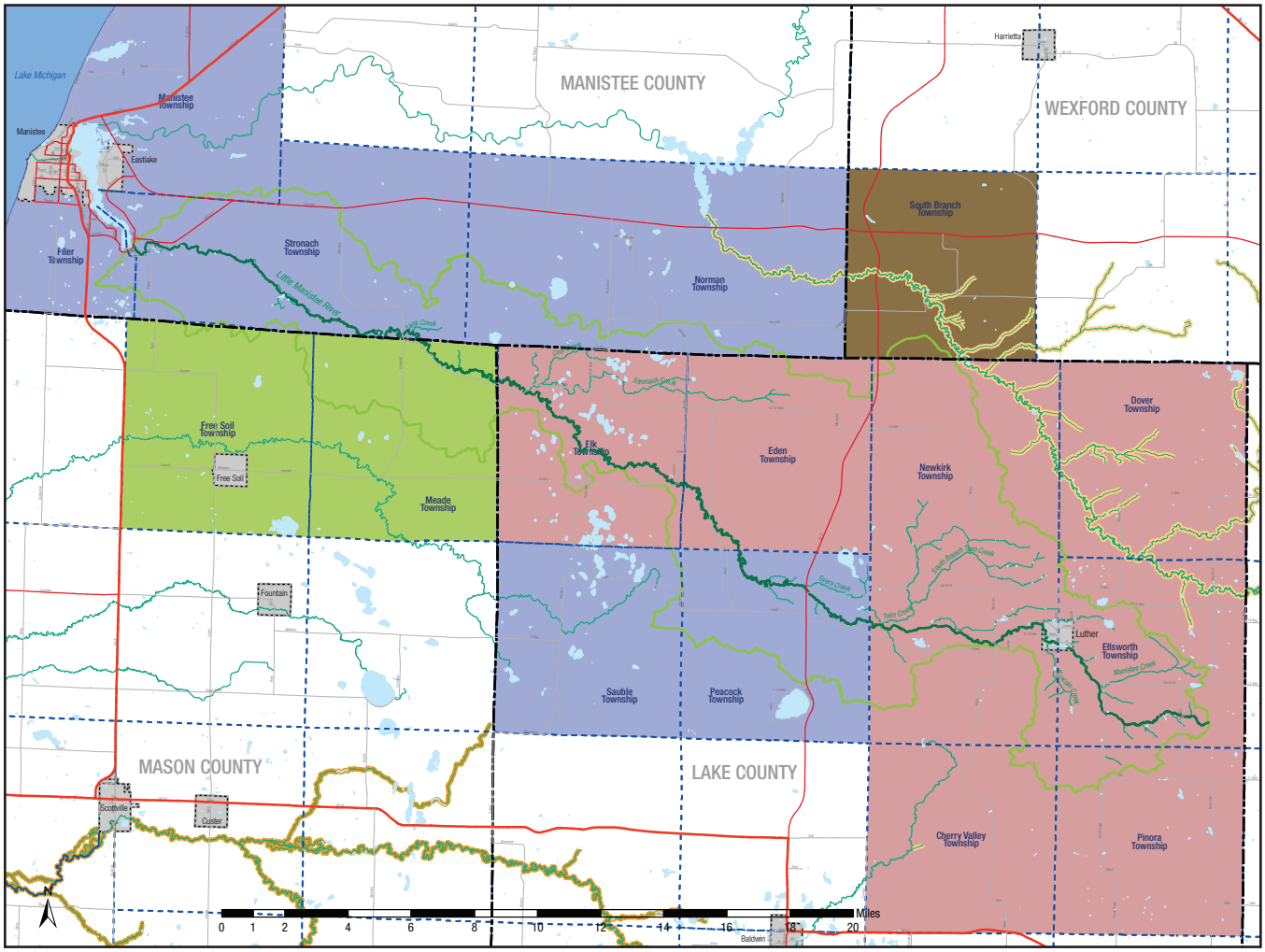
In the Little Manistee Watershed, broad expanses of forest and other undeveloped land have helped to maintain the natural conditions and high water quality desired by local stakeholders. Ensuring that those conditions continue in the future may require some level of regulation to guide potential growth. Regulations enforced by counties and municipalities; by district health departments; by construction code; soil erosion authorities; and by state agencies such as the Department of Environmental Quality may all limit some types of land development and incentivize others.

Within the Watershed, a total of 21 municipal and county governmental units potentially share some aspect of land use regulation. In support of this Watershed Management Plan, consultants worked with a volunteer from the LMWCC to review master plans, zoning and other ordinances of those units (four counties, 16 townships and one village).

The review showed the following distribution of zoning within the Little Manistee Watershed: The two townships in Mason County (Free Soil and Meade), have county-administered zoning; the lone township in Wexford County (South Branch) has zoning through a multi-township authority (The Wexford Joint Planning Commission); and each of the four Manistee County townships (Manistee, Filer, Stronach and Norman) has its own zoning ordinance. In Lake County, two townships (Sauble and Peacock) have their own zoning ordinances. There is no zoning in seven Lake County townships (Elk, Eden, Newkirk, Cherry Valley, Dover, Ellsworth and Pinora) nor in the Village of Luther (see: “Map 11 - Zoning Status by Township” on page 41).

Low Impact Development Example — Green Roof & Rain Gardens

Map 11 - Zoning Status by Township



KEY | LAND USE REGULATION

- Pere Marquette Natural River District
- Pine River Natural River District
- Township Zoning
- County Administered Zoning
- Joint Planning & Zoning
- Not Zoned
- Incorporated Cities & Villages

FEATURES

- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Township Boundary
- Inland Lakes
- Little Manistee River
- LMW Tributaries
- Area Rivers
- Lake Michigan
- Little Manistee Watershed Boundary

The existing ordinances (see: "Table 12 - Zoning Provisions, Manistee and Wexford Counties" on page 45 and "Table 13 - Zoning Provisions, Lake and Mason Counties" on page 46) were reviewed to look for inclusion of two major policy classifications: Regulations that promote land use efficiency; and those that provide environmental protections. The review showed that zoning provisions differ significantly from one jurisdiction to another. Required waterfront setbacks, for example, range from 35 feet to 100 feet. The differences are reflective of the fact that each township has the power to design its own regulations.

Provisions that may be protective of natural resources include zoning districts along or around surface water (including overlay districts); wetland provisions in zoning; surface water protections; setbacks and buffers; groundwater protections; floodplain reviews; limitations to building on steep slopes; and special environmental areas protection.

Research has demonstrated that increasing the density of development in existing growth and investment areas can reduce impervious surfaces compared to low density development for a given amount of new housing-unit creation.

This concentration of development also lends itself to lowering the cost and impact of infrastructure, and to preserving open space.

Conversely, environmental benefits may result from well-designed regulations that codify low-density policies in situations where high-density development does not presently exist and is unlikely to exist in the future. Such low-density policies may include: larger parcel sizes, minimum parcel widths along shorelines; greater setbacks for impervious surfaces (e.g. 50 feet) and nutrient sources (e.g. 100 feet); required woody-plant greenbelts along shorelines; secondary containment for potentially hazardous materials; site plan design requirements, and so on.

Examples of policies that might promote the efficient use of land resources in rural areas may include allowing a mix of uses on the same site, and clustering to incentivize low impact development techniques.

While zoning is intended to regulate site-specific land uses, master plans serve as instruments which guide the evolution of the community by bringing the social, physical, economic and political considerations into focus. The master plan provides guidance for the future use of the land as well as the employment of other capital resources such as infrastructure to support community goals.

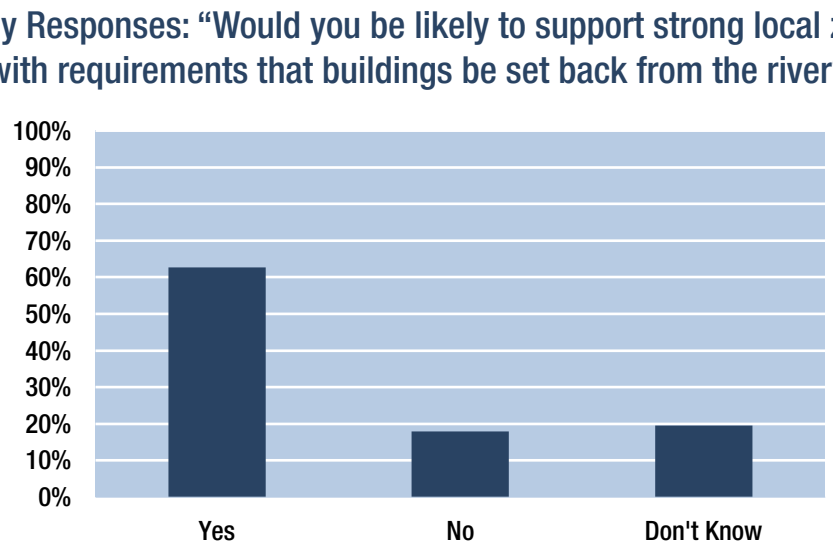
A thoughtful and comprehensive master plan can lay the framework to improve the quality of life, make more efficient use of resources, provide for a cleaner environment, and build an economically vibrant community. The master plan is required as the basis for a zoning ordinance.

Decisions surrounding land use have become increasingly complex as greater understanding has been developed about environmental impacts and interrelationships that may significantly affect watersheds.

With no large population or commercial centers and relatively little construction of impervious surfaces, the present land uses in the Little Manistee Watershed are generally supportive of good water quality. That means local governments have an opportunity to protect water quality and the area's rustic character by regulating future development, while causing little immediate impact on existing residences or businesses. This is a major strength of zoning: Being proactive by putting in place preventive measures to protect the resource, rather than depending on enforcement action, lawsuits or environmental remediation after damage has been done to the watershed.

A social indicators survey conducted on-line during the WMP process found significant support for regulation to protect the river corridor. In the WMP survey, 63 percent of respondents indicated they would be likely to support "Strong local zoning, with requirements that buildings be set back from the river" (see: "Table 11 - Support for Zoning" on page 43). Nearly 70 percent indicated support for "State designation of the Little Manistee as a natural river, with development restrictions" (see: "Table 3 - Support for Natural River Designation" on page 14).

Table 11 - Support for Zoning



Source: WMP Social Indicators Survey, 2019

The survey – with approximately 200 respondents – was one element of the Steering Committee's commitment to obtain public participation in the planning process. It is not considered to be a statistically valid representation of the Watershed population, since participants were not selected at random. The on-line survey instrument was publicized in local media and all persons with an interest in the Little Manistee Watershed were invited to participate. Of all respondents, 61.4 percent identified themselves as property owners in the watershed.

The full survey results are included as Appendix A to the WMP.

The goal of land use regulation in this watershed should be to guide future growth and developments in ways that are protective of the area's water resources and rustic character. Regions to the north, south, east and west of the Little Manistee are all more heavily developed than this watershed. Potential growth could come from any direction at any time. It is important for citizens and governmental units to understand the issue, and promote policies that will allow the region to grow in ways that protect water quality and natural resources.

The WMP recommends an extensive education program to inform policymakers of possible options for land use regulation and water quality protection – including local zoning and/or natural river designation.

Under Michigan law, zoning ordinances are often written at the township level. The seven townships listed above with no zoning ordinance all have small populations, which can make it difficult to maintain individual zoning programs. For that reason, the WMP recommends consideration of the benefits of joint arrangements among several municipalities. The Michigan Joint Municipal Planning Act allows municipalities (that is, cities, townships and/or villages), to join together for planning and zoning purposes.

The statute would enable the entities to engage in zoning for the entire communities, or to do so only along the river corridor and not in the rest of the municipality. Either approach could help to protect the resource while maintaining local control and creating a cost-sharing formula to minimize the expense to each municipality. The Wexford Joint Planning Commission, which encompasses South Branch and several other townships in Wexford County, may serve as a model for consideration.

Designation as a Michigan natural river could accomplish a similar goal of preserving the river corridor without affecting other areas of the townships. However, the political climate in the state and a general shortage of funding for new natural river designations make it appear that natural river status is possible only if it were to grow from grass roots efforts within the watershed. The WMP recommends continuing education on the natural river issue while also developing a further understanding of the interest the watershed residents have in such a designation. If support for the designation is found to exist, then the plan recommends moving forward with the designation.

Expertise on land use regulation is available through several sources in the region, including the Michigan State University Extension, Networks Northwest, West Michigan Shoreline Regional Development Commission, Michigan Association of Planning, and Manistee and Mason County planning offices. The MSU Extension's Citizen Planner program offers land use education for local officials through in-person or on-line courses. The WMP recommends seeking grant funding for a coordinated effort to educate the public and develop locally supported land use ordinances that provide long- term protection to the watershed.

Rural Clustered Development Example (Photo credit: Empire New Neighborhood)

Table 12 - Zoning Provisions, Manistee and Wexford Counties

	Unit of Government		
	South Branch Township	Stronach Township	Norman Township
Zoning Authority	Wexford Joint Planning Commission	Individual township zoning	Individual township zoning
Relevant Districts	R1 Rural Residential	Forest Preservation; Res.-Commercial; Little Manistee River Corridor	Rural Residential; Agricultural; Natural
Minimum Parcel Size	43,560 s.f.	Varies: 15,000 s.f. in Stronach village area to 40 acres in low-density forest preservation district	Rural residential or Agricultural zoning: 2.5 acres; "Natural" Zoning: 10 acres
Minimum Parcel Width	At water's edge: 165 ft.	Varies: 100 feet in village area to 660 feet in Little Manistee Corridor District	Rural residential or Rural agric. zoning: 165 ft. Natural Zoning, 330 ft.
Minimum Buildable Area	20,000 s.f. per principal use	Not addressed in zoning ordinance	Not addressed in zoning ordinance
Maximum Lot Coverage	Not addressed in zoning ordinance	Not addressed in zoning ordinance	Rural residential or Rural Agricultural zoning: Max. 30 percent of parcel
Setback From Surface Water Resources	Buildings: 50 feet from water or wetland; nutrient sources: 100 feet from water or wetland	100 feet minimum	Buildings: 100 ft. from water's edge
Surface Water Buffer Or "Greenbelt"	10 feet from water's edge	100 feet from Little Manistee River	20 feet from water's edge
Landscape Requirements In Buffer Zone	Not addressed in zoning ordinance	Maintain natural vegetation; limited tree pruning for view	Not addressed in zoning ordinance
Groundwater Protection Hazardous Waste	Yes: Secondary containment, etc.	Yes: Secondary containment, etc.	Yes: Secondary containment, etc.
Stormwater Management	Included in Site Plan review	Included in Site Plan review	Included in Site Plan Review
Planned Unit Development	Included	Included	Included
Steep Slope Building Restrictions	Not addressed in Zoning Ordinance	Not addressed in zoning ordinance	Not addressed in Zoning Ordinance
On-Site Wastewater Systems	Health Department approval required for new systems	Health Department approval required for new systems	Health Department approval required for new systems
Wetland Protections	Must comply with state and federal regulations	Must comply with state and federal regulations	Must comply with state and federal regulations

Note: Manistee and Filer Townships, in Manistee County, have marginal geographic extent in the Little Manistee Watershed and are not assessed in this zoning review.

Table 13 - Zoning Provisions, Lake and Mason Counties

	Unit of Government		
	Free Soil & Meade Townships	Sauble Township	Peacock Township
Zoning Authority	Mason County Zoning	Individual township zoning	Individual township zoning
Relevant Districts	Agriculture; Rural Estates; Rec. Residential; Greenbelt	R1 and R2 Residential; AG-F Agricultural-Forestry	R2 Residential; C1 Commercial
Minimum Parcel Size	Agriculture and Rural Estates: 1 acre; Recreational Residential: 20,000 s.f.; Greenbelt: 20,000 s.f.	15,000 s.f.	20,000 s.f.
Minimum Parcel Width	Agriculture, forestry and Rural Estates: 150 ft.; Recreational Residential and Greenbelt: 100 ft.	100 feet	100 feet
Minimum Buildable Area	Not in Zoning Ordinance	Not in Zoning Ordinance	Not in Zoning Ordinance
Maximum Lot Coverage	35 percent	30 percent	Not in Zoning Ordinance
Setback From Surface Water Resources	Structures: 40 ft. generally, 50 ft. in Greenbelt District Septic Systems: 100 ft.	Average distance of structures on adjacent parcels, but not less than 30 feet.	35 feet
Surface Water Buffer Or “Greenbelt”	40 feet generally; 50 ft. in Little Manistee Greenbelt District	30 feet	Not in Zoning Ordinance
Landscape Requirements In Buffer Zone	Natural Conditions; limited pruning allowed for view of water	Natural conditions; one tree per 100 s.f. limited pruning allowed for view of water	Not in Zoning Ordinance
Groundwater Protection Hazardous Waste	Yes: Secondary containment, etc.	Yes: Secondary containment, etc.	Addressed in separate ordinance
Stormwater Management	Required; Included in site-plan review	Included in site-plan review	Not addressed in Zoning Ordinance
Planned Unit Development	Included	Included	Not addressed in Zoning Ordinance
Steep Slope Building Restrictions	Not addressed in Zoning ordinance	Not addressed in Zoning ordinance	Not addressed in Zoning ordinance
On-Site Wastewater Systems	Health Department approval required for new systems	Health Department approval required for new systems	Health Department approval required for new systems
Wetland Protections	Must comply with state and federal regulations	Must comply with state and federal regulations	Must comply with state and federal regulations

Note: No zoning ordinance has been adopted in the Lake County townships of: Cherry Valley, Dover, Eden, Elk, Ellsworth, Newkirk and Pinora, or the Village of Luther.

Chapter 3

Non-Point Pollution Inventories

By its very nature, non-point source pollution is difficult to quantify. This is especially true in a rural area such as the Little Manistee River Watershed, where surface waters meet the numerical and narrative quality standards, and stressors tend to be widely separated.

Despite that challenge, it is important to create an inventory of actual and potential sources – such as storm run-off, erosion, on-site wastewater systems and road-stream crossings – and to estimate current pollution loads (see: "Table 14 - Pollutants by Assessment Category"). The source inventory and load estimates may help to identify problem sites and also provide a baseline to monitor progress in meeting the Watershed Management Plan goals.

Table 14 - Pollutants by Assessment Category

Assessment Category	Sediment (Tons)	Phosphorus (Pounds)
Runoff from Land	131	1,268
Septic Systems	N.A.	2,328
Road Stream Crossings	50	42
Streambank Erosion	645	547

Sources:
Streambank Erosion and Road Stream Crossings from CRA Data
Septic Loadings Calculated from 2010 Census Housing Data
Runoff from STEPL and Stroud Water Research Center

This chapter discusses the sources of stressors and pollutants that may have significant impact in the Little Manistee Watershed. Chapter 4 will identify priority levels for the major stressors.

The Little Manistee Watershed has no watershed-wide impairments. Monitoring to date indicates that loadings are moderate and well below levels that threaten the designated and desired uses of lakes and streams. The watershed has no "point source" pollution permits—that is, there are no commercial, industrial or municipal discharges regulated under the National Pollutant Discharge Elimination System (NPDES).

For water bodies with impairments, EGLE often develops a "Total Maximum Daily Load" (TMDL) – that is, a document that describes the process used to determine how much pollutant a lake or stream can assimilate and meet water quality standards. Because there are no known impairments in the Little Manistee Watershed, no such document has been developed.

The major stressors of concern – sediments, thermal issues and nutrients – are not shown to be present in such concentrations as to impair the designated uses of surface waters. The plan adopts a non-degradation standard, asserting that pollutant loads must not be allowed to increase from the present levels. Achieving this standard will require long-term monitoring of water quality, along with application of Best Management Practices (BMPs) to future land uses and other potential causes of the identified stressors. Those plan elements are discussed in later chapters.

Pollutants enter the water from a number of sources. This chapter provides estimates and identifies several potential sources, such as land use practices, septic systems, recreational infrastructure and road crossings.

These causes of ecological stress have not been systematically or comprehensively monitored for the overall watershed. For that reason, much of the information presented here is based on estimates, derived through the best available data. As in other sections of the plan, it must be noted here that long-term monitoring (see Chapter 8) is a necessary element for preservation of the resource.

Nutrient and Sediment Loadings In Runoff

Sediment and nutrients in runoff from rainstorms and snowmelt are often directly correlated to land uses. For example impervious surfaces such as parking lots and roofs yield both higher volumes of runoff and higher pollutant loads than pervious surfaces such as grasslands or forest. Lowest runoff volumes are generally associated with forested areas and sandy soils, which promote infiltration and evapo-transpiration of water.

As a general statement, pollutant levels are correlated with runoff, which simply means that greater volumes and velocities of water are capable of carrying more sediment and nutrients. Areas with higher runoff volumes can be assumed to also produce higher pollutant loadings.

The Little Manistee Watershed – as a consequence of its forested land cover and permeable soils – has relatively low runoff loadings, as compared to other regions.

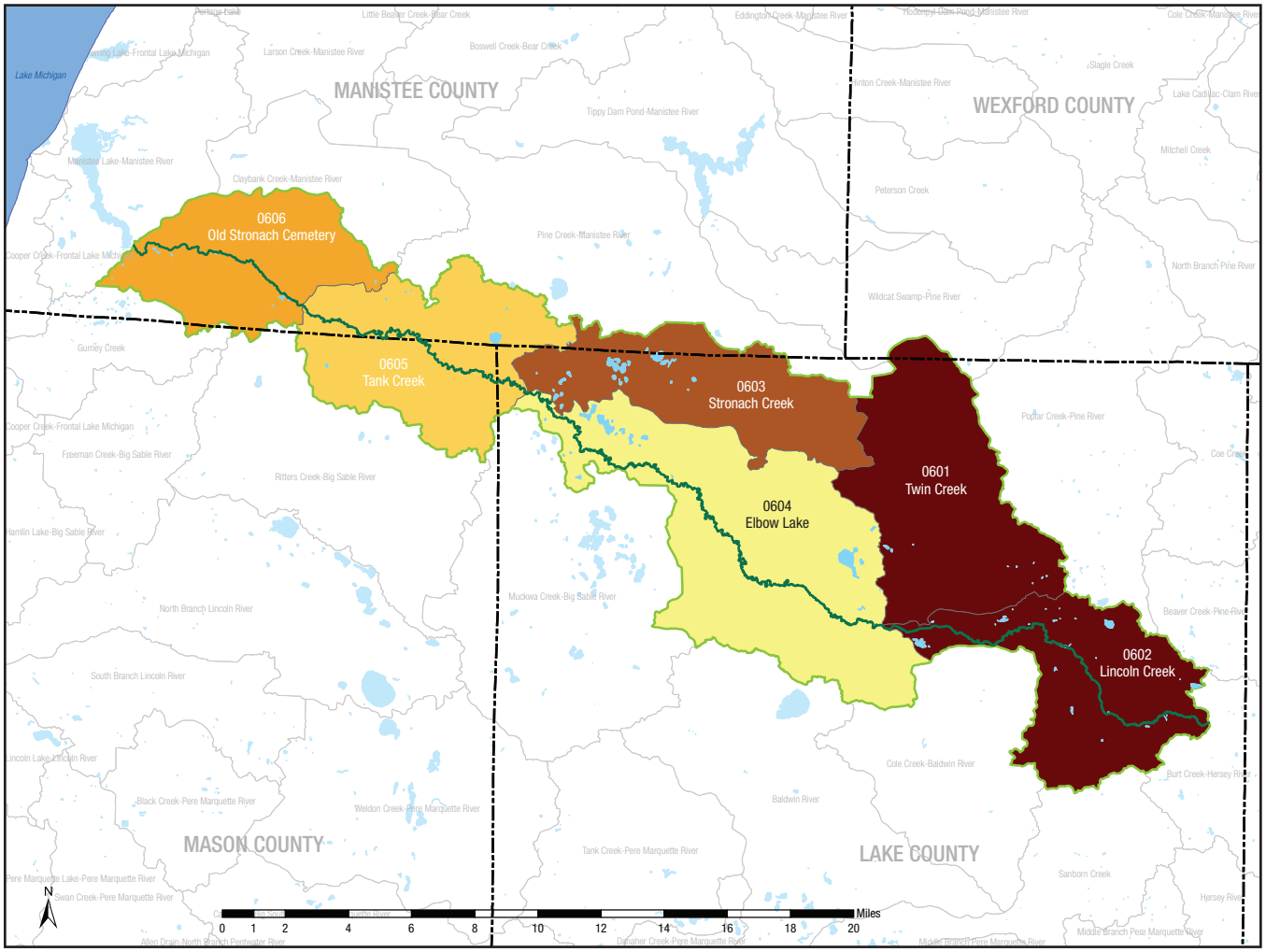
(It should be noted that well-drained sands do tend to reduce runoff, but also pose their own challenges. Chemicals and other materials applied to the surface, may leach through these soils and potentially pollute groundwater.)

To help in estimating sediment and nutrient loadings where specific monitoring is not available, the United States Environmental Protection Agency has developed the Spreadsheet Tool for Estimating Pollutant Loads (STEPL).

As described in Chapter 2 (see: “Table 8 - Storm Runoff Modeling” on page 28), modeling software from the Stroud Water Research Center (wikiwatershed.org) was used along with data from the National Land Cover Database (NLCD) to estimate runoff in a hypothetical storm producing 2.09 inches of rainfall in 24 hours. The STEPL model was then applied to those calculations to estimate volumes and concentrations of nitrogen, phosphorus and total suspended solids within that runoff. The 2.09 inch rainfall is considered the 50-percent probability storm for this region – meaning the probability is that such a storm should occur on average once every two years.

For this WMP, the model was applied for the entire Little Manistee Watershed and for each of the six subwatersheds (see: “Map 12 - Phosphorus in Runoff by Subwatershed” on page 49 and “Table 15 - Pollutants in Stormwater runoff” on page 50).

Map 12 - Phosphorus in Runoff by Subwatershed



KEY | P RATE (KG/HECT)

- 0.002000
- 0.002001 - 0.003000
- 0.003001 - 0.004000
- 0.004001 - 0.005000
- 0.005001 - 0.012000

FEATURES

- Little Manistee River
- County Boundary
- LMW Lakes
- Lake Michigan
- Little Manistee Watershed Boundary

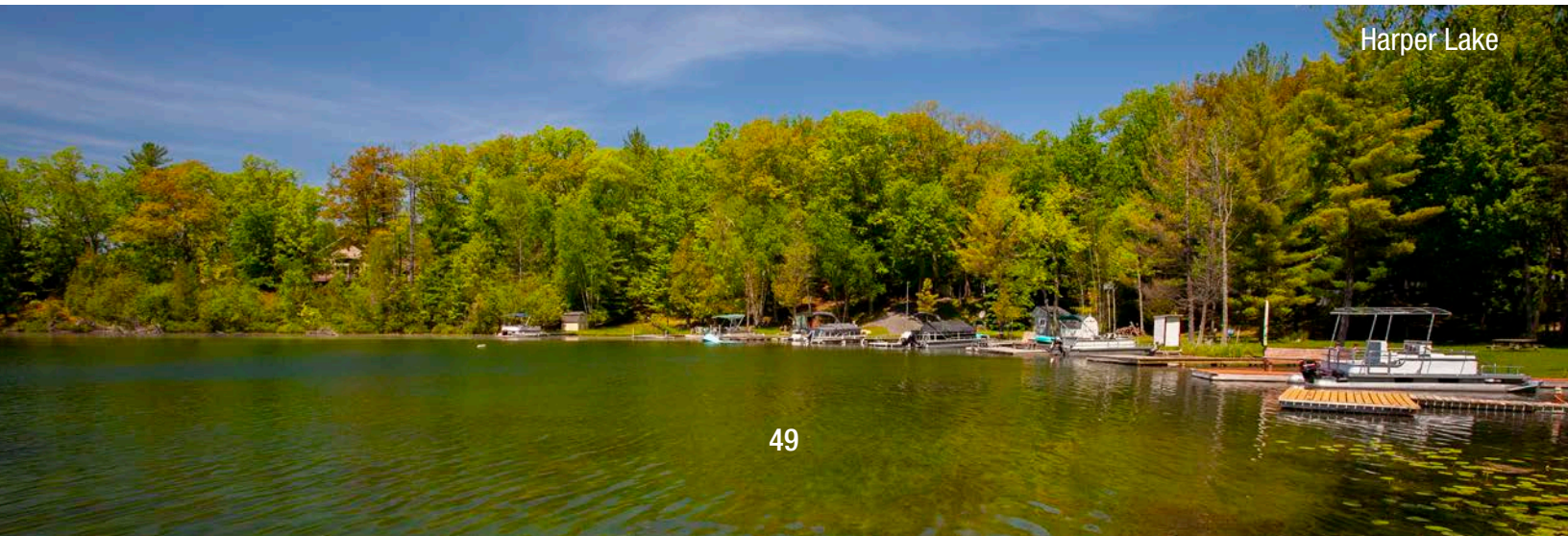

Harper Lake

Table 15 - Pollutants in Stormwater runoff

Subwatershed name	Total Area (Acres)	Runoff (Cu. Ft.)	TSS Load (Tons)	N. load (Lbs)	P. load (Lbs)
Twin Creek Little Manistee River	23,969	5,930,000	22.1	1,390	190
Lincoln Creek Little Manistee River	19,768	6,570,000	23.7	1,520	200
Stronach Creek Little Manistee River	17,792	4,670,000	9.9	550	70
Elbow Lake Little Manistee River	35,583	6,240,000	10.8	530	70
Tank Creek Little Manistee River	21,004	3,480,000	7.6	380	50
Old Stronach Cemetary Little Manistee River	16,803	2,060,000	7.5	400	50
Little Manistee River	134,919	28,950,000	81.6	53,160	650
Estimates based on 2.09 inch rainfall in 24-hour period					

Source: Stroud Water Research Center; STEPL modeling

Near the Mouth of the Little Manistee River

The storm runoff calculations show that, in each of the Little Manistee subwatersheds, the majority of stormwater is infiltrated into the soil, with relatively small percentages of runoff. This is to be expected, given the forested land cover and highly permeable soil types.

On a per-acre basis, the largest volumes of runoff and of phosphorus, nitrogen and sediment occur in the two easternmost subwatersheds, which also contain the majority of the watershed's agricultural land covers.

Table 16 - Runoff concentrations by Subwatershed

Subwatershed	Area	T.S.S.		Nitrogen		Phosphorus	
	Acres	Lbs/acre	Conc. mg/L	Lbs/acre	Conc. mg/L	Lbs/ acre	Conc. mg/L
01 Twin Creek Little Manistee River	23,969	1.851	119.6	0.058	3.7	0.0080	0.5
02 Lincoln Creek Little Manistee River	19,768	2.412	116.1	0.077	3.7	0.0107	0.5
03 Stronach Creek Little Manistee River	17,792	1.113	67.9	0.031	1.9	0.0045	0.3
04 Elbow Lake Little Manistee River	35,583	0.606	55.5	0.015	1.4	0.0018	0.2
05 Tank Creek Little Manistee River	21,004	0.721	70.1	0.018	1.7	0.0027	0.2
06 Old Stronach Cemetery Little Manistee River	16,803	0.896	116.9	0.024	3.1	0.0036	0.4
Little Manistee River	134,919	1.213	90.5	0.036	2.6	0.0045	0.4
Estimates based on 2.09 inch rainfall in 24-hour period							

Source: Stroud Water Research Center; STEPL Modeling

These calculations provide a baseline which can be adjusted in the future to gauge the impact of changing land uses or installation of best management practices associated with agricultural systems, transportation infrastructure or low-impact development.

The WMP envisions long-term monitoring of water quality parameters and stream flow to better define loadings in the future. Because of the high permeability of the soils, it also is important to institute a program to monitor groundwater flow and quality.

On-Site Wastewater Systems

Nearly all dwellings in the Little Manistee Watershed are served by on-site wastewater systems that rely on septic tanks and drain fields to process wastewater from toilets, sinks and showers. Homeowners in much of the watershed have no alternative to on-site wastewater systems, since properties are widely dispersed, and municipal sewer lines are both non-existent and impractical to construct.

In a typical system, household wastewater flows by gravity or pumps to a large septic tank, typically with two chambers and a capacity of at least 1,000 gallons. Microbes in the tank break down some organic wastes which precipitate to the bottom of the tank. Partially cleared effluent then flows out and is dispersed into the drainfield – a network of perforated pipes laid in a level bed of gravel.

Under ideal conditions – widely spaced residences and proper separation of the drain field from groundwater or surface water – these on-site systems are highly efficient. Problems may occur, allowing phosphorus and other

nutrients to migrate away, when the system is improperly maintained, overloaded, or constructed too close to a waterway.

Data from the 2010 United States Census indicate the watershed has an estimated 4,065 dwellings, of which 1,594 are used year-round and 2,471 are of "occasional or seasonal use." It is possible to use this estimate, along with national data on septic system efficiency, to approximate the impact of septic systems on the soils of the watershed (see: Table 17).

Table 17 - On-Site Wastewater Systems

Properly Functioning Systems (90 percent of total)						
System Type: (Seasonal Or Year-Round)	Number Of Properly Functioning Systems	Annual Effluent Per System (Gallons)	Total Annual Effluent (Gallons)	Total Annual Phosphorus Released To Drain Fields (Pounds)	Phosphorus Removal At 90% Efficiency (Pounds)	Phosphorus Released To Environment (Pounds)
365-Day Systems	1,435	54,750	78,566,250	6,556	5,901	656
180-Day Systems	2,224	27,000	60,048,000	5,011	4,510	501
Total For Properly Functioning Systems	3,659		138,614,250	11,567	10,411	1,157
Low Functioning Systems (10 percent of total)						
System Type: (Seasonal Or Year-Round)	Number Of Low Functioning Systems	Annual Effluent Per System (Gallons)	Total Annual Effluent (Gallons)	Total Annual Phosphorus Released To Drain Fields (Pounds)	Phosphorus Removal At 30% Efficiency (Pounds)	Phosphorus Released To Environment (Pounds)
365-Day Systems	159	54,750	8,705,250	726	218	509
180-Day Systems	247	27,000	6,669,000	557	167	390
Total For Low Functioning Systems	406		15,374,250	1,283	385	898
Estimated Annual Release of Phosphorus, All Systems: 2,055 Pounds						

Source: National Environmental Services Center, 2013; 2010 U.S. Census Data
Calculations use: Daily effluent per user - 60 gallons; average number of users per system - 2.5; Daily effluent per system - 150 gallons

The estimates used here are for phosphorus, which is an important component of household waste, and is considered to be the limiting factor in growth of algae in surface waters.

A large number of national studies have been conducted over the years, producing a wide range of estimates of both the volume and the phosphorus concentration of septic tank effluents. Taking approximate mean values of those estimates, the calculations used in this section assume residential wastewater flows of about 60 gallons (230 liters) per person per day, and phosphorus concentration in the effluent of 10 mg/L.

Applying those assumptions to a full year and an average of 2.5 residents per dwelling (and converting all measures to pounds and gallons) would indicate that the effluent flowing from an average home into a properly functioning septic system will carry about four to five pounds of phosphorus annually.

In a high functioning system, 85 to 95 percent of the phosphorus is taken up in the septic and drainfield system through processes known as precipitation and adsorption. (National Environmental Services Center, 2013)

Unfortunately, studies by the U.S. Environmental Protection Agency indicate that 10 to 20 percent of systems will fail during their "intended" lifespan. Michigan officials estimate that 10 percent of the state's 1.3 million on-site septic systems are failing (Office of the Great Lakes, 2016).

Applying those estimates to the Little Manistee Watershed indicates the watershed has about 4,000 dwellings with properly working systems, and nearly 450 with low- or non-functioning systems.

Table 17 estimates the phosphorus released to the watershed's environment through the usage of septic tanks. The calculations assume that "seasonal" dwellings are in use for 180 days a year, that 90 percent of the systems are high functional, and that phosphorus removal efficiency averages 90 percent in high functioning systems and 30 percent in those with low or no function.

Based on those assumptions, systems throughout the watershed release some 2,300 pounds of phosphorus into the environment each year. Upgrading all of the low-function systems could reduce that total number by more than 870 pounds, or about 37 percent.

Further improvements could potentially come from system upgrades and use of such techniques as cluster systems for developed areas near lakes or streams.

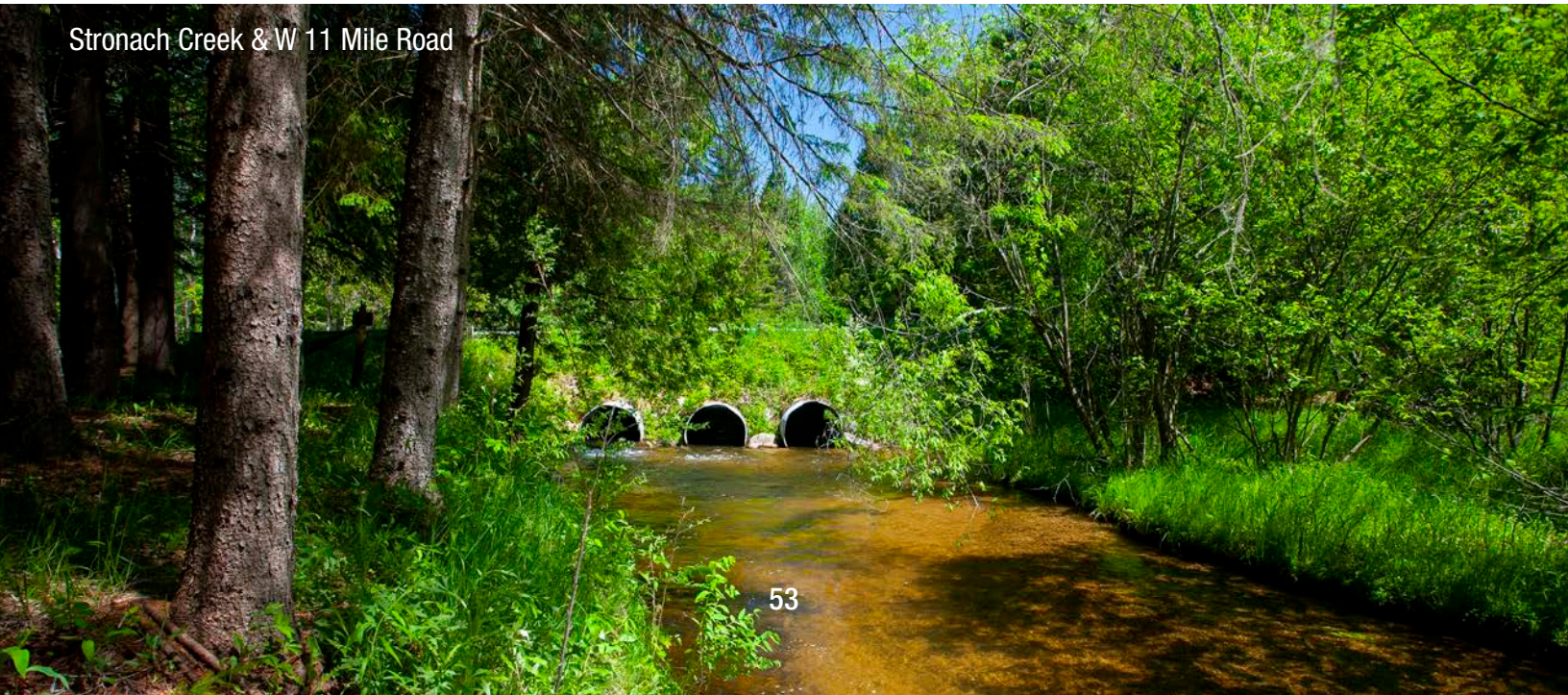
Road Stream Crossings

Pollutants including sediment, nutrients and gas and oil products often enter surface water at points where transportation infrastructure interacts with streams. This includes the sites of bridges, and culverts, as well as roadside ditches which may ultimately drain to lakes or streams.

Improperly sized or poorly maintained culverts may also stress waterways by hindering fish passage or creating eroded "plunge pools" which can warm water and accumulate sediment or trash.

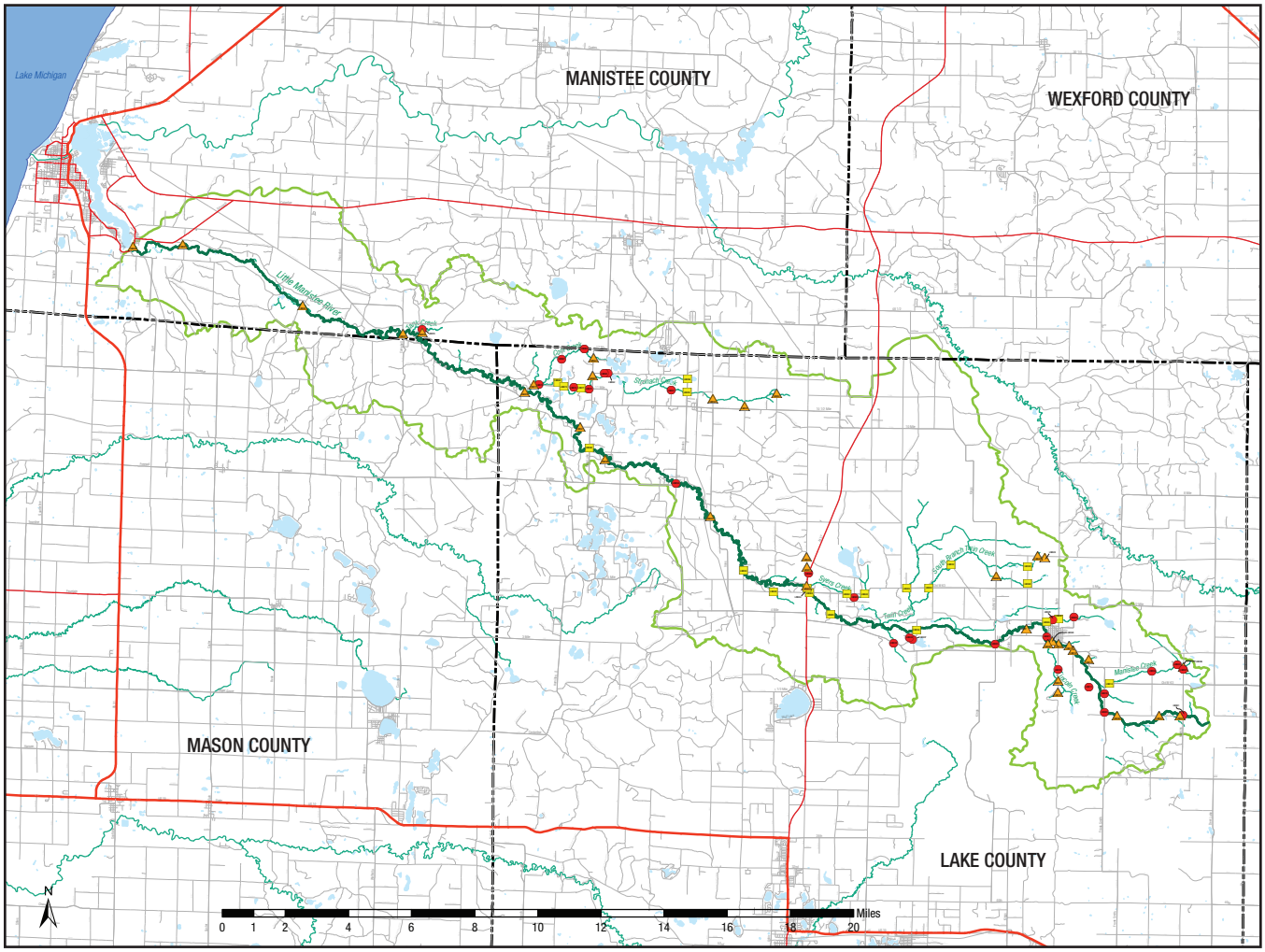
These problems tend to be exacerbated by high water or "flashiness," which can increase sediment loads and overload ditches and culverts. The issues are somewhat naturally mitigated in the Little Manistee Watershed, where forest cover and porous soils limit the volume of stormwater runoff.

Public roadways cross streams at 85 sites in the Little Manistee Watershed, according to an inventory completed in 2014 and updated in 2019 by Conservation Resource Alliance. The crossings range from small culverts carrying unnamed tributaries under forest roads, to major bridges such as that at state Highway M37 in Lake County. (see: "Map 13 - Road Stream Crossings" on page 54)



Stronach Creek & W 11 Mile Road

Map 13 - Road Stream Crossings



KEY | Crossing Severity

- Minor
- Moderate
- Severe

FEATURES

- Little Manistee River
- Other Principal Arterial
- Minor Arterial
- Major Collector
- Local Roads
- County Boundary
- Inland Lakes
- Area Rivers
- Lake Michigan
- Little Manistee Watershed Boundary

The inventory assesses each crossing for such information as erosion potential, condition of the infrastructure and whether the passage of fish is hindered. That information is used to place each crossing in one of three categories: Minor, Moderate or Severe.

