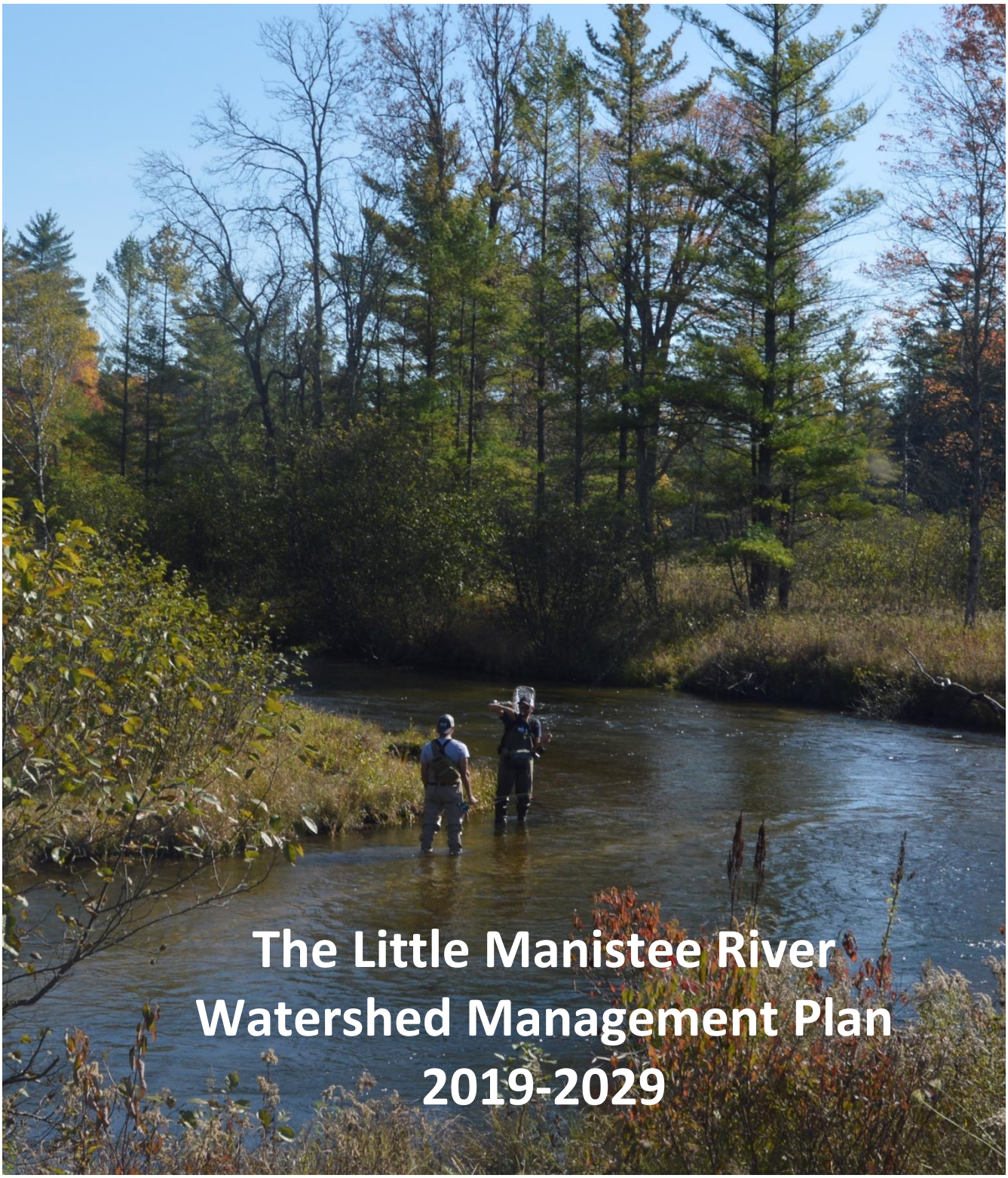


The Little Manistee River Watershed Management Plan 2019-2029

The Little Manistee Watershed Management Plan

The Little Manistee Watershed Conservation Council gratefully acknowledges the contributions of the following organizations and individuals:

The Little Manistee Watershed Assembly:

"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, Elk, Ellsworth, Peacock, Newkirk, Norman and Meade Townships
Luther Village
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 WS Partners
Individual Signatures: 125

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 Trav. Regional Land Conservancy: Chris Sullivan
Lake Co. Economic Dev.: Barbara Stenger
Lake Co. Economic Dev. Committee: John Trimberger
Lake Co. 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 Sauble River-Hamlin Lk. WS: Wayne Andersen
Trout Unlimited: Jeremy Geist
United States Forest Service: Chris Riley
United States Geological Survey: Kevin Kincare

Major Financial Contributors:

Numerous Private Individuals
Jorgensen Family Foundation, Fort Wayne, IN
Little River Band of Ottawa Indians, Manistee, MI
Lake County Community Foundation, Baldwin, MI
Little Manistee Watershed Cons. Council, Irons, MI
Seng's Marina, Manistee, MI
Women Who Care, Manistee, MI

Little Manistee River Watershed Management Plan

TABLE OF CONTENTS

Table of Contents, Continued

Maps and Charts

Note: Large-format versions of all maps are included as Appendix B to the plan)

Chapter 1:

Maps

Charts/Tables

Chapter 2:

Maps

Charts/Tables

Chapter 3:

Maps

Charts/Tables

Executive Summary

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

The Plan is intended to protect surface water quality by preventing or reducing non-point source pollution during the 10-year period from 2019 through 2029. It is a living document which may be amended – or extended into additional years – through action by the LMWCC and Steering. Committee.

The LMWCC chose the Alliance for Economic Success, of Manistee, as the fiscal agent for the project, and Networks Northwest, of Traverse City, to retain consultants for research and drafting of the Plan.

The Steering Committee oversaw the planning process through a series of public meetings and was charged with reviewing the several drafts and approving the final document for submission to the Michigan Department of Environmental Quality and the United States Environmental Protection Agency. 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 Little Manistee River is noted as a high-quality coldwater stream

The Little Manistee Watershed is designated by the United States Geological Survey's 10-digit Hydrologic Unit Code, 0406010306. It encompasses 134,000 acres in Manistee, Lake, Mason and Wexford counties in Michigan's Lower Peninsula.

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 shows more than 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 or the Michigan Department of Natural Resources. The area is sparsely populated with an estimated 3,700 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 the remainder held primarily for seasonal or occasional use, according to the 2010 United States Census.

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 embarked on the planning process with the intent of preserving the coldwater resources and natural character of the watershed. 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.

The Steering Committee approved the following set of goals, which are presented in Chapter 1 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 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 meet or exceed all applicable state and federal standards and locally desired conditions.

Goal 4: Protect the natural character of the watershed, while maintaining the economic and lifestyle 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 of such high quality that they exceed 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.

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.

In addition to an overall monitoring strategy, the Plan designates six 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 4 are: The Luther dam area; the MDNR Weir; 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. However the sites are considered to be at risk of deterioration unless careful management is applied.

The Plan also cites several priority issues for protection and increased attention. They are: Stream ecology and habitat; inland lakes; groundwater; and rustic and natural character of the watershed.

Chapter 5 of the document contains a multi-page table listing 13 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 $7.1 million. More than half of that total ($4.2 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 $453,000 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.

The WMP creates a long-term monitoring strategy with numerous sites to be sampled for water quality on a regular schedule (Chapter 6). 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.

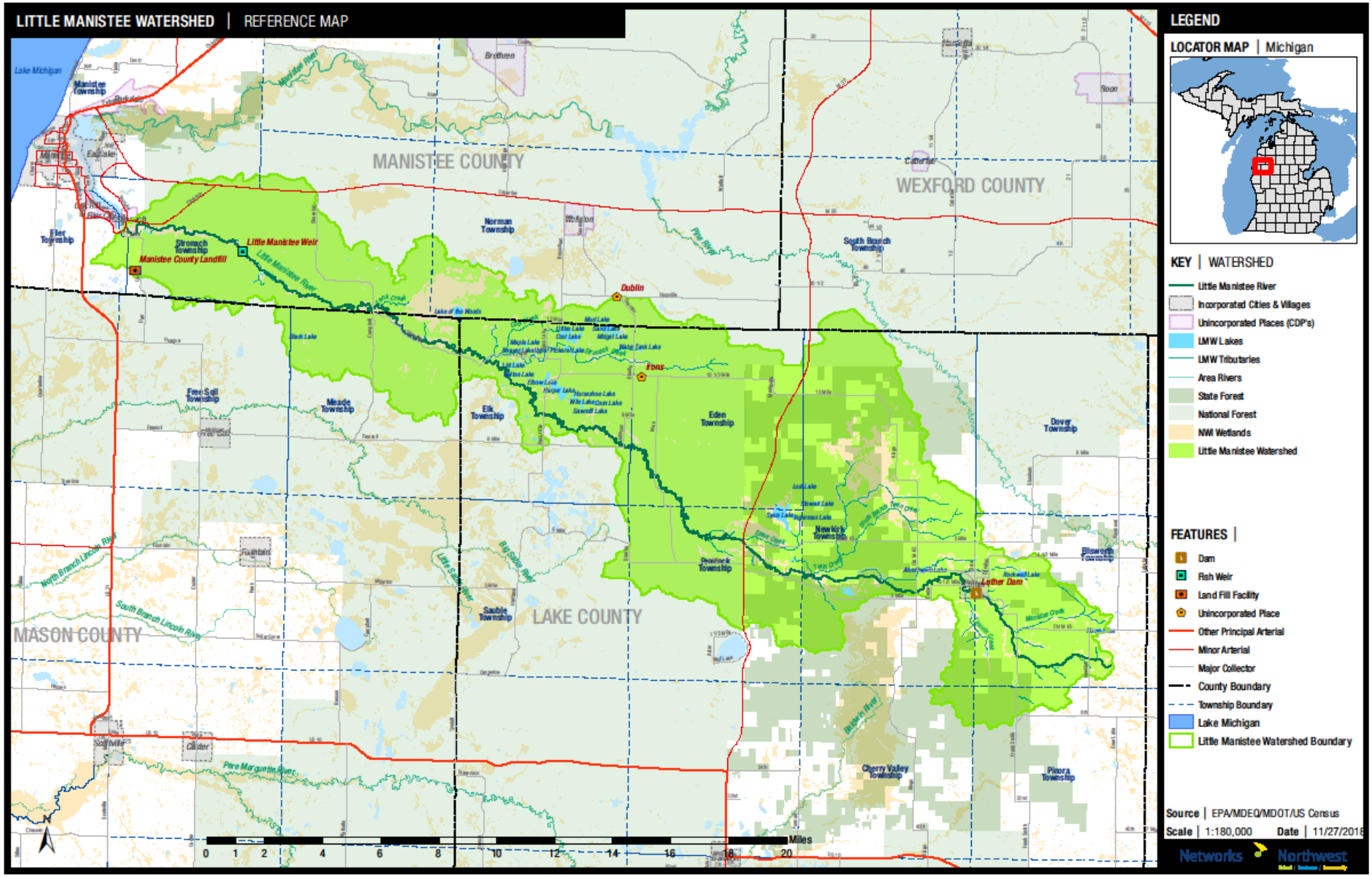
The LMWCC Board of Directors is committed to review and update the plan at the organization’s annual meeting and retreat.

A vital element of the WMP is the continuing information and education component (Chapter 7). This plan will focus 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.

Reference Map for Little Manistee Watershed Management Plan



The Little Manistee River Watershed Management Plan

Chapter 1: Background and Introductory Information

The Little Manistee River Watershed encompasses about 209 square miles (543 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. Monitoring, by volunteers and by the Michigan Department of Environmental Quality, 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 throughout Michigan (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. 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 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.

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. None of those agencies has a service area which covers the entire watershed. The Conservation Resource Alliance, 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; 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.