In the 2019 inventory, 22 sites were ranked as minor; 35 were moderate and 28 ranked as severe. Of particular concern was that the number of severe sites increased from only four in the 2014 survey, an increase of 21 severe sites in only five years. One factor in the increase may be that the period from 2014 to 2019 represented Michigan's wettest five-year period in the past 100 years, according to statistics from the National Oceanic and Atmospheric Administration (NOAA).

The CRA inventory estimated total annual erosion from the 85 sites at 50.1 tons per year. That was broken down as a total of 2.8 tons a year for the 22 sites categorized as minor; 26.7 tons annually from the 35 moderate sites and 20.6 tons at the 28 crossings in the "Severe" category (see: Table 18 on page 55).

Table 18 - Road Stream Crossing Summary

Road Stream Crossing Summary			
Severity Category	Number of sites	Annual Sediment (tons)	Annual Phosphorus (pounds)
Minor	22	2.8	2.4
Moderate	35	26.7	22.7
Severe	28	20.6	17.5
TOTAL	85	50.1	42.6

Source: Conservation Resource Alliance, 2019

The cost of repairing the sites ranked as severe is estimated at $1.7 million, according to 2014 figures (Cost figures were not updated for the 2019 inventory).

Because of the number of sites and the high cost of remediation, road-stream crossings are considered to be a critical threat to water quality. The WMP recognizes the value of monitoring the crossings and correcting those that create stress on water quality or aquatic habitats.

Two sites – a bridge on the mainstream and a culvert on an unnamed tributary have been restored in the past few years. The WMP recommends repairing the severe and moderate sites as funding becomes available. This task will require long-term cooperation among county road commissions, the Conservation Resource Alliance, appropriate grant-making agencies and riparian property owners. The estimated cost of bringing all of this aging infrastructure up to date is $4.5 million.

The full inventory, with maps, GPS coordinates, site photos and data from the field inventory sheets may be viewed online at www.northernmichiganstreams.org/littlemanisteews.asp.

The site is managed by non-profit organizations CRA and Huron Pines.

Streambank Erosion

Modest rates of bank erosion can be regarded as a natural, and even beneficial, process. Flowing streams naturally cut into banks on the outside of meanders, adding new material and habitat to the streambed and creating a richly vegetated flood plain on the inner curve.

However, the process was accelerated to an unnatural degree by historic log drives and timber-cutting practices which removed all streamside vegetation. Erosion from the timbering era introduced huge volumes of sand, which covered the gravel in prime spawning beds and left the river warmer and wider than its natural state. After more than 100 years, scars are still evident at sites like the Chicago Boy Rollway in the National Forest, though much of the stream has recovered.

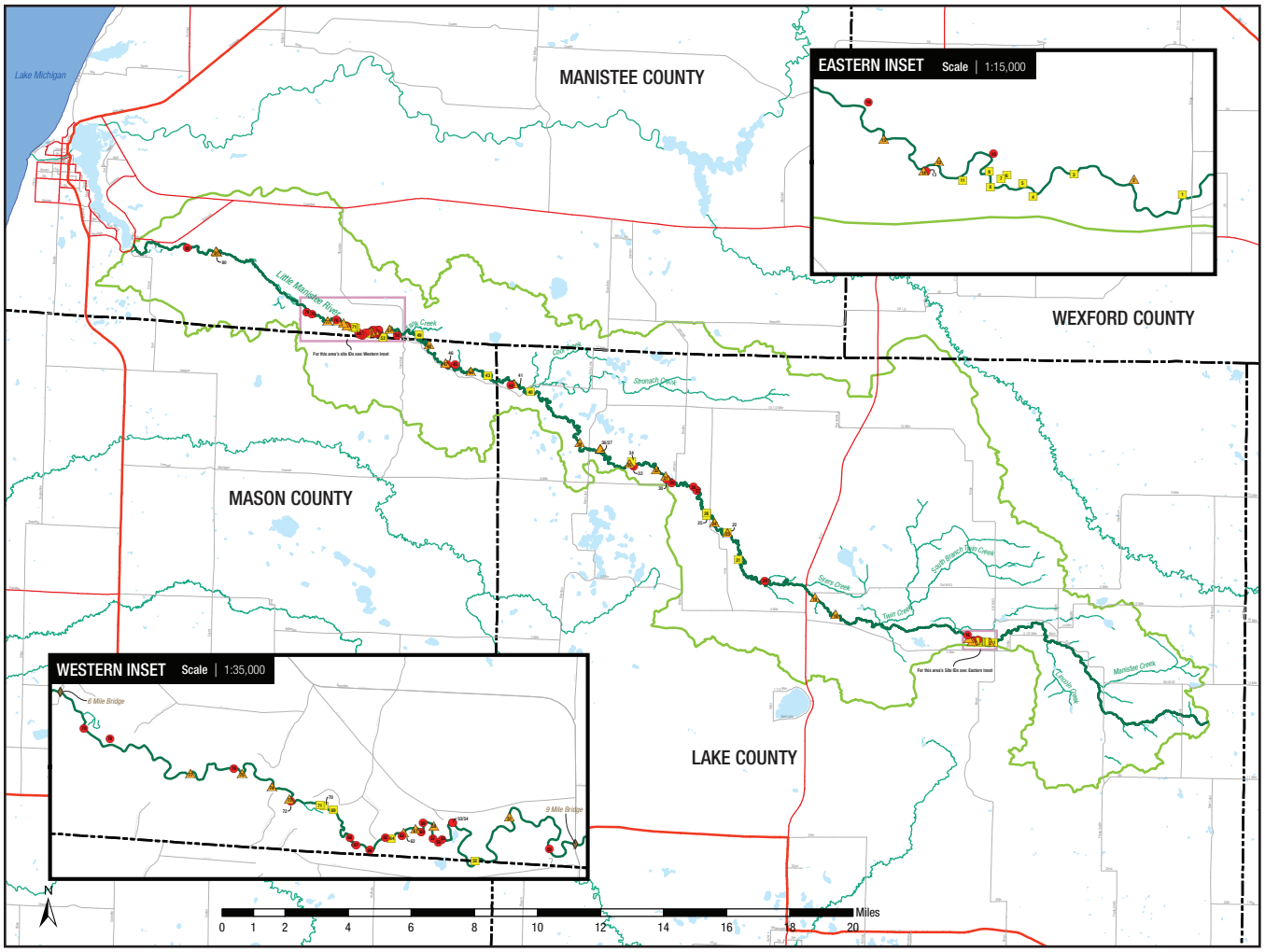
Modern logging methods are less stressful to the stream, but continued human activities such as vegetation removal and development of impervious surfaces may still lead to bank erosion in excess of natural levels. Unregulated access by hikers, fishermen and boaters may also compromise streambanks at some sites.

Of particular concern in this watershed are the coarse sands that can wash from streambanks and accumulate on the river bottom, diminishing habitat for macroinvertebrates and covering the gravel beds favored by spawning fish.

The Conservation Resource Alliance conducted an inventory of streambank erosion sites on the mainstream of the Little Manistee River in 2014.

The project identified 81 sites, ranging from minor to severe on the bank erosion index (see: "Map 14 - Streambank Erosion Sites"). They varied in size from a 10-foot erosion site caused by concentrated foot traffic on National Forest land, to several riverbend locations with bank heights up to 40 feet and eroding banks from 100 to 250 feet in length.

Map 14 - Streambank Erosion Sites



KEY | Erosion Severity

- Minor
- Moderate
- Severe

Site ID 17 not mapped due to incomplete latitude and longitude data for the site.

Streambank erosion site offsets from river channel at inset scale is due to positional errors from a lower river survey point resolution.

FEATURES

- Little Manistee River
- Other Principal Arterial
- Minor Arterial
- Major Collector
- Local Roads
- County Boundary
- Inland Lakes
- Area Rivers
- Lake Michigan
- Little Manistee Watershed Boundary

In all, the inventory recorded 23 minor erosion sites, 29 moderate sites and 29 severe erosion sites. The total eroded length of the inventoried sites was 3,800 feet. Severe erosion sites covered a total of just less than 1,800 feet (see: "Table 19 - Streambank Erosion Summary" on page 57). A general estimate for the cost of erosion mitigation using whole tree revetments is $120 per foot.

Table 19 - Streambank Erosion Summary

Little Manistee River Streambank Inventory, 2014				
Severity Category	Number of sites	Total length (feet)	Sediment (tons)	Phosphorus (pounds)
Minor	23	890	9	7
Moderate	29	1,121	96	81
Severe	29	1,798	540	459
TOTAL	81	3,809	645	547

Source: Conservation Resource Alliance

Thirty of the erosion sites were in the river segment between Nine-Mile Bridge and Six-Mile Bridge, where a high gradient and relatively swift water have the capacity to cut into the segment's high, sandy banks (Winkler, 2014). Much of this sediment accretes on the riverbed in the next downstream stretch, below Six-Mike Bridge.

The LMWCC, working with Conservation Resource Alliance, has identified funding for using woody debris to enhance fish habitat. In many cases this installation may serve a double duty of stabilizing eroding banks.

The WMP recommends mitigation of the severely and moderately eroded sites, as well as continued monitoring and mitigation of additional areas as funding becomes available. CRA anticipates taking on a project to update the erosion inventory in 2020.

Eroding streambanks are considered a critical issue for mitigation in the Little Manistee Watershed. Additional information is presented in the Critical Sites section of Chapter 6.

An online resource maintained by CRA at www.northernmichiganstreams.org/littlemanisteews.asp, shows many of the streambank erosion locations, but has not been fully updated from prior inventories. The site is to be updated with the results of the 2020 inventory.

Agriculture

There are no large concentrated animal feeding operations in the Little Manistee Watershed. Where agriculture exists in the watershed it consists of pastured livestock and moderately scaled row-crop cultivation, chiefly corn.

The National Land Cover Database (NLCD) data from 2016 shows 7 percent of the land in the Little Manistee Watershed is used for cultivated crops, hay or pasture. This limited area, 15.5 square miles or 9,900 acres, does not appear to have a noticeable impact on the watershed as a whole, but should be further evaluated for site-specific impacts. The majority of the agricultural lands are in Ellsworth and Newkirk townships, upstream from the Luther Dam. Streams in this headwaters region of the watershed have not been systematically monitored in the past. The WMP envisions increased monitoring.

One agricultural impact area noted by the MDEQ (Lipsey, 2014) is along Cool Creek, on the Manistee-Lake county line, where pastured cattle have access to several hundred feet of stream. The WMP recommends that state officials work with the property owner to develop a more environmentally sound method for the animals to access drinking water.

Many parcels which formerly supported crops or pasture have been allowed to transition to grassland or forest for hunting, recreation or scenic values.

While agriculture is not a major economic driver in the watershed it remains an important component of the community, significant for its ecological value and its connection to the community's food system and rural roots.

Recreational Infrastructure

Economy and lifestyles in the Watershed are closely associated with boating, fishing, camping, motorized and non-motorized trail use, and other forms of outdoor recreation. As such, the region has a significant recreational infrastructure in the form of campgrounds, trails, guide services, boating access sites, and paddlecraft liveries.

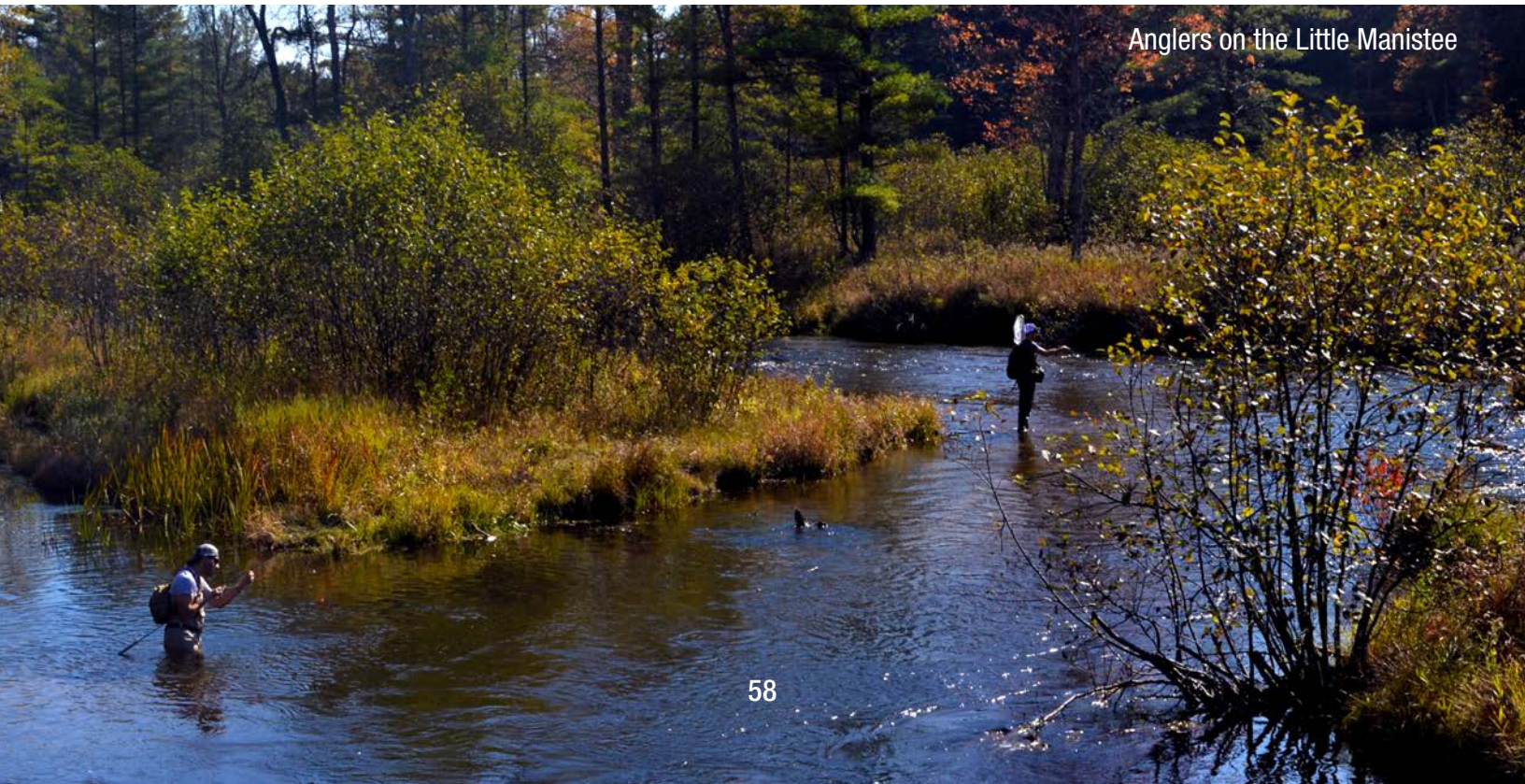
These facilities provide economic value to the community and are vital to allowing the public to experience the designated and desired uses of the watershed. However, careful management must be practiced to minimize pollution. Of particular concern are erosion at poorly designed or casual river entry sites; nutrient loadings from concentrated uses such as campsites near the water, and the spread of invasive species at campgrounds, trails and water access sites.

None of these issues has been quantified locally, though erosion is evident at several riverfront sites. These access sites should be evaluated to determine whether updated infrastructure could reduce erosion and ease entry to the water.

The emerald ash borer was likely transported to the region in campfire wood and has since destroyed thousands of trees in the watershed and adjacent areas of Michigan. Additionally, there is a well-documented risk of introducing aquatic invasives such as New Zealand mud snails at fishing entry sites. Eurasian watermilfoil, zebra mussels and other nuisance species are known to “hitchhike” from one water body to another on boats, fishing gear and trailers. (University of Wisconsin, 2013)

The WMP recommends educational displays and wader cleaning stations at river access sites along with monitoring for the introduction of additional species. Concern about the spread of invasive species through boat traffic can be addressed through use of mobile boat-washing equipment available from Manistee County, Michigan State University Extension or the Benzie Conservation District. Invasive species are also addressed in the WMP’s educational component in Chapter 9.

Recreational access to the forests and waterways of this watershed need not be compromised. A goal of the WMP is to ensure that best management practices are applied in all situations to minimize the negative impacts.



Anglers on the Little Manistee

Chapter 4

Significant Pollutants of Concern

Potential environmental stressors in the Little Manistee Watershed were identified through water quality monitoring and public input. The WMP Steering Committee assessed the relative impact of six potential stressors, and assigned each a priority level from 1 to 3, with 1 denoting the level of greatest significance in this watershed.

The stressors and priority levels are shown in Table 20 and presented in greater detail in the following section.

Table 20 - Stressors in Little Manistee Watershed

Priority Level of Stressors	
Level 1	Thermal Issues
	Sediments
Level 2	Excessive nutrients
	Invasive Species
	Biological Pathogens
Level 3	Other Unspecified Stressors

While the priority listing indicates which conditions pose the most likely issues at this time, it should be noted that each of the listed stressors has the potential to negatively impact waters in the Little Manistee Watershed.

Natural processes may be expected to contribute to some level of each of the above stress factors, and in reality this is not always a bad thing. It would, for example, be counter-productive to remove all nutrients from a body of water, or to completely cut off the introduction of fresh sediments.

Further, it is clear that some water bodies are more naturally productive than others. That is, because of soils and other conditions, some lakes and streams contain more nutrients and therefore produce more plant growth. As a general statement, the goal of watershed management is to observe the natural conditions of each water body and, to the extent possible, reduce any excessive or human-caused loadings of pollutants.

The section below provides more detail on the major environmental stressors listed above. Later sections of this chapter will discuss the impacts of these pollutants on segments of the watershed designated as critical sites or priority areas.

Sediment

Sediment includes sand, silt, muck and other naturally occurring soils and minerals that may be washed from land into water and/or moved to new locations due to stream flow or wave action.

This type of pollution may arise from a number of sources, including construction sites, shoreline or streambank erosion, road stream crossings, urban storm runoff, logging operations, unmanaged recreational access sites, and runoff from non-vegetated open or agricultural land. Failures of the Luther Millpond Dam in the 1980s and 1990s caused tons of sediment to flow downstream from the impoundment site. The loss of ash trees as result of damage caused by the Emerald Ash Borer, has decreased forest cover at some sites and increased the likelihood of erosion.

Once introduced to the surface waters, sediment may cover fish-spawning areas, interfere with benthic invertebrate life cycles, create hindrances to navigation, alter water temperatures or contribute to turbidity. Sediment is perceived as a major stressor in the Little Manistee Watershed because of these potential impacts on the high quality coldwater fishery. The most common sediment concern in the watershed occurs when sandy soils erode into the stream and cover spawning beds and other aquatic habitat on the stream bottom.

Another significant concern is that other pollutants – including phosphorus and nitrates, animal manures, chemicals, and biological pathogens – may adhere to small sediment particles and be washed into surface waters. For this reason, sedimentation almost always contributes to levels of other pollution.

Thermal Stressors

Viability and reproduction of many aquatic species are affected by water temperature. For example, sustained temperatures above 68 degrees limit the reproduction and survival of many trout species. This is a significant concern in the Little Manistee River Watershed, where the river's mainstream and all named tributaries are classed as coldwater streams.

The Little Manistee Watershed Conservation Council monitors water quality parameters, including temperature, at up to 20 sites on the river and tributaries each July. The LMWCC records indicate the temperature is well within the range expected for coldwater streams. For example, in July of 2018, the range of temperatures was from 50 degrees to 61 degrees on 12 sites on the main stream. In 2019, the range was from 59-64. While those one-day numbers are encouraging, the WMP recommends a system of continuous monitoring to ensure that water temperatures can be tracked throughout the summer months.

Any conditions that tend to increase the temperature of naturally cold water bodies may be considered to be thermal stressors.

Groundwater generally has a temperature of 50-55 degrees. Infusion of this thermally stable supply is often the key factor in maintaining a coldwater stream. Decreases in groundwater flow – for example from overuse of high-capacity irrigation wells – may have a significant impact on surface waters.

Other potential causes of thermal stress are increases of surface runoff, timber cutting that reduces streamside shade, reduction of forest cover due to the loss of ash trees, and the influence of dams, which expose impounded areas to additional sunlight and siltation.

The LMWCC is working with a chapter of Trout Unlimited to purchase and install up to seven sensors in the river to monitor water temperature on a constant basis. The sensors will also record water depth, which can help to determine changes in stream flow.

The U.S. Forest Service has conducted thermal monitoring at a location known as Linke's Pond, in the lower watershed, and found that an impoundment associated with a defunct private fish rearing operation raises water temperature in a tributary by 10-15 degrees. The site is now part of the Manistee National Forest, and the agency is reviewing plans to mitigate the thermal impact. The site is not classified as a critical site in the watershed, due to its small size and the fact that the forest service is working to mitigate the impacts.

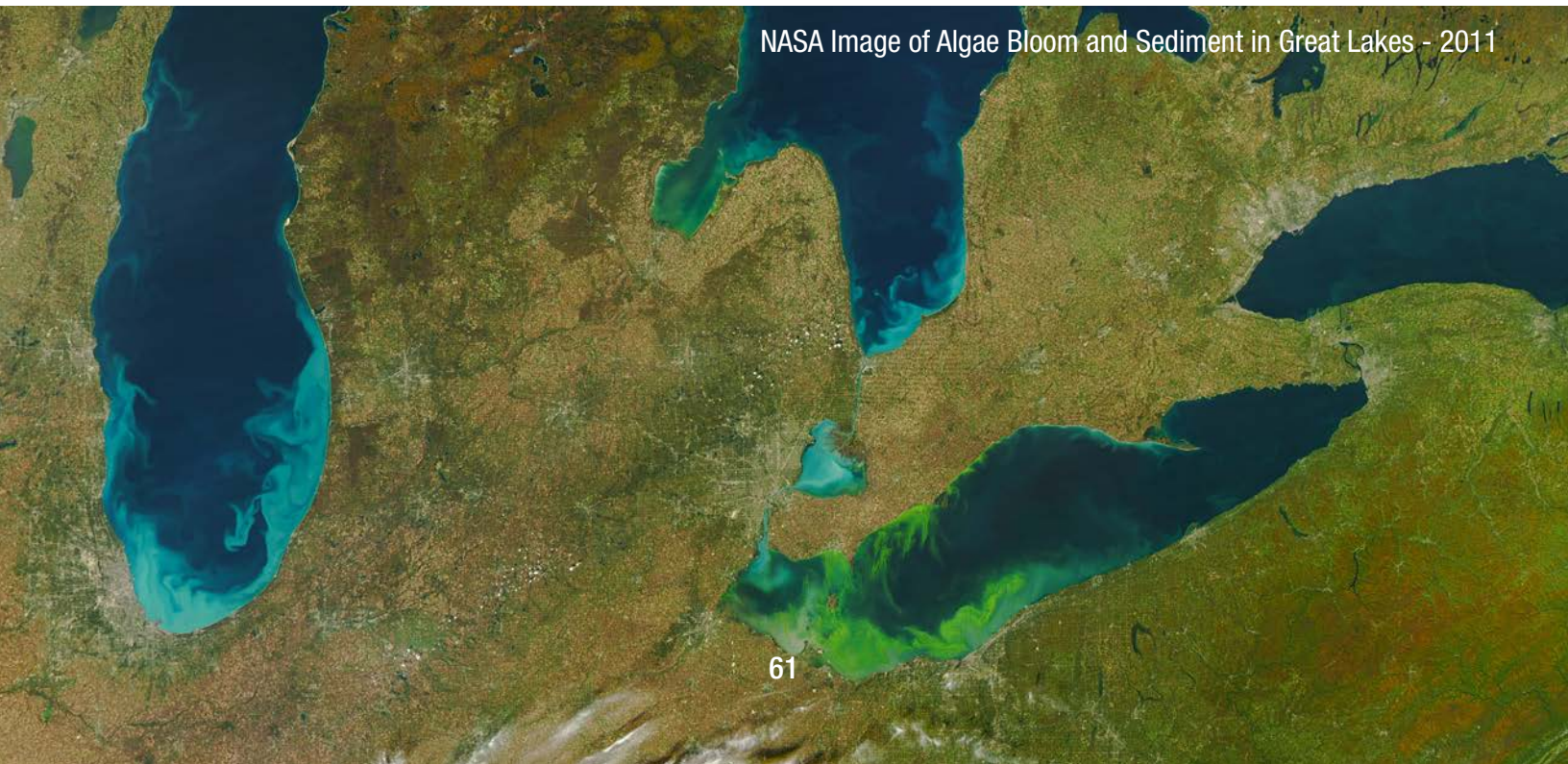
The Little Manistee's distinction as a prime fishery depends on cold, clear water. Maintaining that thermal balance is a goal of the WMP.

Nutrients

Nutrient pollution refers to excessive loadings of substances that act as fertilizers to increase plant and algae growth. Aquatic vegetation generally requires the same three primary nutrients as do terrestrial plants: Nitrogen, phosphorus and potassium.

In most Michigan waters, the "limiting" nutrient is phosphorus. That is to say, the other nutrients tend to be available in greater supply in surface water, so that an increase in phosphorus often results in increased production of weeds and algae. Conversely, reductions in phosphorus loadings often result in decreased weed growth, even when the other nutrients are available in ample amounts.

Excessive weed and algae growth may disrupt pre-existing habitats, and may also interfere with recreational uses such as swimming and boating. Some invasive species and undesirable cyanobacteria are believed to thrive and potentially out-compete more desirable plants in waters with high phosphorus levels. In addition, bacteria involved in the decomposition of dead vegetation make use of dissolved oxygen from the water column. Where heavy blooms of vegetation have occurred, this may deplete the oxygen supply to the point that fish cannot survive. LMWCC volunteers have regularly sampled the water at more than 20 sites (see: "Table 4 - Volunteer Water Monitoring Summary" on page 19). A long-term series of phosphorus loadings at three sites on the Little Manistee is shown in Table 21 on page 62.



NASA Image of Algae Bloom and Sediment in Great Lakes - 2011

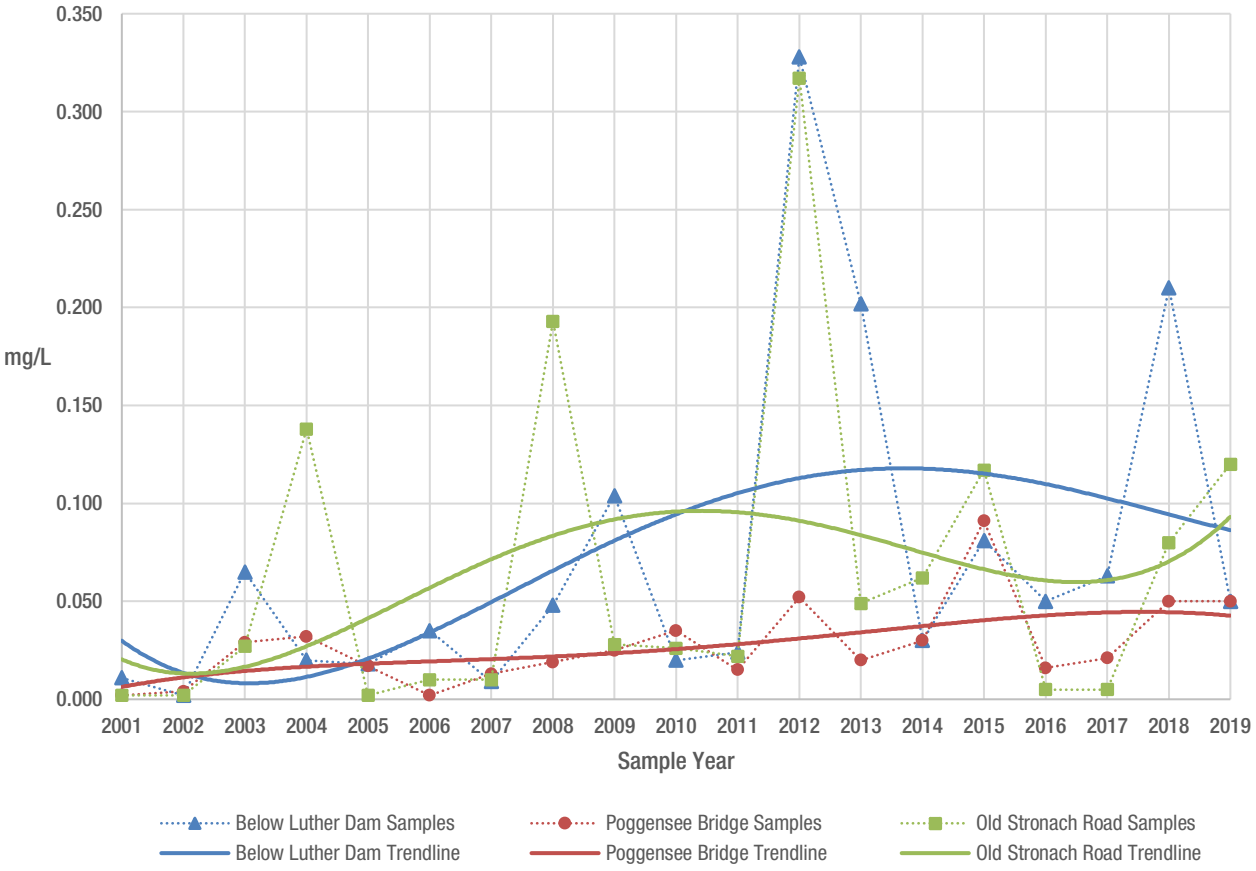
The three sites were selected for additional analysis to show potential trends in levels of phosphorus. The three are: Site No. 1, below Luther Dam, representing the upper reaches of the river; Site No. 11, Poggensee Bridge, representing the middle segment; and Site No. 21, Old Stronach Road, in the lower river close to the watershed's exit point.

Each site was sampled annually from 2001-2019. The 19-year data series shows a slight uptrend in phosphorus levels at each of the sites, along with considerable year-to-year variability (see: Table 21).

Of the three sites, levels were lowest and most consistent year-to-year at Poggensee, the middle river site. All sites were generally below 0.1 mg/L of phosphorus, though Old Stronach exceeded that level five times and Luther four times in the 19 samplings.

Inconsistent management of the Luther Dam may account for at least a portion of the variability at that site. The extremely high phosphorus readings in 2012, shown in both Table 4 and Table 21, likely correlate with low water flows in that year. Though the Little Manistee did not have flow monitoring in place in 2012, both Lake Michigan and Manistee Lake were at near-record low levels at that time.

Table 21 - Phosphorus Monitoring Long-Term Series



Note: Individual samples that tested below the detection threshold were considered at the threshold for the purpose of graphing the results and calculating the trendlines. Trendlines utilized a 4th order polynomial regression.

Michigan has taken steps to reduce phosphorus loading by restricting use of high-phosphorus detergents, and lawn fertilizers containing phosphorus.

Non-point sources of nutrient pollution include on-site septic systems, animal manures, bird droppings, runoff from agricultural and turf areas, and streams or storm sewer inlets into lakes.

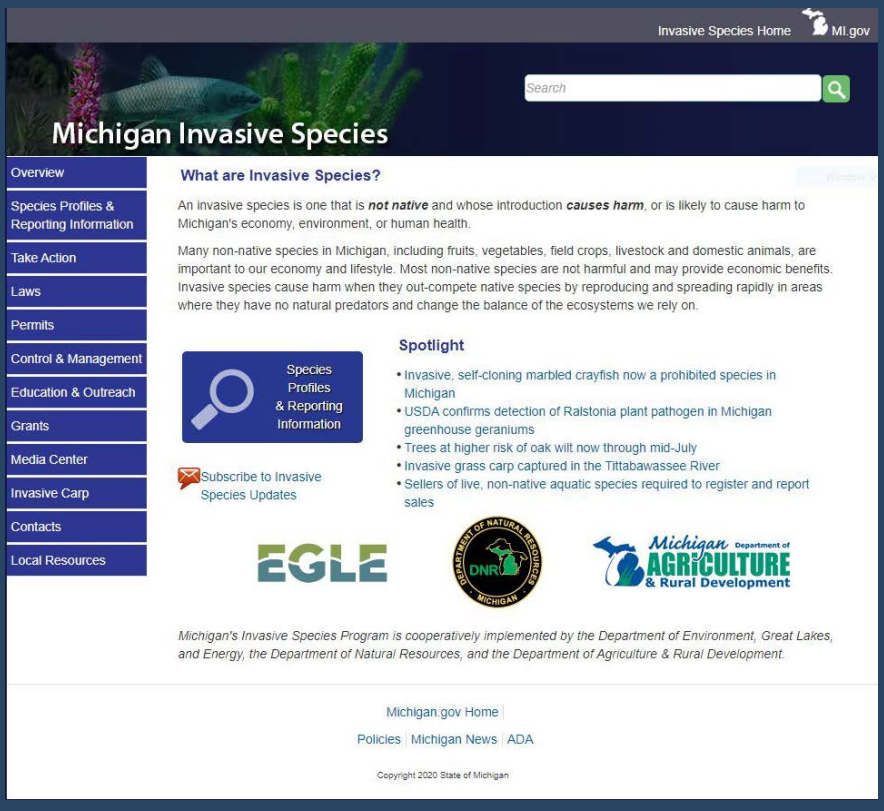
As noted above, nutrients may adhere to particles of sediment that are washed into surface waters, so sources of the two pollutants are often related.

Invasive Species

Invasive species, for the purposes of this Watershed Management Plan, are those non-native plants and animals which, if allowed to become established, are likely to interfere with designated and desired uses of the water or to cause negative impacts on native ecosystems.

Invasive species of significant concern include: Zebra and quagga mussels; Eurasian watermilfoil; garlic mustard; non-native or hybrid strains of phragmites; narrow-leaf cattails; purple loosestrife; baby's breath; reed canary grass; Japanese knotweed; round gobies; spiny water fleas; and, potentially, New Zealand mud snails and various species of Asian carp.

Many of the above plant species are known to create dense monocultures which displace native vegetation and disrupt existing habitat. Invasive fish and invertebrates have the potential to alter aquatic food chains to the extent that some native species can no longer thrive.



The interactions between native and invasive species are often complex. Zebra mussels, for example, are efficient filter feeders, which selectively remove algae from the water column and deposit their own wastes as nutrient in the bottom sediments. In addition to altering the food web, the effect of mussel infestation may be to dramatically increase the clarity of the water column, while at the same time promoting excessive growth of rooted weeds.

Invasive species are commonly introduced by inadvertent human action, and then may be spread by animals, wind, flowing water, recreational boating, or additional human behaviors.

Michigan law prohibits launching a boat with any non-native plant adhered to the vessel or trailer. Boating and water recreation are important economic and social elements in the local community. The WMP supports expansion of boat washing, installation of boot- and wader-cleaning facilities at trailheads and popular river-access sites, and other voluntary measures to ensure that invasives are not spread by the public.

It is recognized that much of the region's existing flora and fauna – from apple trees to steelhead trout and Pacific salmon – are in fact exotic species that were purposefully introduced to the region by humans. Those species have become naturalized in the existing ecosystem, and are not considered "invasive" in this WMP.

Native Plants
Trillium

Little Bluestem

Biological Pathogens

The bacteria *Escherichia coli* are considered a marker for potential disease-causing pathogens. *E. coli* grow in the intestines of humans and warm-blooded animals, including birds, pets and agricultural livestock.

Water borne *E. coli* typically originates in the digestive systems of humans or warm-blooded animals. It may be deposited directly in the water, as with waterfowl droppings, or transferred from land via storm runoff, erosion, leaking septic systems or other modes of transport. Rain events may cause elevated *E. coli* counts by washing pollution from the land into storm drains or directly to surface waters, or by increasing stream flow and thereby stirring up contaminated bottom sediments.

When high levels of the bacteria are detected in water sampling, it is generally considered as an indicator that human or animal fecal matter is somehow entering the water. Though most strains of *E. coli* are harmless, the finding of fecal matter in the water increases the probability that disease-causing microorganisms may also be present.

E. coli is chosen as the indicator species because it is a familiar organism that is relatively simple to test for in the laboratory. The US-EPA determined that higher *E. coli* counts correlate with greater chances of illness for people using the water (Rippke, 2015).

The standard sampling method is to draw a minimum of three samples representative of a given area (for example, the waters just off shore in a public beach area). Laboratory technicians culture those samples and determine the number of "colony forming units" (CFU) per 100 ml of each sample. A geometric mean of the three counts is then calculated for comparison to the health standard.

According to the Michigan standard, a geometric mean of less than 300 CFU on a single testing day indicates the water is OK for full and partial body contact recreation. A mean of 300-1,000 CFU indicates the water is acceptable for partial body contact such as wading or paddling, but health officials advise no contact with water above the waist.

A sampling mean above 1,000 CFU may trigger a health advisory on public beaches, with a recommendation to avoid all body contact with the water.

In any advisory situation, the water is retested as soon as possible, and the advisory is removed when new sampling shows *E. coli* levels below the 300 CFU standard.

According to the Michigan DEQ's 2016 Integrated Report, a water body can be determined to be "not supporting" of the full body contact designated use, if regular sampling occurs and at least 10 percent of the daily mean values exceed the standard.

The LMWCC has conducted *E. Coli* monitoring at several locations in the Watershed (see: "Table 4 - Volunteer Water Monitoring Summary" on page 19). Some past samples have been elevated. This is a concern to the LMWCC, and continued sampling is recommended in the WMP.

Other Unspecified Pollutants

National studies have found low levels of such substances as pesticides, pharmaceutical metabolites, petroleum products, plastic microbeads, PCBs, mercury and others in many surface waters.

Of specific concern in the Little Manistee Watershed, is the possibility that improper disposal of toxic materials could result in contamination of groundwater, which may then flow into surface waters or be taken up by residential water wells.

The region's deep sandy soils are known to have only limited capacity for filtering water as it percolates from the sur- face to the water table. The WMP's Information/Education component (Chapter 9) includes a recommendation for a program to educate residents and property owners of this concern.

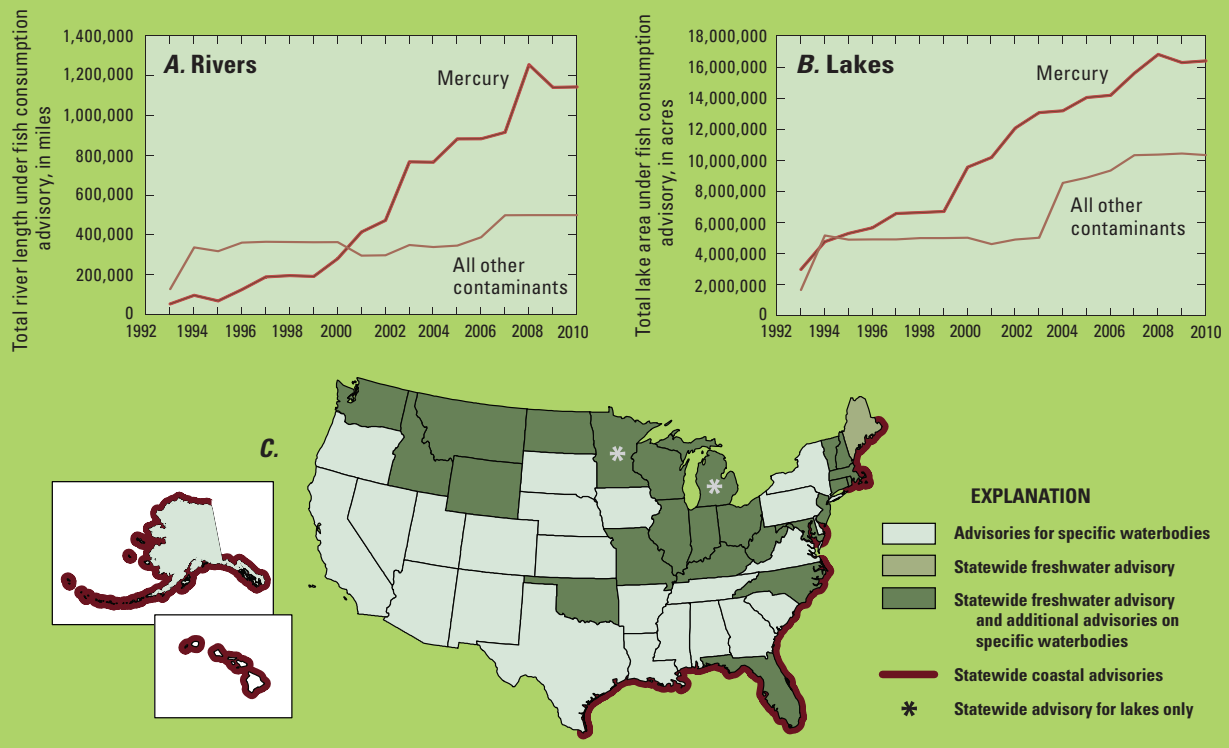
PCB's and mercury are known to be taken up by fish. As a result, Michigan has issued health advisories, limiting the consumption of fish from the state's waters. To date, there has not been an analysis of pollutants such as pharmaceuticals or microbeads in the waters of this watershed. If they occur here, it is likely at extremely low levels. There appears to be no scientific consensus as to the impact of such minuscule traces, though some studies have raised concern that they could function as endocrine disruptors or otherwise affect aquatic life.

The potential impact of these pollutants does raise significant concern, worthy of further study but outside the control of the local community and beyond the scope of this Watershed Management Plan.

Fortunately, strategies designed to protect groundwater and reduce loading of sediment, nutrients and pathogens are also likely to minimize the introduction of additional pollutants into surface waters.

2014 USGS Report Excerpt:

The Quality of Our Nation's Waters, Mercury in the Nation's Streams—Levels, Trends, and Implications



Since 1993, fish consumption advisories related to mercury have increased substantially for both (A) rivers and (B) lakes. As of 2010, fish consumption advisories were issued for about 42 percent of the Nation's lake area and 36 percent of river length, with mercury accounting for most. (C) Fish consumption advisories have been issued by all 50 States to inform the public about health risks associated with mercury in fish.

Chapter 5

Quality Standards; Designated Uses; Goals & Objectives

Michigan has determined that surface waters must be of sufficient quality to support certain "designated uses" such as navigation, agricultural and industrial uses, and body contact recreation. Waters that do not support those uses are considered "impaired."

To receive state approval, the Watershed Management Plan must include provisions to ensure that water quality will be protected or improved to allow the public to engage in these uses. In addition, the WMP may also include provisions to support locally desired uses – for example, recreational enjoyment and/or economic benefits.

In the Little Manistee River Watershed, the only known impairments are fish-consumption limits caused by mercury and PCB pollution. Those limits apply to all Michigan waters and are not directly addressed in this plan. The status of the "designated uses" and "desired uses and conditions" for the Little Manistee Watershed are discussed in a later section of this chapter.

Little Manistee River Downstream of Weir

US-EPA Nine Elements

At the outset of the WMP process, the Steering Committee established its intent to develop a plan that protects the quality of the watershed, responds to the desires of the local community, and meets requirements for approved WMPs under both the Clean Michigan Initiative and Section 319 of the federal Clean Water Act.