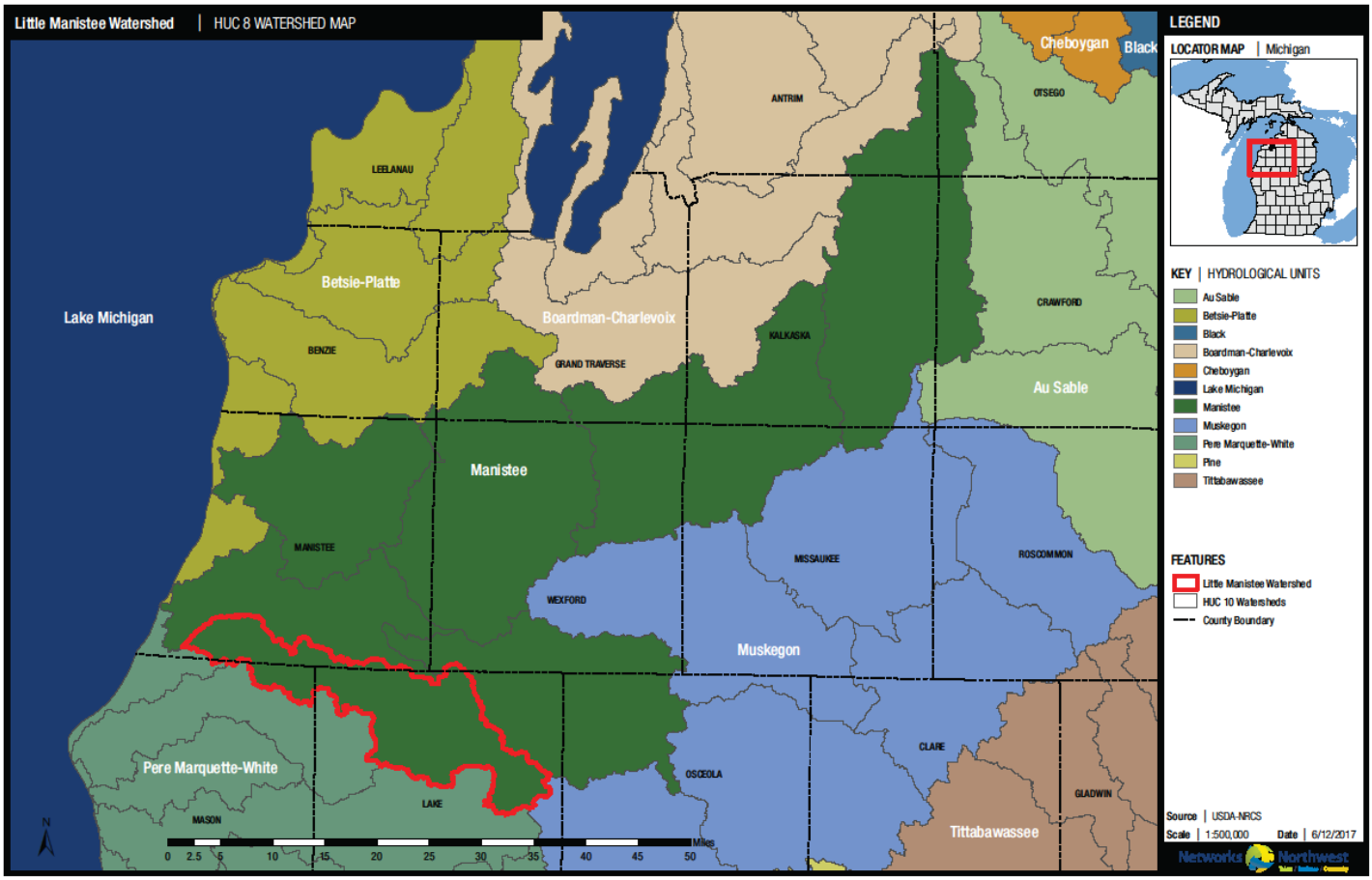
Most of the surface waters in this watershed meet and exceed state and federal clean-water standards. Primary goals of the plan are to preserve – and potentially improve – that situation through land-use education, mitigation of known problems such as erosion sites, and a long-term program of monitoring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

Michigan ecoregions

Michigan's rivers are grouped into distinct ecoregions, based upon the character of the land through which they flow. The Little Manistee River Watershed is in the North Central Hardwood Forests ecoregion, and the Northern Lakes and Forest ecoregion.

Michigan ecoregions are described as follows in the Department of Environmental Quality 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 (Omernik and Gallant, 1988). 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 Southern Michigan/Northern Indiana Till Plains, Northern Lakes and Forests, North Central Hardwood Forests, Huron-Erie Lake Plains, 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."

Creating the Watershed Plan

The Little Manistee River Watershed Plan is a locally based effort led by the Little Manistee Watershed Conservation Council and a number of partners.

The LMWCC raised funds through local sources to develop the plan. The Alliance for Economic Success, in Manistee served as fiscal agent, while Networks Northwest, in its capacity as the Northwest Michigan regional planning agency, was contracted to produce the plan.

Plan development participants included: 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 of Manistee Conservation District; Kurt Schindler of Norman Township; Lou Fitz of Elk Township; Rob Car-

son, Manistee County Planner; Shaughn Barnett of the Little River Band of Ottawa Indians; Barbara Stenger, Lake County Commissioner; Chris Sullivan, Grand Traverse Regional Land Conservancy.

Staff consultants for the project, working through Networks Northwest, are 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, and provided invaluable advice. The Conservation Resource Alliance contributed information from its inventories of road-stream crossings and Little Manistee River streambank conditions. The Northwest Michigan Invasive Species Network developed and provided maps of terrestrial invasives in Manistee County. Michigan Department of Natural Resources compiled fishery status reports and other wildlife information. The U.S. Forest Service provided information on its projects and plans. Volunteers contributed water quality data that had been collected over several years. 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 (see next section). Following the initial plan development period, a draft of the document was presented to the public at two advertised meetings. The draft was amended based on input from those meetings.

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 Michigan Department of Environmental Quality (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.”

At the time the 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 the MDEQ, assists local units of government, non-profit entities, and numerous other state, federal, and local partners to reduce nonpoint source pollution statewide.

Local governments, tribes, individuals and stakeholder groups were invited to participate in the project by attending meetings, commenting on preliminary drafts and/or serving on the Watershed Management Plan Steering Committee.

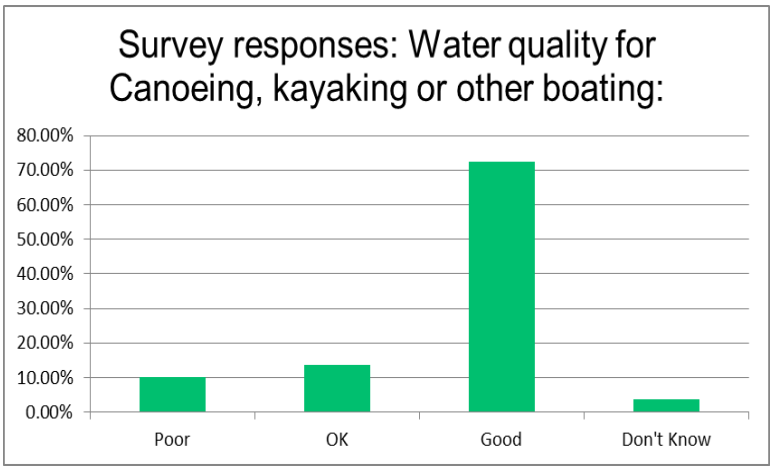
Social indicators survey

A social Indicators survey, conducted during the planning process, was distributed 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 watershed knowledge.

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 is not considered to be truly random. Results

are considered to be an indication of local opinion and knowledge, but confidence level and margin of error cannot be calculated.

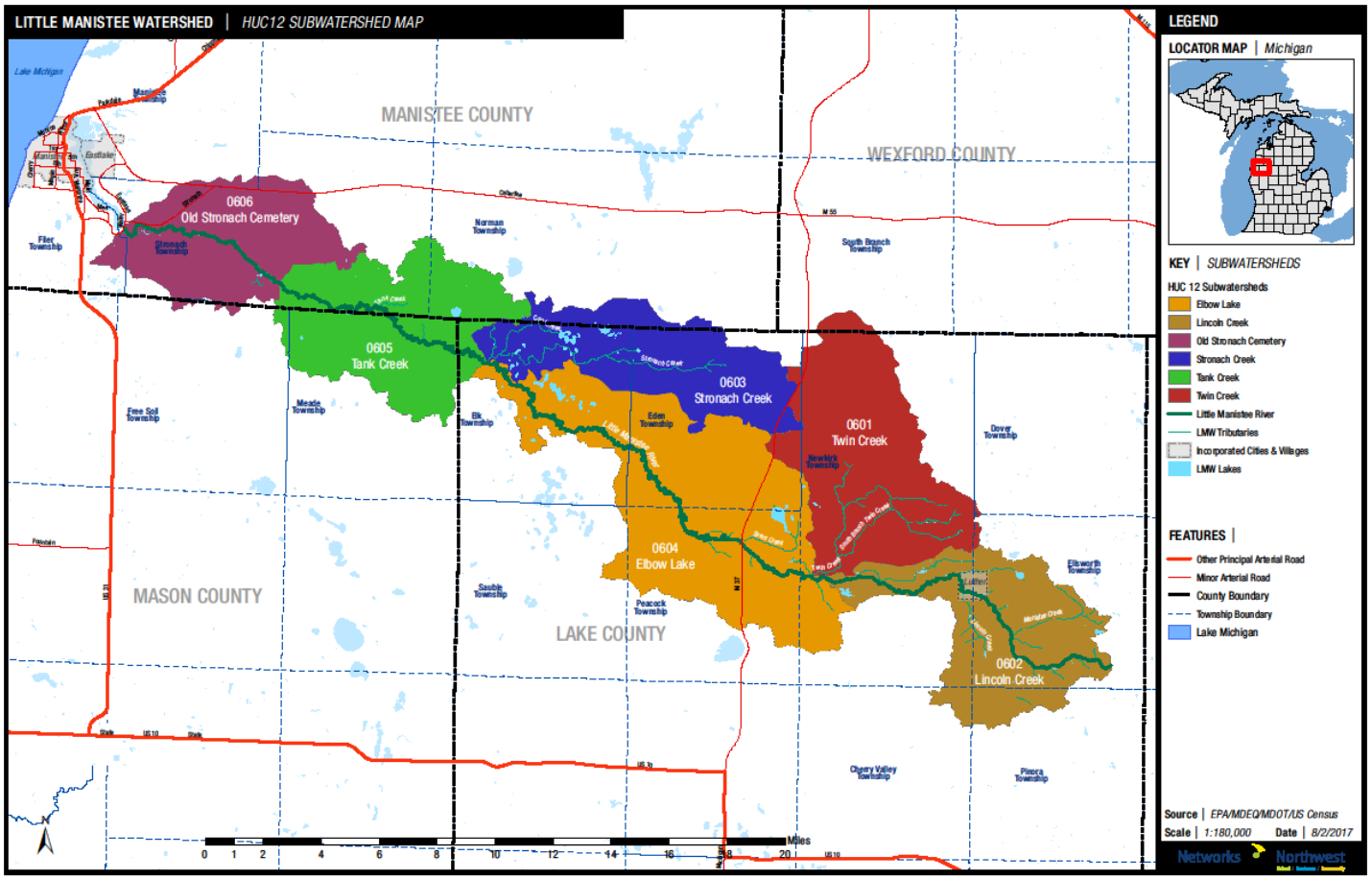
Questions were selected from similar instruments used for watershed planning in this region (e.g. "How would you rate the water quality in your area for canoeing, kayaking or other boating?); and from suggestions regarding locally desired information points (e.g. "Please indicate if you would be likely to support … State Designation of the Little Manistee River as a natural river…?")



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 watershed was "Sedimentation (dirt and soil) in the water."

In addition, strong majorities indicated support for regulation of septic system and for zoning requirements or natural river designation. Preliminary survey results played a role in the determination of WMP goals. The final tabulation was used to inform the plan's educational component. Detailed survey results are included in relevant chapters of the WMP and the full survey is included as Appendix A.

Hydrologic Unit Codes



Watersheds and subwatersheds throughout the United States are identified through a unique set of numerical "Hydrologic Unit Codes" or HUC's.

Under this system, the Manistee River Watershed in Northwest Lower Michigan is identified by the 8-digit HUC: 04060103. 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 those watersheds is identified by a 10 digit HUC – 0406010306 for the Little Manistee

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 in preceding page):

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

Water Quality Standards and the "Integrated Report"

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 watershed are discussed in Chapter 4 of this document.

Michigan's water quality standards, and the overall status of pollution control efforts within the state, are 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 our waters relative to those standards.

"At a minimum," the report states, "all surface waters of the state are designated and protected for all of the following designated uses: agriculture, navigation, industrial water supply, warmwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and fish consumption … In addition, all surface waters of the state are designated and protected for total body contact recreation from May 1 to October 1 ... Specific rivers and inland lakes as well as all Great Lakes and specific Great Lakes connecting waters are designated and protected for coldwater fisheries."

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 Monthly averages for cold water inland streams in this watershed (F°): Jan 38° Feb 38° Mar 43° Apr 54° May 65° Jun 68° Jul 68° Aug 68° Sep 63° Oct 56° Nov 48° Dec 40°	Designated coldwater streams and trout lakes (see list below)
Other Indigenous Aquatic Life and Wildlife	Limits on permitted discharges to prevent nuisance algae blooms and protect wildlife.	All water bodies
Fish Consumpton	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

(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."