In order to achieve USEPA approval under Section 319, the plan must, at a minimum, include these "Nine Elements:"

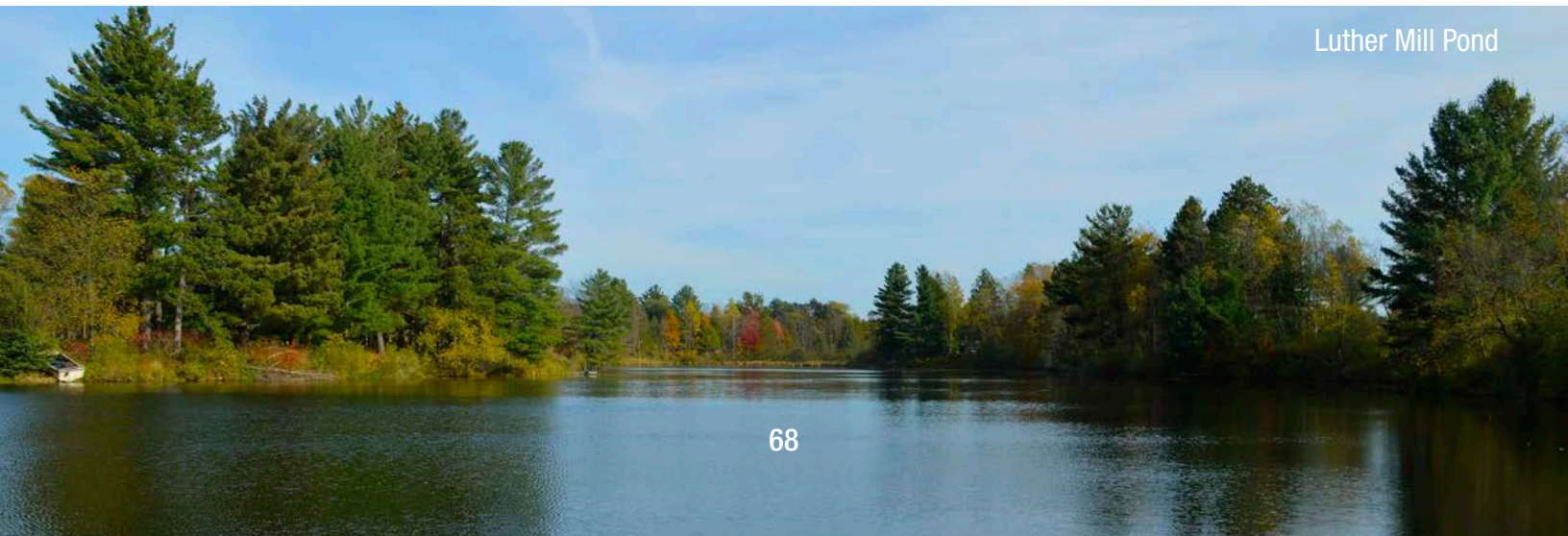
- ☑ **a)** Identify causes and sources of pollution
- ☑ **b)** Estimate pollutant loading into the watershed and the expected load reductions
- ☑ **c)** Describe management measures that will achieve load reductions and targeted critical areas
- ☑ **d)** Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the plan
- ☑ **e)** Develop an information/education component
- ☑ **f)** Develop a project schedule
- ☑ **g)** Describe interim, measurable milestones
- ☑ **h)** Identify indicators to measure progress
- ☑ **i)** Develop a monitoring component

According to the EPA, "The elements are labeled (a) through (i) to reflect how they are presented in the 319 guidelines. The first three elements (a through c) are considered during the characterization and goal-setting phases to address the primary sources of pollution in the watershed and to determine the management strategies needed in specific areas to reduce the pollution to meet water quality goals. The remaining six elements (d through i) are used to develop a specific plan of action with measurable targets and milestones, as well as the necessary financial and technical resources needed to restore the waterbody."

For this WMP, elements (a) and (b) are addressed in Chapters 3 and 4. Management measures related to element (c) are described in the Critical Areas and Priority Issues sections of Chapter 6.

A multi-page graphic (Table 27 on page 90 to Table 41 on page 104) describing Implementation Tasks, in Chapter 7, details the schedules, milestones, costs, monitoring, and progress measurements required in elements (d), (f), (g), (h) and (i). The monitoring and evaluation program is further discussed in Chapter 8.

Chapter 9 describes the Information/Education component (element e).



Luther Mill Pond

Part 4 Water Quality Standards

Water quality standards which must be met in all waters of Michigan are specified in the state's "Part 4 Rules, Water Quality Standards (of Part 31, Water Resources Protection, of Act 451 of 1994)."

The Part 4 Standards require that "…all designated uses of the receiving water be protected. Designated uses include: agriculture, navigation, industrial water supply, public water supply at the point of water intake, warmwater or coldwater fish, other indigenous aquatic life and wildlife, fish consumption, partial body contact recreation, and total body contact recreation from May 1 to October 31."

The MDEQ/EGLE publication "Part 4 Water Quality standards" includes details of both numerical and narrative standards.

An example of a numerical standard is the requirement that *E. coli* levels must be no more than 300 mg/L in any daily sampling event in order to meet the standard for full-body-contact recreation.

An example of a narrative standard is Rule 50 of the Part 4 Standards, which states in part: "The surface waters of the state shall not have any of the following physical properties in unnatural quantities which are or may become injurious to any designated use: (a) Turbidity. (b) Color. (c) Oil films. (d) Floating solids. (e) Foams. (f) Settleable solids. (g) Suspended solids. (h) Deposits."

Table 22 shows a partial list of the most commonly reported standards.

Table 22 - Michigan Surface Water Quality Standards (Partial List)

Designated Use	Standard												Applies to
Total Body Contact Recreation	*E. coli* counts of 130 CFU or less per 100 ml as a monthly average, or 300 or less on any daily sampling event												All water bodies, May 1 to October 1
Partial Body Contact Recreation	*E. coli* count of 1,000 CFU or less in daily sampling event												All water bodies
Warmwater Fishery	Dissolved oxygen not less than 5.0 ppm in epilimnion of lake												All water bodies not designated as coldwater lakes or streams
Coldwater Fishery	Dissolved oxygen not less than 6.0 ppm during summer low flow period; not less than 7.0 ppm at other times												Designated coldwater streams (including all named streams in the Little Manistee Watershed) and trout lakes
	Maximum monthly averages for cold water inland streams in this watershed (F°):												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	40°	48°	56°	63°	68°	68°	68°	65°	54°	43°	38°	38°	
Other Indigenous Aquatic Life and Wildlife	Limits on permitted discharges to prevent nuisance algae blooms and protect wildlife.												All water bodies
Fish Consumption	Advisories triggered if mercury level in fish tissue exceeds 0.35 mg/kg; or PCB's exceed 0.026 ng/L in water column.												All water bodies

Other surface water standards relevant to the Little Manistee Watershed are listed below. In many cases, the narrative standards are supported by additional documentation that could be used in site-specific determinations.

- The pH (a measure of acidity and alkalinity, with 7.0 representing a neutral position on the scale) should be in the range of 6.5 to 9.0 in all surface waters.
- Surface waters "shall contain no taste-producing or odor-producing substances in concentrations which impair or may impair their use for a public, industrial, or agricultural water supply source or which impair the palatability of fish as measured by test procedures approved by the department."

- "Toxic substances shall not be present in the surface waters of the state at levels that are or may become injurious to the public health, safety, or welfare, plant and animal life, or the designated uses of the waters."
- "…nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the surface waters…"
- "Toxic substances shall not be present in the surface waters of the state at levels that are or may become injurious to the public health, safety, or welfare, plant and animal life, or the designated uses of the waters."

The Little Manistee and all of its tributaries are considered coldwater streams, and meet the relevant standards for temperature and dissolved oxygen in Table 22 on page 69. In addition to those cold water standards, the Part 4 rules include maximum monthly temperature standards for point source discharges into inland lakes. These can be interpreted as general guidelines for maintaining good water quality for lakes with warmwater fish populations:

Table 23 - Maximum Monthly Temperature Standards For Point Source Discharges Into Inland Lakes

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
45°	45°	50°	60°	70°	75°	80°	85°	80°	70°	60°	50°

Finally, the Part 4 standards include "anti-degradation" language, which specifies that: "For all waters, the level of water quality necessary to protect existing uses shall be maintained and protected."

The overall status of pollution control efforts within the state is detailed in the Department of Environmental Quality publication: "Water Quality and Pollution Control in Michigan 2016 Sections 303(d) 305 (b) and 314 Integrated Report."

The document, generally known as the "Integrated Report," is published every second year. Where appropriate, this Watershed Management Plan relies on the 2016 Integrated Report as a source for information on standards and the known status of surface waters relative to those standards.

(Surface waters of the state are defined as lakes, rivers, wetlands, streams, and all other watercourses and waters, including the Great Lakes, within the jurisdiction of the state of Michigan.)

According to the Integrated Report, Michigan's standards "establish minimum water quality requirements by which the waters of the state are to be managed, and provide the primary framework that guides the MDEQ's water quality monitoring/assessment and water protection activities."

The report's listing of specific surface waters shows no impairments in the Little Manistee River Watershed, with the exception of the fish-consumption issue noted above.

For purposes of this Watershed Management Plan, fish consumption will be treated as an issue requiring public education and continued monitoring. However there is a recognition that the causes of this impairment are external to the Little Manistee River Watershed and must be addressed on a state and regional basis, not through elements of this plan.

The status of the designated uses in this watershed (see: "Table 24 - Little Manistee River Watershed Designated Uses" on page 71) was determined both by the official MDEQ/EGLE listings of impaired sites (Integrated Report, 2016) and by specific sampling within the watershed, where such data were available.

Table 24 - Little Manistee River Watershed Designated Uses

State of Michigan Designated Use	Impaired Locations (Per 2016 Int. Rep.)	Sites At Risk Of Degradation	Special Concern Areas	Environmental Stressors (Known or Suspected)
Navigation	None		Public access sites	Sediment Invasive Species
Full-Body Contact Recreation	None		Cool Lake, Cool Creek	*E. coli* Nutrients
Partial-Body Contact Recreation	None		Cool Lake, Cool Creek	*E. coli* Nutrients
Warm-Water Fishery	None	Entire Watershed		Sediment Invasive Species
Cold-Water Fishery	None	Entire Watershed	Little Manistee River, and all tributaries	Sediment Invasive Species Thermal Issues Hydrology Issues
Fish Consumption	Consumption limits on all Michigan waters			Mercury; PCBs
Other Indigenous Aquatic Life & Wildlife	None	Entire Watershed		Competition from invasive mussels Nutrients Sediment
Industrial Water Supply	None			
Agriculture	None			Livestock with direct access to waterway

The listing of desired uses and conditions (see: "Table 25 - Desired Uses Not Mandated by Michigan") was developed by the Watershed Steering Committee through a process of public input, including the Social Indicators Survey conducted as part of the development of the WMP. The designated and desired uses, and the status of

each use or condition within the watershed, are presented in tabular form on the following pages for easy understanding.

Table 25 - Desired Uses Not Mandated by Michigan

Desired Use or Condition	Primary Sites For Mitigation Or Monitoring	Priorities For Preservation	Potential Actions
Groundwater With High Water Quality And Sufficient Flows To Support Coldwater Streams	⊕ Oil/Gas Sites ⊕ On-Site Wastewater Systems ⊕ Former Gravel Mine Sites	✣ Wetlands ✣ Wellhead Protection Areas ✣ Vegetated Forest And Rangeland	⚑ Inspection requirements for on-site wastewater systems ⚑ Zoning and regulation to protect critical/priority areas ⚑ Reclamation of gravel mine sites
Multi-Use Forestry Resources (For Timber, Wildlife, Recreation And Ecological Services)	⊕ Public Lands In State And National Forests	✣ Old Growth Stands Of Native Conifers And Hardwoods	⚑ Forestry education ⚑ Natural shoreline demonstrations
Improved Fish Habitat	⊕ Little Manistee River	✣ Natural Instream Structures And Woody Debris ✣ Natural Shorelines On Lakes	⚑ Installation of habitat structures in bank restoration sites ⚑ Protection of native shoreline vegetation
Preservation Of The Little Manistee Watershed's Rustic, Natural Character, Including Scenic Beauty	⊕ Streambanks ⊕ Road Corridors ⊕ Public Lands	✣ Natural Areas ✣ Glacial Landscapes ✣ Riverbanks And Lake Shorelines ✣ State And National Forests ✣ Working Farms	⚑ Forest education; conservation easements or purchase of significant sites from willing sellers ⚑ Invasive species control
Outdoor Recreation Opportunities, Consistent With Preservation Of Environment	⊕ River Access Sites ⊕ Motorized Trails	✣ Motorized And Non-Motorized Trails; Access To Waterways And Natural Areas; Wild Areas For Hunting Or Observing Wildlife	⚑ Work with government, riparian owners and the public to develop and maintain appropriate access ⚑ Control invasive species at access sites ⚑ Design ORV trails to avoid streambanks and other sensitive sites
Economic Opportunities For Watershed Residents		✣ Recreational Industries ✣ Farm Production And Processing ✣ Construction And Real Estate ✣ Retail And Tourism Related Businesses	⚑ Master plans to encourage appropriate siting of businesses and to protect the environment ⚑ Promotion of "cottage industries" and arts related business ⚑ Regulations for low-impact development

Because the majority of the Watershed meets standards for the designated and desired uses, the WMP adopts a non-degradation standard – requiring that the present high water quality is maintained.

Goals and Objectives

After reviewing existing water quality data, and preliminary input from the public survey, the Watershed Steering Committee approved the following set of goals and objectives for the WMP. These provided basic guidance as the plan was developed.

As the planning proceeded, a menu of specific tasks was developed as a way of furthering these project goals and objectives. The WMP implementation tasks are detailed in an extended table as part of Chapter 7. Each task includes a reference to indicate which objective or objectives it is intended to address, along with designation of the organization expected to take the lead in accomplishing the task.

In general, the plan goals recognize that natural resources are inextricably linked to the economy and the quality of life within the watershed. The goals and objectives are structured to reflect the view that protection of water quality is a necessary element in promoting the environment and human health and welfare within the region.

Goal 1: Develop an educational component to inform and engage the public in long-term water-quality protection efforts and the potential impacts of land use and development.

Objectives

A. Develop a public education program to help create understanding of the short and long term threats to the river environment, including the potential impacts of land use and development.

B. Utilize print, broadcast, person-to-person and electronic communication to disseminate a clear, concise message about the public's role in protecting water quality in the Little Manistee River Watershed.

C. Work through conservation districts and the Little Manistee Watershed Conservation Council to coordinate and promote educational efforts of non-profits and government agencies.

D. Support sustainable funding for conservation districts and invasive species control agencies.

E. Support and promote boater, angler and paddlecraft safety and stewardship practices.

F. Engage local residents, landowners and government representatives in discussion of potential water-quality benefits of local zoning or natural river designation, and pursue such action if support appears likely.

Goal 2: Ensure use of Best Management Practices (BMPs) to preserve and enhance the outstanding cold water resources in the Little Manistee River Watershed.

Objectives

A. Protect groundwater flows, which are essential to maintenance of coldwater streams.

B. Ensure that Best Management Practices are followed at all existing dams and/or impoundments to minimize thermal changes.

C. Maintain forested canopy in stream corridors to provide shade.

D. Protect and restore critical resources, including groundwater recharge and discharge areas, headwater streams, wetlands and wildlife corridors.

E. Protect and restore natural hydrologic connectivity where appropriate.

Goal 3: Preserve and improve water quality and the aquatic environment to score as well or better than all applicable state and federal standards and locally desired conditions, including the protection of public health.

Objectives

A. Monitor public access areas and recreational use sites for elevated levels of *E. coli* as an indicator of potential human pathogen contamination; determine contamination sources and institute mitigation as appropriate.

B. Monitor waterways for current conditions and changes in biological, physical or chemical parameters (e.g. clarity, phosphorus, dissolved oxygen, conductivity, temperature, etc.).

C. Support BMP's to minimize stormwater and runoff impacts on surface waters.

D. Monitor external conditions beyond local control – including climate change, invasive species entering the Great Lakes, and atmospheric deposition of mercury – to enhance local resilience and develop appropriate long-term responses.

E. Reduce sediment, nutrient and chemical inputs from all sources, including transportation infrastructure, agriculture and recreational activity.

F. Monitor aquatic and terrestrial invasive species for early detection and treatment.

Goal 4: Protect the natural character of the watershed, while maintaining the economic, lifestyle and public health benefits that accompany a high-quality natural environment.

Objectives

A. Support scientific management of fishery, wildlife and public lands and waters for recreational and environmental benefits.

B. Maintain and improve public access to recreational land and waters, with site designs to protect water quality, provide for public safety and minimize introduction of invasive species.

C. Promote efforts to use BMP's to minimize environmental impacts of non-motorized trails and low-impact motorized (snowmobile and ORV) trails, and to protect natural areas.

D. Maintain navigation for appropriate boating recreation.

E. Promote efforts to minimize environmental impacts of recreational infrastructure such as campgrounds, trails and access sites.

F. Protect significant viewsheds and natural areas throughout the Watershed.

G. Raise public awareness of the Michigan Natural Rivers Program and work for designation of the Little Manistee as a natural river.

Goal 5: Support efforts of governmental and citizen organizations to implement programs for protection and enjoyment of the watershed's natural features.

Objectives

A. Promote watershed protection practices, such as permanent land protection on critical sites, low-impact development techniques and periodic inspection of on-site wastewater systems.

B. Develop tools for governmental agencies, land conservancies and other stakeholders to work cooperatively across artificial boundary lines for protection of water quality and natural resources.

C. Unite Watershed stakeholders to leverage funds, pool resources and skills, broaden outreach, and implement recommendations of the Watershed Management Plan.

D. Protect valuable lands that are critical to water quality, fisheries, and wildlife.

E. Maintain the LMWCC as a permanent entity to serve as a communication hub for the counties, land conservancies and other agencies whose service areas cover separate sectors of the watershed.

Winter on the Little Manistee River

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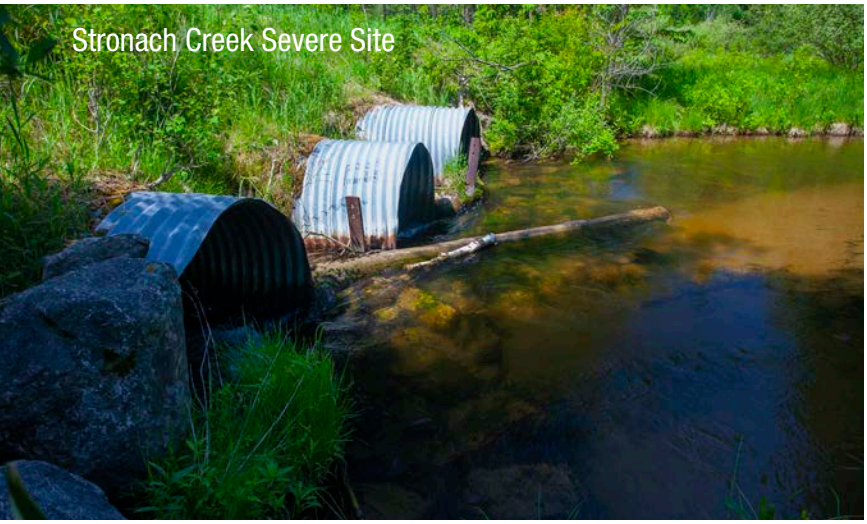
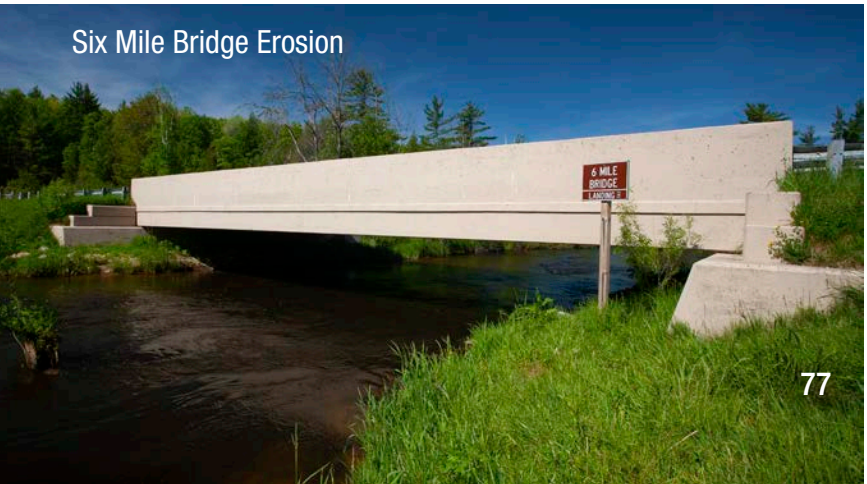
Chapter 6

Critical and Priority Areas

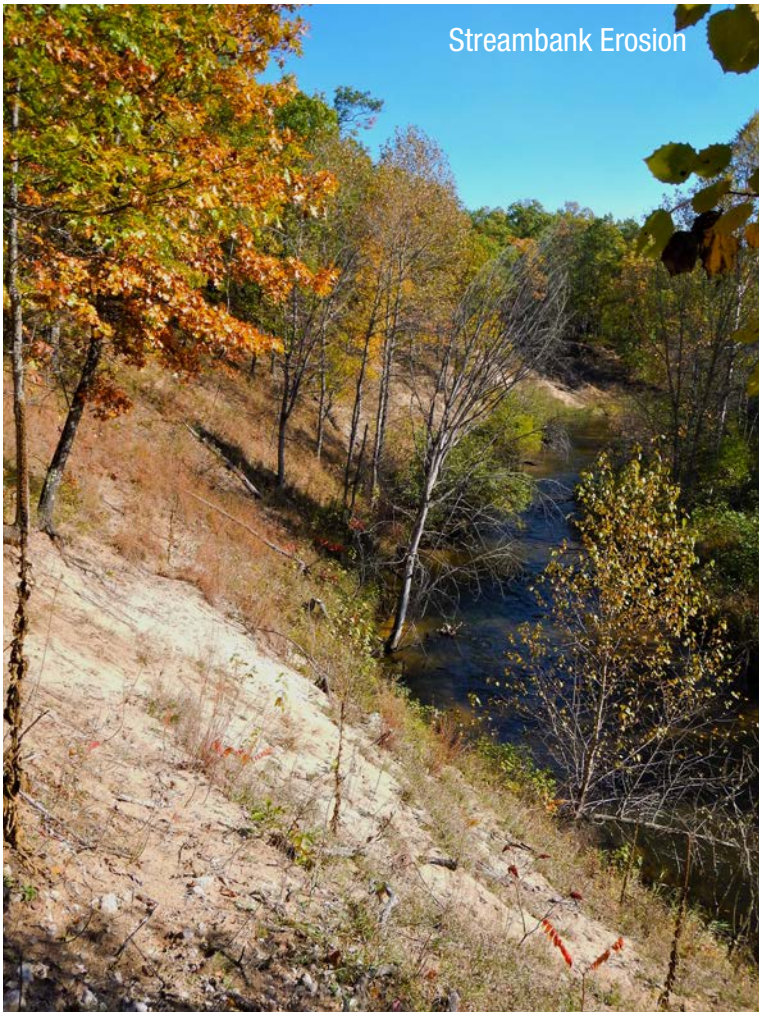
Critical Areas identified in the WMP are those sites in the Watershed which are most severely affected by existing or potential sources of the pollutants discussed above. The priority section, detailed after the critical sites, identifies issues or locations where special attention is needed to preserve designated or desired uses within the Watershed. Specific recommendations for addressing these concerns are included in the Implementation sections in Chapter 7.

The critical areas, detailed below, are: The Luther Dam and Headwaters; Syers Lake and Creek; Cool Creek and Stronach Creek; Streambank Erosion Sites; and Road Stream Crossings.

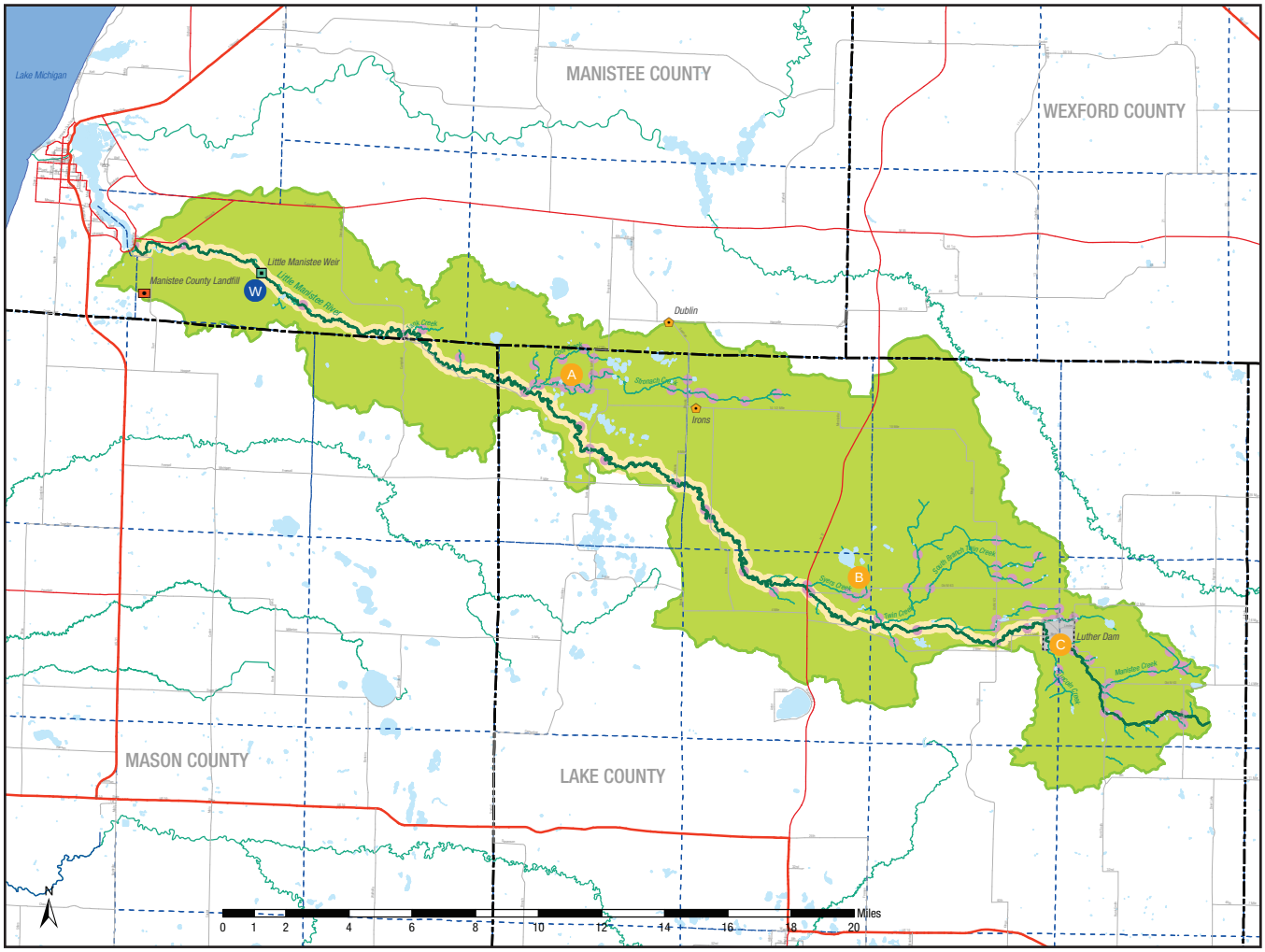

Stronach Creek Severe Site



Six Mile Bridge Erosion


Streambank Erosion

Map 15 - Critical Areas



KEY | CRITICAL/PRIORITY AREAS

Critical Areas

- A — Cool/Stronach Creeks
- B — Syers Lake and Creek
- C — Luther Millpond Dam
- Road Stream Crossings
- Little Manistee Streambank Erosion

Priority Areas

- W — Little Manistee Weir

FEATURES

- Fish Weir
- Land Fill Facility
- Unincorporated Place
- Roads-Other Principal Arterial
- Roads-Minor Arterial
- Roads-Major Collector
- County Boundary
- Township Boundary
- Inland Lakes
- Lake Michigan
- Little Manistee River
- LMW Tributaries
- Area Rivers
- Little Manistee Watershed Boundary
- Luther

Luther Dam and Headwaters

Potential Issues: thermal impacts; sediment; fish passage

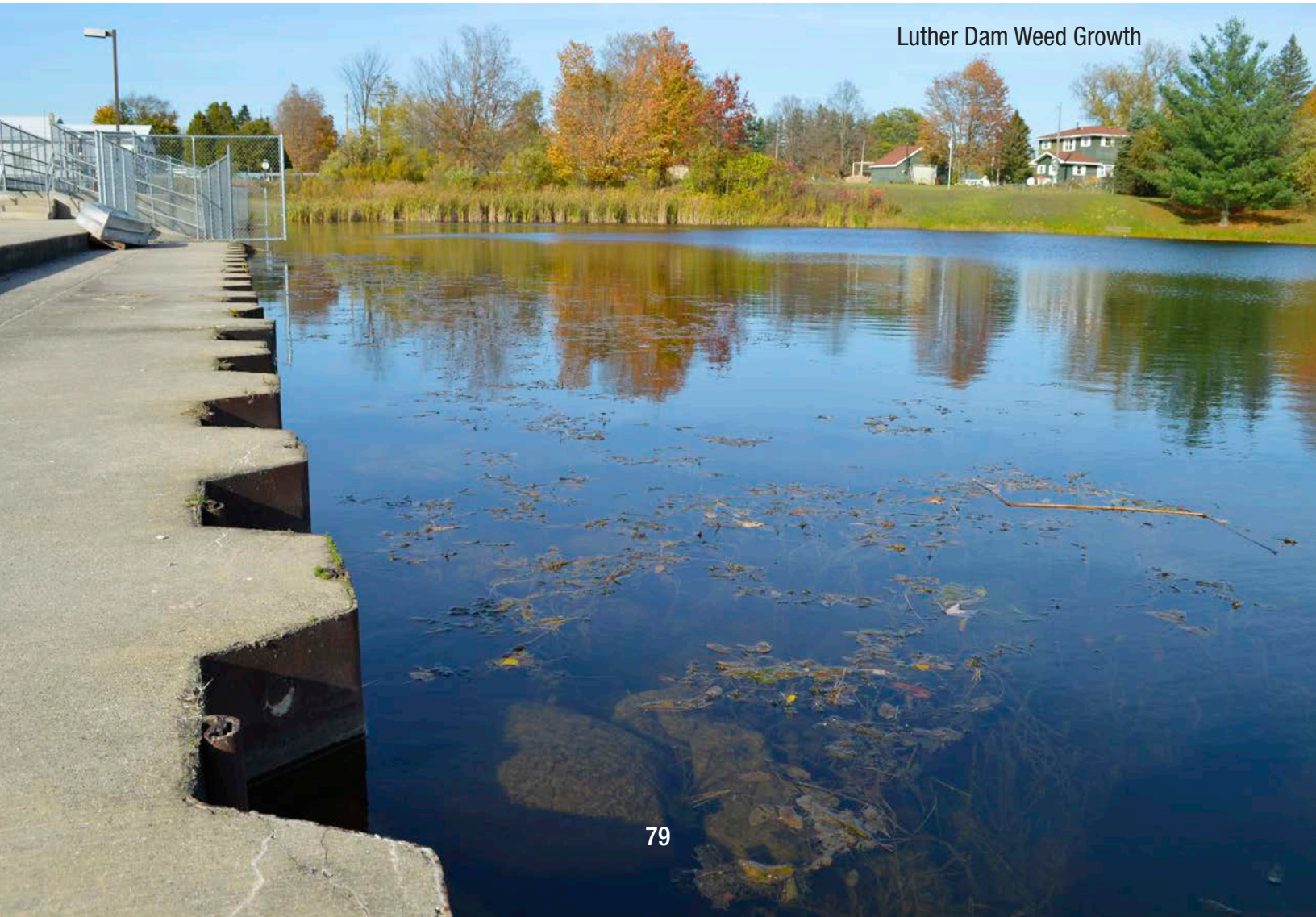
The Luther Millpond Dam, in the Village of Luther near the Little Manistee headwaters, has been a source of controversy since at least 1986, when an earlier version of the structure failed during a historic Michigan rainstorm.

The dam and its eight acre millpond have been valued as a community resource by village residents, while fishing groups and the Michigan Department of Natural Resources have expressed a preference for removing the structure and restoring natural stream flow and fish passage.

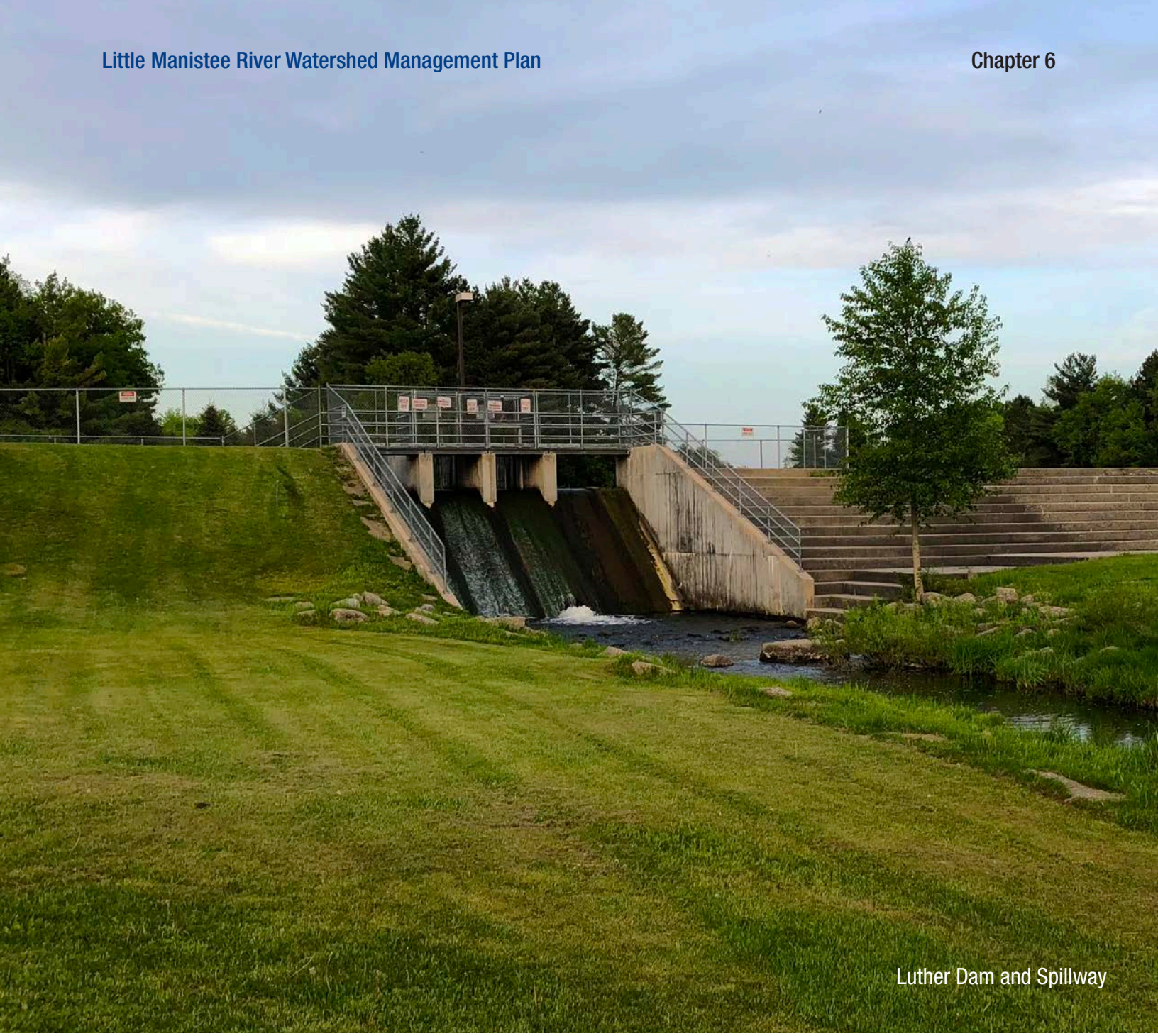
The timber-cutting era in eastern Lake County began around the year 1880, and the Luther Dam was constructed in 1881 to power a sawmill.

The village of Luther, on the boundary between Ellsworth and Newkirk townships, was platted in 1882. The village was soon served by a railroad, and its population reached 1,500 by 1889, according to a local history edited by Doug DeMaw and Franklin Willard (date unknown).

Most of the local timber had been harvested by 1910, and cutover areas were farmed for potatoes, beans, dairy and other crops. The dam was converted to electrical generation about 1915. Railroad service ended in 1920 and village population declined to about 400 persons, where it has remained ever since.



Luther Dam Weed Growth



Luther Dam and Spillway

The dam reverted to village ownership after electrical generation ceased. Local residents valued the pond as a historical legacy and a casual fishing site. The aging structure washed out in September of 1986 during a torrential rainstorm that also caused the failure of a dozen other dams in Michigan. The washout allowed tons of sediment to move downriver, covering spawning beds and damaging the river's ecology.

The Michigan Department of Natural Resources opposed reconstruction of the dam, as did the Michigan United Conservation Clubs and Trout Unlimited. However, at the request of village leaders, the Michigan Legislature voted to allow the structure to be rebuilt. A Federal Emergency Management Agency (FEMA) grant of $450,000 paid for the reconstruction.

The new dam had just been placed in operation and the pond was being refilled in 1993, when it failed again. Sand washed out along the side of the concrete control structure and tons of silt again migrated downstream.

The second washout apparently resulted from design or construction errors. Again, the Legislature overruled objections from the MDNR. The structure was rebuilt, largely with money from an insurance settlement, and has remained in place ever since.

At Luther, about six miles below the headwaters, the river is quite small, not suitable for canoeing or kayaking. From the dam spillway, it bubbles through a small village park and then flows unfettered for more than 50 miles to the watershed's exit point at Manistee Lake.

Management of the dam has remained a point of contention, with village officials and the DNR disagreeing over the proper use of a "bottom draw" system designed to pull cooler water from the depths of the pond.

The dam clearly impedes fish passage. There is no "fish ladder," and steelhead or salmon may often be seen trying unsuccessfully to ascend the concrete spillway. A 2002 survey by the MDNR found a few young rainbow trout in the stream above the impoundment, though it is unclear whether the fish passed the dam or reached the upper river by some other means (Tonello, 2002).

It is unclear whether there is a significant amount of suitable spawning habitat above the dam, where several miles of headwater streams flow sluggishly through forest and agricultural landscapes. Little water-quality monitoring has been conducted in the millpond or the tributaries of the Little Manistee River upstream of Luther. Monitoring in areas below the dam has not shown significant degradation of the resource in the years since the catastrophic failures.

Similar impoundments are known to increase water temperature in cold water streams, and this is likely the case in Luther. The WMP proposes long-term monitoring above and below the millpond to determine if there is an adverse thermal impact. The millpond itself appears little used. The pond is generally shallow and weedy, with a dark bottom. There is no public launch facility for rowboats or canoes. A designated swim area is overrun with cattails and reeds, and may be too close to the dam for safe use in any case. A wooden fishing platform has been constructed adjacent to an auxiliary concrete spillway.

In summary, the millpond's primary positive impact is related to its role in village history and local pride of place. Negative impacts include the dam's blockage to fish passage, the likely thermal impact of the stillwater pond, and the low-probability but high-impact threat of another potential washout.

Careful dewatering of the pond – with removal of the structure and restoration of the streambed – could produce significant benefits, especially if combined with grant funding for village park development.

The focus of the WMP is on water quality and stream ecology. But park-and-stream restoration could also relieve the village of the liability and expense of the dam, increase local usage of the parkland and include elements to memorialize the genuine historic significance of the site.

The WMP recognizes the primacy of the village of Luther in determining the future of the dam and pond. For this reason, two alternatives are included in the plan's implementation tasks (see: Table 34 on page 97).

In alternative one, the dam would continue in place. The bottom-draw mechanism would be managed jointly by the village and the MDNR to ensure that thermal impacts are minimized; a study would assess the feasibility of fish passage strategies; and all safety measures would be continued and monitored to protect against dam failure.

The second alternative is for the village to seek planning grant funds – in cooperation with other stakeholders – to re-develop the park, dewater the pond and remove the dam.

Syers Lake and Creek

Potential Issues: loss of habitat; fish passage; stream and shoreline erosion

A long-planned project to remove an aging dam from the outflow of Syers Lake came to fruition in 2019, while this WMP was awaiting initial review by the MDEQ. The work is expected to restore the lake to its natural configuration, with perennial flow into Syers Creek, a tributary to the Little Manistee River.

Funding for the $120,000 plan came from a number of sources including: The U.S. Fish and Wildlife Service; the Little Manistee Watershed Conservation Council; the Little River Band of Ottawa Indians; private property owners; and fishing organizations. The project was planned and supervised by Conservation Resource Alliance.

With the on-site infrastructure work largely completed, the site still requires revegetation and long-term monitoring to assess its impact and to determine if the intended ecological benefits actually occur.

Syers Lake is located in a forested area of Eden and Peacock townships within the eastern portion of the Little Manistee Watershed, just east of highway M37. Syers Creek flows out of the lake, and enters the Little Manistee River just west of highway M37.

Most of the lake's western shoreline is owned by the state of Michigan and managed by the Department of Natural Resources as part of the Pere Marquette State Forest. The south and east shorelands are largely private, including a number of camps and several year-round homes.

The natural 140 acre lake was enlarged to more than 300 acres sometime around 1970 through construction of a six-foot-high, 120-foot-long sand-berm dam that raised the water level by several feet and included a roadway to provide access to private parcels then being developed on the eastern shore.

New Syers Creek Culvert

Syers Creek, a designated trout stream, was partially impeded by the dam, and allowed to flow intermittently through a small culvert. Over the intervening years, the dam has failed several times and the culvert has often been blocked by debris. Flow in the upper reaches of Syers Creek has been non-existent at times, harming the ecology of the small stream, which is considered to be prime spawning habitat for steelhead and other fish species.

In response to these issues, the Michigan Department of Environmental Quality issued a violation notice, requiring repair or removal of the dam. The Conservation Resource Alliance, a non-profit organization based in Traverse City, developed a plan to remove the berm, and install a bottomless culvert below a rebuilt access road.

The work is expected to lower the lake level by approximately 18 inches and restore natural flow to the stream. Over time, the lake margins are expected to revert to their natural condition, which is a mixture of bog and forest cover. Restoration of the natural stream flow is expected to enhance reproduction of trout in the Little Manistee system.

Cool Creek / Stronach Creek

⚠ *Potential issues: erosion; E. coli; thermal issues, excess nutrients from farm animals*

Cool Creek, a tributary to the Little Manistee River, flows out of Cool Lake in Elk Township and meanders through forest and farmland in northern Lake County before joining Stronach Creek and ultimately the mainstream of the river. Stronach Creek flows through Watertank, Beaver and the three Pickerel Lakes before its confluence with Cool Creek

The two streams flow through a forested area of mixed private land and U.S Forest Service property west of Irons in northern Lake County. Several nearby lakes are ringed with cottages. The region is laced with rural roads, either paved or surfaced with gravel. The 2019 road-stream crossing inventory by Conservation Resource Alliance assessed 15 crossings on Stronach and four on Cool Creek. Most were rated as moderate severity. A 2014 survey looked at the cost of restoring all 19 crossings and estimated that cost at $1.2 million.

Both streams were surveyed by MDNR biologists in 2002 (Tonello, 2002) and found to be at least marginally able to support trout in some segments of their run. Stronach Creek was the warmer of the two, and flow there was found to be intermittent at some locations.

Sampling by LMWCC volunteers showed water in Cool Creek to be significantly warmer than the mainstream. Samples drawn in July 2018 and 2019 at the creek's outlet from Cool Lake were 76 degrees Fahrenheit, 15 degrees warmer than samples taken the same day on the Little Manistee. The 2019 monitoring also showed a somewhat elevated *E. coli* level of 201 cfu. Though higher than other levels in the watershed, that reading is still within the acceptable range of 300 or less.

One highly problematic site is at 12 Mile Road on the Lake-Manistee county line. Here, Cool Creek passes under the gravel road in a 72 inch culvert, flows for several hundred feet through a pasture on the north side of the road, and then flows back through a similar culvert to the south side of the road.

The northern segment, in Manistee County, is open to cattle in the pasture and has been seriously eroded. While conducting invertebrate sampling in 2014, an MDEQ biologist noted that cattle were trampling the banks at the site, resulting in significant erosion. The site was not sampled, but the location was highlighted for possible mitigation of the livestock issue. (Lipsey, 2015)

The biologist suggested that MDEQ's non-point source unit should consult with the Department of Agriculture and Rural Development (MDARD) to consider actions to rectify the problem. Provisions of Michigan's right-to-farm act may permit the property owner to continue his management practice of watering cattle in the stream. However, this practice diminishes water quality downstream from the site.

The Cool/Stronach area should be protected from unwise land uses, road stream crossings should be upgraded as funding is available, and the water should be monitored to detect any further deterioration. The WMP recommends that agencies work with the owner of the pasture at 12 Mile Road and develop funding to assist in fencing the stream and implementing an environmentally sound method of providing water to the pastured cattle.