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.

EPA Nine Elements

The intent of the Steering Committee is to develop a plan that protects the quality of the watershed, responds to the desires of the local community, and meets requirements of the Michigan Department of Environmental Quality and United States Environmental Protection Agency for approved watershed management plans under Section 319 of the Clean Water Act.

In order to achieve EPA approval, 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 measureable 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 4.

A multi-page graphic describing Implementation Tasks, in Chapter 5, 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 6.

Chapter 7 describes the Information/Education component (element e).

Because the majority of the Watershed meets and exceeds standards for the designated and desired uses (described in Chapter 4), the WMP adopts a non-degradation standard – requiring that the present high water quality is maintained.

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 20 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 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, 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, reduced sedimentation by improving or replacing several road crossings.

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

LMWCC has performed annual monitoring of water quality parameters (E. coli, phosphorus, temperature, dissolved oxygen, etc.) at more than 20 sites in the watershed. Descriptions and data from past and ongoing projects are included in the appropriate sections of the WMP.

2000 Little Manistee River Watershed Plan

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 the Michigan Department of Environmental Quality under the guidelines of the Clean Michigan Initiative. It was not submitted for review by the United States Environmental Protection Agency.

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.

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. 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 5. 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 both the environment and human 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.

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

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 meet or exceed all applicable state and federal standards and locally desired conditions

a. Monitor public access areas for *E. coli* contamination; 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…)

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 and lifestyle benefits that accompany a high-quality natural environment

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

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

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.

Chapter 2: Watershed Overview

The Little Manistee River Watershed, a subwatershed of the Manistee River system, encompasses 134,329 acres in Lake, Mason, Manistee and a small corner of Wexford counties in Michigan's northwestern Lower Peninsula.

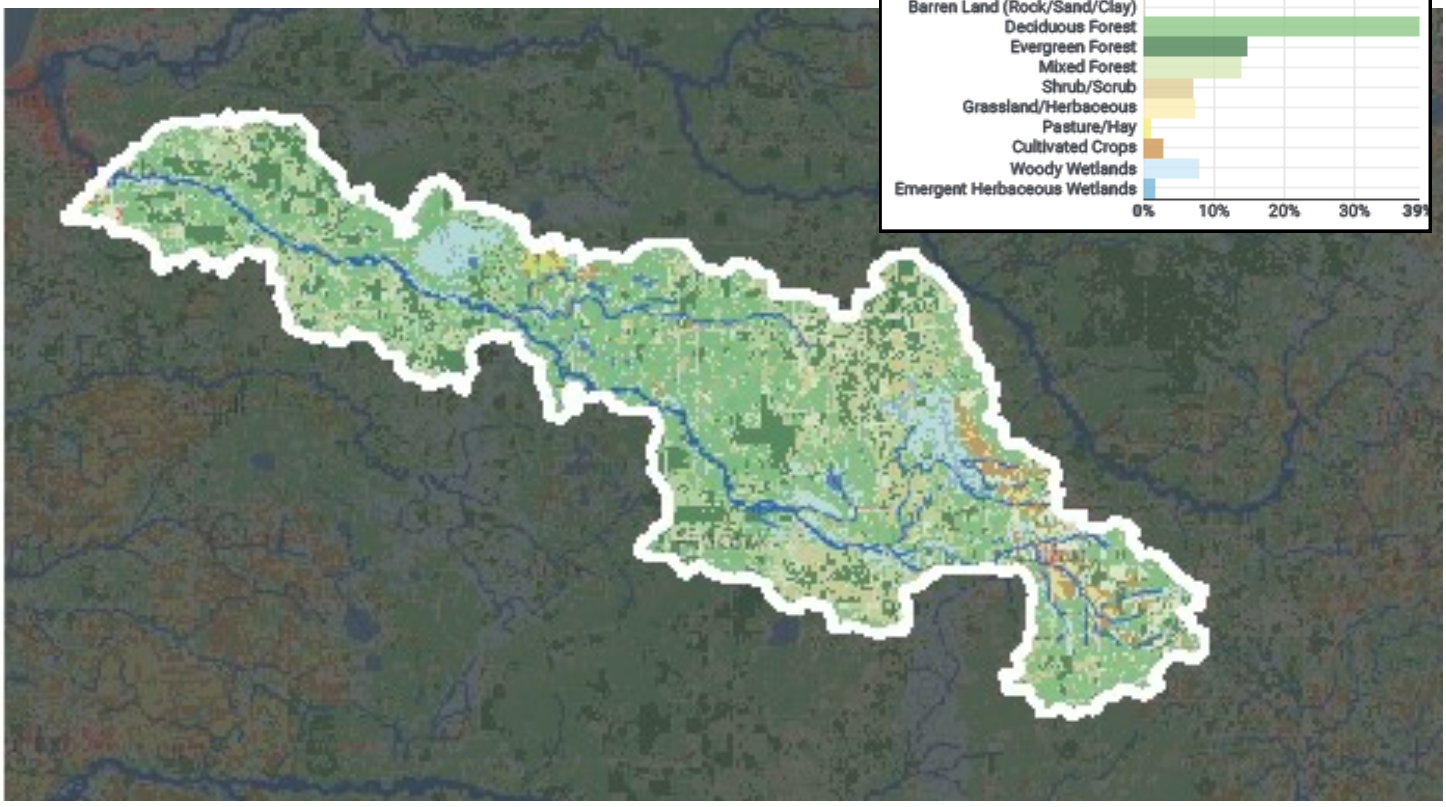
Significant surface water features include the Little Manistee River and tributaries as well as several dozen small lakes. The river and tributaries are fed year-round by stable groundwater aquifers and are all designated as coldwater trout streams.

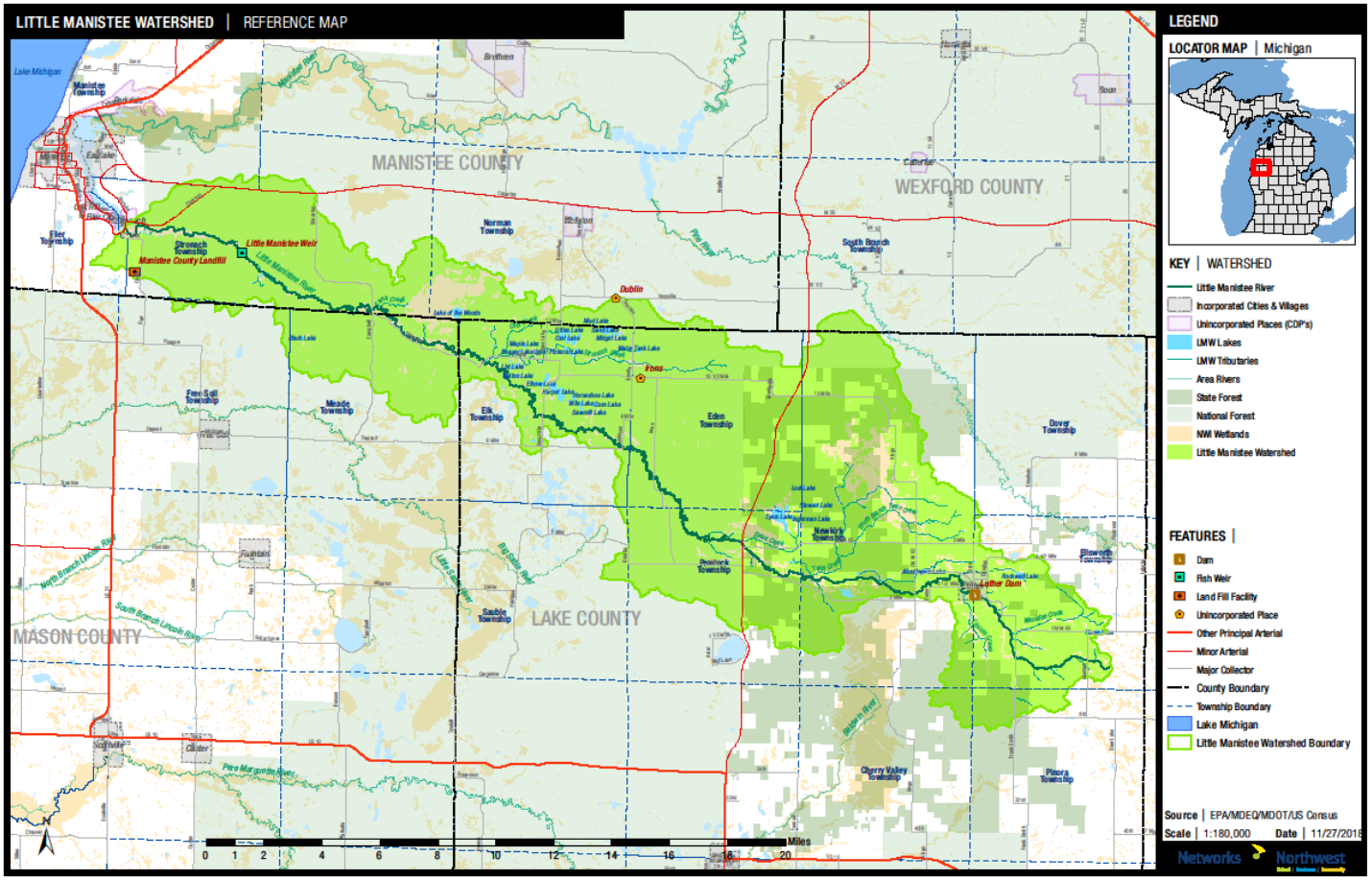
The Little Manistee is one of several high-quality streams – including the White, Pere Marquette, Pine, Big Manistee, Betsie and Platte rivers – which flow east to west into Lake Michigan, draining an extensive, forested area of the Lower Peninsula between the Muskegon River and Grand Traverse Bay watersheds.

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 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).

Little Manistee Watershed Land Cover





Portions of 16 townships and one incorporated village lie within the watershed, as follows:

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.

Winter on the Little Manistee River

From the Lake County headwaters to the exit point at Manistee Lake, the drop in altitude is approximately 600 feet, or an average of 10 feet per mile. 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.

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.

Agricultural land uses, primarily row crops and small livestock operations, occupy about 5 percent of the watershed's acreage. The largest farm area is in Ellsworth and Newkirk townships, near the headwaters.

The Little Manistee mainstream has one dam, at the village of Luther, which impounds a millpond of about 8 acres. The Luther Dam washed out in 1986 and again in 1993, contributing 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 U.S. Forest Service 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.

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.

Land Cover Type	Total Acres	Percent of watershed
Open Water	768	0.6
Developed, Open Space	5,753	4.3
Developed, Low Intensity	855	0.6
Developed, Medium intensity	72	0.1
Developed, High Intensity	15	0
Barren Land (Rock/sand/clay)	84	0.1
Deciduous Forest	52,547	39.1
Evergreen Forest	19,516	14.5
Mixed Forest	18,607	13.8
Shrub/Scrub	9,501	7.1
Grassland/Herbaceous	9,610	7.1
Pasture or hay	1,238	0.9
Cultivated Crops	3,499	2.6
Woody Wetlands	10,366	7.7
Emergent Herbaceous Wetlands	1,898	1.4

Off Road Vehicle trails criss-cross much of the public land, and are well used. A segment of the North Country 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.

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.

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, all tributaries	Sediment; invasive species; thermal issues; hydrology issues
Fish Consumption	Consumption limits on all Michigan waters			Mercury; PCBs
Other indigenous aquatic life and wildlife	None	Entire watershed		Competition from invasive mussels; nutrients; sediment
Industrial Water Supply	None			
Agriculture	None			Livestock with direct access to waterway

Desired Uses Not Mandated by Michigan

Desired Use or Condition	Critical 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

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 designation 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 U.S. Forest Service 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.

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

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.

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.

Kayaks await launching at the Little Manistee River Weir

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 CO_2 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 CO_2 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. (citation 2-1)

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. (citation 2-2)

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 evapotranspiration 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

Over a 30-year period, the Little Manistee River 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 the portions closest to Lake Michigan. (See table in Climate section, above)

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.

Modeling software provided by the Stroud Water Research Center indicates that only about 3 percent of precipitation falling on the watershed is converted to surface runoff. The rest is accounted for by infiltration into soils, evapotranspiration by vegetation and direct contributions to water bodies.

The 50 percent probability rainstorm for this region (that is, a 24-hour rainfall expected to occur on average once every two years) is 2.09 inches. That figure was used along with the Stroud modeling to estimate nutrient loads in runoff as part of the pollution Source Inventory in Chapter 3 of this WMP.

The impervious cover model developed by The Center for Watershed Protection indicates that stream quality degradation is likely when impervious surfaces exceed 5-10 percent of total land area. (Citation 2-3) The Little Manistee Watershed as a whole falls well below those levels, as do each of its subwatersheds.

Because of its sparse development, predominantly forested land cover and porous soils, this watershed's hydrology is close to what existed in the pre-settlement era. However, changes in forest cover and/or significant developments could alter those conditions.

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, etc.) to protect the groundwater and surface water quality benefits of the area's natural hydrology.

Lakes and streams in the Little Manistee Watershed

Named Streams:	**Named Lakes/ponds:**	**Named Lakes/ponds:**
(All considered coldwater streams)	Linke Pond (Stronach Township)	Horseshoe Lake (Elk Township)
Little Manistee River	Black Lake (Meade Township)	Wile Lake (Elk Township)
Tank Creek (Stronach Township)	Lake of the Woods (Norman Township)	Coon Lake (Elk Township)
Cool Creek (Elk Township)	Mud Lake (Norman Township)	Sawmill Lake (Elk Township)
Stronach Creek (Elk Township)	Maple Lake (Elk Township)	Ingerman Lake (Peacock Township)
Twin Creek (Newkirk Township)	Beaver Lake (Elk Township)	Syers Lake (Eden and Peacock Townships)
Syers Creek (Peacock Township)	Upper Pickerel Lake (Elk Township)	Water Tank Lake (Eden Township)
Lincoln Creek (Newkirk and Ellsworth Townships)	Littles Lake (Elk Township)	Lost Lake (Newkirk Township)
Manistee Creek (Ellsworth Township)	Cool Lake (Elk Township)	Stewart Lake (Newkirk Township)
	Sand Lake (Elk Township)	Ahmikwan Lake (Newkirk Township)
	Midget Lake (Elk Township)	Rockwell Lake (Ellsworth Township)
	List Lake (Elk Township)	Howe Lake (Ellsworth Township)
	Walton Lake (Elk Township)	Luther Millpond (Village of Luther)
	Elbow Lake (Elk Township)	
	Harper Lake (Elk Township)	

Fishery

The Little Manistee River is the "parent stream" for steelhead trout planted through the Great Lakes region according to 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, according to Michigan Department of Natural Resources records.

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).

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 in a 2008 report: "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."

Chinook Salmon are among the species harvested at the Little Manistee Weir

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. It provides the primary broodstock for hatchery-raised steelhead in Michigan. Chinook salmon eggs are also harvested at the Weir during the fall salmon run. In addition to the egg-taking function, the river weir serves as a barrier to stop sea lamprey from moving upriver to spawn. The Department of Natural Resources is in process of studying possible changes to improve the weir's effectiveness against lamprey.

Visitors hike the trail below the Little Manistee Weir

Annual 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**
Average	**4,688**	**16,059**	**13,287**	**1,816**	**76**

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.

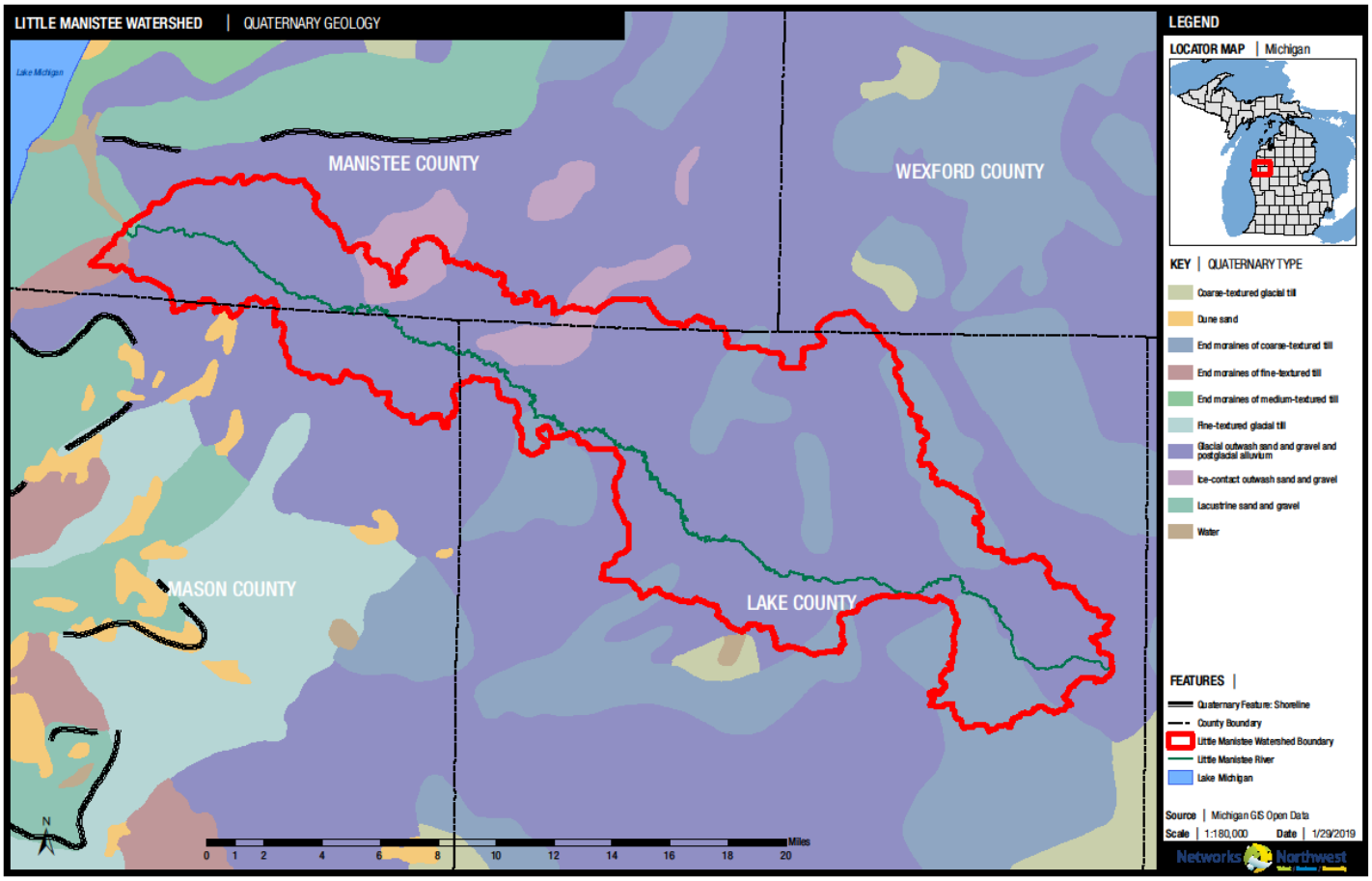
In recent years, there has been no planting of steelhead or Coho in the Little Manistee. Chinook continue to be stocked at or below the weir, though the numbers have been reduced in recent years as part of an ongoing effort to balance the prey/predator ratio in the Great Lakes.

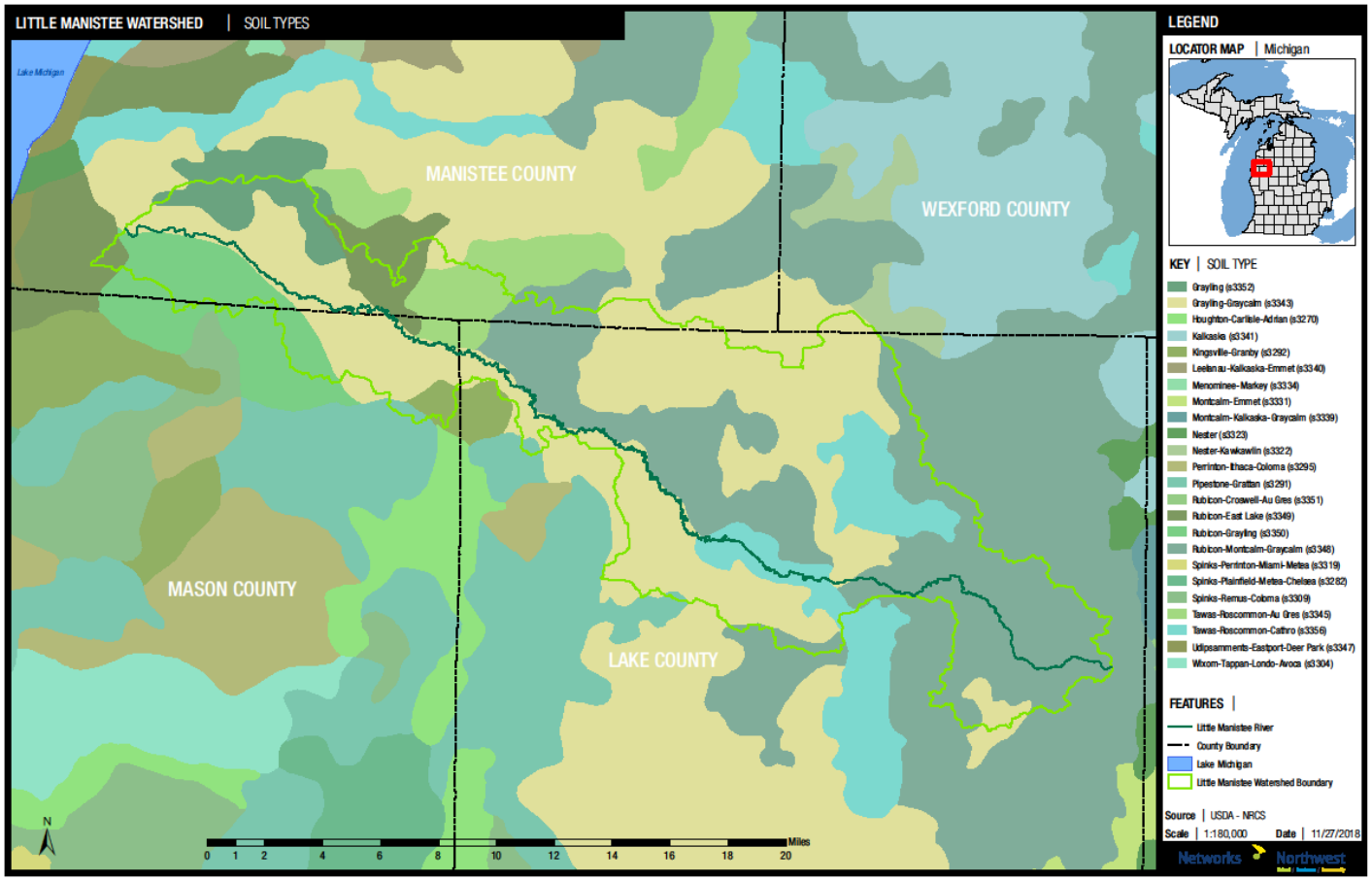
The Little Manistee Weir is open to the public during Chinook salmon and steelhead egg takes, and is heavily visited. During the autumn Chinook salmon egg take, many school groups are given tours of the facility by MDNR personnel. The children get a close up view of weir personnel taking and fertilizing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