Cool Creek at 12 Mile Road

Streambank Erosion Sites

⚠ *Potential Issues: sedimentation; damage to fish habitat; thermal issues*

Streambank erosion has been identified since at least the 1960s as a source of sediment pollution to the Little Manistee River. Some bank erosion is a natural process of a free-flowing stream. But, as noted in Chapter 2, excessive erosion on the Little Manistee is often related to past land uses, including logging and vegetation removal.

Considerable work to restore the natural resilience of Little Manistee River streambanks was accomplished in recent years through habitat restoration work by the LMWCC and Conservation Resource Alliance.

Streambank Erosion Stabilization

Despite those efforts, unstable banks continue to erode sediment into the stream at a number of locations. Of particular concern are the coarse sands that can accumulate on the river bottom, potentially covering fish spawning habitat and also creating a shallower and warmer stream.

A 2014 inventory by CRA identified 81 sites of bank erosion on the river. (see: "Map 14 - Streambank Erosion Sites" on page 56 and "Table 19 - Streambank Erosion Summary" on page 56 in Chapter 3)

The sites were scored on the Streambank Erosion Severity Index which assigns numerical values for such variables as: the site's general condition; vegetation cover; trend toward increasing or decreasing erosion; length and height of eroded bank; current and depth of the river; and other factors. Sites scoring less than 28 points are considered as minor; those with 28-31 points are ranked as moderate; and those scoring 32 or above are classed as severe.

On that scale, 23 of the sites were ranked as minor, 29 as moderate and 29 as severe. On an annual average, the eroding banks introduce an estimated 644 tons of sediment into the waterway, potentially impacting the stream's thermal characteristics and covering habitat for fish and invertebrates.

A 2002 inventory ranked only 12 sites as severe, and the increase in severity is a cause for additional concern (Winkler, 2014) particularly in the mid-watershed segment between Nine Mile Bridge and Six Mile Bridge, where 30 eroding bank sites were found.

The severe and moderate erosion segments collectively are considered in the WMP as a critical site.

Because the Little Manistee is eligible for Natural River designation, bank stabilization projects should use native materials and the least obtrusive methods. Placements of whole tree revetments, and/or revegetation are the preferred treatments where applicable.

The entire 2002 streambank inventory – including point scores, GPS coordinates, photographic images and recommended mitigation methods – is online at www.northernmichiganstreams.org. CRA staff is scheduled to canoe and wade the river to update the inventory in 2020, and the online resource will also be updated.

Road Stream Crossings

Potential Issues: sedimentation; oil and gas pollution; fish passage

Public roads cross the Little Manistee River and its tributaries at 85 sites in the watershed, according to a 2019 inventory conducted by the Conservation Resource Alliance, with funding from LMWCC.

Many of the crossings are on gravel roads, where rain and snowmelt may wash sediment and associated petroleum products into the streams. In addition, the general shortage of infrastructure funding available to rural areas in Michigan has allowed bridges, culverts and road approaches to deteriorate over time.

Road-stream crossings—including everything from a state highway bridge over the mainstream to steel culverts that carry unnamed tributaries below gravel roads – are an important factor in maintaining stream ecology and fish habitat. Improperly functioning crossings may block fish passage and allow sediment and nutrients to erode into the waterway. Many of the crossings date from the 1950s or earlier. They may be poorly designed, too small, or simply deteriorating from age.

Because malfunctioning crossings require work on both the road and the stream, these repairs typically represent a large percentage of the costs of mitigating non-point source pollution in Michigan watersheds.

The inventory assessed each crossing for factors including general condition, erosion potential and whether fish passage was impeded. Scoring of environmental concerns at the crossing sites placed 22 in the “minor” category. Thirty-five were rated as “moderate,” and 28 as “severe.” (see: “Map 13 - Road Stream Crossings” on page 54 and “Table 18 - Road Stream Crossing Summary” on page 54 in Chapter 3)

The 2019 inventory did not estimate the cost of remediation at the road stream crossings. However, an earlier survey, conducted by CRA in 2014, did include cost estimates. That inventory estimated the total cost to improve all the crossings in the watershed at $4.5 million.

Applying those figures to the 2019 inventory would yield the following amounts, by category: For 25 minor sites, $868,000; for 35 moderate sites, $1,961,000; for 28 severe sites, $1,681,000.

The cost figures are necessarily inexact, since they do not reflect the deterioration of several crossings which moved from “Moderate” to “Severe” over the five-year period. With that caveat, they do give an indication of the magnitude of the costs entailed in updating this aging infrastructure.

Stronach Creek at Java Road

The WMP identifies the road-stream crossings together as a critical site, and recommends that, as funds become available, all should receive improvements to mitigate their adverse environmental impacts.

The Little Manistee system's status as prime habitat for wild strains of steelhead and brook trout means that a priority should be placed on maintaining and restoring connectivity in the small tributaries, which offer critical spawning habitat.

The severe crossings should generally receive the highest priority. But it is recognized that opportunities to improve moderate or even minor sites may occur when adjacent property owners are willing to share the costs, or when local road commissions are doing work to resurface or repair segments of the transportation infrastructure. Mitigation of any road steam crossing should be considered a plus for the watershed.

The WMP recommends repairing the severe and moderate sites as funding becomes available. This task will require long-term cooperation among county road commissions, the Conservation Resource Alliance, appropriate grant-making agencies and riparian property owners.

The full inventory of road stream crossings may be viewed online at www.northernmichiganstreams.org/little-manisteews.asp.

Priority Areas and Conditions for Protection

Priority areas and conditions within the watershed are those general areas which may not be currently impaired or threatened, but must be protected in order to prevent future degradation of water quality. Watershed Plan goals, presented in Chapter 5, are intended to address these issues in such a way as to protect the designated and desired uses of surface water. Specific recommendations for addressing these concerns are included in the Implementation sections (see: Table 27 on page 90 through Table 41 on page 104) in Chapter 7.

Priority concerns identified by the Watershed Steering Committee are: Stream Ecology and Habitat; Inland lakes; Groundwater; Rustic and Natural Character; and the Little Manistee River Weir.

Stream Ecology and Habitat

⚠ *Potential issues: loss of habitat; decrease in native species diversity*

Preserving the ecology of the Little Manistee River system – that is, the animal, vegetable and mineral features that support the web of life in the stream – is a priority goal of the WMP and of Watershed stakeholders. All aspects of the plan relate directly to this priority.

Since its creation in 1996, the Little Manistee Watershed Conservation Council (LMWCC) has been engaged in projects to preserve and enhance the aquatic habitat in the river and tributaries. The river's natural condition provides the cold, flowing water necessary for trout to thrive. Enhancement activities have primarily involved placement of "lunker" structures and woody debris to provide diversity and resting areas for fish.

The LMWCC, along with the Little Manistee River Restoration Committee, has used donations, grant funds and both paid and volunteer labor to restore hundreds of feet of eroded streambank and to plant thousands of seedlings.

In addition, the groups worked with state and federal agencies to install two "sand traps" to remove excess sediment that entered the river through bank erosion and the failures of the Luther Dam in 1986 and 1993. (The sand trap activity has since been discontinued.)

Additional funding has been identified for habitat structures – chiefly whole trees and woody debris – to be installed in coming years. Carefully placed, such structure may improve fish survival and also protect banks from further erosion.

Since 2000, the LMWCC has conducted annual macroinvertebrate studies (see: Table 26), a process that involves collecting and analyzing river-bottom insect populations as a marker for water quality. Those studies have consistently indicated good to excellent water quality, as have periodic studies by MDEQ biologists. The WMP recommends continuing the studies through the Volunteer Stream Monitoring Program as an effective tool for early detection of problems.

Table 26 - Habitat Monitoring 2007 — 2016 (Macroinvertebrates)

Annual Macroinvertebrate Survey Data (Volunteer Stream Monitoring Program)											
Collection Site	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Site Average
Below Queen's Highway	45	35	37	36	27	36	42	36	52	40	39
Old Grade Campground	49	40	35	36	35	56	54	42	46	44	44
Johnson Bridge	20	31	32	37		33	45	59	51	29	37
DeWitt's Bridge	24	35	28	30	36	34	43	50	43	36	36
Poggensee Bridge		33		28	51	23	36	22	39	25	32
Cool Creek @ Sikkenga's	47	23	32			48	22	35	35	38	35
Bear Track Campground	25	18	23	28	27	38	35	43	43	31	32
9 Mile Bridge (South)	35	5	36	39	46	26	43	42	35	45	35
Bowman's (Cross Hole)	45	25	31	26	47	32	28	49			
6 Mile Bridge (NW Access)									47	15	31
Annual Average (all sites)	36	27	32	33	38	36	40	41	43	34	36
Rating Key: 48 or more Excellent; 34-47 Good; 19-33 Fair; Less than 19 Poor											

Source: LMWCC sampling through Isaac Walton Save Our Streams program model

Table 27 - Habitat Monitoring 2016 — 2019 (Macroinvertebrates)

Annual Macroinvertebrate Survey Data (Volunteer Stream Monitoring Program)								
Collection Site	Oct 2016	May 2017	Oct 2017	May 2018	Oct 2018	May 2019	Oct 2019	Site Average
Below Queen's Highway		47		50	45	37	55	47
Old Grade Campground		42		35	50	41	43	42
Indian Bridge		50	37	23	28	40	54	39
Johnson Bridge	34	30	35	26	44	57	45	39
Cool Creek West of Hamilton Road	37	33	36	41	43	47	49	41
6 Mile Bridge (NW Access)	49	66	23	41	51	55	43	47
Annual Average (all sites)	40	45	33	36	44	46	48	42
Rating Key: 48 or more Excellent; 34-47 Good; 19-33 Fair; Less than 19 Poor								

Source: LMWCC sampling through VSMP

Inland Lakes

Potential issues: weed growth; invasive species; loss of shoreline diversity; reduction of water clarity

The Little Manistee Watershed has 28 named lakes, ranging in size from a few acres to more than 100 acres. Among the larger lakes are Syers, with a natural size of about 140 acres; Harper and Cool, each about 80 acres; and Elbow Lake, Sand Lake and Lake of the Woods, each in the 50 to 60 acre range.

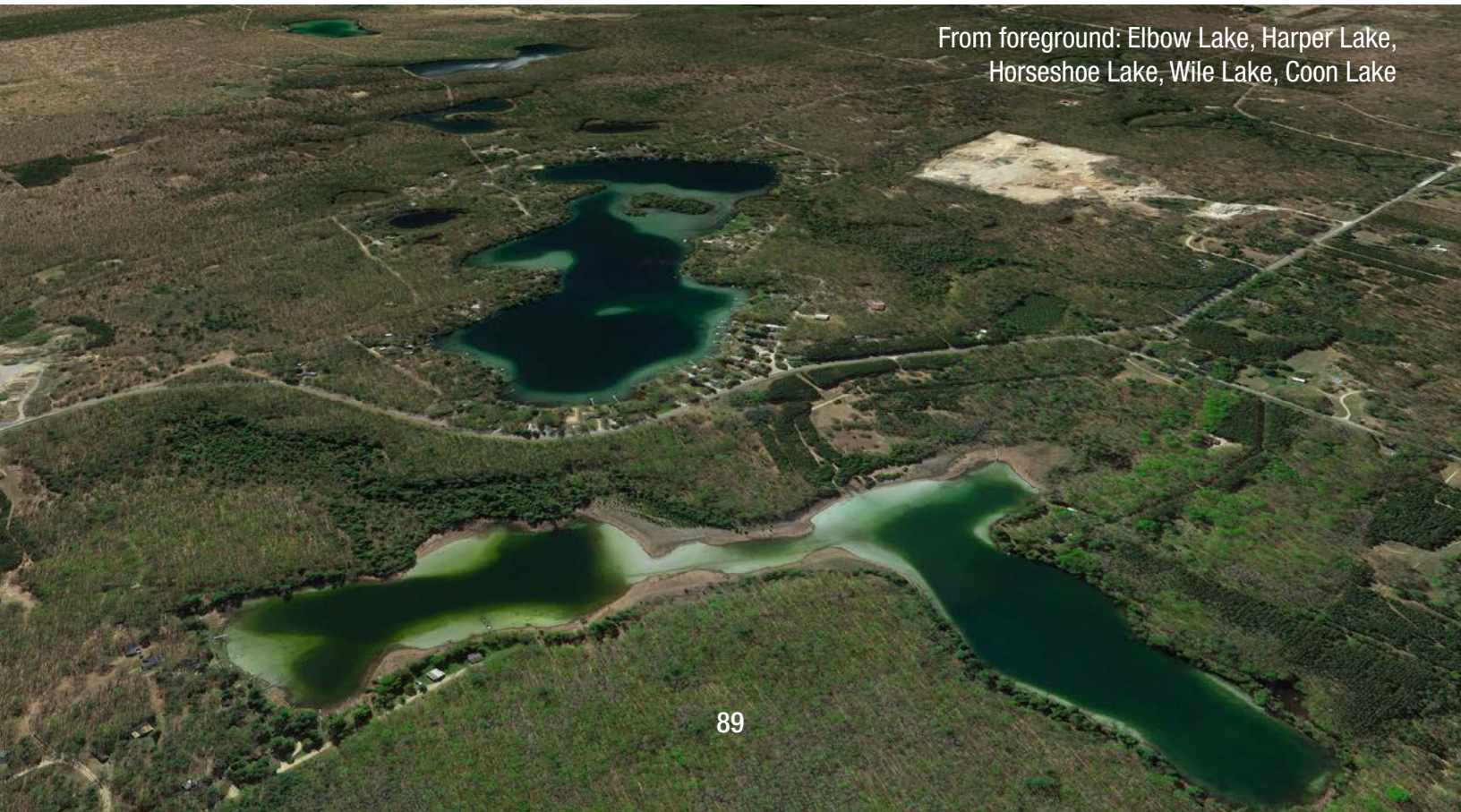
While the watershed is best known for its river and streams, these small lakes also provide a diverse set of natural habitats, recreational opportunities and home sites. The lakes should be considered as significant contributors to the quality of the watershed.

The U.S. Forest Service operates a public beach, boat launch and 46-site campground on Sand Lake. Several lakes in the watershed, including Harper and Cool, are developed with shoreline cottages and homes, while others, such as Elbow and Syers have a mix of public and private shoreline. All are believed to have a direct connection with the groundwater.

Maintaining clarity, water quality and natural fish habitat on all water bodies will enhance the desired uses of the watershed.

Water clarity on these small bodies of water is significantly impacted by management of the shorelands. Water clarity can be preserved through use of low-impact development techniques along with careful management. Native vegetation at the shoreline protects habitat for invertebrates, fish and wildlife. Best management practices such as installation of rain gardens and permeable pavements and avoidance of lawn fertilizer can help keep phosphorus and nitrogen from leaching into the water.

Conversely, hard-paved surfaces, broad turfgrass lawns and improperly maintained septic systems may allow excessive nutrients to enter a lake, leading to weed growth and eutrophication.



From foreground: Elbow Lake, Harper Lake, Horseshoe Lake, Wile Lake, Coon Lake

Clear lake water is a benefit for the environment and for property owners.

Educational materials are available from a number of sources, including the Michigan Natural Shoreline Partnership (MNSP). The partnership works along with Michigan State University Extension, MDEQ, Tip of the Mitt Watershed Council and others. Its services include demonstrating planting strategies, training contractors and educating landowners in the use of native plants to stabilize shorelines.

The partnership has developed an online tool to help landowners evaluate their shoreline conditions and identify potential improvements. The free project is on the Internet at www.MIshorelandstewards.org.

LMWCC has worked with some lake property-owner groups in the watershed to monitor water quality. The Manistee National Forest contracted with the Manistee Conservation District on a project to evaluate water quality parameters at Elbow Lake and several others. Water quality remains high, in general, and there are no known impairments to Michigan's designated uses on any of the watershed's lakes.

Surveys at Cool Lake have indicated the presence of invasive zebra mussels and Eurasian watermilfoil.

The WMP recommends that all lakes with private shorelands take part in annual monitoring through the Cooperative Lake Monitoring Program (CLMP), which maintains a database of sampling results from participating lakes. CLMP is part of Michigan's MICORP program, which offers training for volunteers, also provides information to better understand the data that is collected.

Groundwater

⚠ *Potential issues: contamination by petroleum products; depletion by overuse in minor aquifers; nutrient contamination from on-site wastewater systems or agricultural operations*

Groundwater is a key resource in the Little Manistee Watershed. Survival and reproduction of trout and salmon are enabled by the stable flow of cold groundwater into the river and tributaries. Groundwater also provides water for human consumption and for agricultural irrigation.

The 28 named lakes in the watershed are primarily fed by springs and/or direct groundwater flows.

At the present time, groundwater supplies in the watershed are both abundant and of high quality. However, given the vital nature of the resource, steps must be taken to provide total assurance against future degradation.

The watershed's sandy soils create a particular challenge in this respect. The majority of soils in the region are highly permeable, which means that rain and snowmelt sink quickly and may reach the water table without being completely filtered. That increases the possibility that substances near the surface – including fertilizers, waste motor oils, or septic system effluents – may potentially contaminate the groundwater (Schindler, 1995).

The Information/Education component of the WMP (Chapter 9) recommends the creation and dissemination of materials to inform landowners and the public about best management practices to minimize the potential for groundwater contamination.

In addition, the WMP calls for a system of groundwater sampling to monitor both flow and water quality. This would be best accomplished through a statewide system such as that envisioned in the Michigan Water Strategy created by MDEQ/EGLE (Michigan Office of the Great Lakes, 2016). If a statewide program is not offered, the WMP recommends that LMWCC work with its partners to study and implement a system of groundwater monitoring.

Groundwater recharge areas must be protected. Farms and residences must employ best management practices to avert any chance of contaminants reaching the water table.

Mining, mineral extraction, gravel pits and oil and gas production operations – along with their associated infrastructure – must be strictly regulated by state and local governments to provide 100 percent assurance against groundwater contamination.

Rustic and Natural Character

⚠ *Potential issues: erosion; loss of diversity; loss of scenic areas*

Visitors and residents are attracted to the Little Manistee Watershed by the region's outdoor recreation offerings and by the "peace and quiet" of the river, wetlands and forest. Retaining these rustic and natural attributes – along with appropriate access for human enjoyment – is a desired use of the region's resources.

The present level of development in the watershed appears to meet this desired condition, with unlimited fishing opportunities, scenic forest roads, a network of small campgrounds and dispersed camping sites, and a system of motorized and non-motorized trails. However, as noted in Chapter 1, the Little Manistee Watershed is less than 50 miles from Michigan's fastest growing metropolitan area, Grand Rapids, and therefore the possibility of future development should not be ignored.

The WMP recommends a major effort of land use education targeted to the public and to township officials, to engage a conversation about potential ways of preserving the desired character of the watershed. Ultimately, this conversation should aim to develop a community consensus on whether to support protective local zoning, natural river designation and/or other strategies. If a consensus emerges, the townships should work cooperatively to create ordinances protective of water quality and of the desired character of the community. Michigan State University Extension is able to provide assistance in the educational effort.

An additional concern is the loss of forest diversity as result of the emerald ash borer, oak wilt, beech bark disease and other threats to the health of native trees. Thousands of ash trees within the watershed have been destroyed by the emerald ash borer and removed from the forest canopy. While the other diseases have so far been less devastating, they also pose significant threats.

Education, and potentially regulation, about the impacts of moving firewood is an important element in preserving the forest, which comprises more than 75 percent of the watershed's land cover.

The Watershed's land base is more than 50 percent publicly owned and managed through state and federal forest agencies. That means that additional land protection may be less of a need here than in other regions. Still, the private sector and non-profit land conservancies have a role to play along with property owners in protecting the desired watershed character.

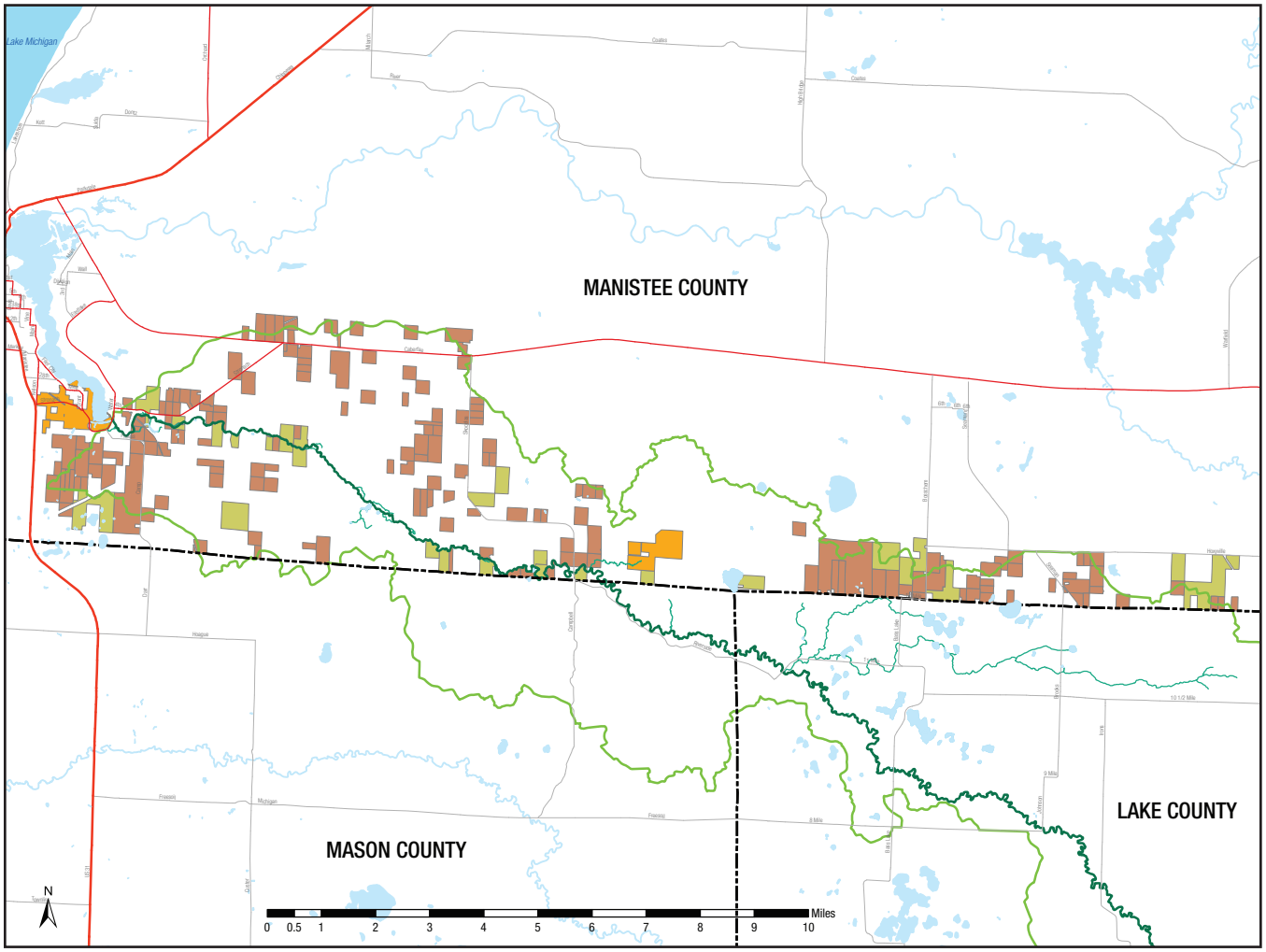
The Grand Traverse Regional Land Conservancy, in cooperation with other organizations, has developed a set of criteria to identify parcels that are likely to have the greatest impact on water quality and the ecosystem (see: "Map 16 - Manistee County Priority Parcel Analysis" on page 93). These "Priority Parcels" should be among the first considered for investment of funds for acquisition of conservation easements, development rights and outright purchase from willing sellers.

The selection criteria include the following: Parcel size (larger parcels are considered to have greater ecological impact); groundwater recharge potential, based on soils and topography; the presence of wetlands; lake or stream frontage; floodplains; steep slopes; adjacency to previously protected lands; and the presence of endangered or threatened species. The sites are tiered in categories 1-4, with 1 being the highest priority. Land conservancies with service areas covering Lake, Mason and Wexford counties, are encouraged to develop similar priority assessments.

Permanent protection or low-impact development in high priority areas will help ensure the ecological integrity of sensitive areas while preserving water resources throughout the watershed.

The WMP also recommends that local stakeholders should work to support designation by the MDNR of the Little Manistee as a natural river under the Michigan Natural Rivers Program.

Map 16 - Manistee County Priority Parcel Analysis

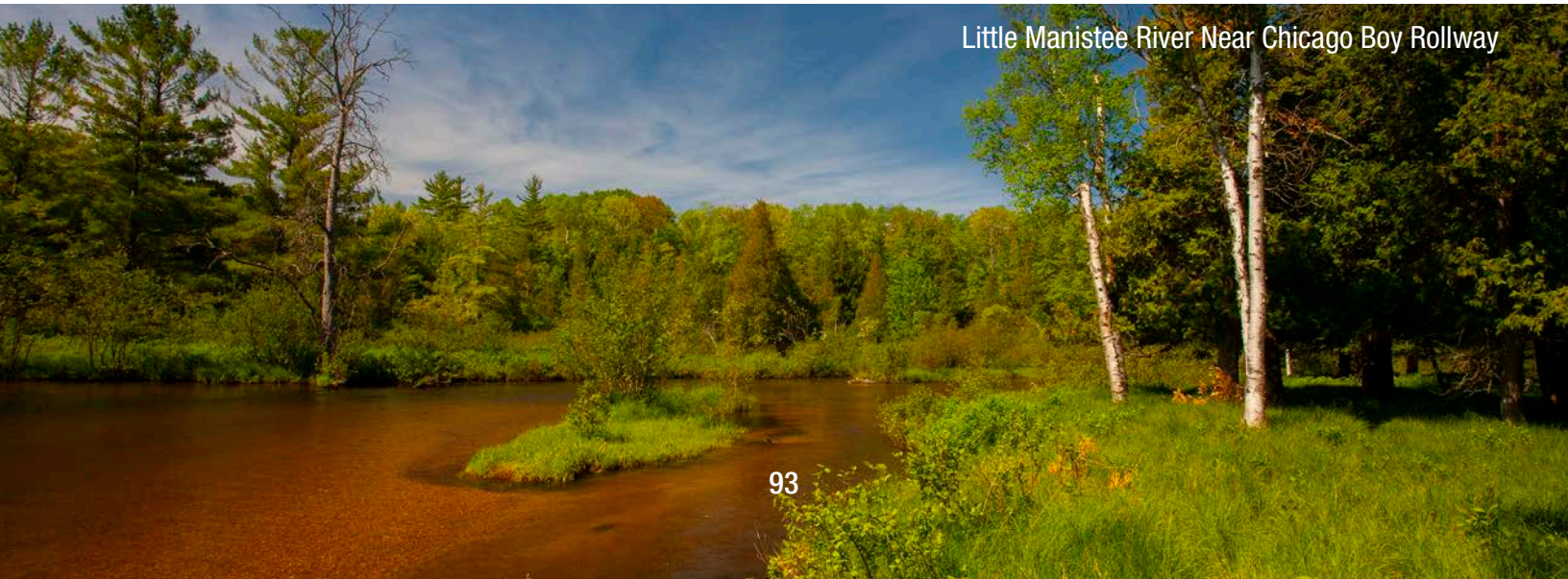


KEY | PRIORITY LEVEL

- Tier 1
- Tier 2
- Tier 3
- Tier 4

FEATURES

- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Little Manistee River
- LMW Tributaries
- Nearby Rivers
- Little Manistee Watershed Boundary



Little Manistee River Near Chicago Boy Rollway

Little Manistee River Weir

Potential Issues: public access; quality of fishery; sea lamprey passage

The site of the MDNR Weir and egg-taking station on the lower river is in good condition at the present time, but is considered a priority site because of its importance to the Little Manistee ecosystem and to fishery quality throughout the region.

When the weir is in operation, migrating fish are diverted into a series of concrete holding pens where they can be sorted and held for stripping of eggs and milt. The process is active during the migrations of steelhead in the spring and Chinook salmon in the fall. During those times it is open to the public, with tours offering a valuable educational experience for school groups.

At other times of year, the blocking gates are open, but a low coffer dam functions as a barrier to migrating sea lamprey. The MDNR is studying possible alterations to improve the effectiveness of the lamprey barrier. That study is being undertaken in cooperation with the U.S. Army Corps of Engineers, to ensure that any changes comport with the Little Manistee's status as a Study River under the national Wild And Scenic Rivers program.

Despite its remote location, accessed by gravel roads, the weir is a popular site for visitors even when it is not in operation. A viewing deck provides scenic access to the stream, and a short trail passes within sight of an eagle's nest on the opposite side of the river. Kayakers use the weir property as a put-in or take-out site.

The WMP proposes no change in operation of the weir site, which should be monitored for water quality and maintained as one of the Little Manistee's prime sites for education.

Little Manistee River Weir

Chapter 7

Implementation of the Plan

The charts on the following pages, (Table 28 through Table 42) detail the tasks necessary to implement the Little Manistee River WMP. Each row in the chart identifies one task, followed by columns showing costs, milestones for meeting a reasonable schedule, and other information. The Little Manistee Watershed Conservation Council has the major role of monitoring tasks and coordinating activities among the many partners and stakeholders in the Watershed.

The charts assume a 10-year time frame – from 2020 to 2030 – for implementation of the plan. The Planning process began in earnest in 2017, with an expectation that the WMP would be completed in 2019, and cover the 10 years from 2019-2029. Delays in data compilation and agency review pushed completion back to April of 2020, and the implementation period was extended to cover 2020-2030.

Costs listed for individual tasks are based on the best possible information and are necessarily subject to refinement. Interim milestones are included for each task so that the LMWCC can evaluate progress toward accomplishing the plan goals within the 10-year schedule. LMWCC will review the plan progress each year at its annual meeting and retreat.

Table 43 on page 112 (reproduced here and as Table 1 on page 4 in the Executive Summary) shows anticipated costs by category.

While the implementation tables contain an inclusive listing of tasks to be addressed by Watershed partners, it is helpful to define a smaller set of actions that can be initiated quickly. Defining – and accomplishing – those initial tasks will have a positive impact on water quality, and will help to create a strategic momentum for completing the remaining items on the lists. Under this strategic plan, items to be addressed immediately upon approval of the plan (or, in some cases, underway during the WMP development phase) are:

- The baseline monitoring program, including new thermal monitoring on the Little Manistee;
- The work on Syers Lake, removing an earthen dam and reestablishing connectivity;
- Streambank mitigation and associated habitat improvement using woody debris;
- The educational component focusing on groundwater protection and the potential long-term benefits of land use regulation.

For each task, Table 28 through Table 42 list one or more “Project Partners.” Where multiple partners are given, the organization listed first and in bold, underlined text, is the lead organization working to accomplish that task.

Where the letter "X" appears in any milestone column, it indicates that no activity is anticipated in that milestone period. The letter "C" is used to indicate that activity continues from the prior column.

The implementation task listing, like the overall WMP, is intended as a "living document" to be revised periodically by the LMWCC as tasks are accomplished and new information becomes available.

Below are abbreviations for organizations listed as potential partners for implementation tasks.

AES	Alliance for Economic Success
CLMP	Cooperative Lake Monitoring Program
CDs	Conservation Districts:
	Mason-Lake Conservation District (**MLCD)**
	Osceola-Lake Conservation District (**OLCD)**
	Manistee Conservation District (**MCD)**
CRA	Conservation Resource Alliance
EGLE	Michigan Department of Environment, Great Lakes and Energy (formerly MDEQ)
GTRLC	Grand Traverse Regional Land Conservancy
ISNs	Invasive Species Networks:
	Northwest Michigan Invasive Species Network (**ISN**)
	North Country Cooperative Invasive Species Area (**NCCISMA**)
LCEDA	Lake County Economic Development Alliance
LMWCC	Little Manistee Watershed Conservation Council
LRBOI	Little River Band of Ottawa Indians
MAEAP	Michigan Agriculture Environmental Assurance Program
MCCF	Manistee County Community Foundation
MDARD	Michigan Department of Agriculture and Rural Development
MDEQ	Michigan Department of Environmental Quality (now EGLE)
MDNR	Michigan Department of Natural Resources
MDOT	Michigan Department of Transportation
MNSP	Michigan Natural Shoreline Partnership
MSU	Michigan State University
MSUE	Michigan State University Extension
MTA	Michigan Townships Association
NNW	Networks Northwest
NRCS	USDA's Natural Resource Conservation Service
TU	Trout Unlimited
USFS	United States Forest Service
USGS	United States Geological Survey

Table 28 - Category A: Shoreline/Streambank Issues

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
A1	Restore severe and moderate streambank erosion sites identified in CRA inventory. Use whole-tree revetments where practicable to improve aquatic habitat while stabilizing streambanks.	$120 per linear foot	$387,000	5 sites restored	C	10 additional sites restored	**LMWCC, CRA**	Private property owners; Fisheries Trust; Grants	2; 3c; 3e
	Priority - High	**Notes**	Inventory by CRA found 3,222 linear feet of severely or moderately eroded streambanks						
A2	Update streambank inventory on Little Manistee River and major tributaries on 10-year cycle.		$18,000	Inventory updated (Planned for 2020-21)	X	X	**CRA**	Trout Unlimited; G.L. Fisheries Trust	3c; 3e
	Priority - Medium	**Notes**	Could be expanded to include streamside habitat (F5) and invasive species (F6) inventories.						
A3	Work with conservation districts and MSU extension to demonstrate natural shoreline protection techniques on Cool, Harper and other developed lakes in the Watershed.	$5,000 per site	$15,000	One site demo. complete	C	C	**Lake Assocs.; Property Owners**	Private Property owners; MSUE; Cons. Dists	3c
	Priority - Medium	**Notes**	Work through Michigan Natural Shoreline Partnership and local certified contractors						
A4	Complete removal of sand-berm dam at Syers Lake to restore natural lake configuration and perennial flow to Syers Creek	$120,000	$120,000	Project complete	Creek monitored	C	**CRA; LMWCC; Private Landowners**	LMWCC; T.U.; Grants; Private landowner funds	2e
	Priority - High	**Notes**	Work accomplished in 2019 while WMP was under review. Monitorng continues.						

Table 29 - Category B: Stormwater and Runoff

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
B1	Update stormwater infrastructure and impervious surface maps. Identify problem sites and institute Green Infrastructure BMP's for all new construction.	unknown		X	Maps and BMP education in place	C	County Planning Depts; MSUE; Networks Northwest	Local foundations; in-kind funding	2d; 3c
	Priority - Low	Notes							
B2	Inventory & monitor all streams for nutrients, *E. coli*, and other pollutants, including thermal stressors. Institute BMP's as appropriate.	See task I2	See task I2	Existing program continues	Progbram expanded to additional sites	C	LMWCC	LMWCC funds; volunteers	3a; 3b; 3e
	Priority - High	Notes	This is a continuation and expansion of existing LMWCC program. For costs, see I2						
B3	Promote shoreline stewardship education through Michigan Natural Shoreline Partnership and local conservation districts	no new costs identified		X	Information available on Websites or through Township mailings	C	Conservation Districts; MNSP		3c; 3e
	Priority - Medium	Notes							
B4	Promote reforestation of public and private lands within the stream corridor to reduce storm runoff and thermal pollution.	$5,000 per year	$50,000	Sites identified	Reforestation activity on 5 sites	Reforestation activity on 10 sites	Conservation Districts; Private Land Owners; USFS; MDNR	Private funds; grants	2a; 2c; 2d
	Priority - High	Notes	This task is important due to loss of ash, oak and beech trees to insects and disease.						
B5	Encourage voluntary private land stewardship practices such as native plantings, rain gardens, conservation easements, and preservation of wildlife habitat.	$2,000 per rain garden	$24,000	2 rain gardens installed	5 rain gardens installed	12 (total) rain gardens installed	Conservation Districts; Property Owners; MSUE	MSUE; Conservation districts	Goal 2; 3a
	Priority - High	Notes							

Table 30 - Category C: Planning, Zoning and Land Use – Part 1

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
C1	Work with township and county planners to develop cooperative land-use practices that extend across government boundaries to protect the entire watershed.	$5,000 per township	$80,000	Create multi-jurisductional task force	Funding secured	Program in place	**Townships; MSUE; LMWCC; AES**	Will require outside grant assistance. Tribal 2 pct. Funding	Goal 1; Goal 5
	Priority - High	**Notes**	See task L7. This task must be coordinated with I/E component						
C2	Identify locally important viewsheds, incorporate protection into master plans and local zoning ordinances to maintain the natural and rustic character of the watershed.	Included in C1		X	Sites identified for protection	C	**LMWCC; Audubon Clubs;**	N/A	Goal 4
	Priority - Medium	**Notes**	Maintaining rustic, natural character was an objective of both the 2000 WMP and the present document						
C3	Develop and adopt ordinances to prevent introduction of terrestrial and aquatic invasive species, and permit treatment of existing infestations	No new costs identified		Provide model ordinances to townships	C	C	**ISN's; Township and County Govts**	N/A	1d; 3f
	Priority - Medium	**Notes**	Model ordinances available through ISN's. May require state legislation						
C4	Investigate multi-jurisdictional zoning ordinance or overlay district to establish uniform, locally based rules for development within the Little Manistee Watershed and River Corridor. Work with township governments to establish such protections when public support exists.	See C1		See C1	C	C	**LMWCC; Townships; MSUE; AES; NNW**	N/A	Goal 1; Goal 5
	Priority - High	**Notes**	This is a specific task included in the more general actiivities of C1						
C5	Promote 'green infrastructure' principles including cluster development for rural residential, and low impact stormwater design requirements as part of local planning and zoning process for new developments.	No costs identified		See C1	C	C	**Townships; MSUE; LMWCC; AES**	N/A	5a
	Priority - Low	**Notes**	This is a specific task included in the more general actiivities of C1						

Table 31 - Category C: Planning, Zoning and Land Use – Part 2

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
C6	Begin public education regarding Michigan Natural River and/or U.S. Wild and Scenic River designation; promote such designation if local support exists.	Variable		X	River forums conducted	C	**LMWCC; MDNR; TU.**	N/A	1f
	Priority - High	**Notes**	Designation would require decisions by MDNR and/or USFS. This task envisions coordination with I/E program as well as local planners.						
C7	Seek grant funding and fiduciary partners to hire or contract with a person for work on implementation of the WMP	$25,000 annually	$250,000	Implementation staff person in place	C	C	**LMWCC; Conservation Districts; CRA**	Tribal Grants, Local foundations	All Goals
	Priority - High	**Notes**	Employee may be full- or part-time. If no funding is received, LMWCC volunters will continue to lead implementation.						