Geology and soils

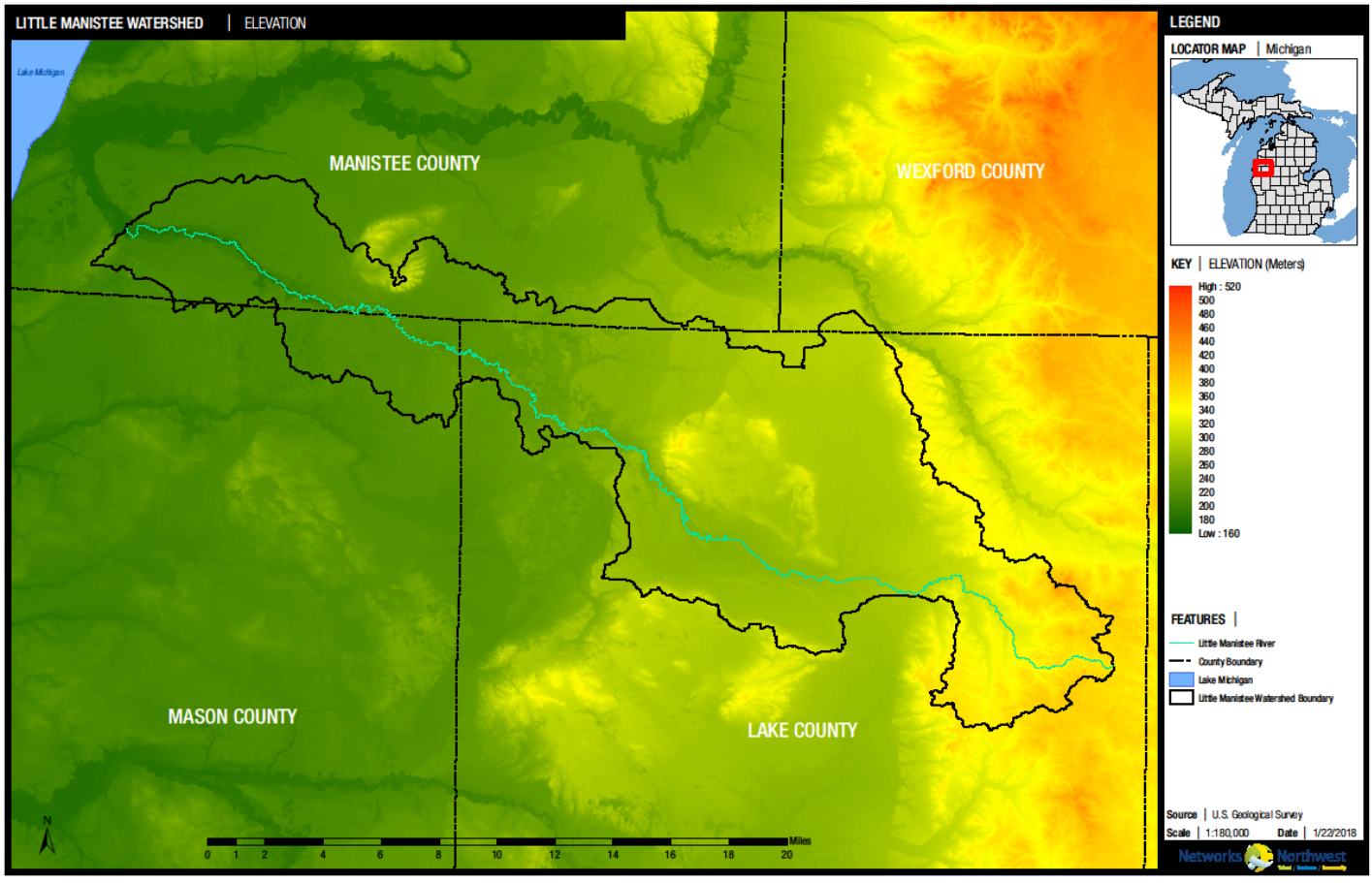
The surface geology of the watershed is dominated by glacial features, including moraines, outwash plains and kettle lakes. Soils are primarily well-drained sands and sandy loams, with some more productive soils in eastern Lake County, upstream of Luther.

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.

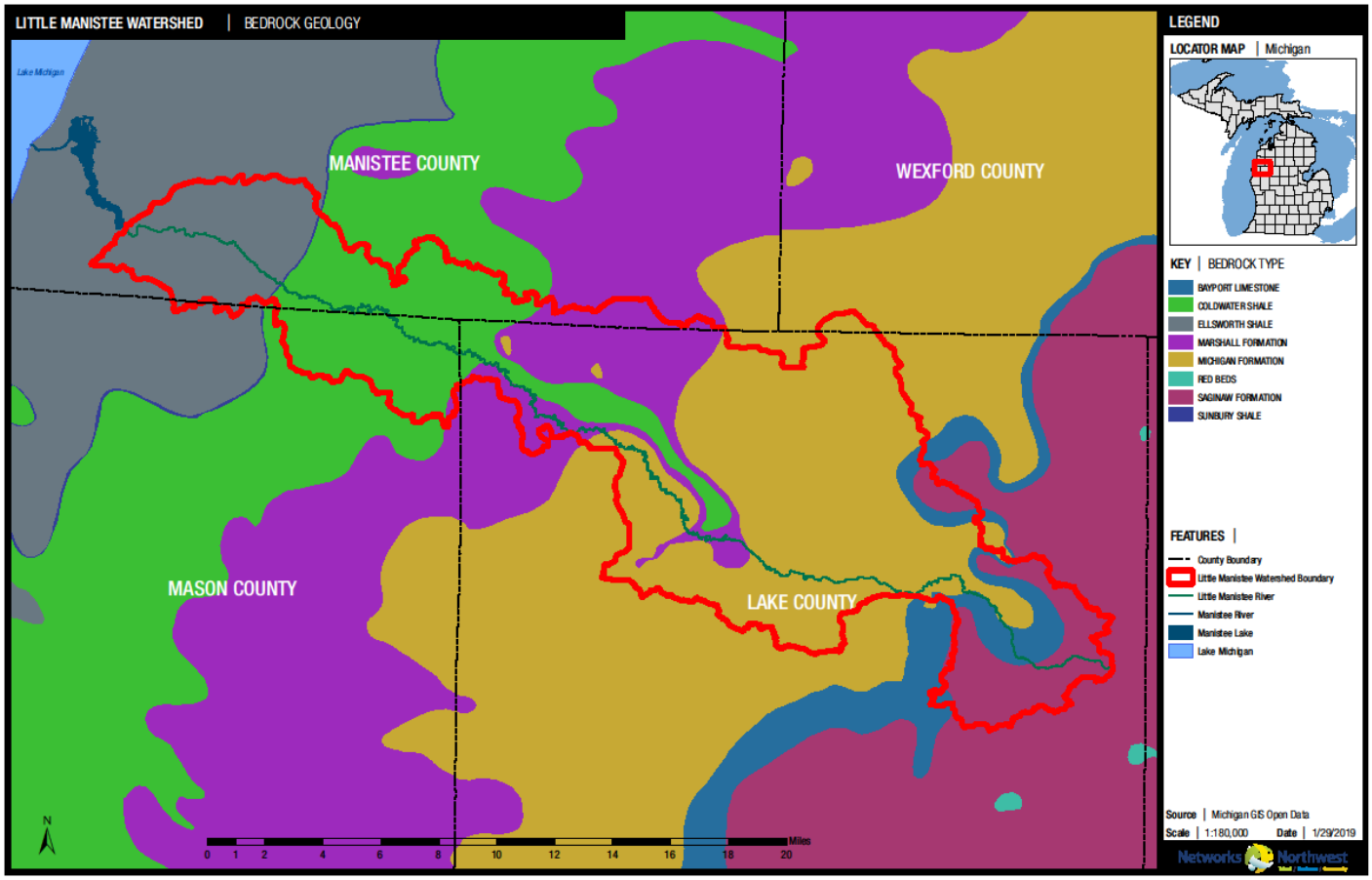


According to the Official Soil Series Descriptions published by NRCS, Rubicon sands are “very deep, excessively drained soils” formed in glacial drift areas. Native vegetation on these soils was mostly evergreen forest, with some hardwoods. Some of these soils were cleared and used for cropland or pasture 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., thoug some have been used for hay or pasture over he 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 is approximately 1,200 feet above sea level. That drops to below 600 feet at the watershed’s exit point at Manistee Lake.

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 at 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 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.

Wetlands

Wetlands (see map on page 13) 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) 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.

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 regulated development in 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 are 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 the DEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

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.

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.

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.

Population and Housing in Little Manistee Watershed

Township	Population Total	Housing Units Total	Housing Units Seasonal	Population in Watershed (est)	Housing Units in Watershed (est)
Cherry valley	396	522	318	20	26
Dover	395	370	184	4	4
Eden	487	793	544	463	753
Elk	985	1,589	1,029	660	1,065
Ellsworth	817	622	237	490	373
Newkirk	632	860	502	379	516
Peacock	492	1,132	841	271	623
Pinora	717	461	147	57	37
Sauble	333	688	481	17	34
Filer	2,325	1,188	125	233	119
Manistee	4,084	1,598	202	204	80
Norman	1,553	1,633	803	311	327
Stronach	821	581	184	550	389
Free Soil	822	655	177	25	20
Meade	181	208	116	72	83
South Branch	386	455	268	19	23
TOTALS	**15,426**	**13,355**	**6,158**	**3,774**	**4,471**

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 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 and exotic animals. Both Irons and Luther have small business districts that cater to local and tourist trade.

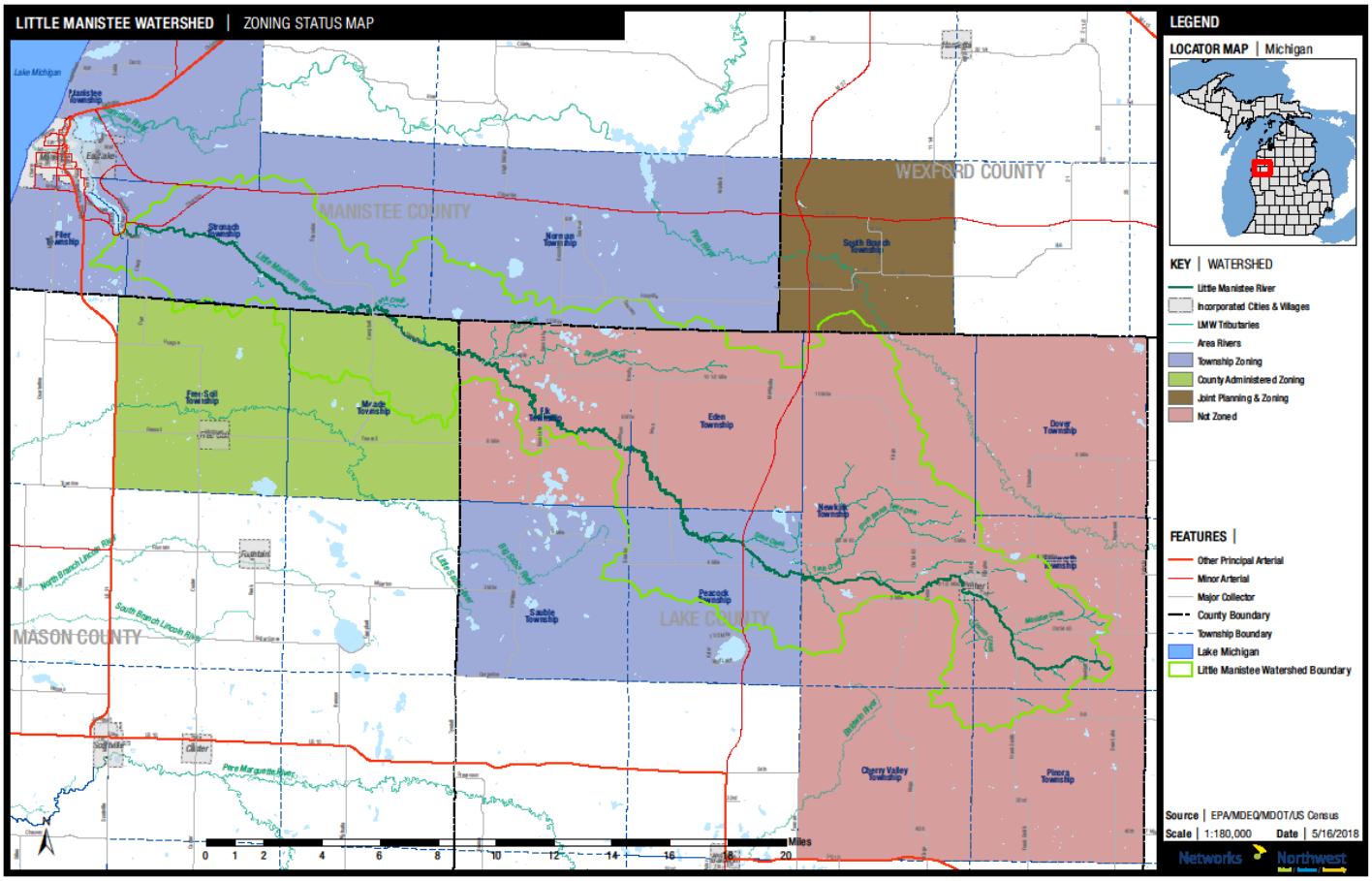
Public and private woodlands provide some timber harvest employment, though milling and processing are done outside the watershed.

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).

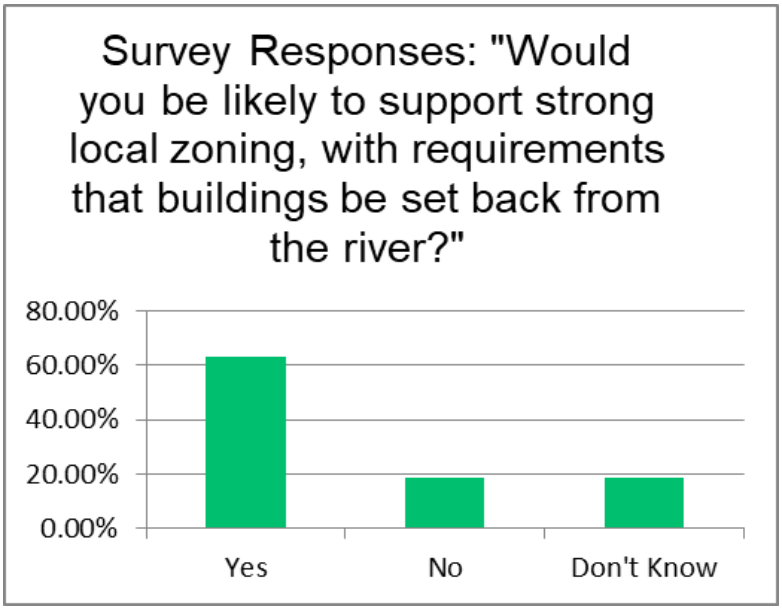
The review showed the following distribution of zoning within the Little Manistee Watershed: The two townships in Mason County (Free Soil and Meade), have county-administered zoning; the lone township in Wexford County (South Branch) has zoning through a multi-township authority (The Wexford Joint Planning Commission); and each of the four Manistee County townships (Manistee, Filer, Stronach and Norman) has its own zoning ordinance.I n 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.