Table 32 - Category D: Road-Stream Issues

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
D1	Update existing stream crossing inventory every 10 years to reflect changes & document improvements	$15,000	$15,000	Inventory complete	C	C	**CRA; LMWCC**	Tribal 2 pct. Funding; Great Lakes Fisheries Trust	2e; 3e
	Priority - High	**Notes**	New inventory completed in 2019						
D2	Restore and protect 63 road-stream crossings identified in the inventory as sites of severe or moderate concern. Restore and protect additional sites on road-stream crossing inventory as conditions require and funding becomes available.	varies	$3,642,000	5 sites addressed	15 sites addressed	All severe and moderate sites improved	**CRA; LMWCC; MDOT; Road Commissions**	Grant funding required; Road comms; MDOT; MDEQ	2e; 3e
	Priority - High	**Notes**	Cost cited is for 63 sites, per 2014 inventory. (Costs not updated in 2019 inventory) Estimates may change as new needs are identified						
D3	Identify sites where private roads may have an impact on surface water qualiity. Work with property owners to minimize movement of sediments, nutrients, salts, etc. into adjacent water	varies		X	Sites Identified	C	**Private Land Owners; CRA**	Private funds	3e
	Priority - Medium	**Notes**							
D4	Develop & institute policies regarding use of dust control agents on unpaved roads near surface waters. Institute BMPs to prevent dust-control agents from entering surface waters.	unknown		X	Policies developed	C	**Road Commissions; MDOT; MDEQ**	N/A	3e
	Priority - Low	**Notes**							

Table 33 - Category E: Land Protection and Management

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
E1	Work with Land Conservancies and/or other agencies to develop a systematic priority parcel analysis for significant lands in Mason County and Lake County segments of the Watershed. Update the existing analysis for the Manistee County segment.		$10,000	Manistee analysis complete	Analysis complete for Lake and Mason	C	**GTRLC; Land Conservancies**	Grants; private donations	4b; 4f; Goal 5
	Priority - Medium	**Notes**	No single conservancy covers the entire watershed						
E2	Assist and support USFS, MDNR and/or local government acquisition of property for protection of water quality, threatened or endangered species, wildlife habitat and other sensitive ecological features		$500,000	X	2 sites protected	C	**MDNR; USFS; Townships; Land Conservancies**	Nat. Res. Trust Fund. USFS funds	Goal 5
	Priority - Medium	**Notes**	Acquisition from willing sellers only.						
E3	Support land-protection and land purchase activities on high-priority sites throughout watershed, including conservation easements and transfer/ purchase of development rights where appropriate.		$500,000	X	2 sites protected	C	**Land Conservancy; Private Land Owners**	Nat. Res. Trust Fund; Private donations	Goal 5
	Priority - High	**Notes**	Conservation Easements are generally favored, since the watershed already has significant acreage in public ownership						
E4	Promote participation in NRCS programs and Michigan Agriculture Environmental Assurance Program (MAEAP) to encourage BMP's in agriculture, including the Forest, Wetlands and Habitat program		No costs identified	X	1 farm certified	C	**MDARD; Farm Owners;**	N/A	3e
	Priority - Low	**Notes**							
E5	Use expertise of MSU Extension and Osceola-Lake Conservation District to educate farmers and riparian residents on use of buffer strips and cover crops to improve soil and manage storm runoff.		Unknown	Education programs offered and publicized	C	C	**MSUE; Conservation Districts; Land Owners**	N/A	Goal 1; 2a; 3c; 3e
	Priority - Medium	**Notes**							

Table 34 - Category F: Habitat for Fish and Wildlife – Part 1

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
F1	Maintain multiple-use management policies on public lands. Preserve upland habitat and wildlife corridors. Discourage new roads in state/national forest and wetland areas		No new costs	Continuation of current practice	C	C	**USFS; MDNR**	N/A	4a; 4b; 4c
	Priority - High	**Notes**	This is a continuation of current policies						
F2	Conduct fishery surveys on the Little Manistee River on a minimum 10 year cycle to monitor changes & evaluate stocking & management programs.		$30,000	X	New survey complete	C	**MDNR; T.U.; LRBOI**	MDNR funds	4a; 4e
	Priority - High	**Notes**	Little Manistee provides critical broodstock for regional fishery						
F3	Maintain current fish stocking & management strategies unless changes are warranted by scientific studies such as in F2		No New costs	C	C	C	**MDNR; Trout Unlimited; LRBOI**	N/A	4a
	Priority - Medium	**Notes**	Continuation of current policies						
F4	Install and maintain fish habitat improvement structures as appropriate. Consider instream habitat and fish passage implications of all road crossing and bank stabilization projects.	$10,000 per site	$120,000	Woody debris installed, per plan	C	C	**LMWCC; MDNR; CRA; Trout Unlimited**	Private donations; volunteer in-kind	Goal 2
	Priority - Medium	**Notes**	Funds committed for woody debris work in 2019/20						
F5	Evaluate & document stream and streamside habitat, including shade and forest cover for the Little Manistee River and major tributaries.		Not identified (See A2)	X	Evaluation complete	X	**USFS; MDNR; LMWCC**	N/A	Goal 2
	Priority - Medium	**Notes**	This can be included in an enhanced bank erosion survey (A2)						
F6	Restudy & document habitat and fishery potential in each of small lakes and streams in watershed, many of which have not been evaluated in more than 50 yrs.		$50,000	X	Inventory complete	X	**MDNR Private Land Owners**	Grants; MDNR funds; lake associations	4a
	Priority - Low	**Notes**							
F7	Evaluate fishery potential in the Luther Millpond and sites upstream of the Luther Dam.	$30,000	$30,000	Develop plans for study with MDNR; Village and Township	Complete Study	Publicize study's results	**Ellsworth Twp.; Village of Luther; TU; MDNR; LMWCC**	Grants; LRBOI; TU; MDNR	1a; 1f
	Priority - High	**Notes**							

Table 35 - Category F: Habitat for Fish and Wildlife – Part 2

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
F8	Closely monitor operation of Luther Dam and spillway. Recommend changes as appropriate. Specify which agency (Village or MDNR) is responsible for operation of the dam.	No new costs identified		Develop operation and monitoring plan	C	C	**Village of Luther; Ellsworth Twp. MDNR; LMWCC**	Village and township funds	2b; 2e
	Priority - High	**Notes**	This item could be a short-term option or a long-term option, depending on action in F9						
F9	Develop long-term options for removal of the Luther Dam and restoration of the Millpond and park area and upstream tributaries. Recognize that the dam is the property of the village, and removal/restoration can occur only if village residents and officials determine it is in their best interests.		Variable: $50,000 to $2 million	Phase 1; create working group; identify costs and benefits of maintaining the dam and pond	Phase 2: Identify benefits and costs of fish passage, stream restoration; dam removal and/or operational changes	Phase 3: Act on appropriate phase 2 findings	**Village of Luther; Ellsworth Twp. LMWCC; MDNR; MDEQ**	State or federal grants required	1a; 2b; 2e
	Priority - Medium	**Notes**	Changes in dam operation and/or fish passage may have modest costs; Dam removal and stream restoration would cost up to $2 million						

Table 36 - Category G: Recreation, Safety, Navigation and Human Health

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
G1	Continue and expand volunteer monitoring for *E. coli* and other potential pathogens	See task I2	See task I2	Monitoring in place	C	C	**LMWCC; Lake Associations; CLMP**		3a; 3b
	Priority - High	**Notes**	*E. coli* monitoring costs are included with general monitoring in task I2						
G2	Work with State Forest and National Forest staff and ORV groups to ensure that motorized trails are designed and used in ways that do not negatively impact water quality.	No new costs identified		Trails inspected and site issues identifieid	Sites corrected	C	**MDNR; USFS; Snowmobile and ORV Organizations**	Trail program funds	4b; 4c; 4e
	Priority - High	**Notes**							
G3	Initiate "adopt a stream" or similar volunteer program for ongoing river clean-up and tree management.	No new costs identified		Program in place	C	C	**Conservation Districts;**	N/A	1c; 1e
	Priority - Medium	**Notes**							
G4	Monitor paddlecraft volume to ensure that such use does not exceed the river's carrying capacity.	No new costs identified		Monitoring dates/criteria identified	Program in place	C	**LMWCC; Private Landowners**		4b; 4d; 4e
	Priority - Low	**Notes**							
G5	Keep at least one campground open through October to accommodate late-season paddlers	Unknown		Campground operational costs and options assessed	C	C	**Campground Operators**	N/A	4b; 4d
	Priority - Medium	**Notes**	Proposed by the public at informational session						

Table 37 - Category H: Hydrology, Groundwater and Wetlands

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
H1	Install permanent gauges throughout watershed to evaluate & report stream flow, water temperature, and high-low water conditions.	variable	$15,000	Permanent gauges in place	C	C	**LMWCC; TU; USFS; USGS; MDNR**	T.U grant; LMWCC funds	2a
	Priority - High	**Notes**	Plan is inplace to install up to 7 sensors.						
H2	Study and Implement a system of local groundwater monitoring to assess both flow levels and quality of this vital resource. Actively support legislation to develop a statewide system of groundwater and surface water monitoring.	variable	$50,000	Collect aquifer data and design monitoring strategy	Monitoring begins	C	**LMWCC; District Health Departments; Michigan Legislature**	N/A	2a; 2d; 5c; 5e
	Priority - High	**Notes**	Costs may vary widely depending on study design. Funding for statewide program is preferred.						
H3	Work with local government to regulate installation of new impervious surfaces in the stream corridor and mandate BMP's to control stormwater and mitigate impact of new and existing impervious surfaces.		No new costs	X	Impervious surface policies in effect	C	**Township Planning Comms.**	Grants, in-kind labor	1a; 1f; 2d; 3c; 4e
	Priority - Medium	**Notes**	This element of groundwater protection is also included in categories B and C, and in education component (Cat L)						
H4	Protect wetland areas; initiate programs to educate the public about the role of wetlands in water quality		$5,000	X	Wetland program offered to schools and service groups	C	**LMWCC; MDEQ; MDNR, Township Planning Comms.**	Conservation Districts; Inland Lake Groups; townships	1a;2a; 2d
	Priority - Medium	**Notes**	Wetland education costs also included in I/E progam estimates (Category L)						
H5	Adopt state and local rules, protective of groundwater, to monitor and regulate the practices of horizontal drilling & hydraulic fracturing for oil & gas extraction, including associated infrastructure and disposal facilities		unknown	C	C	C	**District Heath Depts; Legislature, MDEQ, Township Planning Comms.**	N/A	2a; 2d; 4f
	Priority - High	**Notes**							
H6	Monitor for nitrates in well water, especially at sites with light soils and historic agricultural use		unknown	C	C	C	**Health Depts**	N/A	2d; 5d
	Priority - Medium	**Notes**							

Table 38 - Category I: Water Quality Monitoring

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
I1	Continue & expand volunteer stream monitoring program for biological markers.	$500	$5,000	Program continues in place	C	C	**LMWCC; Conservation Districts; MDEQ**	Local funds	1a;3b; 3f
	Priority - Medium	**Notes**	LMWCC has VSMP records back to 2007						
I2	Continue regular phosphorus, DO and *E. coli* monitoring by Watershed Council. Expand this program to include all lakes in the watershed. Add monitoring of thermal conditions	$5,000	$50,000	Program continues in place	New sites added as appropriate	C	**LMWCC; Conservation Districts; Lake Assocs; MDEQ**	LMWCC funds; local donations; volunteer in-kind	Goal 3
	Priority - High	**Notes**	This funding includes monitoring in tasks B2 and G1						
I3	Develop a database of water quality information to be maintained on publicly accessible website such as the Manistee Conservation District.	$1,500	$15,000	Database in place	C	C	**LMWCC; Conservation Districts**	Local grant funds; LRBOI 2 pct. Funds; MACD funds for continuing operation	1c; Goal 3
	Priority - High	**Notes**							
I4	Continue MDEQ monitoring program to track stream biology.	No new costs identified		MDEQ monitoring scheduled	C	C	**MDEQ**	Exisitng MDEQ funding	3b
	Priority - High	**Notes**	MDEQ monitoring scheduled for 2019 on a 5-year cycle						
I5	Per category H2: Actively support the portion of the Michigan Water Strategy that calls for a statewide system of groundwater and surface water monitoring. Coordinate letter of support campaign with watersheds in region.	No new costs identified		Develop and distribute letter of support	C	C	**LMWCC**	N/A	2a;2d; 5b; 5e
	Priority - Medium	**Notes**	This expands on a portion of item H2						

Table 39 - Category J: Invasive Species

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
J1	Develop terrestrial and aquatic invasive species monitoring program for entire watershed. Create Little Manistee River task force to coordinate among the various ISN agencies.		Unknown	Task Force created	C	C	**ISN groups**	N/A	3f; 5e
	Priority - High	**Notes**	The Watershed is split among service areas of two Invasive Species Networks; This task would ensure coordination through periodic meetings.						
J2	Use information from the monitoring program (J1) and existing strategies to develop and implement a comprehensive invasive species strategy, which will include elements of prioritization, control, education, and habitat restoration.		$20,000	Plan in Place	C	C	**Local Task Force; ISN Groups**	ISN funding; local volunteers	3f;
	Priority - High	**Notes**							
J3	Develop and implement plans to control or eradicate invasive phragmites on public and private sites.	$1,000	$10,000	Plan in place	C	C	**ISN's; Townships; Property Owners; USFS**	Private funds	3f
	Priority - Medium	**Notes**							
J4	Research boat-washing methods and promote boat washing throughout the watershed, in cooperation with Manistee County and the Benzie Conservation District.	No new costs identified		Demonstrate boat-washing systems twice annually in watershed.	C	C	**Benzie Cons Dist; Manistee County**	MDNR Invasive Species pathways grant	1a; 3d; 3f
	Priority - High	**Notes**	Three mobile boat washing facilities are available regionally						
J5	Develop educational and demonstration facilities for cleaning waders and other fishing gear at popular river entry sites	$2,000	$20,000	Wader cleaning facility in place at Bear Track Campground	3 stations in place	Stations in place at all popular fishing entry points	**Trout Unlimited; Boy Scouts; MDNR; LMWCC**	Local donations and volunteer in-kind labor.	1a;1e; 3f
	Priority - High	**Notes**	May be co-located with kiosks in task L2						
J6	Float navigable segments of mainstream with Invasive Species Network staff to inventory terrestrial and emergent invasives		$15,000	X	Inventory complete	C	**LMWCC, ISN's**	LRBOI grant; in-kind labor	1a, 3f
	Priority - Medium	**Notes**	Could be combined with streambank inventory (A2) for cost savings						

Table 40 - Category K: Wastewater and Septic Systems

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
K1	Work with local governments to establish and enforce uniform mandatory "inspection-on-sale" regulations for septic systems throughout watershed	$300 per inspection	$330,000	County boards asked to consider rule	Rule in place in Lake and Mason counties	C	**County Comms; Health Depts; Pumping Contractors; Legislature**	Private inspection fees.	1a; 1f; 3e5e
	Priority - High	**Notes**	State legislation (See K3) is preferable. Cost estimate based on inspection of 25 percent of systems during 10 year period.						
K2	Consider rules to ease the creation of community systems or other alternatives where individual septic systems are problematic		Unknown	Proposals to planning comms	C	C	**LMWCC; Planning Comms; Township Boards**	N/A	1a; 1f; 5e
	Priority - Low	**Notes**							
K3	Support legislation to create statewide standards for installation, operation and inspection of on-site wastewater systems, including septic tank and drainfield systems. Coordinate with other watersheds in region.	Unknown	Unknown	Develop strategy and letters of support; share with regional watersheds	C	C	**LMWCC; Manistee Watersheds Group Legislature**	N/A	1a; 3e; 5e
	Priority - High	**Notes**	Michigan is only state without a statewide code. Costs would likely be borne by property owners, as in K1						
K4	Develop educational materials to inform landowners of the proper management and impact of septic systems and fertilizers. Distribute through local health departments, volunteer groups and septic pumping companies.	$5,000 for materials and printing	$5,000	X	Materials developed for distribution	Materials shared through twps and health depts	**LMWCC; Townships, Health Depts; Pumping Contractors**	Local donors	1a;3e;5e
	Priority - Medium	**Notes**							

Table 41 - Category L: Information and Education – Part 1

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
L1	Preserve the distinctive character of the Watershed by promoting rustic and natural appearance of all structures, signage and facilities at access sites. Work with campgrounds and access sites to establish voluntary uniform designs	Unknown		Establiish working group to consider designs	C	C	LMWCC; MDNR; USFS, Camp-Grounds		4b; 4e;5b
	Priority - Medium	Notes							
L2	Install educational kiosks or signage at appropriate sites to inform users of Watershed concerns and stewardship opportunities.	$1,000 per kiosk	$3,000	one kiosk installed	C	Three kiosks in place	LMWCC; MDNR; USFS, Camp-Grounds Local Govts	Local donations; in-kind volunteer labor	1a; 4b;4c
	Priority - Medium	Notes	May include invasive species information and wader-cleaning station at fishing access sites						
L3	Develop a list of all riparian property owners for dis-semination of edicational and informational materials.		$2,000	List in place	List Updated semi-annu-ally	C	LMWCC; County Govern-ments	In-kind volunteer labor	1b
	Priority - High	Notes							
L4	Assign communications el-ement (group or individual) within LMWCC to promote Watershed education through multiple path-ways, including in-school programs, local media, public presentations and direct mail.	$3,000 per year	$30,000	Commiuni-cation group and strategy inentified	C	C	LMWCC; Schools; Libraries	Local foundations; LRBOI	1a; 5e
	Priority - Medium	Notes							
L5	Establish outreach to developers and real estate professionals to share research showing that clean water and land stewardship can positively impact property values, and to communicate the range of possible land protection strategies.		$5,000	Contact list established; Outreach in place	C	C	LMWCC Commu-nication Group; Local Real-tors	Local funds	1a; 1f
	Priority - Medium	Notes							
L6	Maintain updated versions of the WMP on a publicly accessible website, and provide hard copies to libraries in and near the Watershed.		$1,000	Plans available	C	C	LMWCC; Schools, Libraries		1a; 1b
	Priority - High	Notes	Ideally, water quality database will be on same website						

Table 42 - Category L: Information and Education – Part 2

Task		Unit Cost	Estimated Total Cost	Milestone 2021-2023	Milestone 2024-2027	Milestone 2028-2030	Potential Project Partners	Potential Funding Sources	Objectives Addressed
L7	Create grant-supported project to inform/educate township governments and the public of the role of land use BMP's in maintaining water quality.	$40,000	$40,000	Project Planning	Funding secured; project begins	C	**LMWCC**	Foundation grants; LRBOI	
	Priority - Medium	**Notes**	This task creates additional funding to extend the work in task C1						
L8	Include review of WMP implementation progress as an agenda item for annual membership meeting of LMWCC	No new costs	No new costs	Annual review in place	C	C	**LMWCC; All partners invited to participate**	None needed	All Goals
	Priority - Medium	**Notes**	Annual review will include progress reports and opportunity to amend the plan						
L9	Conduct an annual day long meeting of all interested stakeholders to review the status of the plan, update it and set Goals and Objectives for the upcoming year(s).	No new costs		Initial meeting scheduled for Feb.2 2018.	Annual Meetings	Annual Meetings	**LMWCC; All interested Stakeholders**	None needed	All Goals
	Priority - High	**Notes**	Annual review at LMWCC retreat will include progress reports and opportunity to amend the plan						
L10	Repeat Social Indicators Survey on 10-year cycle	$2,000	$2,000	X	X	Survey repeated	**LMWCC**	None needed	Goal 1
	Priority - Medium	**Notes**							

Table 43 - Estimated 10-year WMP Implementation Cost

Category	Estimated Cost
A. Shoreline/Streambank Issues	$540,000
B. Stormwater and runoff	$74,000
C. Planning, Zoning and Land Use	$330,000
D. Road-Stream issues	$3,657,000
E. Land Protection and Management	$1,010,000
F. Habitat for Fish and Wildlife*	$280,000
G. Recreation, Safety, Navigation, Health*	(N/A)
H. Groundwater and Wetlands	$70,000
I. Water Quality Monitoring	$70,000
J. Invasive Species	$65,000
K. Wastewater and Septic Systems	$335,000
L. Information and Education	$81,000
TOTAL 10-year Cost	$6,512,000

*Cat. F cost est. does not include option for dam removal
*Cat. G costs are included in other line items

Little Manistee River Ice Formations

Chapter 8

Monitoring and Evaluation

Watershed planning can be effective only if the goals, tasks and other plan elements are monitored and reviewed on a regular basis to assess progress and compliance. Concrete steps must be taken up front to ensure that monitoring takes place during the plan's anticipated "lifespan" of 10 years.

To meet this important consideration the Little Manistee Watershed Conservation Council (LMWCC) is designated as the entity to oversee implementation and assess progress in meeting the goals of the WMP. The LMWCC has been in existence for more than 20 years, has conducted annual sampling the Little Manistee River for water quality since 2000, and has demonstrated the ability both to sustain its own operations and to oversee multiple projects. The council will review progress each year at its annual meeting, and report as appropriate to the community and to MDEQ/EGLE.

Because of the many facets of the plan and the number of partners involved, the Steering Committee recommends that a person be hired to assist with plan implementation. LMWCC will work with other partners to determine the amount of paid hours necessary and to seek grant funding for that purpose. Since LMWCC is a 100 percent volunteer organization, it is anticipated that another partner – likely a conservation district or existing non-profit – will act as the fiduciary to hire or contract with the implementation worker.

Evaluation Criteria and Milestones

In order to evaluate progress toward meeting the WMP goals and objectives, the WMP Steering Committee has approved a set of measurable milestones and evaluation criteria.

The specific milestones for each task are included in the implementation tasks (Table 27 through Table 41) in Chapter 7.

Existing WMPs representing some other watersheds have listed annual goals for these milestones, attempting to predict activities in each of the 10 years of the plan's life. Funding availability, scheduling considerations and other issues often make it unrealistic to expect that level of specificity, especially in the out-years of the plan. For those reasons, the Little Manistee WMP divides its milestones into three time segments: An initial period of three years, beginning Jan. 1, 2021 (and including tasks underway prior to plan approval); a middle period of four years; and a final three-year period running through the end of 2030.

For example, in the category of Shoreline/Streambank Issues (Table 27 on page 90), task 1A reads: “Restore severe and moderate streambank erosion sites identified in CRA inventory. Use whole-tree revetments where practicable to improve aquatic habitat while stabilizing streambanks.”

The milestone columns show targets of completing five site restorations in the initial period, through 2023, continuing that work in the middle segment and completing an additional 10 sites by the end of the third time period in 2030. Staging the milestones in this fashion will allow evaluation and monitoring of progress during the life of the plan.

The LMWCC will be the permanent body tasked with monitoring progress toward attainment of each of the 12 categories of tasks and milestones. The committee will report annually on progress.

Long-Term Monitoring Plan

Present conditions are of sufficient quality to support the designated and desired uses of surface water in the Little Manistee Watershed. For that reason, much of the WMP is focused on preservation of the existing high water quality. In furtherance of that preservation objective, the plan recognizes the need for long-term monitoring of physical, chemical, biological and social indicators in such a way as to create a baseline of information and to identify future challenges.

Macroinvertebrate Sampling

This monitoring plan expands and refines activities that have been in place in the watershed since 2000 (see: Map 17 on page 117; Table 44 on page 116), adding thermal and stream flow monitoring in addition to bringing additional lakes into the program.

The plan also recommends sampling and monitoring of groundwater, which has not been done systematically in the past. Michigan's Office of the Great Lakes proposed a water strategy that includes development and funding of a statewide program to monitor surface and groundwater (Office of the Great Lakes, 2016). The WMP supports that proposal. In the interim, with no state funding for such a program, the WMP recommends that the partners study and implement a system of groundwater sampling.

The purpose of monitoring, in both surface and ground waters, is to provide early notice of changes – either positive or negative – and to track multi-year trends so that the community can respond rapidly and appropriately.

Watershed organizations, including the LMWCC and the Cool Lake Association, already participate in Michigan's Volunteer Stream Monitoring Program (VSMP) and Cooperative Lake Monitoring Program (CLMP). Both programs are part of the Michigan Clean Water Corps (MiCORPs), which is administered by the Great Lakes Commission under the direction of EGLE and in partnership with the Huron River Watershed Council, Michigan Lakes and Streams Association, and Michigan State University.

This participation will continue with, at a minimum, regular sampling for *E.coli*, dissolved oxygen and phosphorus. Additionally, a new program sponsored by LMWCC, in partnership with Trout Unlimited, will place automated sensors at several sites in the river or tributaries to provide continuous monitoring of water temperature and stream levels.

The program is structured to create baseline data where none exists, and to produce trend lines to alert the community of emerging threats. Monitoring results will be evaluated relative to the following water quality objectives:

- *E. coli* levels in all watershed lakes and streams must meet state water quality standards.
- Dissolved oxygen levels in all watershed lakes and streams must meet state water quality standards.
- Water temperatures of all watershed lakes and streams (including coldwater streams) must meet state water quality standards.
- No statistically significant increase may occur in average total phosphorus concentrations in any of the watershed's lakes and streams (see: "Table 4 - Volunteer Water Monitoring Summary" on page 19).
- Macroinvertebrate communities in monitored stream sites should score "good" or "excellent" using the MDEQ procedure 51 scoring metrics for wadeable streams (see: "Table 26 and Table 27 - Habitat Monitoring (Macroinvertebrates) on page 88).
- Aquatic invasive species communities are reduced to the smallest population levels possible. In no geographic area should there be a statistically significant increase in the area infested by aquatic invasive species such as Eurasian milfoil.

Table 44 - Monitoring Sites

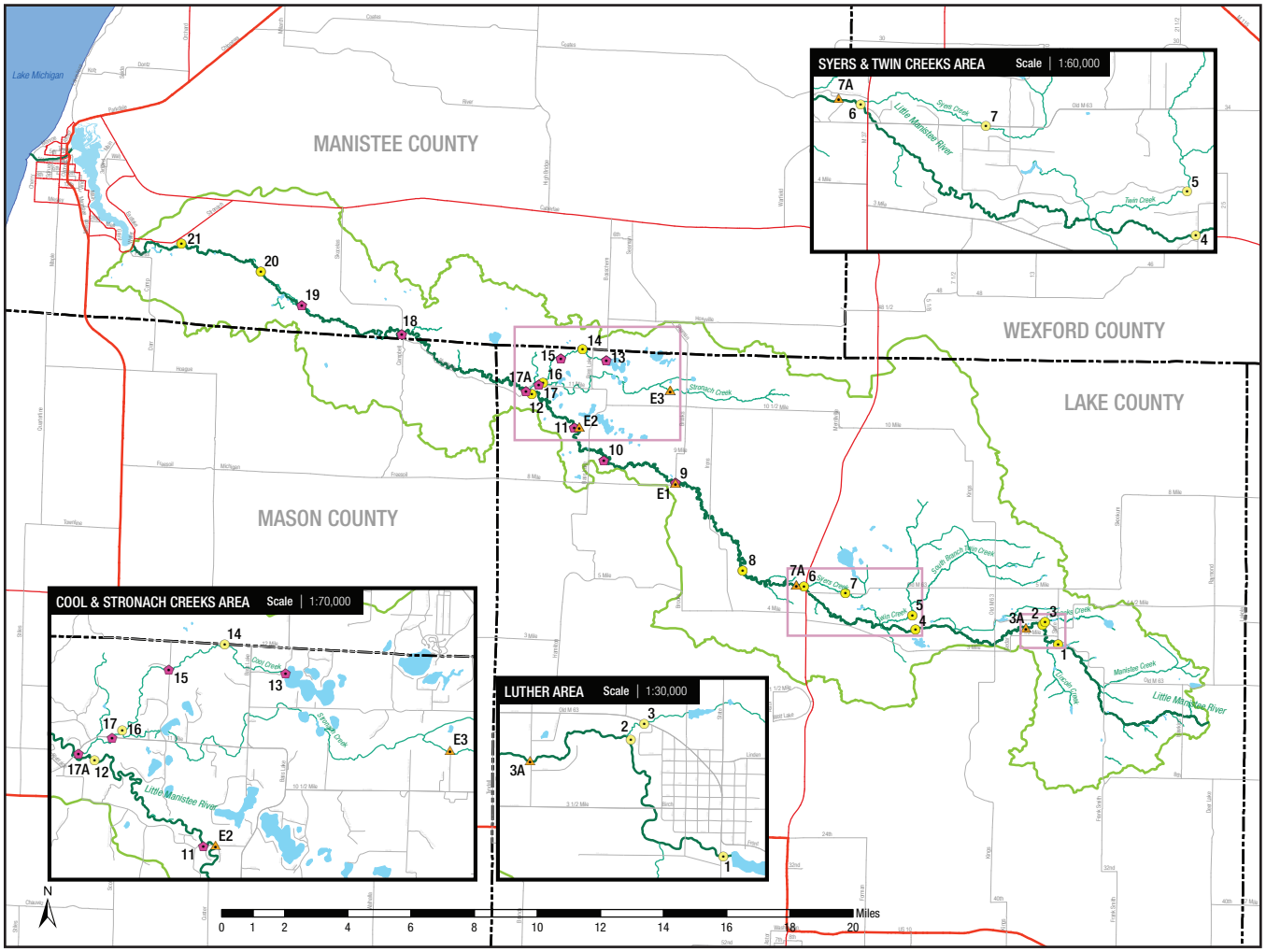
Site	Location Description	Monitoring Type	Monitoring Org	Body	Latitude	Longitude
1	LM below Luther Dam	Water Quality	LMWCC	LM	44.03475	-85.68214
2	LM above Fairbanks Creek	Water Quality	LMWCC	LM	44.04357	-85.69213
3	Fairbanks Creek below Old M63	Water Quality	LMWCC	TRIB	44.04479	-85.69072
3a	Queen's Highway	Macroinvertebrates	LMWCC	LM	44.04186	-85.70276
4	LM above Twin Creek	Water Quality	LMWCC	LM	44.04009	-85.77288
5	Twin Creek	Water Quality	LMWCC	TRIB	44.04678	-85.77496
6	LM above Syers Creek	Water Quality	LMWCC	LM	44.05919	-85.84443
7	Syers Creek	Water Quality	LMWCC	TRIB	44.05627	-85.81779
7a	Old Grade Campground	Macroinvertebrates	LMWCC	LM	44.06001	-85.84918
8	LM @ Spencer Bridge	Water Quality	LMWCC	LM	44.06567	-85.88356
9	LM @ Johnson Bridge	Water Quality/Macroinvertebrates	LMWCC/MCD	LM	44.10552	-85.92748
10	LM @ Dewitt's Bridge	Water Quality/Macroinvertebrates	LMWCC	LM	44.11553	-85.97322
11	LM @ Poggensee Bridge	Water Quality/Macroinvertebrates	LMWCC	LM	44.13012	-85.99247
12	LM above Cool Creek	Water Quality	LMWCC	LM	44.14503	-86.01985
13	Cool Creek @ Cool Lake	Water Quality/Macroinvertebrates	LMWCC	TRIB	44.16132	-85.97289
14	Cool Creek @ 12 Mile Road	Water Quality	LMWCC	TRIB	44.16614	-85.98807
15	Cool Creek @ Hamilton Road	Water Quality/Macroinvertebrates	LMWCC/MCD	TRIB	44.16151	-86.00187
16	Stronach Creek above Cool Creek	Water Quality	LMWCC	TRIB	44.15045	-86.01308
17	Cool Creek above Stronach Creek	Water Quality/Macroinvertebrates	LMWCC	TRIB	44.14923	-86.01554
17a	Cool Creek @ 18 Mile Bridge	Water Quality/Macroinvertebrates	LMWCC	TRIB	44.14617	-86.02382
18	LM @ 9 Mile Bridge	Water Quality/Macroinvertebrates	LMWCC	LM	44.17111	-86.10347
19	LM @ 6 Mile Bridge	Water Quality/Macroinvertebrates	LMWCC/MCD	LM	44.18367	-86.16774
20	LM @ DNR Weir	Water Quality	LMWCC	LM	44.19825	-86.19415
21	LM @ Old Stronach Road	Water Quality	LMWCC	LM	44.21025	-86.24527
E1	LM at Johnson's Bridge	Macroinvertebrates	MDEQ/EGLE	TRIB	44.14809	-85.93178
E2	LM at 10 Mile Road	Macroinvertebrates	MDEQ/EGLE	LM	44.13041	-85.98941
E3	Stronach Creek d/s of Java Road	Macroinvertebrates	MDEQ/EGLE	LM	44.10552	-85.92743

Notes:
Parameters at "Water Quality" monitoring sites include: Temp; D.O.; Phos; pH; *E. coli*; etc.
Samples drawn by volunteers; analysis by Great Lakes Water Quality Lab, Lake Ann, MI.
Manistee Conservation District (MCD) assisted volunteers with macroinvertebrate ID.
Sites E1-E3 are MDEQ/EGLE macroinvertebrate monitoring sites

Action is recommended at any time monitoring indicates these goals are not being met. Much of the interpretive value of monitoring stems from the creation of data which is consistent and can be compared over time. For that reason, the plan defines a level of basic monitoring that can be sustained over the long-term, even given the limited resources of some of the participating entities. The monitoring described in this section should be seen as a minimum level.

The WMP seeks to improve coordination by tasking the LMWCC with the responsibility to collect, organize and distribute data generated by the member entities. In addition, it is a goal to organize all water quality data on a single Website available to the public. This may be accomplished directly by LMWCC, or assigned to another organization such as the Manistee Conservation District, which could potentially create a database with relevant information from the Little Manistee and other watersheds in the region.

Map 17 - Monitoring Sites



KEY | MONITORING SITES

- Macroinvertebrates
- Water Quality
- Water Quality/Macroinvertebrates

FEATURES

- LMW Lakes
- Little Manistee River
- LMW Tributaries
- Lake Michigan
- Little Manistee Watershed Boundary
- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary


Linke's Pond

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Chapter 9

Information and Education

Watershed protection can be sustained over the long term only with the informed support of local stakeholders – including property owners, residents, businesses, government agencies, boaters and anglers.

Watershed Management Plans approved by MDEQ/EGLE and US-EPA must include an Information/ Education (IE) element. This section of the plan will be implemented to inform stakeholders about the specific goals and objectives of the WMP, and engage the public in the long-term process of watershed protection.

The Goals and Objectives for the Little Manistee Watershed Management Plan are presented in Chapter 5 of this document. The IE component is addressed in the first goal, which is reproduced below:

Goal 1: Develop an educational component to inform and engage the public in long-term water-quality protection efforts and the potential impacts of land use and development.

Objectives

A. Develop a public education program to help create understanding of the short and long term threats to the river environment, including the potential impacts of land use and development.

B. Utilize print, broadcast, person-to-person and electronic communication to disseminate a clear, concise message about the public's role in protecting water quality in the Little Manistee River Watershed.

C. Work through conservation districts and the Little Manistee Watershed Conservation Council to coordinate and promote educational efforts of non-profits and government agencies.

D. Support sustainable funding for conservation districts and invasive species control agencies.

E. Support and promote boater, angler and paddlecraft safety and stewardship practices.

F. Engage local residents, landowners and government representatives in discussion of potential water-quality benefits of local zoning or natural river designation, and pursue such action if support appears likely.

The high water quality in the Little Manistee Watershed is largely a result of the region's forested land cover and extremely low percentage of impervious surfaces. The Steering Committee recognized that unplanned development and changes in land use could negatively affect the watershed's lakes and streams. Because of that, the

committee chose to include land use education (objective 1a) and discussion of zoning or Natural River designation (objective 1f) among the primary objectives of the WMP.

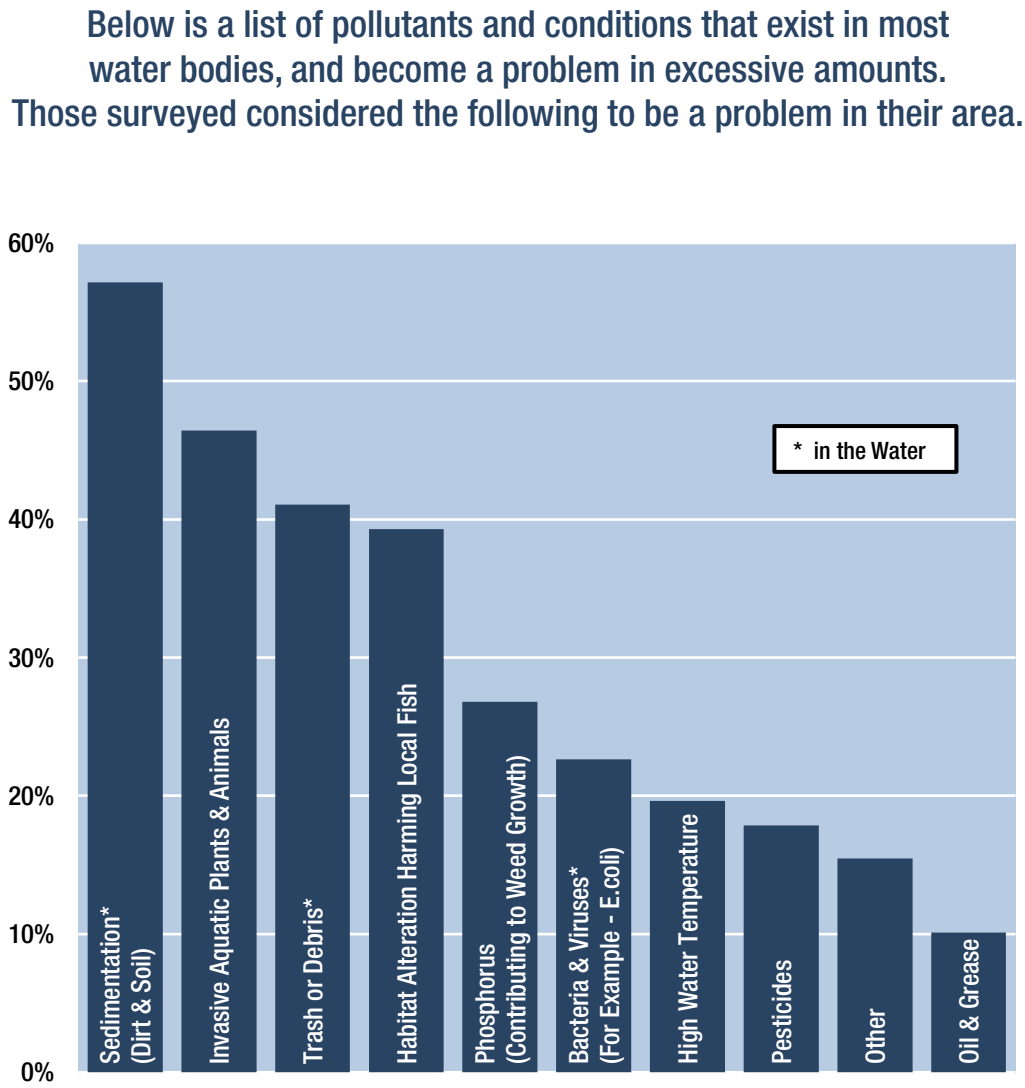
In addition to general watershed education, the IE component of this WMP focuses on three main categories:

- The impact of land use practices and regulations on water quality – including ground water
- Limiting the introduction and spread of invasive species.
- Management of on-site wastewater systems (septic tanks and drain fields).

These elements were developed during the public planning process, and presented along with a draft of the full WMP document in two informational meetings in 2019.

A social indicators survey was widely distributed to watershed stakeholders to assist in development of the educational component. Respondents identified sedimentation and invasive species as the most significant in a list of several pollution concerns in this watershed. (see: Table 45) Full survey results are presented in Appendix A. It is recommended that similar surveys be administered in the future to monitor the effectiveness of the program.

Table 45 - Watershed Pollution Concerns



Source: WMP Social Indicators Survey, 2019

Understanding the Impact of Land Use Practices on Water Quality

The watershed has remained lightly populated since the end of the initial timber-harvesting era in the early 20th century. Forests have grown back over the past hundred years, and many – though not all – of the scars from that earlier era have healed. In recent decades, most development in the watershed has been of recreational amenities or dispersed homes, cabins and campsites.

However, the Little Manistee Watershed lies only about 50 miles from Michigan's fastest growing area – the Grand Rapids Metropolitan Area – which is home to more than a million residents.

Grand Rapids Metro residents have traditionally made use of the recreational assets in the Little Manistee and adjacent watersheds, including the Pine, Big Manistee and Pere Marquette, so there is a significant probability that the area will eventually see an increased level of development pressure.

The IE proposal in the WMP does not aim to discourage or deter investment or development in the area, but to promote best management practices with a goal of minimizing any adverse impacts.

The overall goal is to help local communities understand the issues of non-point source (NPS) pollution, and to acquire the tools to preserve natural resources and water quality should that growth occur. Those tools could include such strategies as river setbacks for buildings, control of storm runoff, limitation of impervious surfaces, management of vegetation cutting in stream corridors, updating of stream-crossing infrastructure and/or other "low impact development" techniques.

Ultimately, local governments will have the lead role in deciding whether to pursue this goal through local zoning, promotion of natural river status, or other means.

There is a long-standing local perception that the rural population is opposed to adoption of local zoning. However, the social indicators survey distributed during development of this WMP found support for some level of zoning (Table 11 on page 42, Chapter 2), as did a 2006 survey conducted by Newkirk Township.

Beyond the question of zoning, an important consideration for land use education in the watershed is that permeable soils and interconnected aquifers make the region's groundwater particularly susceptible to contamination that may leach from materials on the surface.

Coarse, sandy soils, especially in the absence of deep-rooted vegetation, have only limited ability to filter materials that dissolve in rain or snowmelt and percolate into the ground. Thus, pesticides and fertilizers applied to lawns or field crops have the potential to leach all the way to the water table if not carefully applied at rates that can be taken up by the vegetation.

A similar risk holds true for used motor oil or other petroleum products that may be improperly disposed of on the ground.

A 1995 report by the Manistee County Planning Department (Schindler, 1995) found that most soils on the area fall into "very rapid" or "rapid" permeability categories. That finding means the region has "a high potential for contamination from activities involving hazardous materials which take place on the surface…"

The WMP proposes that the land use education program include materials to inform property owners of Best Management Practices for groundwater protection. The LMWCC will work with local conservation districts, Networks Northwest, the Manistee County Planning Department and others to develop and disseminate information.

Land use is likely to be the single largest factor in determining future water quality in the Little Manistee Watershed. For that reason the WMP's implementation tasks (see: Table 41 on page 104 in Chapter 7) include a grant-

supported project to engage with township governments and the public for discussion and consideration of zoning and other potential forms of land use regulation.

Limiting the Introduction and Spread of Invasive Species

Aquatic nuisance species of concern in this region include zebra and quagga mussels, Eurasian watermilfoil, round gobies, sea lampreys, New Zealand mud snails, Didymosphenia geminata ("rock snot") and potentially many others. Terrestrial plants of concern include garlic mustard, Phragmites, narrow leaf cattails Japanese knotweed and more.

Surveys here and in adjacent watersheds identify invasives as a major water-quality concern. But many residents and visitors may be unable to identify the problem species and may be unaware of best practices to limit their spread.

The emerald ash borer likely reached the area in campfire wood transported from previously infested regions; zebra mussels and Eurasian watermilfoil have been inadvertently introduced to some lakes by recreational watercraft; Didymosphenia may adhere to the boots of fishermen's waders; and hikers may accidentally spread garlic mustard seeds along forest trails.

The WMP recognizes that recreational activities – by both residents and visitors – are vital to the region's economic and cultural well-being. Therefore, it is important that this element of the plan focus on encouraging responsible recreation in ways that minimize the spread of invasives.

The Northwest Michigan Invasive Species Network and the North Country Cooperative Invasive Species Area are regional entities that work to monitor and control invasive species in portions of the watershed. The Midwest Invasive Species Information Network (MISIN) operates an informative website with photographs and information about invasive plants that occur in the region. Additional resources available to the public include print materials and the opportunity for group presentations and plant identification by network staff.

The Clean Boats, Clean Waters program, sponsored by Michigan Sea Grant, provides informational materials and instructional forums to educate boaters on ways to detect and remove weeds and other invaders before launching into new waters. Generally, the advice is that any vessel which has not been out of water and dry for 10 days should be cleaned before launching in a new waterway. If a dedicated boat-wash facility is not available, kayaks and canoes can easily be washed at home, or at commercial car washes.

The Benzie Conservation District, through an MDNR grant, operates a mobile boat-washing system that is available for educational events in Manistee County and may eventually be available throughout the watershed.

To help control the spread of invasives on fishing gear, the WMP proposes installation of information kiosks and wader cleaning stations at popular river entry sites.

Management of Onsite Wastewater (Septic and Drain Field) Systems

As detailed in Chapter 3 of this WMP, most residential properties in the watershed are served by individual on-site wastewater systems – primarily by septic tanks and drain fields. These systems, when properly sited and maintained, can efficiently break down bacteria and nutrients in household waste, while protecting the environment. However, some property owners unfortunately take an "out of sight, out of mind" attitude toward these systems, and may ignore preventative maintenance.

Without proper attention, the systems may become clogged or overloaded. When that happens, nutrients and/or pathogens may contaminate the soil and ultimately reach groundwater, lakes or streams.

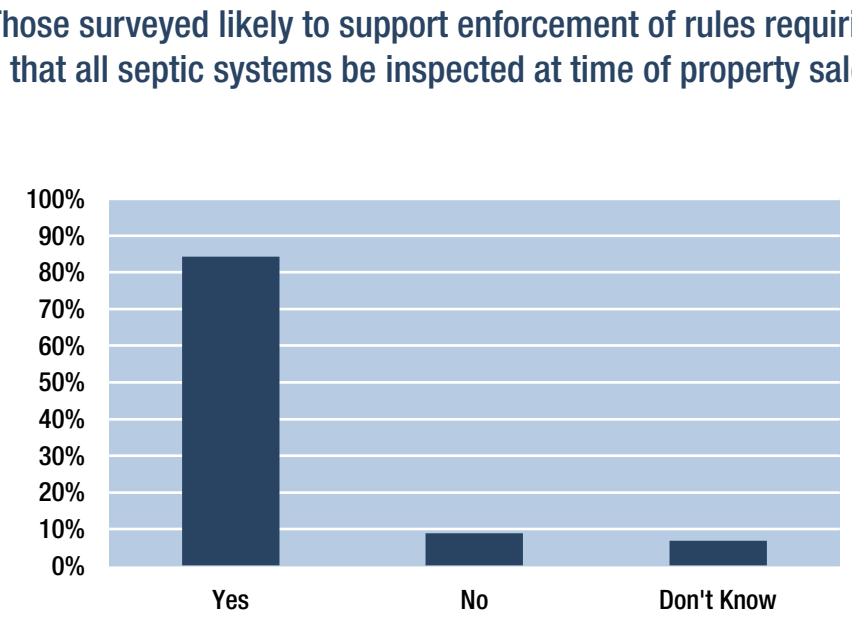
The most important BMP for septic systems (assuming the system is designed and installed properly) is regular pumping, with the waste transported to a facility for proper treatment.

Information is readily available on wastewater BMP's, but this information has not been communicated effectively to all property owners. To improve this communication, the LMWCC will work with health departments to develop clear and simple information sheets, which can then be included on lake association websites, offered as public service announcements in local media, and mailed to property owners with tax bills and other township communications.

Respondents to the social indicators survey indicated a level of support for regulation of on-site systems (see: Table 46). The WMP also supports, at a minimum, a regulation to require inspection of septic systems whenever a property is sold. This will be best accomplished through statewide legislation, as Michigan is the only state without a septic system code. Such a provision is included in the governor's 30 year water strategy for the state, and is under consideration in the Legislature at the time of the completion of the WMP.

The Information/Education component is structured as a continuing project, to be directed by the LMWCC in cooperation with local governments, conservation districts, Michigan State University Extension and other stakeholders.

Table 46 - Septic System Regulation



Source: WMP Social Indicators Survey, 2019

Little Manistee River

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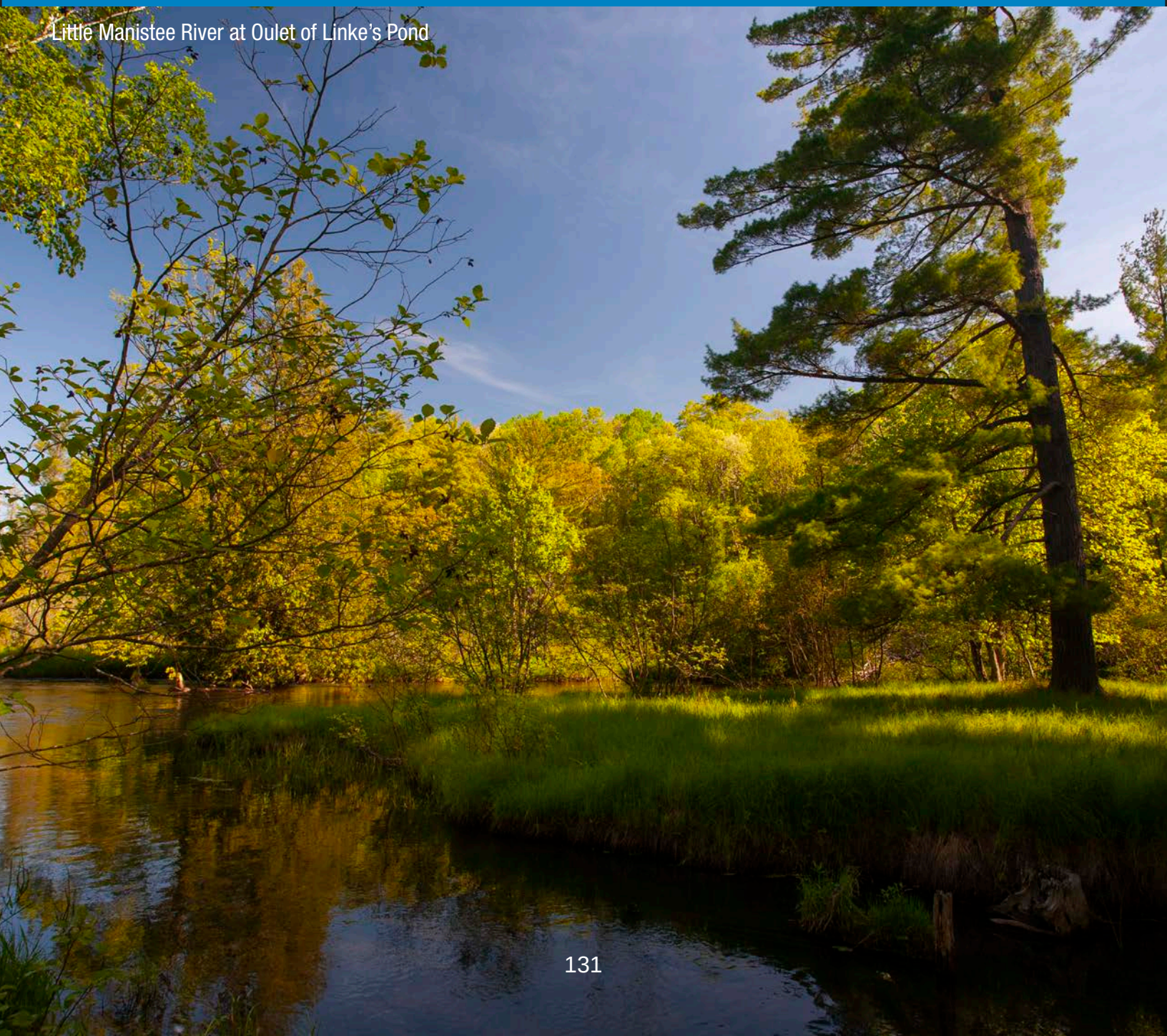
Appendix A — Little Manistee River Watershed Survey

Twenty-four question public opinion survey conducted online using SurveyMonkey in 2018.

Survey Format — pages 132 to 140 (as printed by SurveyMonkey)
Survey Results — pages 141 to 165 (as printed by SurveyMonkey)



Little Manistee River at Oulet of Linke's Pond

Little Manistee River Watershed Survey

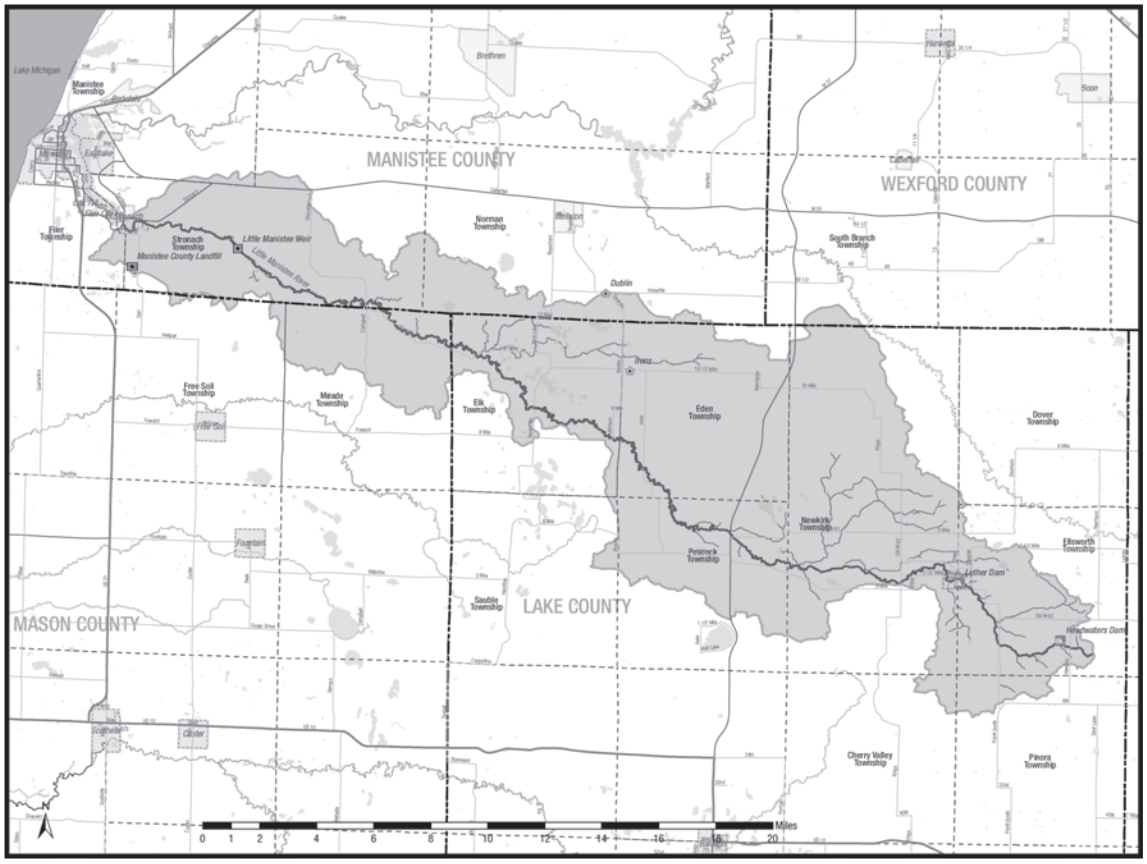
Welcome!

This survey should take only five to 10 minutes to complete and will provide information and community input for the Little Manistee River Watershed Management Plan.

The Little Manistee Watershed Conservation Council is working with the Alliance for Economic Success, Networks Northwest and others to develop this important plan, which will guide long term efforts to protect the quality of local lakes and streams. Public input plays an important role in the process. Your participation will help ensure that the plan meets the needs and desires of those who live in the watershed and those who make use of the local resources.

Thank You for caring about our waters!

Little Manistee Watershed (green shaded area)



Little Manistee River Watershed Survey

Water Quality

Overall, how would you rate the quality of the water in your area?

1. For Canoeing, kayaking or other boating:

- ◯ Poor
- ◯ OK
- ◯ Good
- ◯ Don't Know

2. For eating locally caught fish:

- ◯ Poor
- ◯ OK
- ◯ Good
- ◯ Don't Know

3. For swimming or wading:

- ◯ Poor
- ◯ OK
- ◯ Good
- ◯ Don't Know

4. For picnicking and family activities:

- ◯ Poor
- ◯ OK
- ◯ Good
- ◯ Don't Know

5. For high quality fishing and fish habitat:

- ◯ Poor
- ◯ OK
- ◯ Good
- ◯ Don't Know

6. For scenic beauty:

- ○ Poor
- ○ OK
- ○ Good
- ○ Don't Know

3

Little Manistee River Watershed Survey

Watershed Activities

7. Please rank these activities (1st thru 6th) in order of their importance to you

Canoeing / kayaking / other boating

Eating locally caught fish

Swimming

Picnicking and family activities

High quality fishing and fish habitat

Scenic beauty

Little Manistee River Watershed Survey

Sources of Water Pollution

The items below may be sources of water pollution. In your opinion, how much of a problem is each source in your area?

8. Soil erosion and fertilizer runoff from farm fields:

- Not a problem
- Slight problem
- Severe problem

9. Soil erosion from shorelines and streambanks:

- Not a problem
- Slight problem
- Severe problem

10. Excessive use of lawn fertilizers and/or pesticides:

- Not a problem
- Slight problem
- Severe problem

11. Improperly maintained septic systems:

- Not a problem
- Slight problem
- Severe problem

12. Erosion and stormwater runoff from public roads:

- Not a problem
- Slight problem
- Severe problem

13. Droppings from geese, ducks and other waterfowl:

- Not a problem
- Slight problem
- Severe problem

14. Removal of shoreline and streambank vegetation:

- Not a problem
- Slight problem
- Severe problem

15. Recreational and tourism activities:

- Not a problem
- Slight problem
- Severe problem

16. Other source (please specify):

6

Little Manistee River Watershed Survey

Pollutants

17. Below is a list of pollutants and conditions that exist in most water bodies, and become a problem in excessive amounts. Please check the boxes for those which you consider to be a problem in your area.

- [ ] Sedimentation (dirt and soil) in the water
- [ ] Phosphorus (contributing to weed growth)
- [ ] Bacteria and viruses in the water (such as E.coli)
- [ ] Trash or debris in the water
- [ ] Oil and Grease
- [ ] Other (please specify)
- [ ] Invasive aquatic plants and animals
- [ ] Habitat alteration harming local fish
- [ ] High water temperature
- [ ] Pesticides

Little Manistee River Watershed Survey

Courses of Action

Please indicate whether you would be likely to support the following courses of action to address water quality in the Little Manistee River Watershed:

18. Education and voluntary action by property owners

- Yes
- No
- Don't Know

19. Enforcement of rules requiring that all septic systems be inspected at time of property sale

- Yes
- No
- Don't Know

20. Strong local zoning, with requirements that buildings be set back from the river

- Yes
- No
- Don't Know

21. State designation of the Little Manistee as a natural river, with development restrictions

- Yes
- No
- Don't Know

Little Manistee River Watershed Survey

Participant Information

22. Please check all that apply to you

- [ ] Own property in the Little Manistee Watershed
- [ ] Full-time resident of the area in or near the Little Manistee River Watershed
- [ ] Serve as a public official or local government employee (elected or appointed)
- [ ] Visit or use lakes and streams in the Watershed

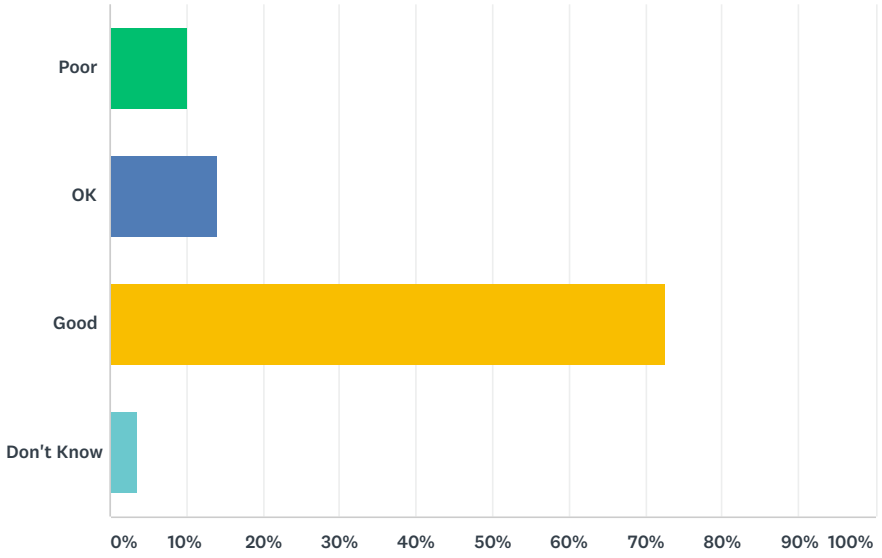
23. Please enter your age

24. Comments & Suggestions

Little Manistee River Watershed Survey

Q1 For Canoeing, kayaking or other boating:

Answered: 201 Skipped: 3

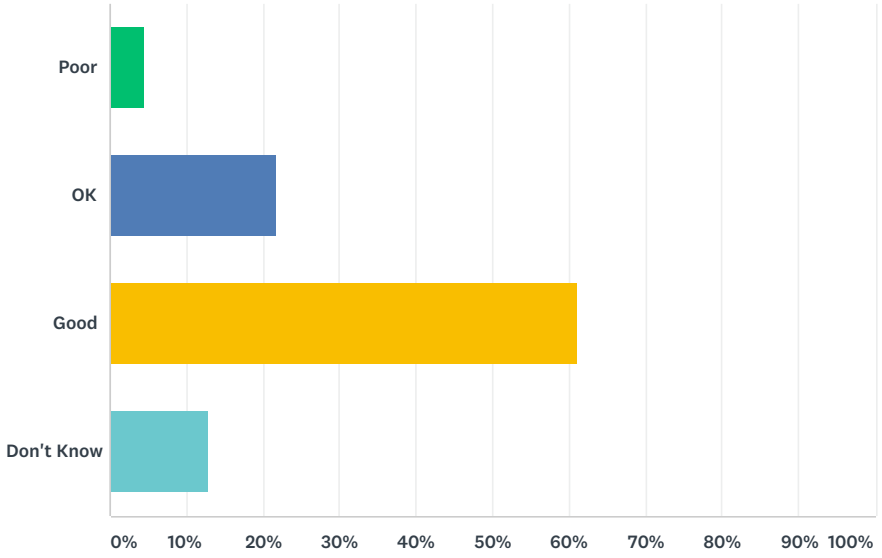


ANSWER CHOICES	RESPONSES	
Poor	9.95%	20
OK	13.93%	28
Good	72.64%	146
Don't Know	3.48%	7
TOTAL		201

Little Manistee River Watershed Survey

Q2 For eating locally caught fish:

Answered: 203 Skipped: 1

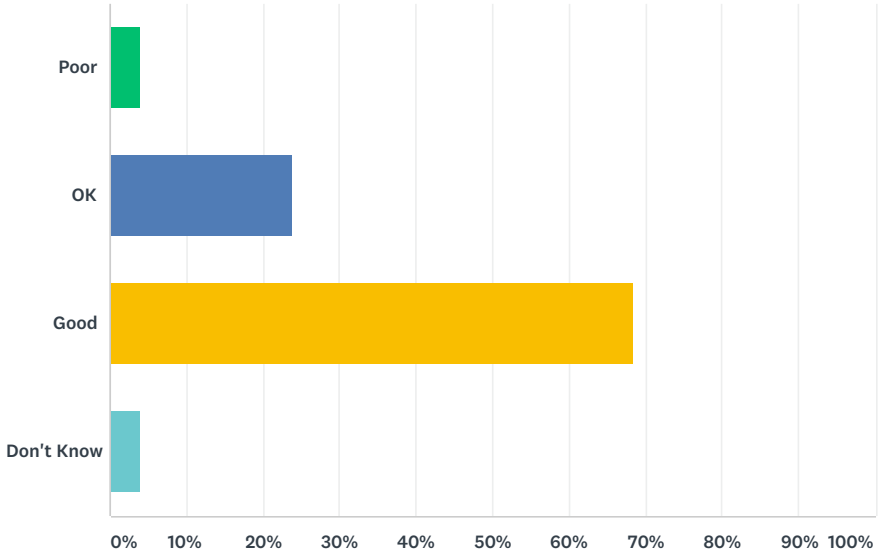


ANSWER CHOICES	RESPONSES	
Poor	4.43%	9
OK	21.67%	44
Good	61.08%	124
Don't Know	12.81%	26
TOTAL		203

Little Manistee River Watershed Survey

Q3 For swimming or wading:

Answered: 202 Skipped: 2

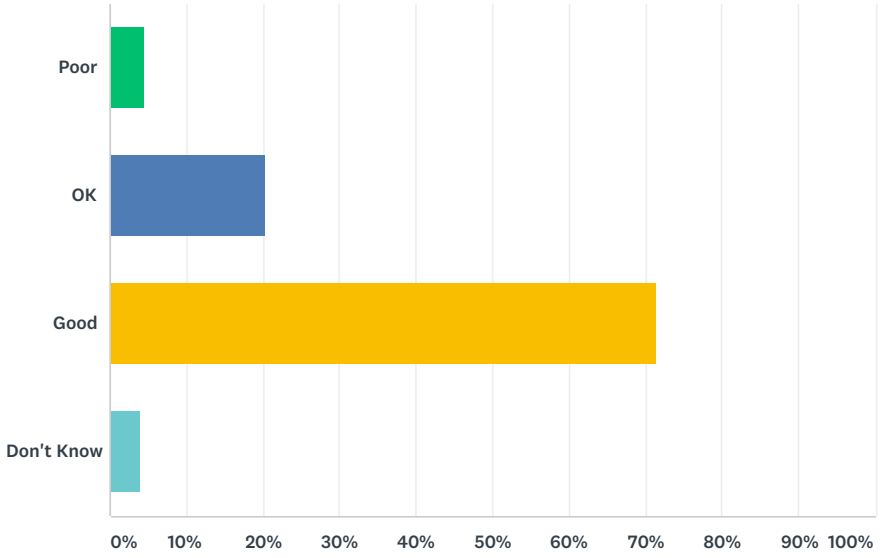


ANSWER CHOICES	RESPONSES	
Poor	3.96%	8
OK	23.76%	48
Good	68.32%	138
Don't Know	3.96%	8
TOTAL		202

Little Manistee River Watershed Survey

Q4 For picnicking and family activities:

Answered: 203 Skipped: 1

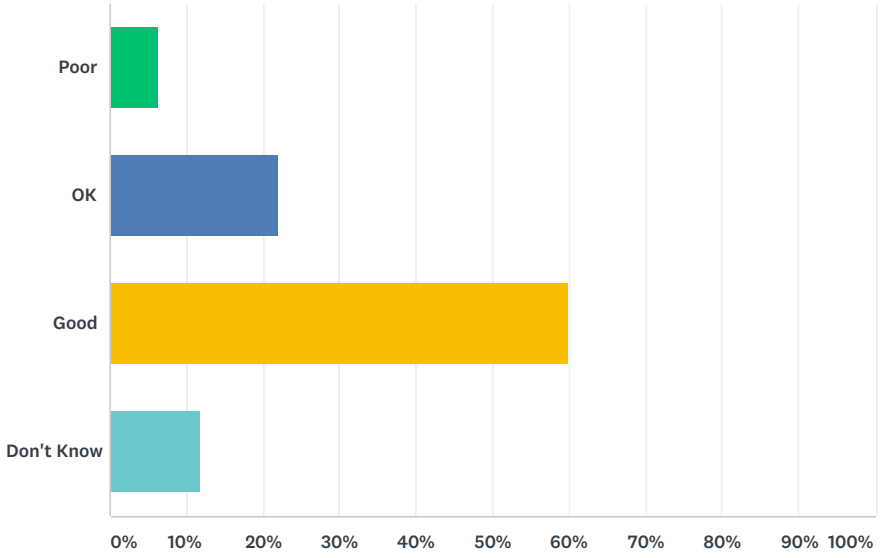


ANSWER CHOICES	RESPONSES	
Poor	4.43%	9
OK	20.20%	41
Good	71.43%	145
Don't Know	3.94%	8
TOTAL		203

Little Manistee River Watershed Survey

Q5 For high quality fishing and fish habitat:

Answered: 204 Skipped: 0

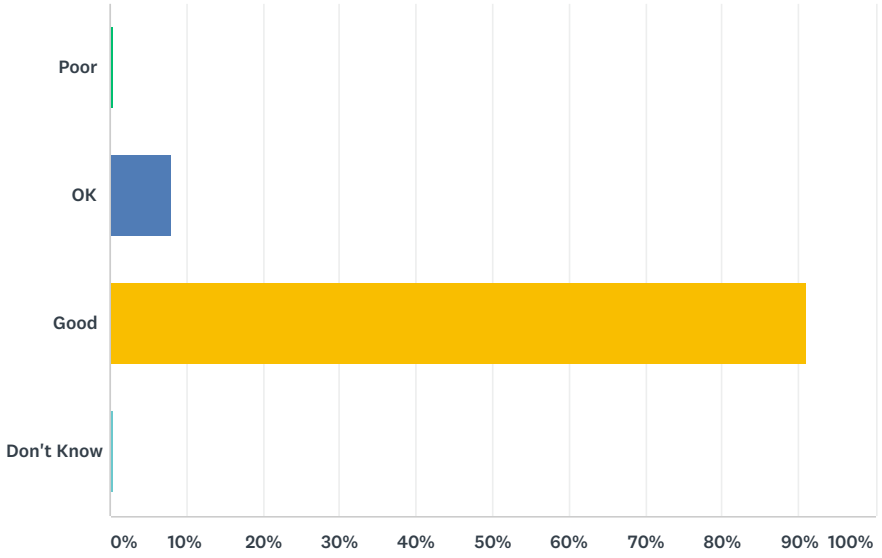


ANSWER CHOICES	RESPONSES	
Poor	6.37%	13
OK	22.06%	45
Good	59.80%	122
Don't Know	11.76%	24
TOTAL		204

Little Manistee River Watershed Survey

Q6 For scenic beauty:

Answered: 201 Skipped: 3

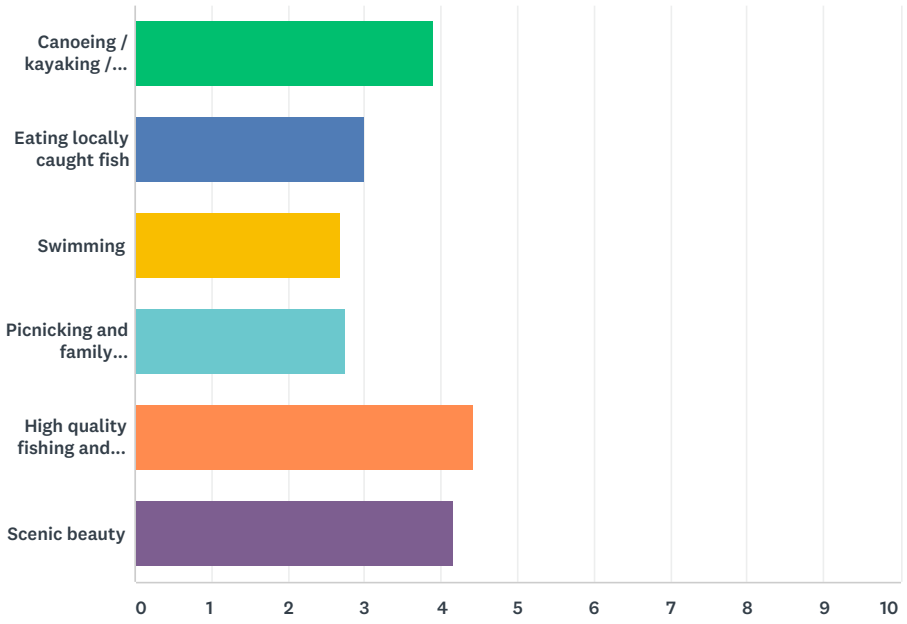


ANSWER CHOICES	RESPONSES	
Poor	0.50%	1
OK	7.96%	16
Good	91.04%	183
Don't Know	0.50%	1
TOTAL		201

Little Manistee River Watershed Survey

Q7 Please rank these activities (1st thru 6th) in order of their importance to you

Answered: 197 Skipped: 7

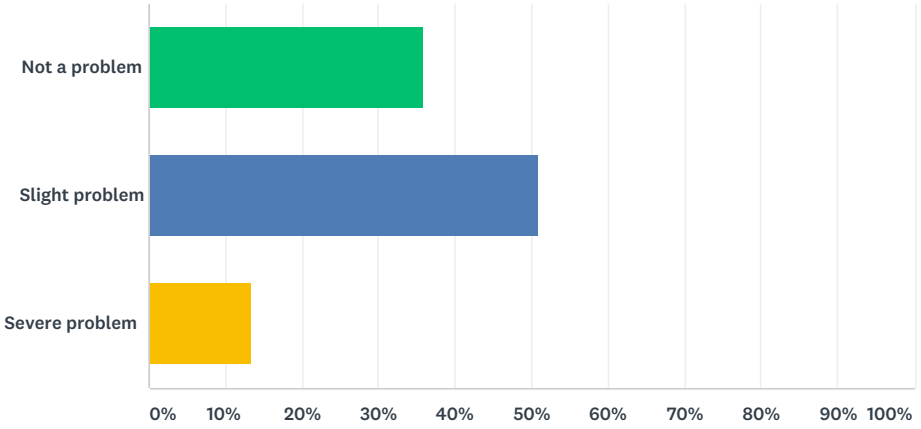


	1	2	3	4	5	6	TOTAL	SCORE
Canoeing / kayaking / other boating	20.86% 39	15.51% 29	25.67% 48	18.72% 35	9.09% 17	10.16% 19	187	3.90
Eating locally caught fish	6.70% 12	18.99% 34	15.08% 27	15.64% 28	13.97% 25	29.61% 53	179	3.00
Swimming	4.84% 9	9.68% 18	13.44% 25	18.28% 34	27.96% 52	25.81% 48	186	2.68
Picnicking and family activities	1.60% 3	6.95% 13	19.25% 36	25.67% 48	29.41% 55	17.11% 32	187	2.74
High quality fishing and fish habitat	42.78% 80	16.58% 31	9.63% 18	10.70% 20	11.23% 21	9.09% 17	187	4.42
Scenic beauty	23.59% 46	31.28% 61	14.87% 29	10.77% 21	8.21% 16	11.28% 22	195	4.17

Little Manistee River Watershed Survey

Q8 Soil erosion and fertilizer runoff from farm fields:

Answered: 193 Skipped: 11

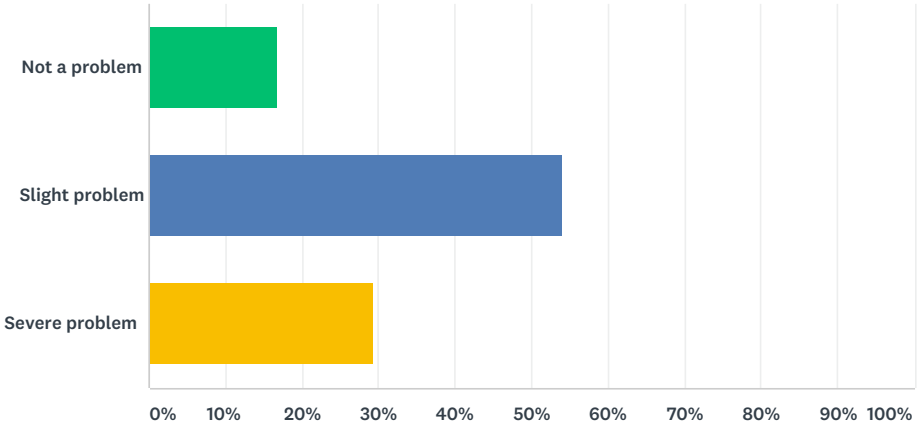


ANSWER CHOICES	RESPONSES	
Not a problem	35.75%	69
Slight problem	50.78%	98
Severe problem	13.47%	26
TOTAL		193

Little Manistee River Watershed Survey

Q9 Soil erosion from shorelines and streambanks:

Answered: 191 Skipped: 13

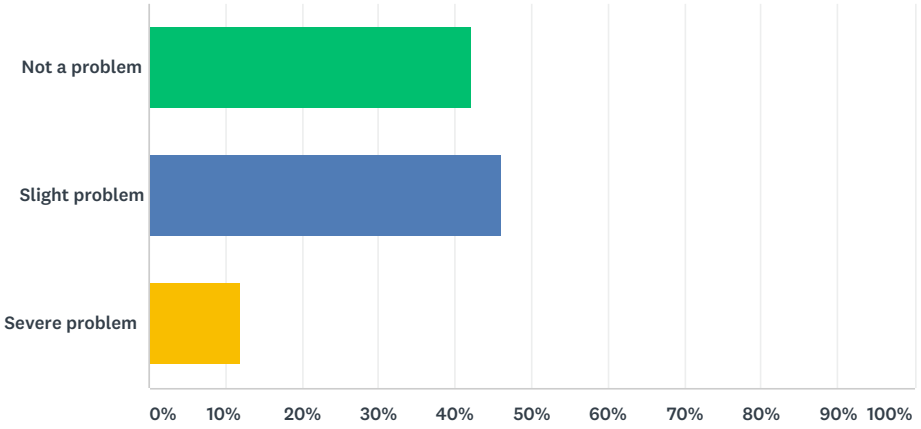


ANSWER CHOICES	RESPONSES	
Not a problem	16.75%	32
Slight problem	53.93%	103
Severe problem	29.32%	56
TOTAL		191

Little Manistee River Watershed Survey

Q10 Excessive use of lawn fertilizers and/or pesticides:

Answered: 193 Skipped: 11

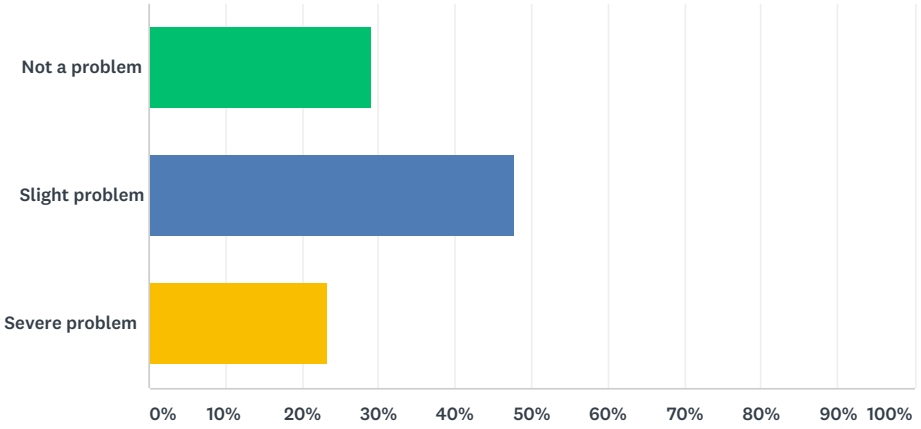


ANSWER CHOICES	RESPONSES	
Not a problem	41.97%	81
Slight problem	46.11%	89
Severe problem	11.92%	23
TOTAL		193

Little Manistee River Watershed Survey

Q11 Improperly maintained septic systems:

Answered: 193 Skipped: 11

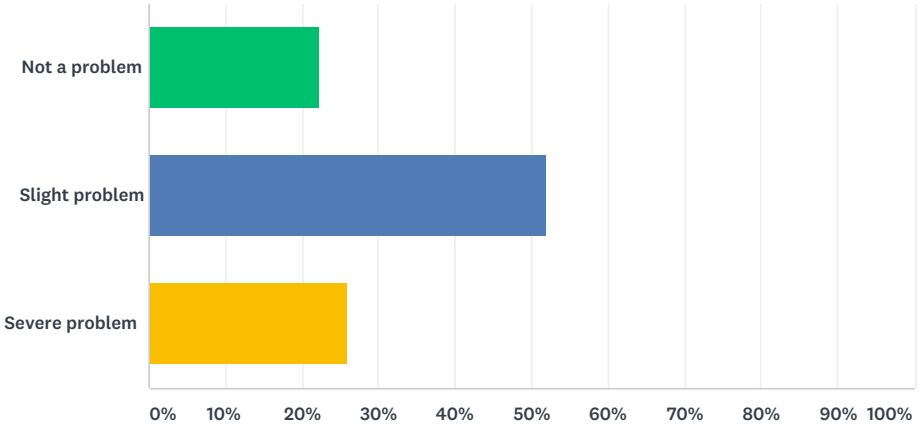


ANSWER CHOICES	RESPONSES	
Not a problem	29.02%	56
Slight problem	47.67%	92
Severe problem	23.32%	45
TOTAL		193

Little Manistee River Watershed Survey

Q12 Erosion and stormwater runoff from public roads:

Answered: 193 Skipped: 11

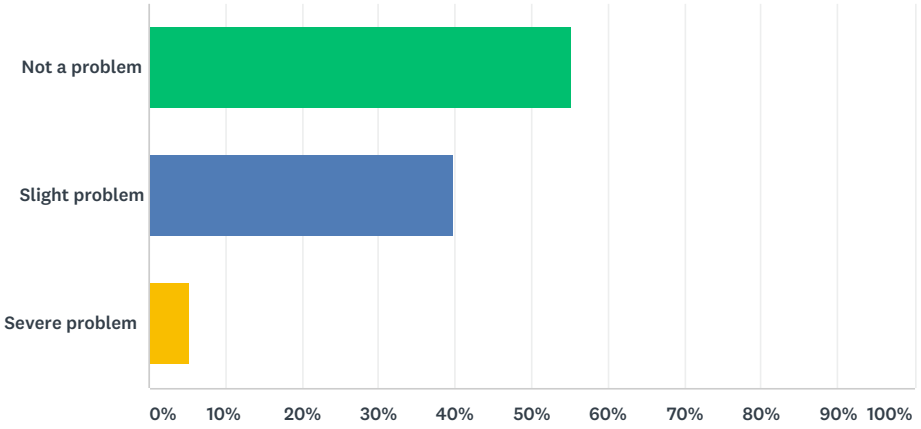


ANSWER CHOICES	RESPONSES	
Not a problem	22.28%	43
Slight problem	51.81%	100
Severe problem	25.91%	50
TOTAL		193

Little Manistee River Watershed Survey

Q13 Droppings from geese, ducks and other waterfowl:

Answered: 194 Skipped: 10

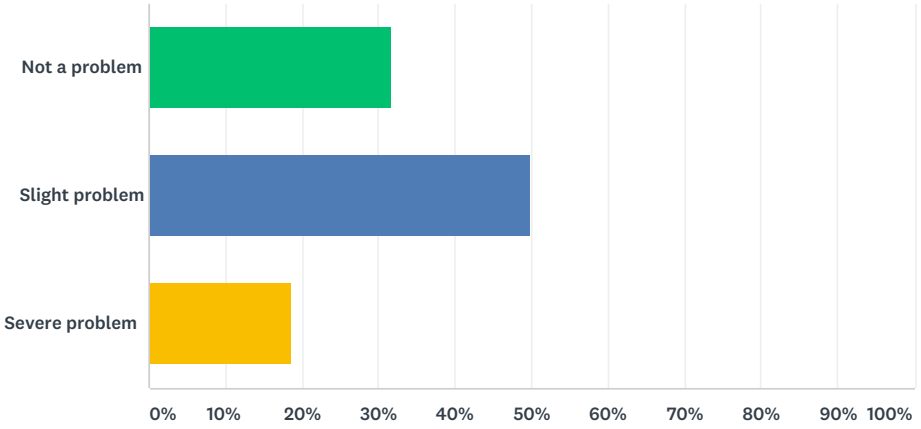


ANSWER CHOICES	RESPONSES	
Not a problem	55.15%	107
Slight problem	39.69%	77
Severe problem	5.15%	10
TOTAL		194

Little Manistee River Watershed Survey

Q14 Removal of shoreline and streambank vegetation:

Answered: 193 Skipped: 11

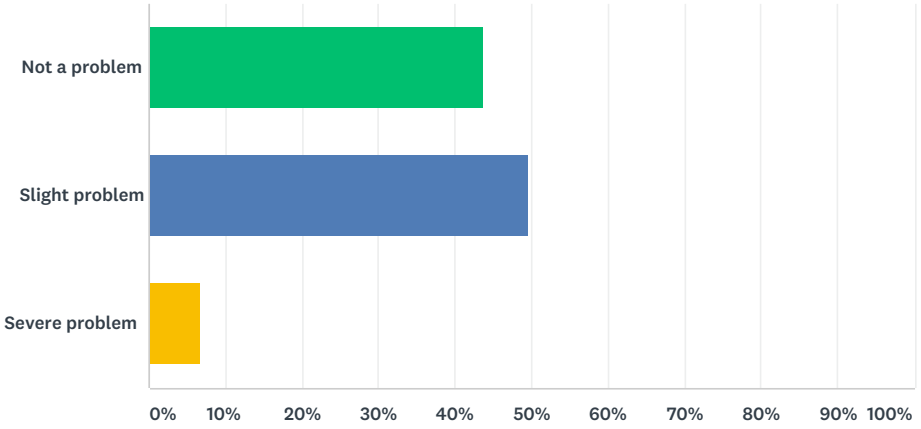


ANSWER CHOICES	RESPONSES	
Not a problem	31.61%	61
Slight problem	49.74%	96
Severe problem	18.65%	36
TOTAL		193

Little Manistee River Watershed Survey

Q15 Recreational and tourism activities:

Answered: 194 Skipped: 10



ANSWER CHOICES	RESPONSES	
Not a problem	43.81%	85
Slight problem	49.48%	96
Severe problem	6.70%	13
TOTAL		194

Little Manistee River Watershed Survey

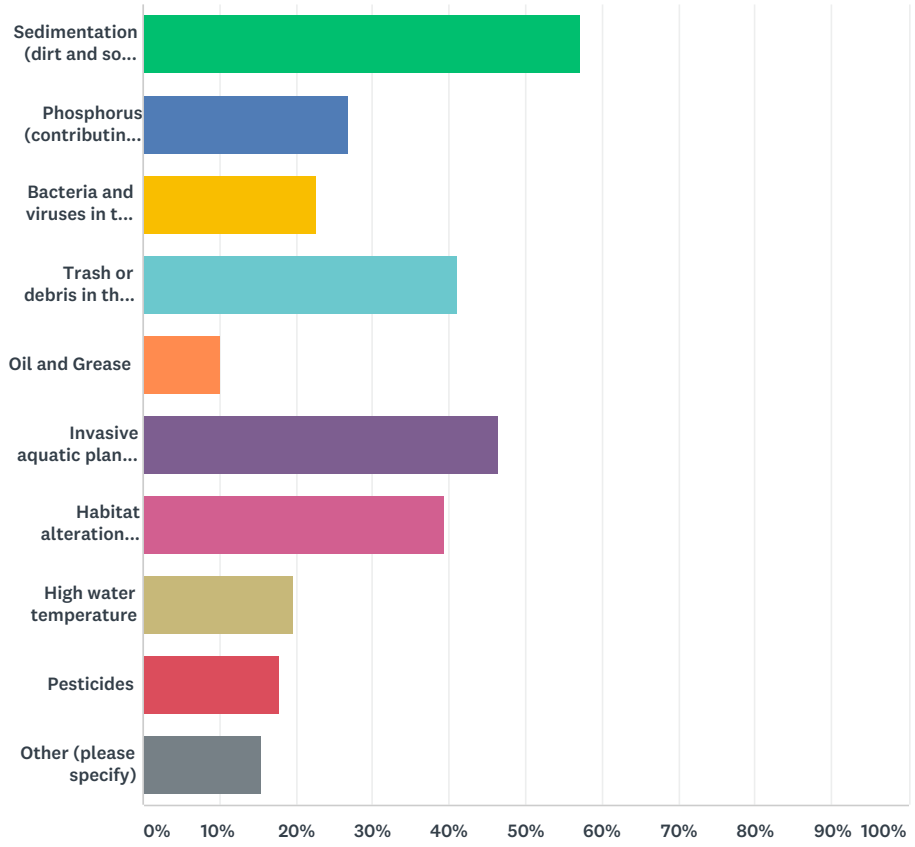
Q16 Other source (please specify):

Answered: 33 Skipped: 171

Little Manistee River Watershed Survey

Q17 Below is a list of pollutants and conditions that exist in most water bodies, and become a problem in excessive amounts. Please check the boxes for those which you consider to be a problem in your area.

Answered: 168 Skipped: 36



ANSWER CHOICES	RESPONSES	
Sedimentation (dirt and soil) in the water	57.14%	96
Phosphorus (contributing to weed growth)	26.79%	45
Bacteria and viruses in the water (such as E.coli)	22.62%	38
Trash or debris in the water	41.07%	69
Oil and Grease	10.12%	17
Invasive aquatic plants and animals	46.43%	78
Habitat alteration harming local fish	39.29%	66
High water temperature	19.64%	33
Pesticides	17.86%	30
Other (please specify)	15.48%	26

17 / 25

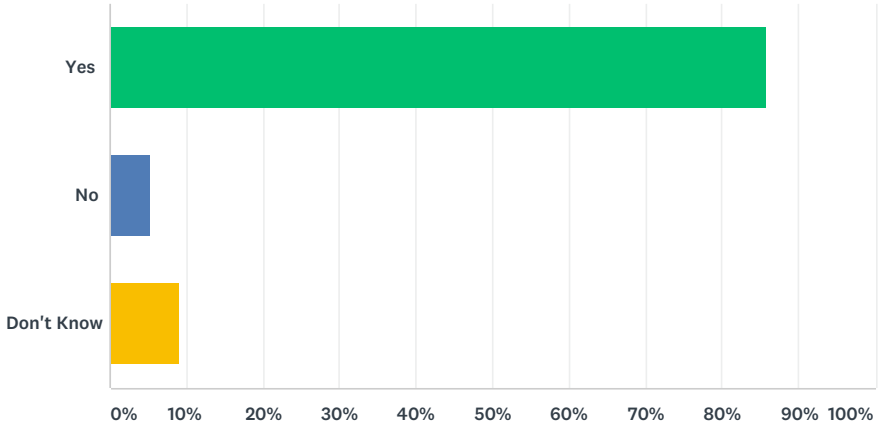
Little Manistee River Watershed Survey

Total Respondents: 168	

Little Manistee River Watershed Survey

Q18 Education and voluntary action by property owners

Answered: 190 Skipped: 14

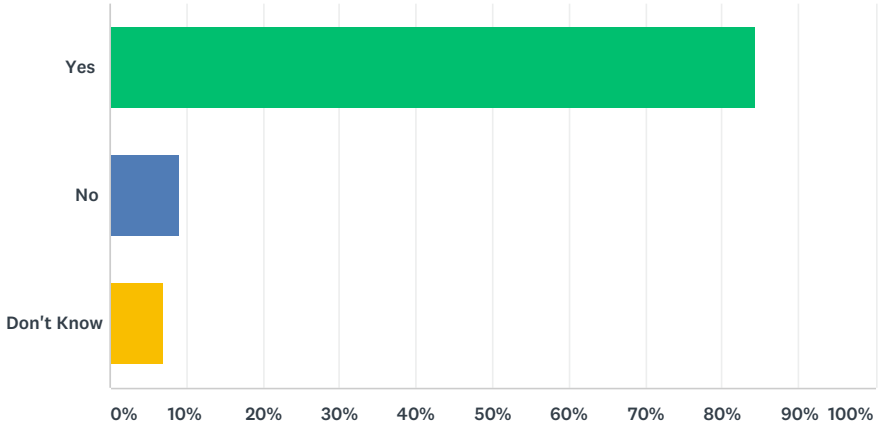


ANSWER CHOICES	RESPONSES	
Yes	85.79%	163
No	5.26%	10
Don't Know	8.95%	17
TOTAL		190

Little Manistee River Watershed Survey

Q19 Enforcement of rules requiring that all septic systems be inspected at time of property sale

Answered: 190 Skipped: 14

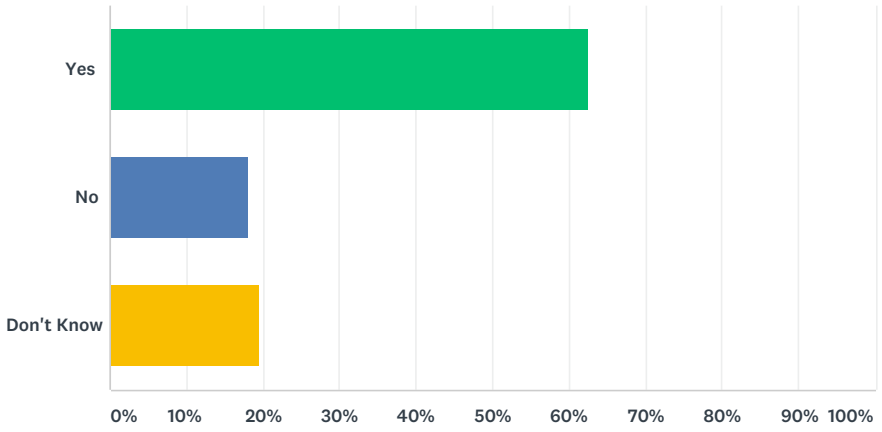


ANSWER CHOICES	RESPONSES	
Yes	84.21%	160
No	8.95%	17
Don't Know	6.84%	13
TOTAL		190

Little Manistee River Watershed Survey

Q20 Strong local zoning, with requirements that buildings be set back from the river

Answered: 190 Skipped: 14

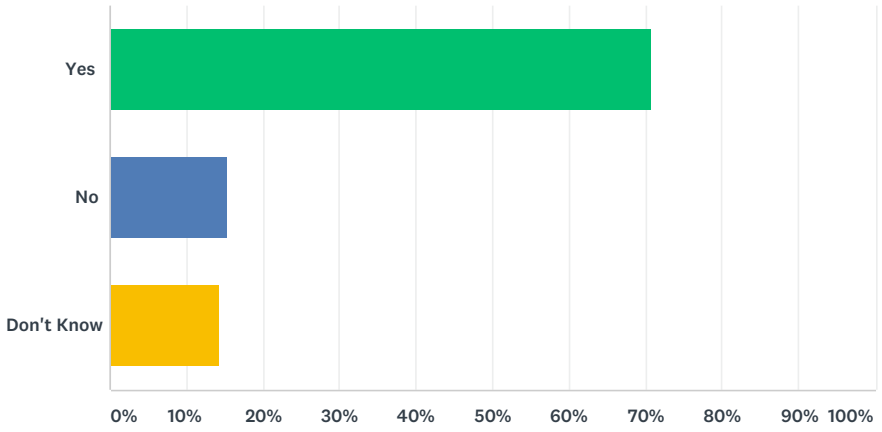


ANSWER CHOICES	RESPONSES	
Yes	62.63%	119
No	17.89%	34
Don't Know	19.47%	37
TOTAL		190

Little Manistee River Watershed Survey

Q21 State designation of the Little Manistee as a natural river, with development restrictions

Answered: 191 Skipped: 13

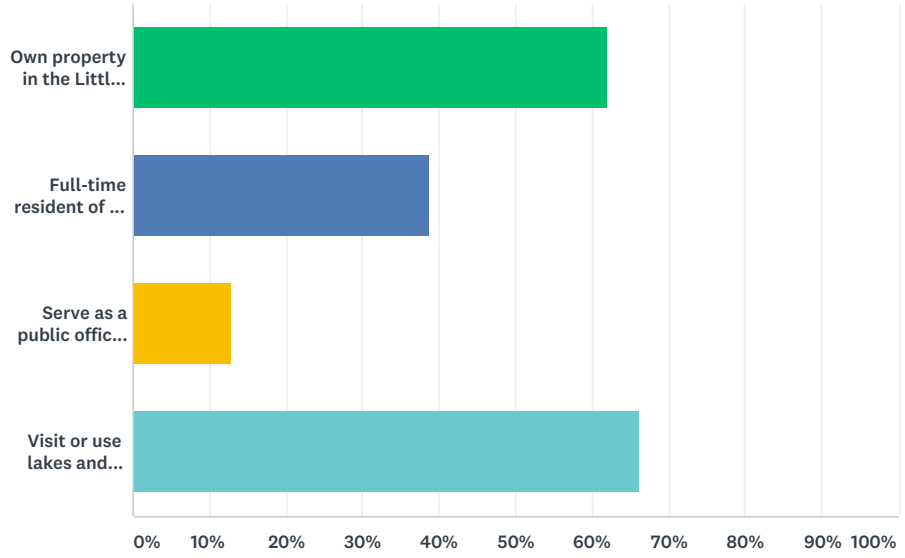


ANSWER CHOICES	RESPONSES	
Yes	70.68%	135
No	15.18%	29
Don't Know	14.14%	27
TOTAL		191

Little Manistee River Watershed Survey

Q22 Please check all that apply to you

Answered: 189 Skipped: 15



ANSWER CHOICES	RESPONSES	
Own property in the Little Manistee Watershed	61.90%	117
Full-time resident of the area in or near the Little Manistee River Watershed	38.62%	73
Serve as a public official or local government employee (elected or appointed)	12.70%	24
Visit or use lakes and streams in the Watershed	66.14%	125
Total Respondents: 189		

Little Manistee River Watershed Survey

Q23 Please enter your age

Answered: 185 Skipped: 19

Little Manistee River Watershed Survey

Q24 Comments & Suggestions

Answered: 55 Skipped: 149

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Appendix B — Summary of Outreach

As Curated By Armas Soorus, Little Manistee Watershed Conservation Council, March 2020

Linke's Pond

SUMMARY OF OUTREACH

The following summary, derived from meeting minutes and contact with participants, provides a record of outreach efforts taken during the development phases of the Little Manistee Watershed Management Plan, from 2014 through 2020

– Armas Soorus, Little Manistee Watershed Conservation Council, March 2020

Efforts to include all stakeholders in the watershed plan creation process and the ongoing implementation of the plan include outreach to LMWCC members, individuals, riparian owners, local watershed organizations, commercial interests, Indian tribes, governmental units and departments at the village, city, township, county, state and federal levels and all other interested parties.