The existing ordinances (see tables at the end of this section) 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 set-backs, 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 may include zoning districts along or around surface water (including overlay districts); wetland provisions in zoning; surface water protections; setbacks and buffers; groundwa-ter 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 develop-ment 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 al-lowing 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 evolu-tion of the community by bringing the social, physical, economic and political considerations into focus. The master

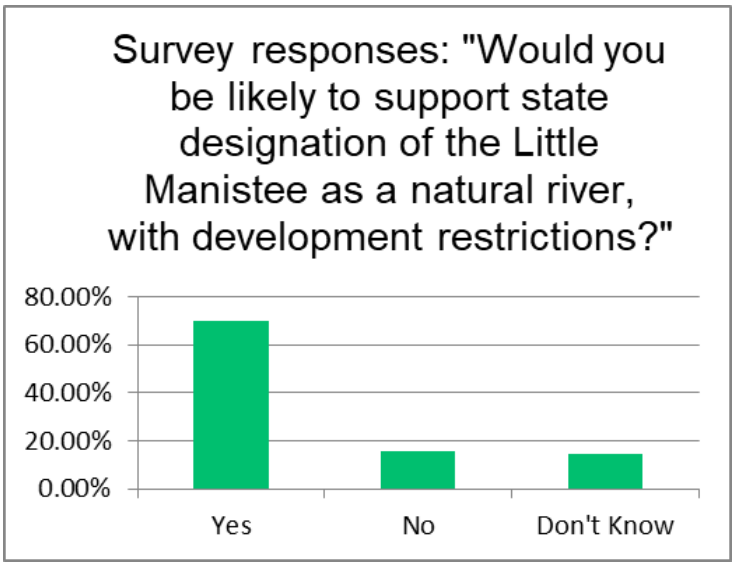
plan provides guidance for the future use of the land as well as the employment of other capital resources such as infrastructure to support community goals.

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 are increasingly complex as we gain more knowledge of effects and interrelationships in our environment that may significantly impact 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." Nearly 70 percent indicated support for "State designation of the Little Manistee as a natural river, with development restrictions."



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.

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 be there or can be developed 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.

Footnotes

2-1 Saunders, Stephen, and Tom Easley, "Extreme Storms I Michigan, Dec. 2014, the Rocky Mountain Climate Organization

2-2 Christiansen, Daniel E., John F. Walker, and Randall J. Hunt, "Basin-Scale Simulation of Current and Potential Climate Changed Hydrologic Conditions in the Lake Michigan Basin, United States"; U.S. Geological Survey, 2014

2-3 Impacts of Impervious Cover on Aquatic Systems, 2003, Center for Watershed Protection,

(Zoning review tables begin on following page)

Zoning Table A: Manistee and Wexford municipalities (page 1 of 2)

	South Branch Twp. **Wexford Joint Planning comm.** Relevant Districts: R1 Rural Residential	**Stronach Twp.** **Individual township zoning** Relevant Districts: Forest Preservation; Res.-Commercial; Little Manistee River Corridor	**Norman Twp.** **Individual township zoning** Relevant Districts: 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

Zoning Table A: Manistee and Wexford municipalities (page 2 of 2)

	South Branch Twp.	Stronach Twp.	Norman Twp
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 only marginal geographic extent in the Little Manistee Watershed, and are not assessed in this zoning review.

No Zoning ordinance has been adopted in the Lake County townships of Cherry Valley, Dover, Eden, Elk, Ellsworth, Newkirk and Pinora, nor in the Village of Luther.

Zoning Table B: Lake and Mason municipalities (page 1 of 2)

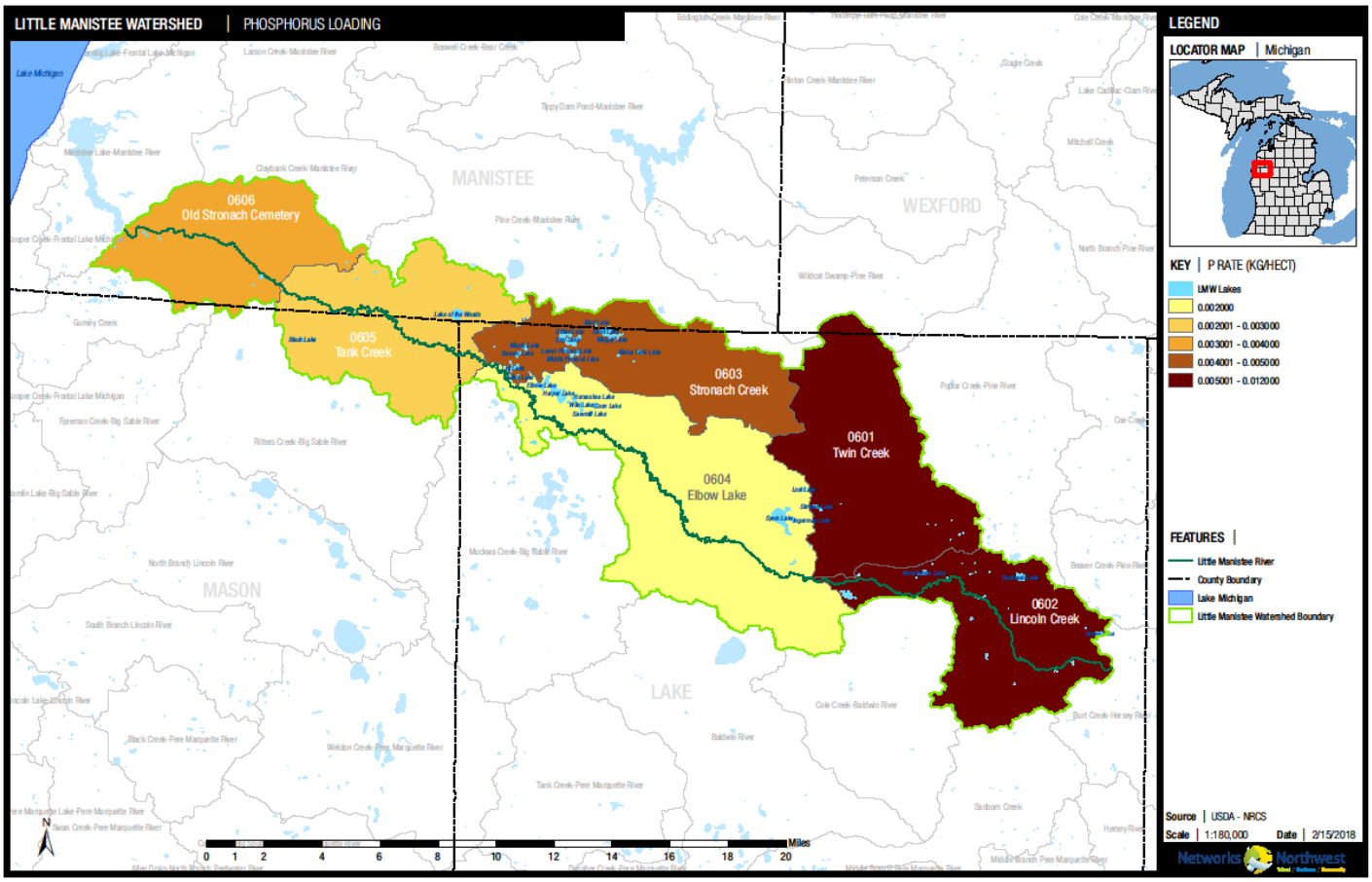
-	**Free Soil Twp. Meade Twp. Mason County Zoning** Relevant Districts: Agriculture; Rural Estates; Rec. Residential; Greenbelt	**Sauble Twp. Individual township zoning** Relevant Districts: R1 and R2 Residential; AG-F Agricultural-Forestry	**Peacock Twp. Individual township zoning** Relevant Districts: 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
Setbacks from surface water resources	Structures: 40 ft. generally, 50 ft. in Greenbelt Dist. 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 Lit. 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

Zoning Table B: Lake and Mason municipalities (page 2 of 2)

	Free Soil Twp. Meade Twp.	Sauble Twp.	Peacock Twp.
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: Manistee and Filer Townships, in Manistee County, have only marginal geographic extent in the Little Manistee Watershed, and are not assessed in this zoning review.

No Zoning ordinance has been adopted in the Lake County townships of Cherry Valley, Dover, Eden, Elk, Ellsworth, Newkirk and Pinora, nor in 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 or exceed 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, and to estimate current pollution loads. The source inventory and load estimates may help to identify problem sites and also provide a baseline to monitor progress meeting the Watershed Management Plan goals.

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, and detail the critical sites for preservation or mitigation.

The Little Manistee Watershed has no watershed-wide impairments. Most loadings are moderate and

Sediment and Phosphorus Loading Estimates by Assessment Category

Assessment category	Sediment (Tons)	Phosphorus (Pounds)
Runoff from Land	174	1,430
Septic Systems	0	2,328
Road Stream Crossings	Not assessed	Not assessed
Streambank Erosion	5,123	499
Subsurface Flow	91	2,967

in

Figures are best estimates for loadings associated with the assessed categories. They are derived from standard models applied to data from the Little Manistee Watershed

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).

The major stressors of concern – sediments, thermal issues and nutrients – are not present in such concentrations as to impair the designated uses of surface waters. For this reason, the WMP has not calculated Total Maximum Daily Loads (TMDLs). 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 6) 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.

Storm runoff estimates by subwatershed

HUC 12 No.	HUC12 Name	Total Area KM^2	Evapo-transpiration (M^3)	Runoff (M^3)	Infiltration (M^3)	TSS load (kg)	N load (kg)	P load (kg)
040601030601	Twin Creek LMR	97	520,426	167,893	4,392,233	20,078	630	85.6
040601030602	Lincoln Creek LMR	80	428,995	185,904	3,578,993	21,590	689	92.7
040601030603	Stronach Creek LMR	72	377,220	132,320	3,273,135	8,988	250	34
040601030604	Elbow Lake LMR	144	761,167	176,637	6,643,351	9,808	241	33.4
040601030605	Tank Creek LMR	85	459,141	98,417	3,919,927	6,894	172	23.3
040601030606	Old Stronach cem LMR	68	359,150	58,420	3,153,039	6,826	184	24.7
406010306	**Little Manistee River**	**546**	**2,906,101**	**819,635**	**24,960,633**	**74,186**	**24165**	**293.8**

(Data based on 2.09 inch rainfall in 24 hour period)

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).

Watershed modeling software from the Stroud Water Research Center (wikiwatershed.org) was used to estimate runoff volumes and concentrations of nitrogen, phosphorus and total suspended solids. The estimates are reported both as an annual average and as runoff from a hypothetical storm producing 2.09 inches of rainfall in a 24 hour period. That rain volume 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.

Runoff concentrations by subwatershed

HUC 12 No.	HUC12 Name	Total Area KM^2	TSS lb/a	N lb/a	P lb/a	TSS conc. mg/L.	N conc. mg/L	P conc. mg/l
040601030601	Twin Creek LMR	97	1.851	0.058	0.0080	119.6	3.7	0.5
040601030602	Lincoln Creek LMR	80	2.412	0.077	0.0107	116.1	3.7	0.5
040601030603	Stronach Creek LMR	72	1.113	0.031	0.0045	67.9	1.9	0.3
040601030604	Elbow Lake LMR	144	0.606	0.015	0.0018	55.5	1.4	0.2
040601030605	Tank Creek LMR	85	0.721	0.018	0.0027	70.1	1.7	0.2
040601030606	Old Stronach cem LMR	68	0.896	0.024	0.0036	116.9	3.1	0.4
406010306	**Little Manistee River**	**546**	**1.213**	**0.036**	**0.0045**	**90.5**	**2.6**	**0.4**

(Data based on 2.09 inch rainfall in 24 hour period)

The program employs STEP-L and other software to analyze data from national land cover and soil type databases.

For this WMP, the model was applied for the entire Little Manistee Watershed and for each of the six subwatersheds. Results are presented in the accompanying table, and shown on the accompanying map.