The Little Manistee Watershed Conservation Council (LMWCC) is the lead organization in bringing together the interested parties to create and implement the plan and is committed to the ongoing implementation of the plan after approval. The Alliance for Economic Success (AES) has provided critical guidance in plan creation, especially in the early stages. The AES helped by providing a draft partnership agreement and a pamphlet explaining what a watershed management plan is and why we need a watershed management plan for the Little Manistee River.

The LMWCC Board identified and prioritized the need for a watershed management plan in in a series of board meetings in late 2014. The LMWCC initially reached out to Michigan DEQ and DNR (now EGLE), Trout Unlimited, the National Forest Service, the Alliance for Economic Success, conservation districts and the Little River Band of Ottawa Indians to help us understand how to create and implement a watershed management plan. Our partners at Spicer Group in Manistee also provided valuable input to the plan as we were proceeding through the process.

June 2015 - The first meeting of what would become the Little Manistee River Watershed Steering Committee was held. This Steering Committee forms the central core of our outreach program as well as bringing expertise from interested stakeholders in the watershed. Throughout the course of the creation of the plan there has been input from a broad range of interests throughout the watershed at the Steering Committee meetings. All Steering Committee meetings are open to the public and we listen to everyone that wants to speak and use their ideas as input to the plan.

At this first meeting the Steering Committee:

- Approved the Partnership Agreement, including the Watershed Description within the Partnership Agreement.
- Established the Plan Criteria as both Michigan DEQ and US EPA Nine Elements pending agreement by the LMWCC Board.
- Initiated RFP process to identify a consultant to develop and write the plan.
- Suggested the Creation of Funds at the Manistee County Community Foundation for Plan Creation and Implementation.
- Identified LMWCC as the lead organization.

SUMMARY OF OUTREACH

Present at this meeting were representatives of: LMWCC (2), LRBOI (1), Manistee County Planning Dept. (1), AES (1), Michigan DEQ (1), MCCF (1), USDA Farm Service Agency (FSA), Wexford, Osceola, Missaukee Counties (1) and, Trout Unlimited (1).

In July of 2015 the LMWCC Board presented the idea to their membership at their annual meeting and asked for signatures on the Partnership Agreement. The idea was well received by membership and the board felt it was meeting the wishes of the membership by continuing the development of the plan.

The LMWC then began the public outreach process by attending township and county commissioner meetings in the watershed. The LMWCC made presentations at each, explaining who they are, why they wanted a watershed management plan for the Little Manistee River and asked the individuals and organizations to sign the partnership agreement and participate in the creation and implementation of the plan. With the exception of one township and one county commission they received signed partnership agreements and contacts for email distribution so they could stay apprised of the plan status and take part in the creation and implementation. The LMWC then reached out to additional townships and counties, city and village governments, lake associations, conservation districts, land conservancies and individuals through presentations and personal contacts. The AES created a flyer that explained what a watershed management plan is and why one should be created that was distributed.

During the development of the plan the Little Manistee River Watershed Steering Committee has evolved into the broad-based group listed in detail in the introduction to the WMP.

At the August 1, 2015 meeting the LMWCC Board:

- LMWCC agrees to develop the Watershed Management Plan to both Michigan DEQ and US EPA Nine Elements Criteria.
- LMWCC authorizes creation of 3 funds at the Manistee County Community Foundation – “Plan Fund” to develop the Watershed Management Plan, the “Implementation Fund” to implement and maintain the watershed management plan and an “LMWCC Fund” to contain funds donated to the LMWCC to help ensure its long-term viability.

The Funds created at the Manistee County Community Foundation were intended to help bring in funds from individuals and organizations that were not familiar with the LMWCC and would feel more confident the funds they donated would be appropriately used with the oversight of a community foundation.

October 2015 - The second meeting of the Little Manistee River Watershed Steering Committee was held to:

- Confirm our shared vision of the high-level Scope and Objectives for the Watershed Management Plan (EPA and DEQ Criteria)
- AES began preparing a news release plan

SUMMARY OF OUTREACH

At this point in time 10 counties and townships had signed the partnership agreement and 5 were pending final signature. Attendance at this meeting included representatives from: LMWCC (3), LRBOI (1), Manistee County Planning Dept. (1), AES (1), MCCF (1), TU (1), Public Sector Consultants (1), NFS (1), Lake County Commissioner (1), Michigan DEQ (1), private citizens (2).

In December 2015 the third meeting of the Little Manistee River Watershed Steering Committee was held and:

- Public Sector Consultants formally selected as Consultant by consensus vote of Steering Committee. Tim Ervin and AES to assist in writing contingency contract.
- The group agreed to use the "Little Manistee River Watershed Steering Committee" as our identity.
- Agreed to identify a subgroup of 5 to 7 members to act as a "Fund Advisory Committee" with this group and the LMWCC per the Manistee County Community Foundation documents to administer the 2 funds at the MCCF.
- Elected a President and a Secretary.
- Elected initial members of the Fund Advisory Committee

Work on the consultant contract continued thru March of 2016 when it was approved by the LMWCC board. The Funding Committee was also approved by the LMWCC board at the March 2016 meeting. The funding committee consists of 2 LMWCC board members and 5 other non-LMWCC board members from the community. As of this date it consists of the 2 LMWCC board members, a county commissioner, a fishing guide and two local businessmen. Attendance at this meeting consisted of representatives from: LMWCC (3), AES (1), MDEQ (1), Lake County Commissioner(1), Private Citizen (1), Grand Traverse Regional Land Conservancy (1), Manistee Area Conservation District (1), Cool Lake Association (3), Sable River Watershed (1).

In December of 2015 the AES made a news release that the Little Manistee River Watershed Steering Committee had been formed and was working to create a watershed management plan for the Little Manistee River. The new release was circulated in all the local newspapers.

Fund raising for the plan creation began in earnest during May of 2016 and continued through June 2017. The AES and LMWCC worked to solicit contributions from businesses, foundations, individuals, community foundations and others for the plan creation. By June of 2017 it was clear that sufficient funds for Public Sector Consultants were not going to be raised so the AES reached out to Networks Northwest as a lower cost alternative.

June, 2017 – The Little Manistee River Watershed Steering Committee agreed we would work with the LMWCC and Networks Northwest to negotiate a contract for creation of the plan. The contract was formally approved by the LMWCC at their July 7, 2017 meeting. Attendance at this meeting included representatives from: Elk Township (1), Lake County Commission (1), Spicer Group (1), Manistee Conservation District (1), MDEQ (1), Sable River Watershed (2), Manistee County Planning Dept. (1), NFS (1), LMWCC (4) and Networks Northwest (1).

SUMMARY OF OUTREACH

August 2017 - The Little Manistee River Watershed Steering Committee meeting served as the kick-off for the Networks Northwest team and they brought templates of forms and maps as well as prototype plans and goals for the team to review. This meeting was attended by representatives of the LMWCC (5), NNW (2), MDEQ (1), Manistee Conservation District (1), Manistee Planning Dept. (1), Grand Traverse Area Land Conservancy (1), The Spicer Group (1), Lake County Commissioner (1), Trout Unlimited (1), MCCF (2), Elk Township (1) and NFS (1).

September 2017 - The Little Manistee River Watershed Steering Committee met to review final negotiations on the contract between Networks Northwest, The Alliance for Economic Success (acting as fiduciary for LMWCC) and the LMWCC. Networks Northwest had already begun work and brought documents on Designated Uses, Goals and Objectives, Critical Areas, Maps and a Survey Outline which were discussed at length. Attendance at this meeting included: LMWCC (3), NNW (1), The Spicer Group (1), LRBOI (1), Manistee County Community Foundation (1), Manistee County Planning Dept. (1), NFS (1), MDEQ (1), and USGS(1), LRBOI (1), TU (1).

January of 2018 - The Little Manistee River Watershed Steering Committee met to review and discuss Implementation Tasks, Goals and Objectives, Maps, Data gathered, Acceptable Safe Uses, Preservation of the Rustic Character, Economic Opportunities and the importance of Education in our plan. Also noted was the importance to the local community of the lifestyle in the watershed and how they want to protect it. At this point in time Networks Northwest had the Public Survey on line and ready for use. The LMWCC committed to notifying the public of the survey and encouraging them to take the survey through newspaper announcements, bulletins and email. Attendance at this meeting included representatives from LMWCC (3), NNW (1), NFS (1), Elk Township (1), Sable River Watershed (1), TU (1) LRBOI (1), MSUE (1) and AES (1).

March 2018 - The Little Manistee River Watershed Steering Committee met to review and discuss Stronach Creek road crossing issues, the Seyers Lake dam failure, the Luther Dam, Zoning and Master Plans. The group recognized the primacy of the Village of Luther to determine the future of the dam and agreed to a position of monitoring the condition of the dam and helping to remove it if the village can no longer afford to maintain it. Significant portions of the plan were posted to the LMWCC.org web site in draft form for review and comment. Attendance at this meeting included representatives of AES (1), Manistee Co. PC (1), LMWCC (3), Portage Lake Watershed Forever (1), Norman Township (1), NFS (1), NNW (1) and Cool Lake POA (1).

April 2018 - The Little Manistee River Watershed Steering Committee met to review and discuss the dates for the public meetings and how to publicize them, Data gathered by NNW, Implementation Tasks, Milestones, the Luther Dam , the Education Plan, Invasive Species and Septic Systems. Public Meeting dates were set as May 24, 2018 - Luther Lions Club, 6 - 8 pm and June 7, 2018 - Manistee ISD, 6 - 8 pm. Attendance at this meeting included representatives from: LMWCC (2), NFS (1), LCEDA (2), AES (1), Portage Lake Watershed Forever (1), Manistee County Planning (1), MDEQ (1), MDNR Fisheries (1), Private Citizen (1), Cool Lake POA (1), LRBOI (1), USFS (1).

May 2018 - The Little Manistee River Watershed Steering Committee held a meeting in the Village of Luther at the North end of the watershed to gather more public input on the plan. The meeting had been publicized in the local newspapers, television news, via an email distribution that included all parties that had provided

SUMMARY OF OUTREACH

contact information to the steering committee including many for local township and village governmental representatives as well as bulletins in the local Libraries and businesses. Conservation Districts within the watershed also posted meeting notices on their web sites. In addition, the LMWCC created a listing of all property owners addresses within the watershed based on county records. Due to funding limitations it mailed a meeting notice to half (2149) of the addresses. The addresses were selected by listing the owner's names in alphabetical order, numbering them sequentially and sorting out the odd numbered addresses for mailing.

Attendance at the meeting consisted of 30 people. Attendance included representatives of: Elk Township (1), LMWC (4), Ellsworth Twp. (2), OLCD (1) and 21 Private citizens. Attending as resources to answer questions were Rob Carson (Manistee County Planning Director), Chelsea Cooper (Water Quality Technician, Manistee Conservation District) and Chris Riley (Fish and Wildlife Biologist at U.S. Forest Service). There was an extensive public comment session at the end of the meeting.

The presentation to the public included who the LMWCC, Little Manistee River Watershed Steering Committee and Networks Northwest are and the purpose and content of a watershed management plan. It also explained the purpose of the plan and meeting were not to drive zoning or the removal of the Luther dam, both of which were clear concerns of the local residents. It was explained the meeting was focused on getting public input on Critical Areas, Locally Desired Uses, Implementation, the Informational/Educational Component and Zoning Ordinance Issues as well as other thoughts they had related to the plan. Mark Tonello of the Michigan DNR made a presentation on the Little Manistee River Fishery and Cold Water Ecology. Christina Curell from the Michigan State University Extension made a presentation on Groundwater, Agriculture and Best Management Practices. Vicki Sawicki of the North Country Cooperative Invasive Species Management Area made a presentation on the Invasive Species Program. Ed Hoogterp and Scot Gest Presented an overview of the current draft of the plan and Ed then led a session for public Comments and Questions.

June 2018 - The Little Manistee River Watershed Steering Committee held a meeting in the City of Manistee at the southern end of the watershed to gather more public input on the plan. This meeting had been advertised in conjunction with the May Meeting in Luther and had the same agenda and similar presentations. This meeting was much smaller with 14 people attending. Because of the much smaller size the meeting was much less formal and structured and had an open discussion as the presentations were made with a short comments and questions period after the presentations. Attendance at the meeting included: Sable River Watershed (1), Private Citizens (5), MDNR (1), MACD (1), Portage Lake Forever (1), NNW, (1), LMWCC (1) and Manistee Planning Dept (1).

November 2018 - The Little Manistee River Watershed Steering Committee met to review the results of the Luther and Manistee meetings and the current draft of the watershed management plan. An annual summit to review status of the plan was added to the Task List as well as seeking a paid watershed technician to implement the plan. The group recognized that groundwater, septic systems and monitoring stations needed to be emphasized as items in the plan and related information needs added to the plan. Road crossings were added as a critical area due to their impact. Ed Hoogterp expected a version to be at MDNR for an informal review In

SUMMARY OF OUTREACH

several weeks. Attendance at this meeting included representatives from Sable River Watershed (1), LCEDA (1), LMWCC (3), Portage Lake Watershed Forever (1), Hamlin Lake Association (2), USGS (1), NMU (1), MACD (3), USFS (1), LRBOI (1) and Norman Twp. (1).

February 2019 - The Little Manistee River Watershed Steering Committee met to conduct the first Watershed Summit. The Michigan DEQ has been closely monitoring the progress and content of the watershed management plan drafts and recommended that the Steering Committee assume the plan will be approved and move forward with the implementation tasks identified in the plan. The purpose of this meeting was to be the first step in implementing the watershed management plan. It was the first annual summit to review progress and understand the status of the tasks identified in the plan and to identify and plan specific tasks for the coming year. Armas Soorus updated the group on the status of the plan: That it had not been submitted for informal review but was proceeding to be completed and in the final stages. The group then proceeded to identify Task Description, Status, Target Date and a Leader for all tasks listed under the following categories in the task list:

- Shoreline/Streambank Issues
- Storm Water and Runoff
- Planning, Zoning and Land Use
- Road Stream Issues
- Habitat for Fish and Wildlife
- Wastewater and Septic Systems

Attendance at this meeting included representatives from: AES (1), LMWCC (5), Indian Club (1), MACD (1), Ellsworth Twp. (1), Norman Twp. (1), MDNR (1), Private Citizens (2) and the Michigan District 100 State Representative.

April 2019 – The Steering Committee submitted the draft watershed management plan to MDEQ for an informal review of contents before submitting it for official approval.

August 2019 - The Little Manistee River Watershed Steering Committee held a second summit to continue to identify Task Description, Status, Target Date and a Leader for all tasks listed under the following categories in the task list:

- Hydrology, Groundwater and Wetlands
- Water Quality Monitoring
- Information and Education

Attendance at this meeting included LMWCC (2), Osceloa-Lake Conservation District (1), The Indian Club(1) and Newkirk Township (1).

March 2020 - The Little Manistee River Watershed Steering Committee held a Third summit to continue to identify Task Description, Status, Target Date and a Leader for all tasks listed under the following categories in the task list:

- Land Protection and Management

SUMMARY OF OUTREACH

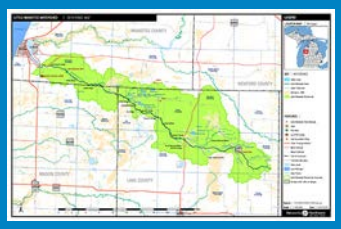
- Recreation, Safety, Navigation and Human Health
- Invasive Species
- Identify Priority Items for 2020
- Further Investigate the public interest in the Michigan Natural Rivers Program for the Little Manistee River
- Install Monitoring Stations Designed by Trout Unlimited
- Identify additional resources for implementing the plan

The Funding Committee voted to purchase a Trout Unlimited Mayfly monitoring station for $1,500 to monitor conductivity, depth and temperature at one point on the Little Manistee.

Attendance at this meeting included representatives from MACD (2), Portage Lake Watershed Forever (2), Goucker Fly Fishing (1), LMWCC (6), Spicer Group (1), Lake County Economic Development Assoc. (1), Osceola-Lake Conservation District (2), LRBOI (1).

Appendix C — Large Maps



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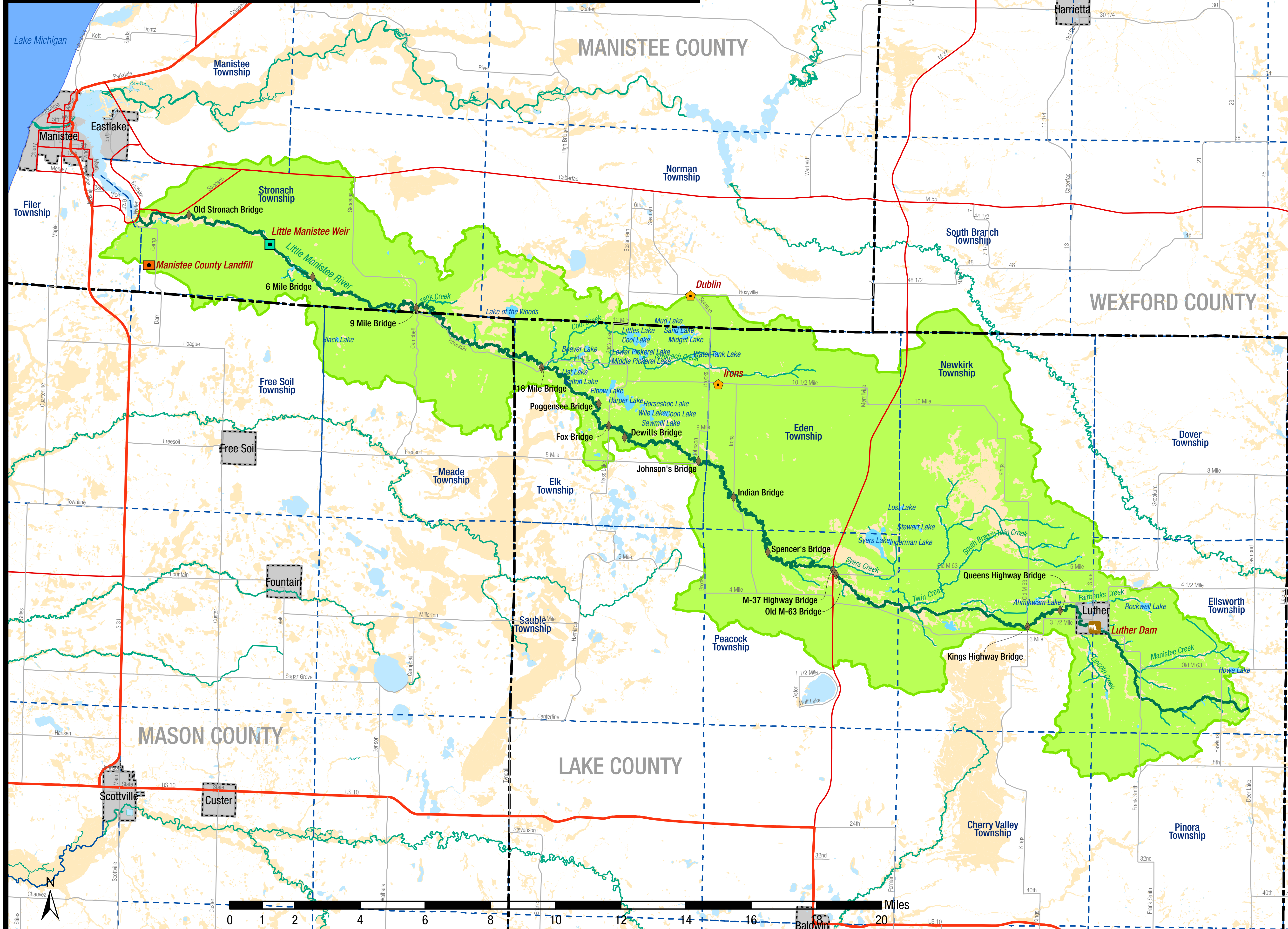
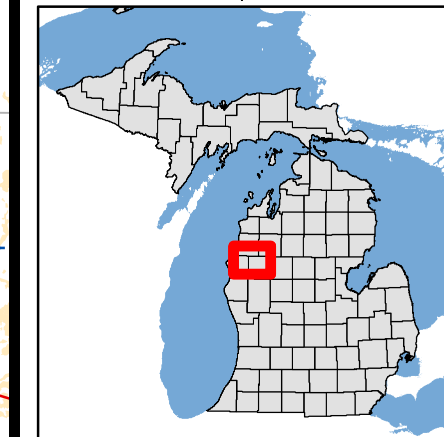
LITTLE MANISTEE WATERSHED | LARGE MAP 1 - LITTLE MANISTEE WATERSHED REFERENCE MAP



MANISTEE COUNTY
WEXFORD COUNTY
MASON COUNTY
LAKE COUNTY
Lake Michigan
Manistee
Eastlake
Harrietta
Free Soil
Fountain
Scottville
Custer
Luther
Baldwin
Manistee Township
Filer Township
Stronach Township
Norman Township
South Branch Township
Free Soil Township
Meade Township
Elk Township
Newkirk Township
Eden Township
Dover Township
Sauble Township
Peacock Township
Ellsworth Township
Cherry Valley Township
Pinora Township
Old Stronach Bridge
Little Manistee Weir
Manistee County Landfill
Little Manistee River
6 Mile Bridge
9 Mile Bridge
Dublin
Irons
18 Mile Bridge
Poggensee Bridge
Fox Bridge
Dewitts Bridge
Johnson's Bridge
Indian Bridge
Spencer's Bridge
M-37 Highway Bridge
Old M-63 Bridge
Queens Highway Bridge
Kings Highway Bridge
Luther Dam
Tank Creek
Lake of the Woods
Black Lake
Mud Lake
Little Lakes
Sand Lake
Cool Lake
Midget Lake
Beaver Lake
Lower Pickerel Lake
Middle Pickerel Lake
Water Tank Lake
Elbow Lake
Harper Lake
Horseshoe Lake
Wile Lake
Coon Lake
Sawmill Lake
Lost Lake
Stewart Lake
Syers Lake
Ingerman Lake
Syers Creek
South Branch Twin Creek
Twin Creek
Fairbanks Creek
Ahmikwam Lake
Rockwell Lake
Manistee Creek
Howe Lake
Lincoln Creek
M 55
US 10
Miles
0
1
2
4
6
8
10
12
14
16
18
20
N

LEGEND

LOCATOR MAP | Michigan



KEY | WATERSHED

- LMW Lakes
- Little Manistee River
- LMW Tributaries
- Wetlands - NWI
- Little Manistee Watershed

FEATURES |

- Little Manistee River Bridges
- Dam
- Fish Weir
- Land Fill Facility
- Unincorporated Place
- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Township Boundary
- Area Lakes
- Lake Michigan
- Area Rivers
- Little Manistee Watershed Boundary
- Incorporated Cities & Villages

Source | EPA/MDEQ/MDOT/US Census

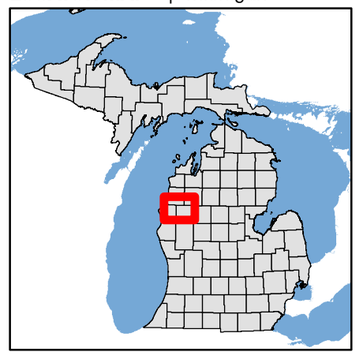
Scale | 1:180,000 Date | 5/20/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 2 - LITTLE MANISTEE WATERSHED SATELLITE IMAGE

LEGEND

LOCATOR MAP | Michigan



KEY | Imagery Description

World Imagery provides one meter or better satellite and aerial imagery in many parts of the world and lower resolution satellite imagery worldwide. The map includes 15m TerraColor imagery at small and mid-scales (591M down to 72k) and 2.5m SPOT Imagery (288k to 72k) for the world, and USGS 15m Landsat imagery for Antarctica. The map features 0.3m resolution imagery in the continental United States and 0.6m resolution imagery in parts of Western Europe from Digital Globe. Recent 1m USDA NAIP imagery is available in select states of the US. In other parts of the world, 1 meter resolution imagery is available from GeoEye IKONOS, AeroGRID, and IGN Spain. Additionally, imagery at different resolutions has been contributed by

FEATURES |

- Little Manistee River
- County Boundary
- Little Manistee Watershed Boundary

N

0 1 2 4 6 8 10 12 14 16 18 20 Miles

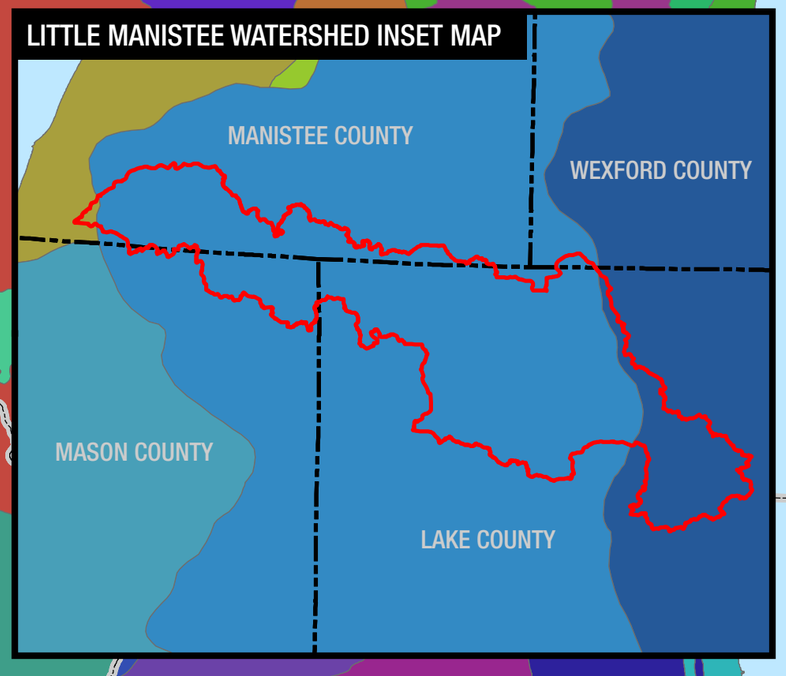
Source | ESRI

Scale | 1:188,415 **Date** | 4/30/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 3 - MICHIGAN LEVEL IV ECOREGIONS

LITTLE MANISTEE WATERSHED INSET MAP



N

0 10 20 40 60 80 100 120 140 160 180 200 Miles

LEGEND

LOCATOR MAP | Michigan

KEY | LEVEL IV ECOREGIONS

- Cadillac Hummocky Moraines
- Door Peninsula
- Lake Michigan Lacustrine Clay Plain
- Lake Michigan Moraines
- Lansing Loamy Plain
- Manistee-Leelanau Shore
- Michigan Lake Plain
- Mio Plateau
- Newaygo Barrens
- Platte River Outwash
- Saginaw Lake Plain
- Tawas Lake Plain
- Vanderbilt Moraines

FEATURES |

- Little Manistee Watershed Boundary
- State Boundary
- County Boundary

Source | EPA

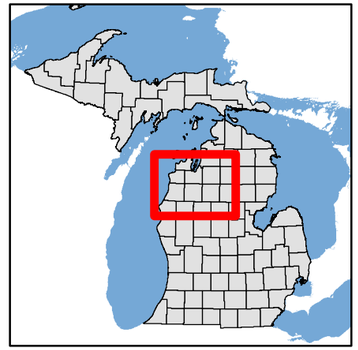
Scale | 1:2,000,000 **Date** | 4/29/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 4 - MANISTEE AND ADJACENT WATERSHEDS (HUC8)

LEGEND

LOCATOR MAP | MICHIGAN



KEY | SUBWATERSHEDS

- Au Sable
- Betsie-Platte
- Black
- Boardman-Charlevoix
- Cheboygan
- Lake Michigan
- Manistee
- Muskegon
- Pere Marquette-White
- Pine
- Tittabawassee

FEATURES

- County Boundary
- HUC 10 Watersheds
- Little Manistee Watershed Boundary

Source | USGS

Scale | 1:500,000 Date | 4/29/2020

Networks Northwest
Talent / Business / Community

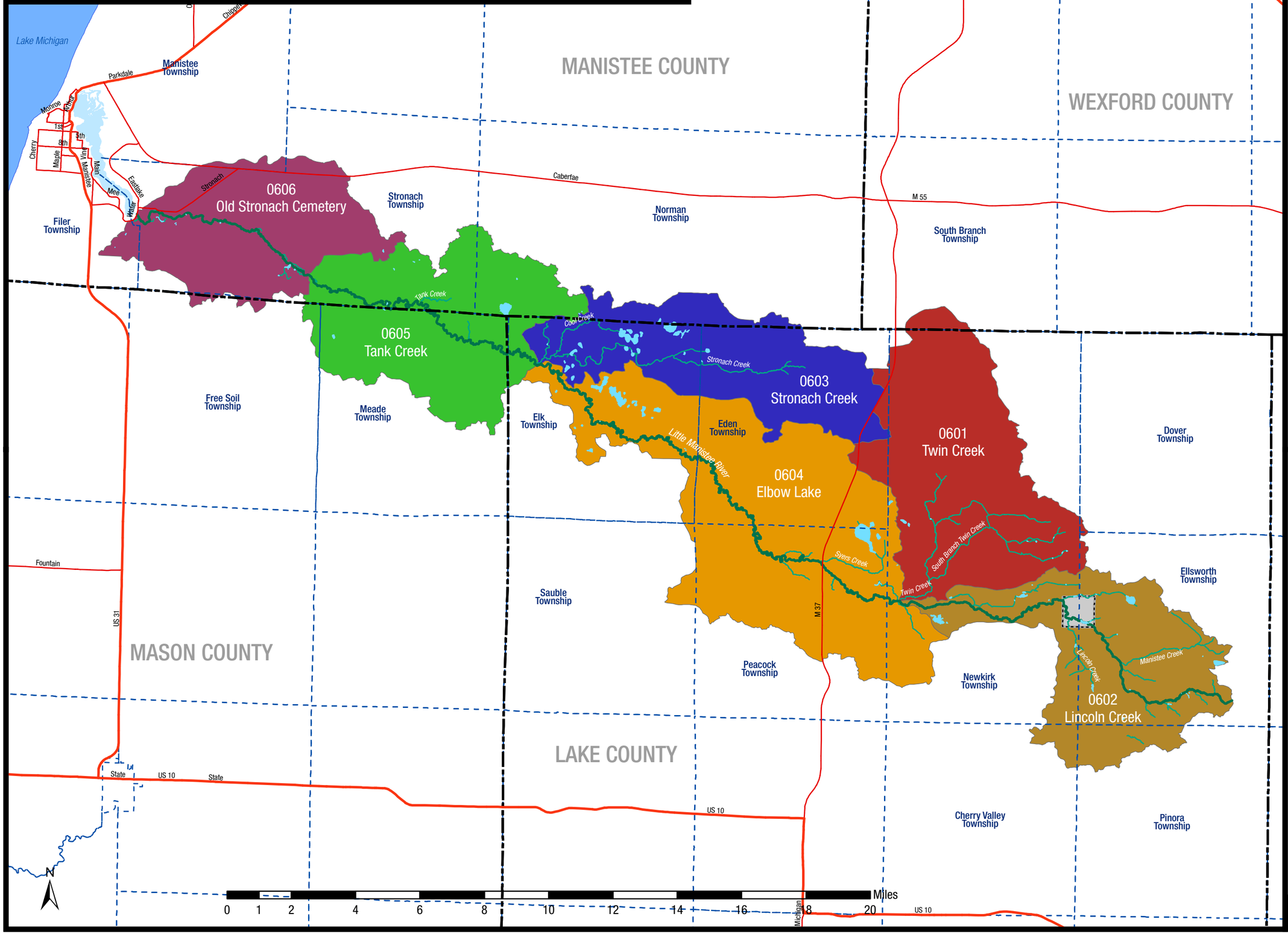
Glen Lake-Frontal Lake Michigan
Lake Leelanau
Threemile Creek-Frontal Grand Traverse Bay
Torch Lake
Lake Charlevoix
Sturgeon River
Cheboygan
Pigeon River
North Branch Au Sable River
Lake Michigan
Platte River
Betsie-Platte
Elk River
Boardman-Charlevoix
Boardman River
East Branch Au Sable River-Au Sable River
Au Sable
North Branch Manistee River-Manistee River
Betsie River
South Branch Au Sable River
Bear Creek
Manistee
Peterson Creek-Manistee River
Silver Creek-Manistee River
Butterfield Creek-Muskegon River
Houghton Lake-Muskegon River
Clam River
Manistee River
Muskegon
Stony Creek-Frontal Lake Michigan
Little Manistee River
Pine River
Town Line Creek-Muskegon River
Big Sable River
Linclon River
Cedar River
Middle Branch River-Muskegon River
Pere Marquette-White
Pere Marquette River
Hersey River-Muskegon River
Tittabawassee
Tobacco River

ANTRIM
LEELANAU
KALKASKA
CRAWFORD
OTSEGO
BENZIE
MANISTEE
GRAND TRAVERSE
WEXFORD
MISSAUKEE
ROSCOMMON
MASON
LAKE
OSCEOLA
CLARE
GLADWIN

N

0 3 6 12 18 24 30 36 42 48 54 60 Miles

LITTLE MANISTEE WATERSHED | LARGE MAP 5 - LITTLE MANISTEE RIVER SUBWATERSHEDS (HUC12)



LEGEND

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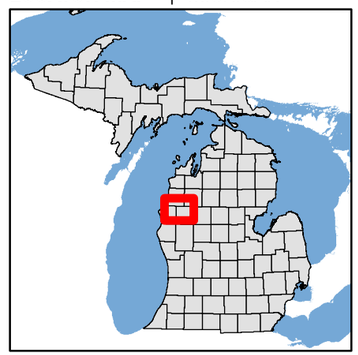
LOCATOR MAP | MICHIGAN



KEY | SUBWATERSHEDS

HUC 12 Subwatersheds

- Elbow Lake
- Lincoln Creek
- Old Stronach Cemetery
- Stronach Creek
- Tank Creek
- Twin Creek

FEATURES

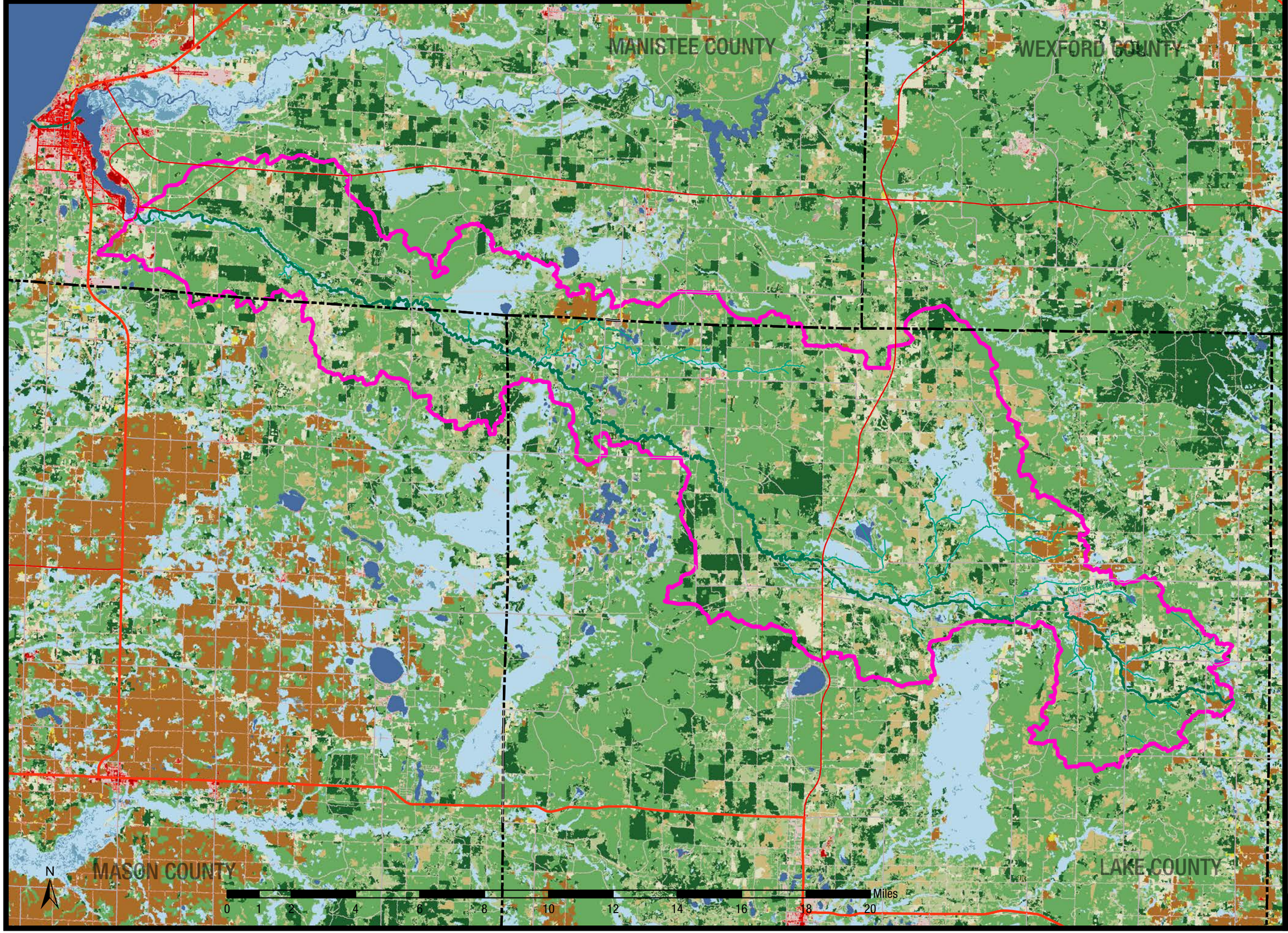
- Other Principal Arterial Road
- Minor Arterial Road
- County Boundary
- Township Boundary
- LMW Lakes
- Manistee Lake
- Lake Michigan
- Little Manistee River
- LMW Tributaries
- Luther

Source | EPA/MDEQ/MDOT/US Census

Scale | 1:180,000 **Date** | 4/30/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 6 - LAND COVER (NLCD 2016)



LEGEND

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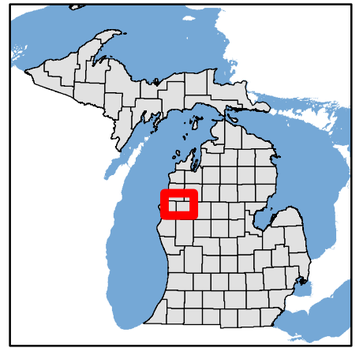
LOCATOR MAP | Michigan



KEY | LAND COVER CLASS

- Barren Land
- Cultivated Crops
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Emergent Herbaceuous Wetlands
- Evergreen Forest
- Hay/Pasture
- Herbaceuous
- Mixed Forest
- Open Water
- Perennial Snow/Ice
- Shrub/Scrub
- Unclassified
- Woody Wetlands

Anderson Level II Classification System

FEATURES |

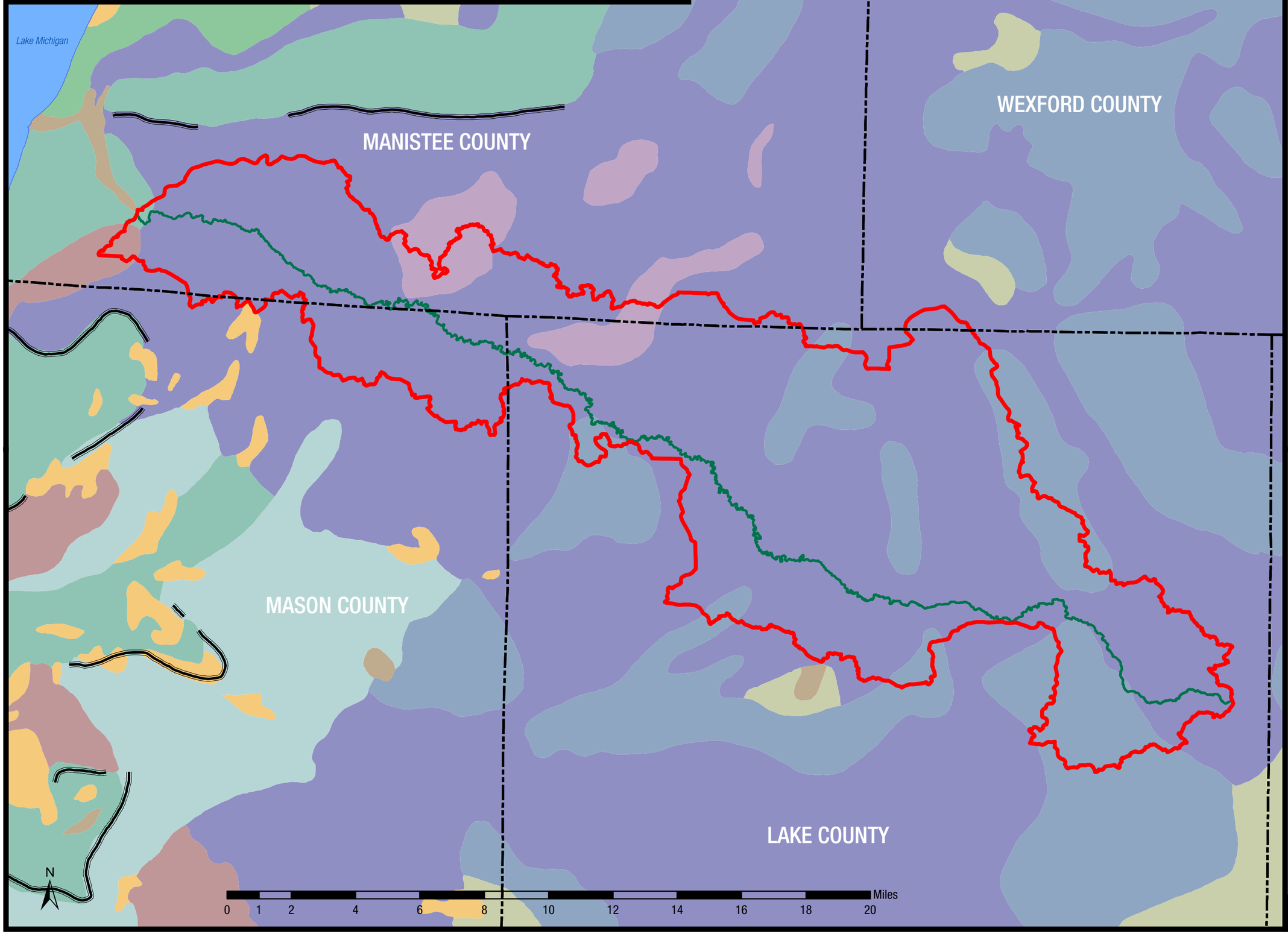
- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Little Manistee River
- LMW Tributaries
- Little Manistee Watershed Boundary