The 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.

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.

Septic 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 4,471 dwellings, of which 1,934 are used year-round and 2,537 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.

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 median 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. (citation 3-1)

*Unfortunately, studies by the U.S. Environmental Protec*tion Agency indicate that 10 to 20 percent of systems will fail during their "intended" lifespan. Michigan officials estimated in 2016 that 10 percent of the state's 1.3 million on-site septic systems are failing.

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.

The accompanying table 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 sys-

Estimates of annual septic system impacts (4,471 total systems)

Properly functioning systems (90 percent of total)

System type: (Seasonal or year-round)	Number of properly functioning systems	Daily effluent per system (gallons)	Annual effluent per system (gallons)	Total annual effluent (gallons)	Total annual phosphorus released to drain fields (pounds)	Phosphorus removal at 90 percent efficiency (pounds)	Phosphorus released to environment (pounds)
365-day systems	**1,741**	**150**	**54,750**	**95,319,750**	**7,954**	**7,159**	**795**
180-day systems	**2,283**	**150**	**27,000**	**61,641,000**	**5,144**	**4,630**	**514**
Total for properly functioning systems	**4,024**	**150**		**156,960,750**	**13,098**	**11,789**	**1,310**

Low functioning systems (10 percent of total)

System type: (Seasonal or year-round)	Number of low functioning systems	Daily effluent per system (gallons)	Annual effluent per system (gallons)	Total annual effluent (gallons)	Total annual phosphorus released to drain fields (pounds)	Phosphorus removal at 30 percent efficiency (pounds)	Phosphorus released to environment (pounds)
365-day systems	**193**	**150**	**54,750**	**10,566,750**	**882**	**264.54**	**617**
180-day systems	**254**	**150**	**27,000**	**6,858,000**	**572**	**171.69**	**401**
Total for low functioning systems	**447**	**150**		**17,424,750**	**1,454**	**436.23**	**1,018**

Estimated pounds of phosphorus released to environment annually: 2,328

tems 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 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 82 sites in the Little Manistee Watershed, according to an inventory completed and updated by Conservation Resource Alliance in 2014. 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.

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.

Signs at crossings designate the Little Manistee Watershed

The majority of the crossings are classified as being of moderate severity, according to the ranking criteria used in the inventory. Six are listed as "minor," the least severe classification, and four are ranked as severe. The cost of repairing the four severe crossings is estimated at a total of $242,000.

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 $4.2 million.

A map showing the Little Manistee Watershed road stream crossings is included in the "Critical Areas" section of Chapter 4. The full inventory may be viewed online at www.northernmichiganstreams.com.

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 prime gravel 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.

The Conservation Resource Alliance conducted an inventory of streambank erosion sites on the mainstream of the Little Manistee River in 2012.

The project identified 69 sites, ranging from minor to severe on the bank erosion index. 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.

In all, the inventory recorded 26 minor erosion sites, 31 moderate sites and 12 severe erosion sites. The severe sites covered a total of just less than 1,100 feet. A general estimate for the cost of erosion mitigation using whole tree revetments is $120 per foot.

The Little Manistee Watershed Conservation Council, working with the 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 eroded sites, as well as continued monitoring and mitigation of additional areas as funding becomes available.

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 4.

A map showing streambank erosion locations along with a full inventory of the sites may be viewed online at www.northernmichiganstreams.com.

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) shows 3.5 percent of the land in the Little Manistee Watershed is used for cultivated crops, hay or pasture. This limited area, approximately 19 square kilometers (4,700 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 MDEQ 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 watershed has a significant recreational infrastructure in the form of campgrounds, trails, guide services, boating access sites, and paddlecraft liveries.

Campgrounds provide access to Little Manistee riverbanks

These facilities provide economic value to the community and are vital to allowing the public to enjoy the designated and desired uses of the waters.

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 sites. 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. In addition, Eurasian milfoil, zebra mussels and other nuisance species are known to "hitchhike" from one water body to another on boats, fishing gear and trailers. (citation 3-3)

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 ad-

dressed 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 7.

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.

Footnotes:

3-1 National Environmental Services Center; "Phosphorus and On-site Wastewater Systems," Pipeline, Summer 2013 Vol 24, No. 1

3-2 Michigan Turfgrass Environmental Stewardship Program (http://www.mtesp.org)

3-3 Monitoring confirms that boaters, not ducks, moving aquatic invasive species around. University of Wisconsin-Madison, March 5, 2013

Chapter 4: Significant Pollutants in This Watershed / Critical Areas for Mitigation and Preservation

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 here and presented in greater detail in the following section.

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.

Sand may enter the stream from eroding banks

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.

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 main-

Impoundments such as the Luther Dam may result in thermal impacts on a stream.

taining 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 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 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 outcompete 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.

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 milfoil; 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, 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. The effect 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.

Signs at access sites alert users about invasive species

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. (citation 4-1)

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. While some samples have appeared to be elevated from background levels, the samples have not exceeded the standards for full or partial body contact recreation.

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 surface to the water table. The WMP's Information/Education component (Chapter 7) 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.

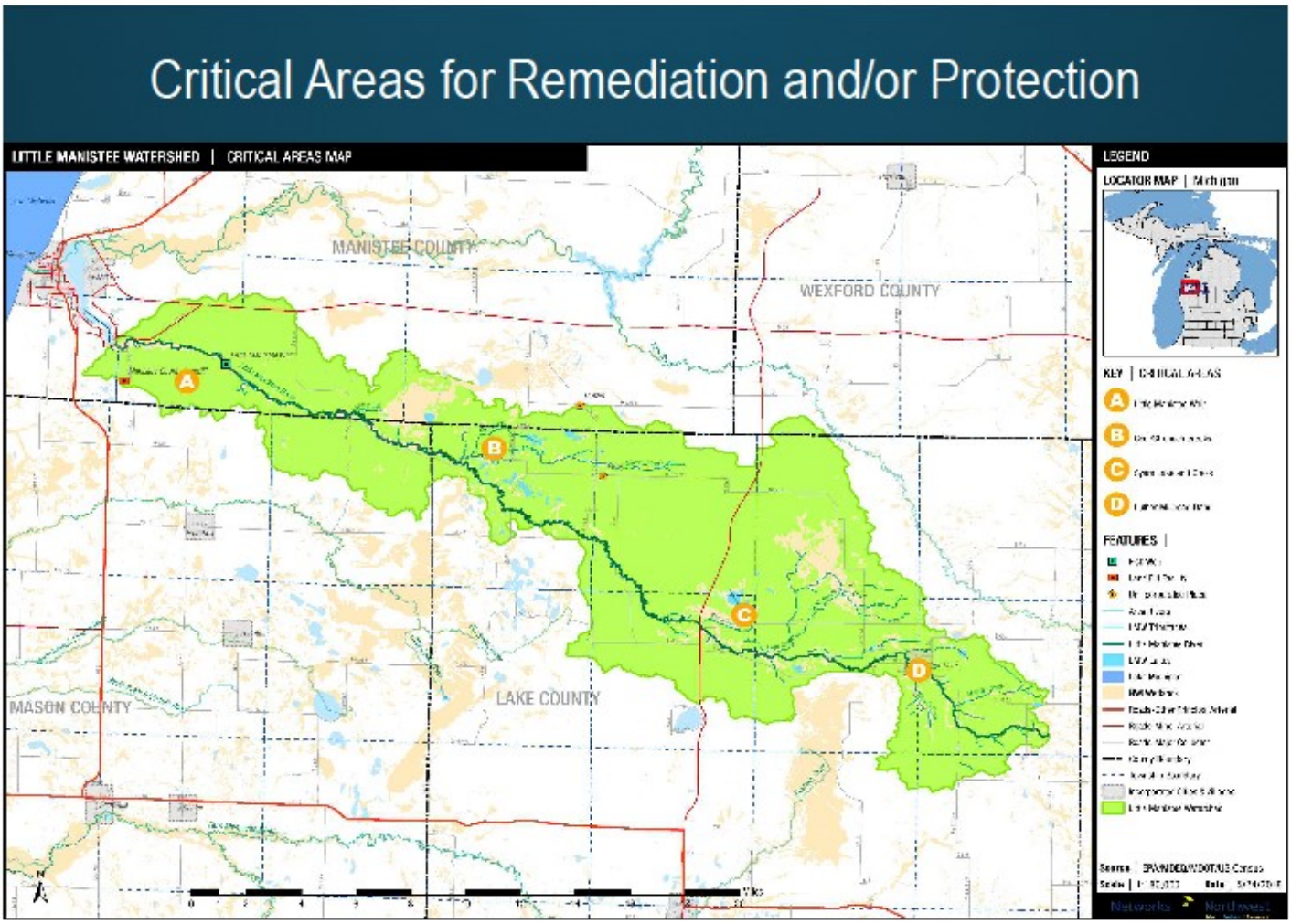
To date, there has not been an analysis of pollutants such as pharmaceuticals or microbeads in the waters of this watershed. If they occur here, it is likely at extremely low levels. There appears to be no scientific consensus as to the impact of such minuscule traces, though some studies have raised 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.

WMP Critical 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 that require special attention to preserve designated or desired uses within the watershed. Specific recommendations for addressing these concerns are included in the Implementation sections in Chapter 5.



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.

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.

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 Luther Millpond covers about eight acres with quiet, still water.

The second washout apparently resulted from design or construction errors. Again, the Legislature overruled objections from the DNR. 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. Citation 4-1

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 (Chapter 5).

In alternative one, the dam would continue in place. The bottom-draw mechanism would be managed jointly by the village and the DNR 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 redevelop the park, dewater the pond and remove the dam.

Syers Lake Dam

Potential Issues: Loss of habitat, fish passage, stream and shoreline erosion

An ongoing project to remove an aging dam from the outflow of Syers Lake 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 has come 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.

Syers Lake is a 130 acre water body located in a forested area of Eden and Peacock townships within the Little Manistee Watershed, just east 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 lake was enlarged about 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.

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, is coordinating the project, which will remove the berm, and install a bottomless culvert below a rebuilt access road.

When complete, in 2018 or 2019, the work will 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, 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.

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 2014 road-stream crossing inventory by Conservation Resource Alliance assessed 15 crossings on Stronach and four on Cool Creek. Most were rated as moderate severity. The total cost of restoring all 19 crossings was estimated at $1.2 million.

Cool and Stronach creeks have a total of 19 road –stream crossings

The most problematic segment of the stream occurs 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 biologist suggested that MDEQ's non-point source unit should consult with the Department of Agriculture and rural development 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 WMP recommends that agencies work with the owner and develop funding to assist in fencing the stream and implementing an environmentally sound method of providing water to the pastured cattle.

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.