Source | MRLC

Scale | 1:180,000 **Date** | 4/29/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 7 - QUATERNARY GEOLOGY



LEGEND

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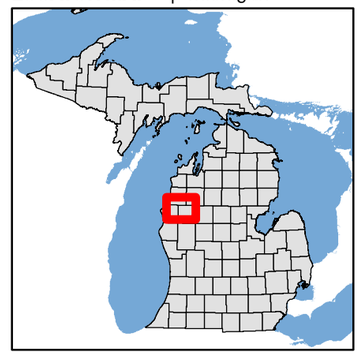
LOCATOR MAP | Michigan



KEY | QUATERNARY TYPE

- Coarse-textured glacial till
- Dune sand
- End moraines of coarse-textured till
- End moraines of fine-textured till
- End moraines of medium-textured till
- Fine-textured glacial till
- Glacial outwash sand and gravel and postglacial alluvium
- Ice-contact outwash sand and gravel
- Lacustrine sand and gravel
- Water

FEATURES |

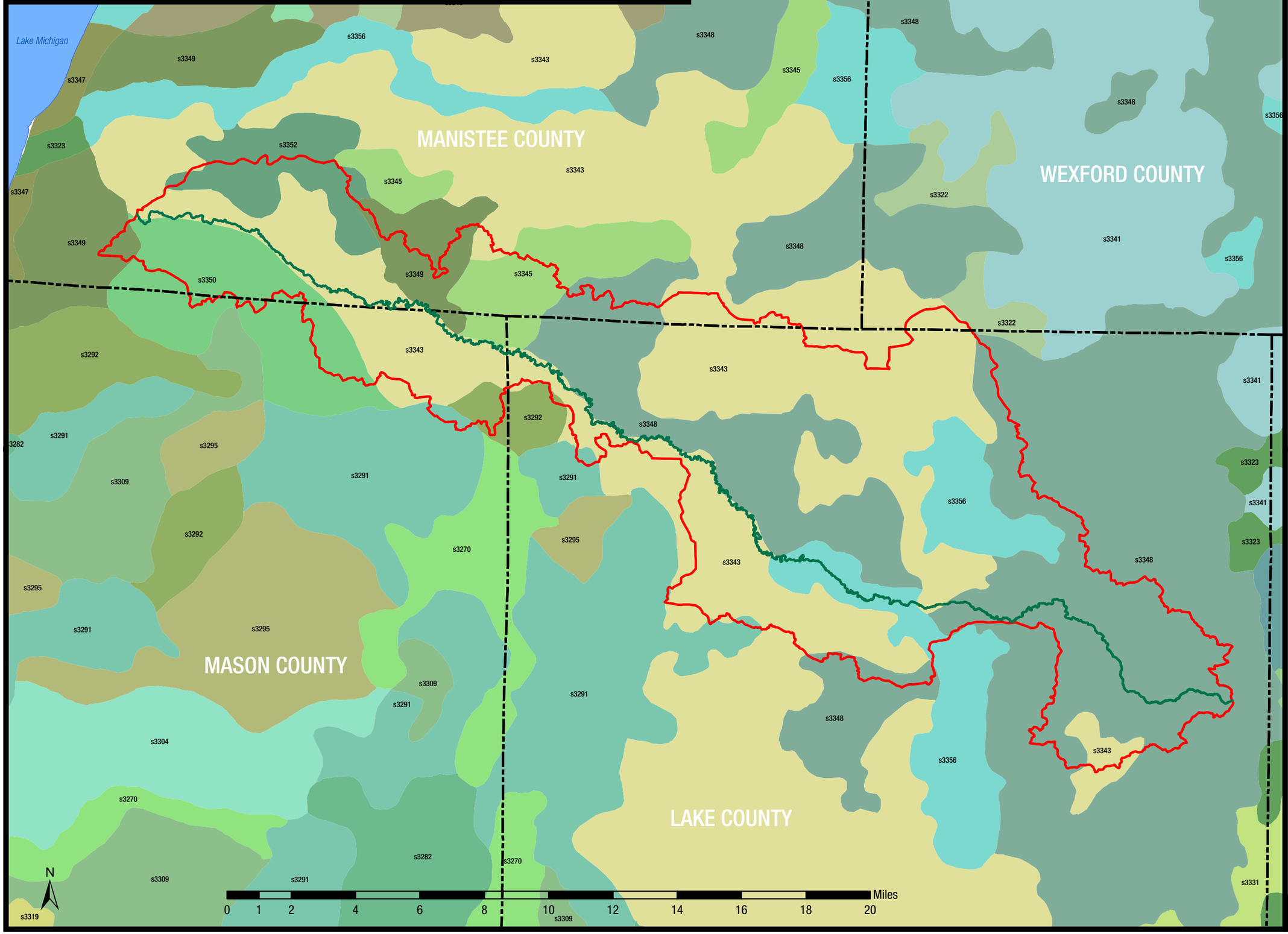
- Quaternary Feature: Shoreline
- County Boundary
- Little Manistee Watershed Boundary
- Little Manistee River
- Lake Michigan

Source | Michigan GIS Open Data

Scale | 1:180,000 **Date** | 4/29/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 8 - SOIL TYPES



LEGEND

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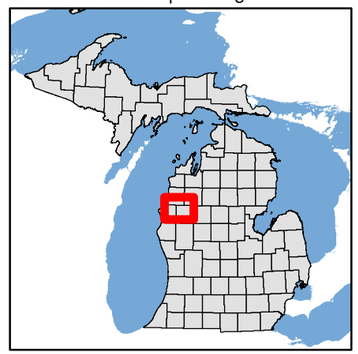
LOCATOR MAP | Michigan



KEY | SOIL TYPE

- Grayling (s3352)
- Grayling-Graycalm (s3343)
- Houghton-Carlisle-Adrian (s3270)
- Kalkaska (s3341)
- Kingsville-Granby (s3292)
- Leelanau-Kalkaska-Emmet (s3340)
- Menominee-Markey (s3334)
- Montcalm-Emmet (s3331)
- Montcalm-Kalkaska-Graycalm (s3339)
- Nester (s3323)
- Nester-Kawkawlin (s3322)
- Perrinton-Ithaca-Coloma (s3295)
- Pipestone-Grattan (s3291)
- Rubicon-Croswell-Au Gres (s3351)
- Rubicon-East Lake (s3349)
- Rubicon-Grayling (s3350)
- Rubicon-Montcalm-Graycalm (s3348)
- Spinks-Perrinton-Miami-Metea (s3319)
- Spinks-Plainfield-Metea-Chelsea (s3282)
- Spinks-Remus-Coloma (s3309)
- Tawas-Roscommon-Au Gres (s3345)
- Tawas-Roscommon-Cathro (s3356)
- Udipsamments-Eastport-Deer Park (s3347)
- Wixom-Tappan-Londo-Avoca (s3304)

FEATURES |

- Little Manistee River
- County Boundary
- Lake Michigan
- Little Manistee Watershed Boundary

Source | USDA - NRCS

Scale | 1:180,000 **Date** | 5/14/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 9 - ELEVATION

Lake Michigan

MANISTEE COUNTY

WEXFORD COUNTY

MASON COUNTY

LAKE COUNTY

31

55

37

10

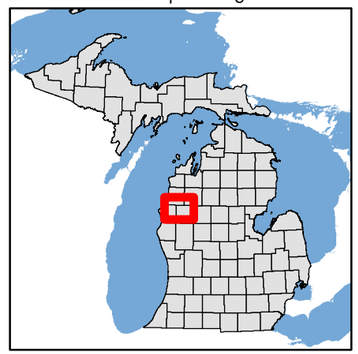
N

0 1 2 4 6 8 10 12 14 16 18 20 Miles

LEGEND

Appendix C: Page 184

LOCATOR MAP | Michigan



KEY | ELEVATION (Feet)

- High : 1700
- 1650
- 1600
- 1550
- 1500
- 1450
- 1400
- 1350
- 1300
- 1250
- 1200
- 1150
- 1100
- 1050
- 1000
- 950
- 900
- 850
- 800
- 750
- 700
- 650
- 600
- Low : 550

FEATURES |

- Little Manistee River
- County Boundary
- Lake Michigan
- Little Manistee Watershed Boundary
- Roads - Other Principal Arterial
- Roads - Minor Arterial

Source | U.S. Geological Survey

Scale | 1:180,000 **Date** | 4/29/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 10 - BEDROCK GEOLOGY

Lake Michigan

MANISTEE COUNTY

WEXFORD COUNTY

MASON COUNTY

LAKE COUNTY

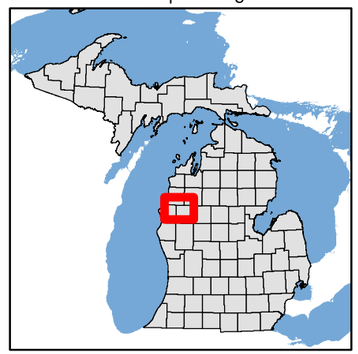
N

0 1 2 4 6 8 10 12 14 16 18 20 Miles

LEGEND

Appendix C: Page 185

LOCATOR MAP | Michigan



KEY | BEDROCK TYPE

- BAYPORT LIMESTONE
- COLDWATER SHALE
- ELLSWORTH SHALE
- MARSHALL FORMATION
- MICHIGAN FORMATION
- RED BEDS
- SAGINAW FORMATION
- SUNBURY SHALE

FEATURES |

- County Boundary
- Little Manistee Watershed Boundary
- Little Manistee River
- Manistee River
- Manistee Lake
- Lake Michigan

Source | Michigan GIS Open Data

Scale | 1:180,000 **Date** | 5/13/2020

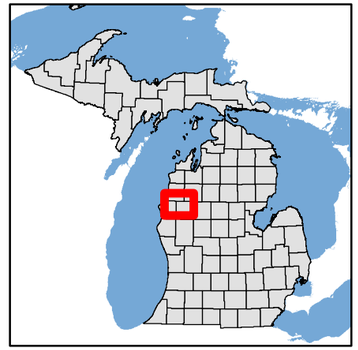
Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 11 - ZONING STATUS BY TOWNSHIP

Lake Michigan
Manistee
Manistee Township
Eastlake
Filer Township
Stronach Township
Little Manistee River
Norman Township
South Branch Township
Harrietta
MANISTEE COUNTY
WEXFORD COUNTY
Free Soil Township
Free Soil
Meade Township
Elk Township
Eden Township
Newkirk Township
Dover Township
Stronach Creek
Coon Creek
Fountain
Sauble Township
Peacock Township
Syers Creek
South Branch Twin Creek
Twin Creek
Luther
Ellsworth Township
Manistee Creek
Bigelow Creek
MASON COUNTY
LAKE COUNTY
Scottville
Custer
Cherry Valley Township
Pinora Township
Baldwin
N
0 1 2 4 6 8 10 12 14 16 18 20 Miles

LEGEND

LOCATOR MAP | Michigan



KEY | LAND USE REGULATION

- Pere Marquette Natural River District
- Pine River Natural River District
- Township Zoning
- County Administered Zoning
- Joint Planning & Zoning
- Not Zoned
- Incorporated Cities & Villages

FEATURES |

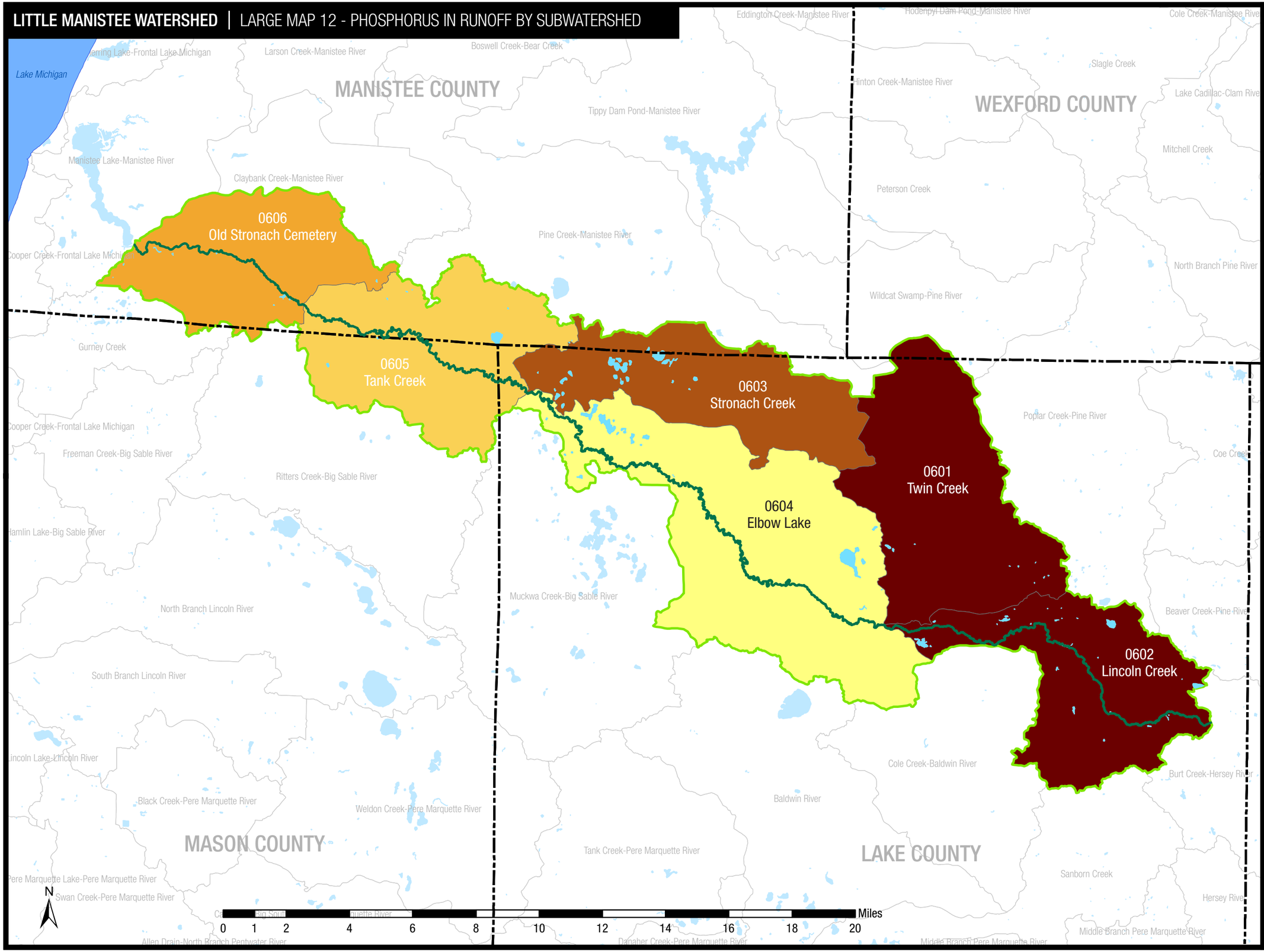
- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Township Boundary
- Inland Lakes
- Little Manistee River
- LMW Tributaries
- Area Rivers
- Lake Michigan
- Little Manistee Watershed Boundary

Source | Local Governments/MDNR

Scale | 1:180,000 **Date** | 5/1/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 12 - PHOSPHORUS IN RUNOFF BY SUBWATERSHED



LEGEND

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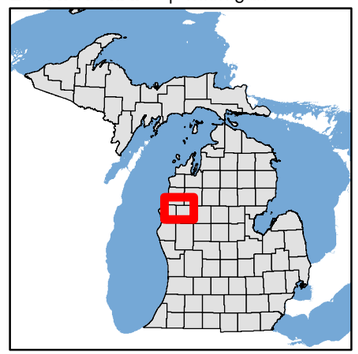
LOCATOR MAP | Michigan



KEY | P RATE (KG/HECT)

- 0.002000
- 0.002001 - 0.003000
- 0.003001 - 0.004000
- 0.004001 - 0.005000
- 0.005001 - 0.012000

FEATURES |

- Little Manistee River
- County Boundary
- LMW Lakes
- Lake Michigan
- Little Manistee Watershed Boundary

Source | USDA - NRCS

Scale | 1:180,000 **Date** | 4/30/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 13 - ROAD STREAM CROSSINGS

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Lake Michigan

MANISTEE COUNTY

WEXFORD COUNTY

MASON COUNTY

LAKE COUNTY

Little Manistee River

Coon Creek

Stronach Creek

Syers Creek

Twin Creek

South Branch Twin Creek

Manistee Creek

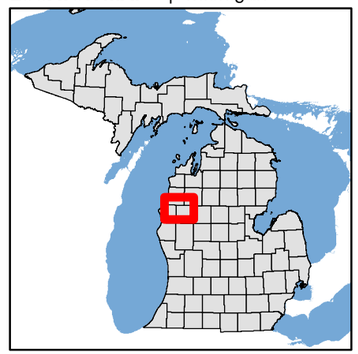
Marcy Creek

N

0 1 2 4 6 8 10 12 14 16 18 20 Miles

LEGEND

LOCATOR MAP | Michigan



KEY | Crossing Severity

- Minor
- Moderate
- Severe

FEATURES

- Little Manistee River
- Other Principal Arterial
- Minor Arterial
- Major Collector
- Local Roads
- County Boundary
- Inland Lakes
- Area Rivers
- Lake Michigan
- Little Manistee Watershed Boundary

Source | CRA

Scale | 1:180,000 **Date** | 5/1/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 14 - STREAMBANK EROSION SITES

Lake Michigan

MANISTEE COUNTY

WEXFORD COUNTY

MASON COUNTY

LAKE COUNTY

Little Manistee River

Cook Creek

Stronach Creek

Syers Creek

South Branch Twin Creek

Twin Creek

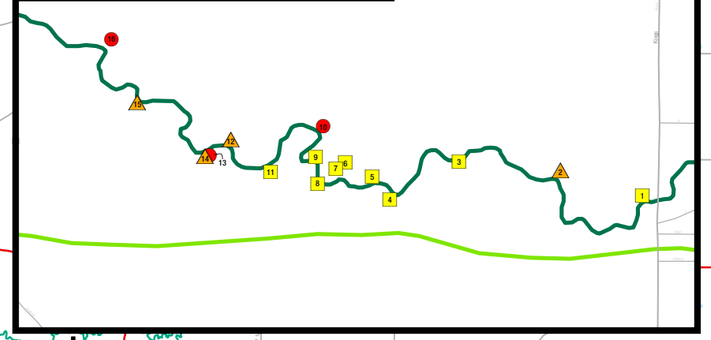
Manistee Creek

Lincoln Creek

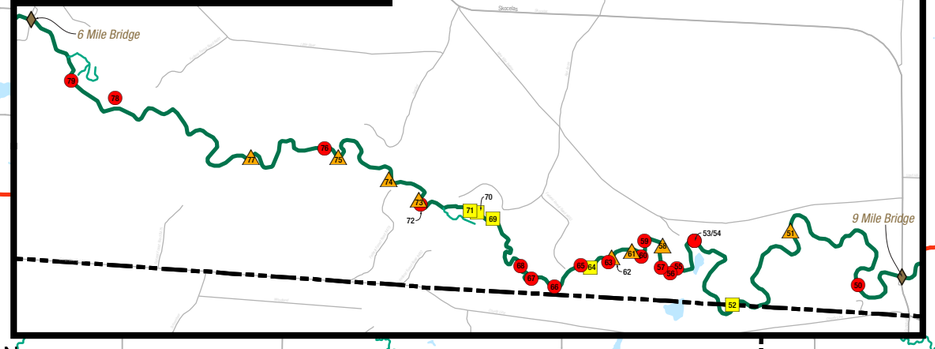
For this area's site IDs see: Western Inset

For this area's Site IDs see: Eastern Inset

EASTERN INSET Scale | 1:15,000



WESTERN INSET Scale | 1:35,000

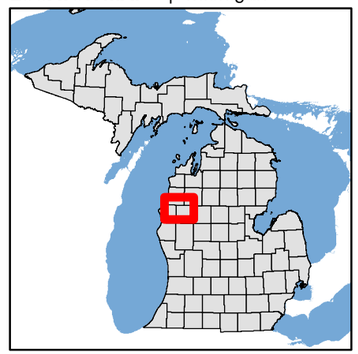


N

0 1 2 4 6 8 10 12 14 16 18 20 Miles

LEGEND

LOCATOR MAP | Michigan



KEY | Erosion Severity

- Minor
- Moderate
- Severe

Site ID 17 not mapped due to incomplete latitude and longitude data for the site.

Streambank erosion site offsets from river channel at inset scale is due to positional errors from a lower river survey point resolution.

FEATURES |

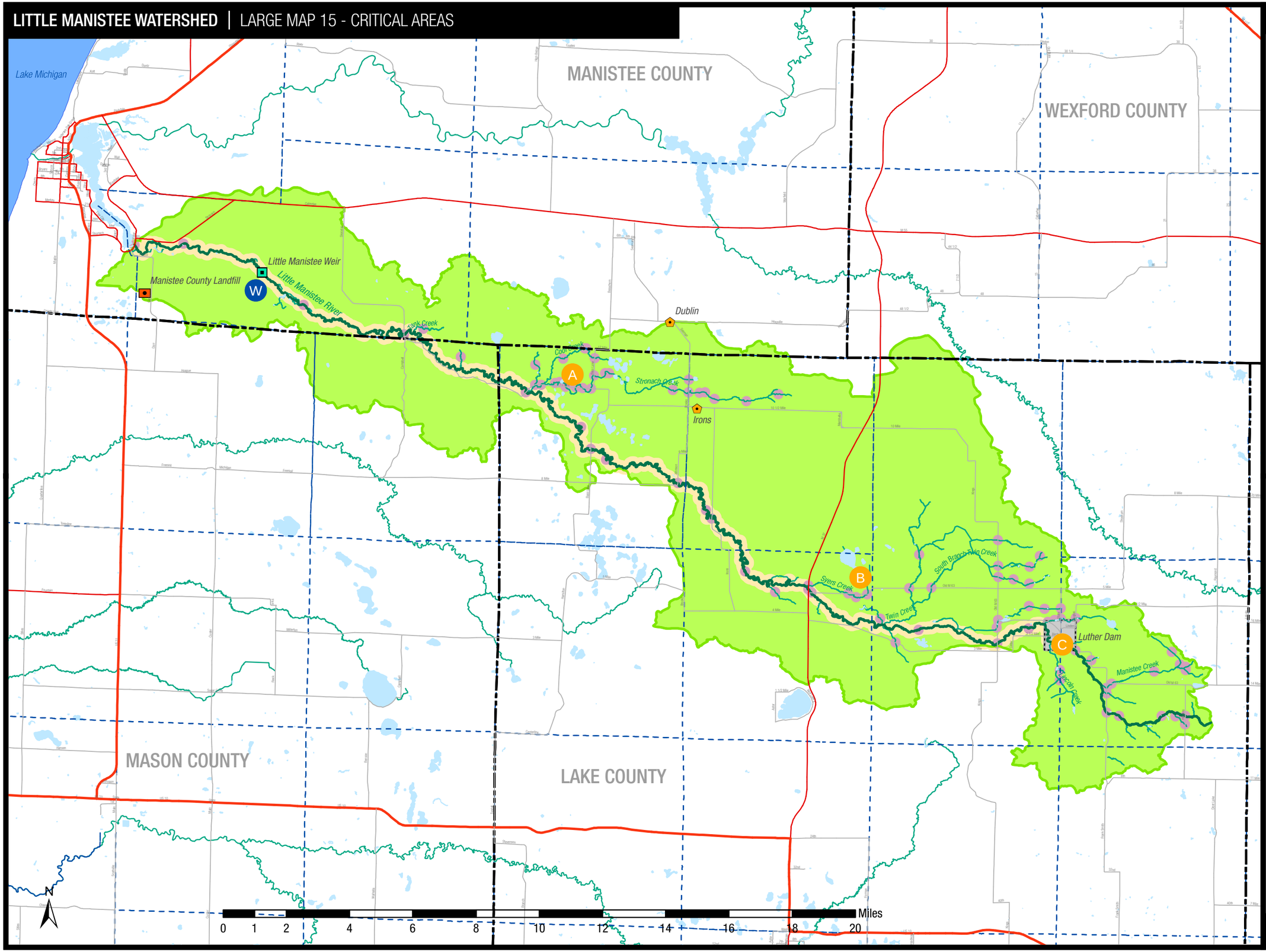
- Little Manistee River
- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Inland Lakes
- Area Rivers
- Lake Michigan
- Little Manistee Watershed Boundary

Source | CRA

Scale | 1:180,000 **Date** | 5/5/2020

Networks Northwest
Talent / Business / Community

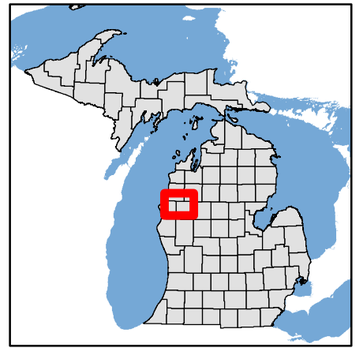
LITTLE MANISTEE WATERSHED | LARGE MAP 15 - CRITICAL AREAS



LEGEND

Appendix C: Page 190

LOCATOR MAP | Michigan



KEY | CRITICAL/PRIORITY AREAS

Critical Areas

- A — Cool/Stronach Creeks
- B — Syers Lake and Creek
- C — Luther Millpond Dam
- Road Stream Crossings
- Little Manistee Streambank Erosion

Priority Areas

- W — Little Manistee Weir

FEATURES |

- Fish Weir
- Land Fill Facility
- Unincorporated Place
- Roads-Other Principal Arterial
- Roads-Minor Arterial
- Roads-Major Collector
- County Boundary
- Township Boundary
- Inland Lakes
- Lake Michigan
- Little Manistee River
- LMW Tributaries
- Area Rivers
- Little Manistee Watershed Boundary
- Luther

Source | EPA/MDEQ/MDOT/US Census

Scale | 1:180,000 **Date** | 5/1/2020

Networks Northwest
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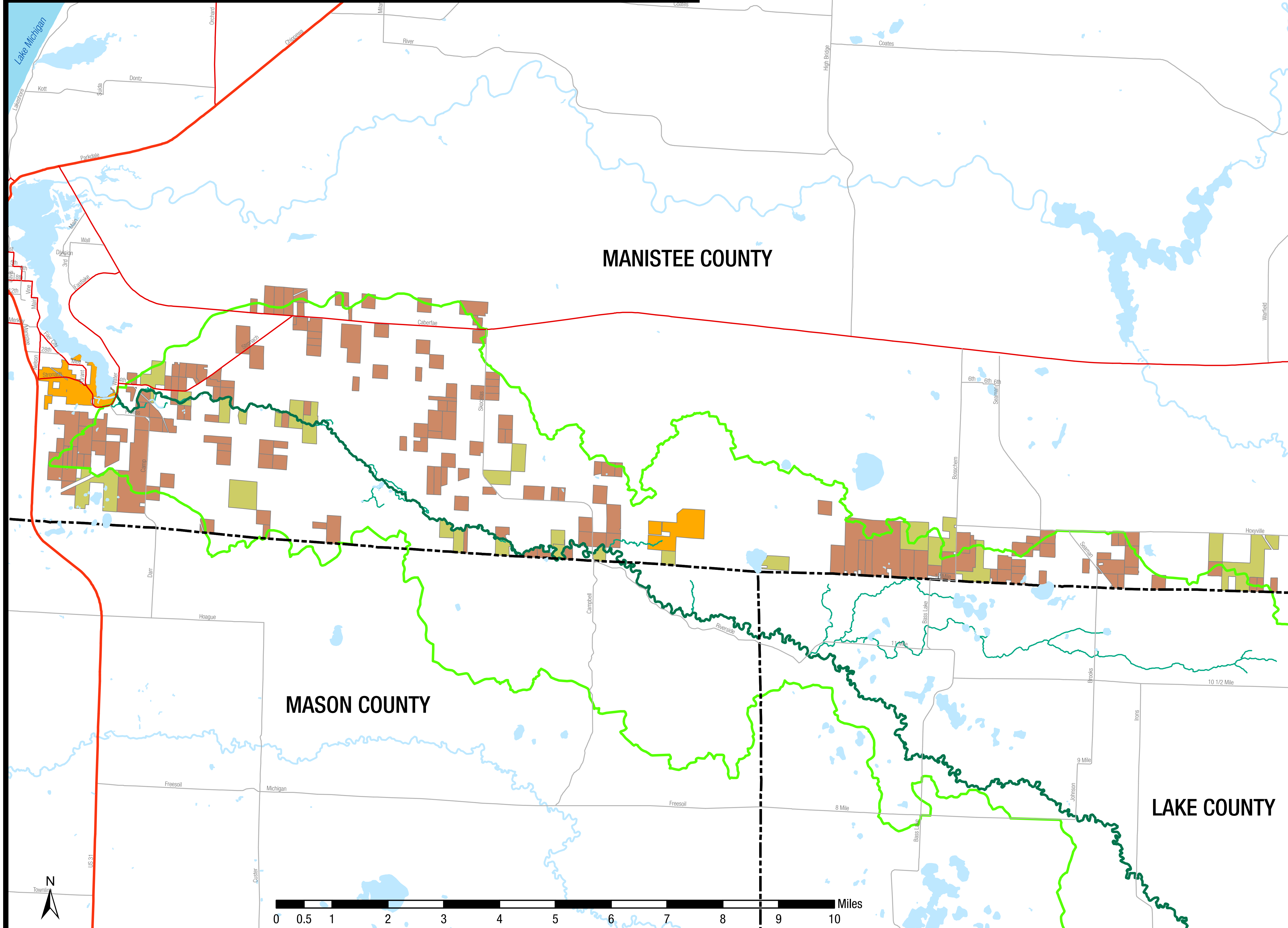

LEGEND

LOCATOR MAP | Michigan

KEY | PRIORITY LEVEL

- Tier 1
- Tier 2
- Tier 3
- Tier 4

FEATURES |

- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- Little Manistee River
- LMW Tributaries
- Nearby Rivers
- Little Manistee Watershed Boundary

Source | GTRLC

Scale | 1:105,000 Date | 5/19/2020

Networks Northwest
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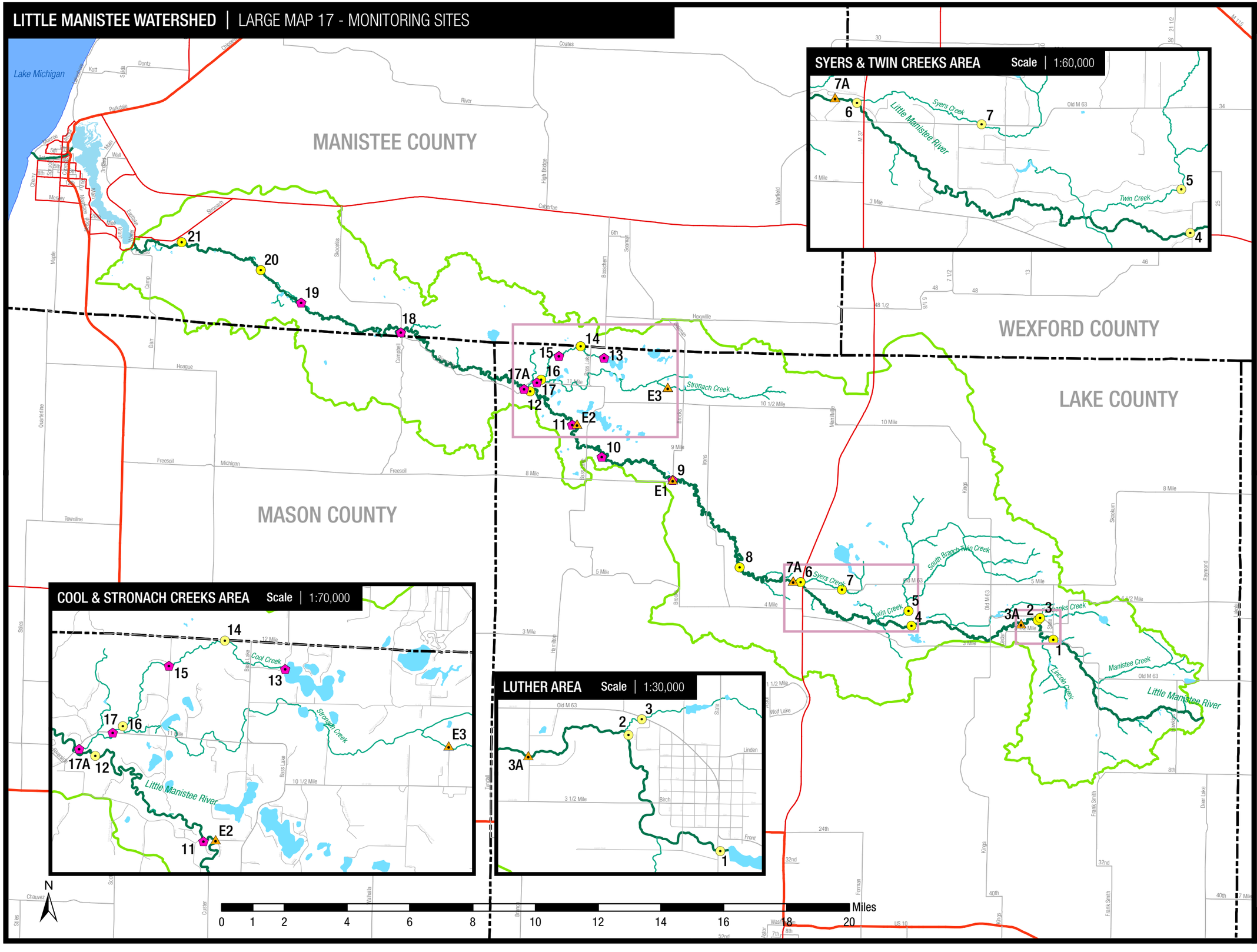
LITTLE MANISTEE WATERSHED | LARGE MAP 17 - MONITORING SITES



SYERS & TWIN CREEKS AREA | Scale | 1:60,000

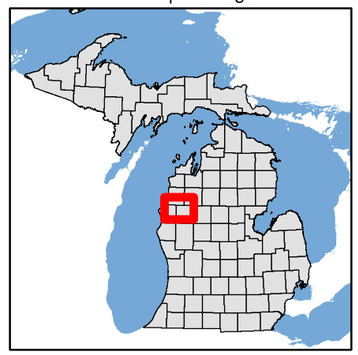
COOL & STRONACH CREEKS AREA | Scale | 1:70,000

LUTHER AREA | Scale | 1:30,000

LEGEND

Appendix C: Page 192

LOCATOR MAP | Michigan



KEY | MONITORING SITES

- Macroinvertebrates
- Water Quality
- Water Quality/Macroinvertebrates

FEATURES |

- Other Principal Arterial
- Minor Arterial
- Major Collector
- County Boundary
- LMW Lakes
- Little Manistee River
- LMW Tributaries
- Lake Michigan
- Little Manistee Watershed Boundary

Source | LMWCC, MDEQ

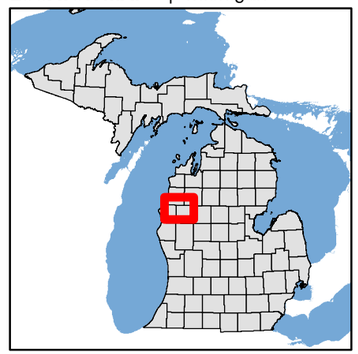
Scale | 1:180,000 **Date** | 5/4/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 18 - NATIONAL & STATE FOREST (ADDITIONAL MAP)

LEGEND

LOCATOR MAP | Michigan



KEY | FOREST AREAS

- State Forest
- National Forest

FEATURES

- National Forest Boundary
- Inland Lakes
- Little Manistee River
- LMW Tributaries
- Area Rivers
- County Boundary
- Township Boundary
- Roads-Other Principal Arterial
- Roads-Minor Arterial
- Roads-Major Collector
- Lake Michigan
- Little Manistee Watershed Boundary

Source | EPA/MDEQ/MDOT/US Census

Scale | 1:180,000 **Date** | 5/1/2020

Networks Northwest
Talent / Business / Community

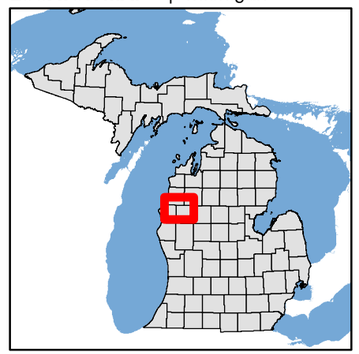
N

0 1 2 4 6 8 10 12 14 16 18 20 Miles

LITTLE MANISTEE WATERSHED | LARGE MAP 19 - ECOSYSTEMS (ADDITIONAL MAP)

LEGEND

LOCATOR MAP | Michigan



KEY | ECOLOGICAL LAND UNITS

- Boreal Jack Pine-Black Spruce Forest
- Laurentian Acidic Rocky
- Laurentian-Acadian Northern Pine-(Oak) Forest
- Laurentian Pine-Oak Barrens
- Laurentian-Acadian Floodplain Forest
- Laurentian-Acadian Alkaline Conifer-Hardwood Swamp
- Northern Appalachian-Acadian Conifer-Hardwood Acidic Swamp
- Laurentian-Acadian Calcareous Rocky Outcrop
- Laurentian-Acadian Acidic Cliff and
- Laurentian-Acadian Northern Hardwoods Forest
- Laurentian-Acadian Pine-Hemlock-Hardwood Forest
- Laurentian-Acadian Wet Meadow-Shrub Swamp
- Water

FEATURES |

- Little Manistee River
- County Boundary
- Township Boundary
- Little Manistee Watershed Boundary

Source | GEO/USGS

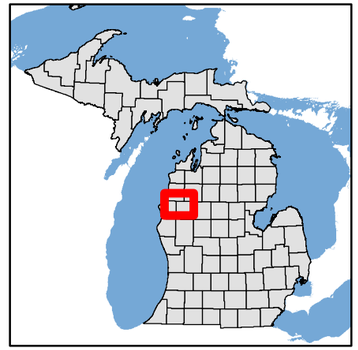
Scale | 1:180,000 **Date** | 4/29/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 20 - 2010 POPULATION DENSITY (ADDITIONAL MAP)

LEGEND

LOCATOR MAP | MICHIGAN



KEY | CENSUS BLOCK DENSITY

- 0.000000 - 0.000999
- 0.001000 - 0.009999
- 0.010000 - 0.099999
- 0.100000 - 0.999999
- 1.000000 - 10.000000

Density: People per Acre by Census Block

FEATURES

- Other Principal Arterial Road
- Minor Arterial Road
- County Boundary
- Township Boundary
- LMW Lakes
- Manistee Lake
- Lake Michigan
- Little Manistee River
- Little Manistee Watershed Boundary

MANISTEE COUNTY
WEXFORD COUNTY
MASON COUNTY
LAKE COUNTY
Lake Michigan
Manistee Township
Stronach Township
Filer Township
Norman Township
South Branch Township
Free Soil Township
Meade Township
Elk Township
Eden Township
Dover Township
Newkirk Township
Ellsworth Township
Sauble Township
Peacock Township
Cherry Valley Township
Pinora Township
Parkdale
Monroe
Cherry
Maple
Main
Manistee
Mee
Eastlake
Stronach
Caberfae
M 55
M 115
M 37
Fountain
US 31
State
US 10
Michigan
N
0 1 2 4 6 8 10 12 14 16 18 20 Miles

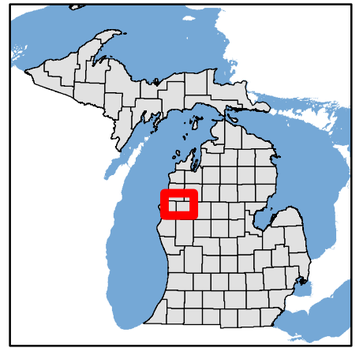
Source | 2010 US Census
Scale | 1:180,000 **Date** | 5/6/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 21 - 2010 HOUSING DENSITY (ADDITIONAL MAP)

LEGEND

LOCATOR MAP | MICHIGAN



KEY | CENSUS BLOCK DENSITY

- 0.000000 - 0.000999
- 0.001000 - 0.009999
- 0.010000 - 0.099999
- 0.100000 - 0.999999
- 1.000000 - 5.000000

Density: Housing Units per Acre by Census Block

FEATURES

- Other Principal Arterial Road
- Minor Arterial Road
- County Boundary
- Township Boundary
- LMW Lakes
- Manistee Lake
- Lake Michigan
- Little Manistee River
- Little Manistee Watershed Boundary

Source | 2010 US Census

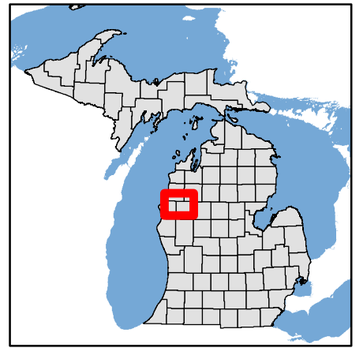
Scale | 1:180,000 **Date** | 6/2/2020

Networks Northwest
Talent / Business / Community

LITTLE MANISTEE WATERSHED | LARGE MAP 22 - GROUNDWATER RECHARGE (ADDITIONAL MAP)

LEGEND

LOCATOR MAP | MICHIGAN



KEY | GROUNDWATER RECHARGE

- 9 - 10
- 11 - 12
- 13 - 14
- 15 - 16

Color scale indicates Groundwater Recharge rate in inches per year.

(Cell Size: 1 Square Mile)

FEATURES

- Other Principal Arterial Road
- Minor Arterial Road
- County Boundary
- Township Boundary
- LMW Lakes >10 acres
- Manistee Lake
- Lake Michigan
- Little Manistee River
- Little Manistee Watershed Boundary

Source | MDEQ, USGS, MSU

Scale | 1:180,000 **Date** | 6/2/2020

Networks Northwest
Talent / Business / Community

Lake Michigan
Parkdale
Monroe
Chief
1st
8th
9th
Cherry
Maple
Vine
Manistee
Main
Mee
Eastlake
Water
Simmons
Chippewa
Caberfae
M 55
M 115
MANISTEE COUNTY
WEXFORD COUNTY
Manistee Township
Filer Township
Stronach Township
Norman Township
South Branch Township
Eden Township
Newkirk Township
Dover Township
Free Soil Township
Meade Township
Elk Township
Sauble Township
Peacock Township
Ellsworth Township
Cherry Valley Township
Pinora Township
LAKE COUNTY
MASON COUNTY
Fountain
US 31
M 37
State
US 10
State
US 10
US 10
Michigan
N
0 1 2 4 6 8 10 12 14 16 18 20 Miles