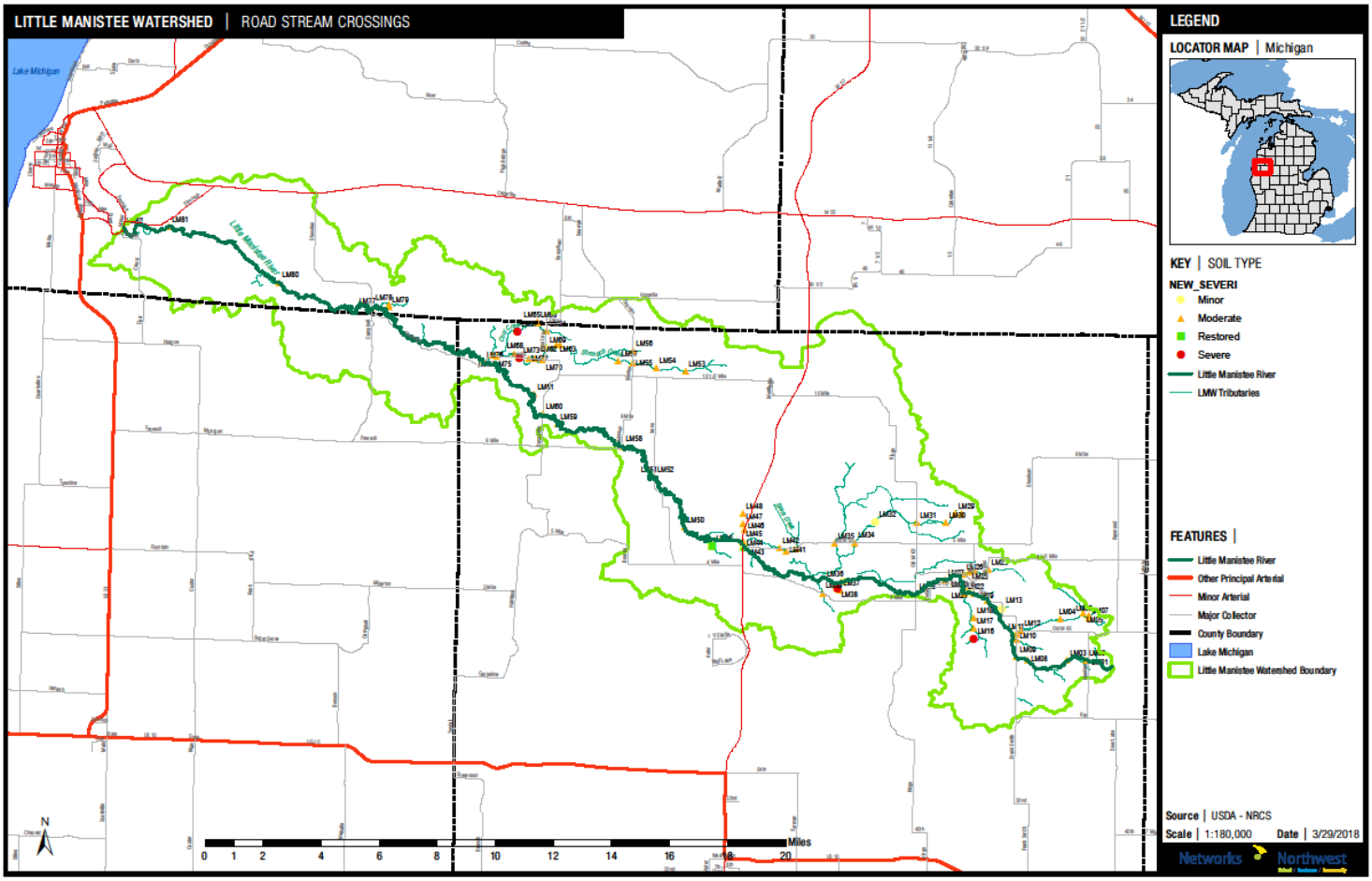
Considerable work to restore the natural resilience of Little Manistee river streambanks was accomplished in recent years through habitat restoration work by the LMWCC and Conservation Resource Alliance. Despite those efforts, unstable banks continue to erode sediment into the stream at a number of locations. Of particular concern are the course sands that can accumulate on the river bottom, potentially covering fish spawning habitat and also creating a shallower and warmer stream.

Sandy banks on riverbends are prone to erosion (CRA image)

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.

The entire inventory -- including point scores, GPS coordinates, photographic images and recommended mitigation methods – is online at www.northernmichiganstreams.org

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.



Road Stream Crossings

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

Public roads cross the Little Manistee River and its tributaries at 82 sites in the watershed, according to a 2014 inventory conducted by the Conservation Resource Alliance.

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 culverts and road approaches to deteriorate over time.

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.

The majority of the crossings are classified as being of moderate severity, according to the ranking criteria used in the inventory. Six are listed as “minor,” the least severe classification, and four are ranked as severe. The cost of repairing the four severe crossings is estimated at a total of $242,000.

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 $4.2 million.

The full inventory of road stream crossings may be viewed online at www.northernmichiganstreams.com.

Little Manistee Weir Site

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 critical site because of its importance to the Little Manistee ecosystem and to fishery quality throughout the region.

When the weir is closed, 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.

Visitors enjoy the view at the Little Manistee Weir

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.

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 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.

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 1, 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 in Chapter 5.

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.

Annual Invertebrate Survey Data (Volunteer Stream Monitoring Program)

Collection Site	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Site AVG
Below Queen's Hwy	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'sBridge	24	35	28	30	36	34	43	50	43	36	**36**
Poggensee Bridge		33		28	51	23	36	22	39	25	**32**
Cool Creek	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 Br. (NW Access)									47	15	**31**
Annual Average	**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

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 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 in2018 or 2019. Carefully placed, such structure may improve fish survival and also protect banks from further erosion.

The Little Manistee provides outstanding habitat

Since 2000, the LMWCC has conducted annual macroinvertebrate studies, 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.

Inland Lakes

Potential issues: Weed growth, 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. 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.

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.

Clear lake water is a benefit for the environment and for property owners. A study in Maine indicated that property values of shoreline property increase along with the clarity of the water.

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.

The WMP envisions an expansion of this work as part of a long-term system of monitoring in the watershed.

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.

The Information/Education component of the WMP (Chapter 7) 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 Water Strategy created by the Michigan Department of Environmental Quality. 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 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. 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.

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.

Footnotes:

4-1 Rippke, Molly, Senior Aquatic Biologist, MDEQ: "Bacterial Monitoring Results for Michigan Rivers and Streams, 2014;" MDEQ Document released March 2015

4-2 "Upper Little Manistee River 2002 Fishery Report;" Mark Tonello, Michigan DNR, 2002

4-3 "Sustaining Michigan's Water Heritage: A Strategy for the Next Generation;" Michigan Office of the Great Lakes, 2016

Chapter 5: Implementation Tasks

The accompanying charts (categories A through L) 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 for implementation of the plan. 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.

The adjacent table summarizes the anticipated costs, which are detailed in the implementation charts on the following pages..

Estimated cost of implementing the WMP

Category	Estimated Cost
A. Shoreline/Streambank Issues	$453,000
B. Stormwater and runoff	$74,000
C. Planning, Zoning and Land Use	$330,000
D. Road-Stream issues	$4,295,000
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	$90,000
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	**$7,083,000**

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

While the 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 planning 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, the charts 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.

Abbreviations used for partners and funding sources in Implementation charts

AES: Alliance for Economic Success
Conservation Districts:
Mason-Lake Conservation District
Osceola-Lake Conservation District
Manistee Conservation District
CRA: Conservation Resource Alliance
GTRLC: Grand Traverse Regional Land Conservancy
ISN: Invasive Species Networks:
NW Michigan Invasive Species Network
North Country Coop. Invasive Species Area
LMWCC: Little Manistee Watershed Conservation Council
LRBOI: Little River Band of Ottawa Indians
MDARD: Michigan Department of Agriculture and Rural Development
MDEQ: Michigan Department of Environmental Quality
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
TU: Trout Unlimited
USFS: United States Forest Service
USGS: United States Geological Survey

(Implementation task charts for Categories A through L begin on next page)

Category A: Shoreline/Streambank Issues

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
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.	H	$120 per linear foot	$300,000	5 sites restored	C	10 additional sites restored	**LMWCC**, CRA	Private property owners; Fisheries Trust; Grants	2; 3c; 3e	Sites included by reference from inventory at northernmichiganstreams.com
A2	Update streambank inventory on Little Manistee River and major tributaries on 10-year cycle.	M		$18,000	X	Inventory updated	X	CRA	Trout Unlimited; G.L. Fisheries Trust	3c; 3e	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.	M	$5,000 per site	$15,000	One site demonstration complete	C	C	Lake Associations; property owners	Private Property owners; MSUE; Cons. Dists	3c	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	H	$120,000	$120,000	Project complete	Creek monitored	C	**CRA**; LMWCC; private landowners	LMWCC; T.U.; Grants; Private landowner funds	2e	Funding committed for 2018/2019

Category B: Stormwater and Run-off

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
B1	Update stormwater infrastructure and impervious surface maps. Identify problem sites and institute Green Infrastructure BMP's for all new construction.	L	unknown		X	Maps and BMP education in place	C	County Planning Departments; MSUE; Networks Northwest	Local foundations; in-kind funding	2d; 3c	
B2	Inventory & monitor all streams for nutrients, E. coli, and other pollutants, including thermal stressors. Institute BMP's as appropriate.	H	See task I2	See task I2	Existing program continues	Progbram expanded to additional sites	C	LMWCC	LMWCC funds; volunteers	3a; 3b; 3e	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	M	no new costs identified		X	Information available on Websites or through Township mailings	C	Conservation Districts; MNSP;		3c; 3e	
B4	Promote reforestation of public and private lands within the stream corridor to reduce storm runoff and thermal pollution.	H	$5,000 per year	$50,000	Sites identified	Reforestation activity on 5 sites	Reforestation activity on 10 sites	**Cons. districts**; Private land owners; U.S. Forest Service; MDNR	Private funds; grants	2a; 2c; 2d	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.	H	$2,000 per rain garden	$24,000	2 rain gardens installed	5 rain gardens installed	12 (total) rain gardens installed	Private funds	**MSUE**; Conservation districts	Goal 2; 3a	

Category C: Planning, Zoning and Land Use (page 1 of 2)

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
C1	Work with township and county planners to develop cooperative land-use practices that extend across government boundaries to protect the entire watershed.	H	$5,000 per township	$80,000	Create multi-jurisductional task force	Funding secured	Program in place	Townships; MSUE; LMWCC; AES	Will require outside grant asistance. Tribal 2 pct. Funding	Goal 1; Goal 5	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.	M	Included in C1		X	Sites identified for protection	C	LMWCC; Audubon Clubs;	N/A	Goal 4	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	M	No new costs identified		Provide model ordinances to townships	C	C	MTA; ISN; township govts	N/A	1d; 3f	Model ordinances available through ISN's. May require state legislation
C4	Investigate the possibility of a 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.	H	See C1		See C1	C	C	Townships; MSUE; LMWCC; AES	N/A	Goal 1; Goal 5	This is a specific task included in the more general actiivities of C1

Category C: Planning, Zoning and Land Use (page 2 of 2)

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
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.	L	No costs identified		See C1	C	C	Townships; MSUE; LMWCC; AES	N/A	5a	This is a specific task included in the more general actiivities of C1
C6	Begin public education regarding the pros and cons of Michigan Natural River designation; promote such designation if local support exists.	H	Variable		X	River forums conducted	C	LMWCC; MDNR; TU.	N/A	1f	This requires coordination with I/E program as well as local planners. Natural river designation is not under consideration at this time.
C7	Seek grant funding and fiduciary partners to hire or contract with a person for work on implementation of the WMP	H	$25,000 annually	$250,000	Implementation staff person in place	C	C	LMWCC, Conservation Districts; CRA	Tribal Grants, Local foundations	All Goals	Employee may be full- or part-time. If no funding is received, LMWCC volunters will continue to lead implementation.

Category D: Road-Stream Issues

Task		Pri-ority	Unit Cost	Estimated Total Cost	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
D1	Update existing stream crossing inventory every 10 years to reflect changes & document improvements	H	$15,000	$15,000	X	New Inventory Complete	C	**CRA**; LMWCC	Tribal 2 pct. Funding; Great Lakes Fisheries Trust	2e; 3e	Current inventory completed in 2014
D2	Restore and protect 74 road-stream crossings identified in the inventory as sites of severe or moderate concern, using appropriate BMP's. Restore and protect additional sites on road-stream crossing inventory as conditions require and funding becomes available.	H	varies	$4,280,000	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	Cost cited is for 74 sites, per 2014 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	M	varies		X	Sites Identified	C	**Private land owners**; CRA	Private funds	3e	
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.	L	unknown		X	Policies developed	C	Road Commissions; MDOT; MDEQ	N/A	3e	

Category E: Land Protection and Management

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal ref.	Notes
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.	**M**		$10,000	Manistee analysis cmplete	Analysis complete for Lake and Mason	C	GTRLC; Land Conservancies	Grants; private donations	4b; 4f; Goal 5	
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	**M**		$500,000	X	2 sites protected	C	MDNR; USFS; townships; Land conservancies	Nat. Res. Trust Fund. USFS funds	Goal 5	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.	**H**		$500,000	X	2 sites protected	C	Land Conservancies ; private land owners	Nat. Res. Trust Funds; Private donations	Goal 5	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 agricultural operations	**L**		No costs identified	X	1 farm certified	C	Farm owners; MDARD	N/A	3e	
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.	**M**		Unknown	Education programs offered and publicized	C	C	**MSUE;** Conservation Districts; land owners	N/A	Goal 1; 2a; 3c; 3e	

Category F: Habitat for Fish and Wildlife (Page 1 of 2)

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
F1	Maintain multiple-use management policies on public lands. Preserve upland habitat and wildlife corridors. Discourage new roads in state forest and wetland areas	**H**		No new costs	Continuation of current practice	C	C	USFS; MDNR	N/A	4a; 4b; 4c	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 & managment programs.	**H**		$30,000	X	New survey complete	C	**MDNR; Trout unlimited; LRBOI**	MDNR funds	4a; 4e	
F3	Maintain current fish stocking & management strategies unless changes are warranted by scientific studies such as in F2	**M**		No New costs	C	C	C	**MDNR; Trout unlimited; LRBOI**	N/A	4a	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.	**M**	$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	Funds committed for woody debris work in 2018/2019
F5	Evaluate & document stream and streamside habitat, including shade and forest cover for the Little Manistee River and major tributaries.	**M**		Not identified (See A2)	X	Evaluation complete	X	USFS; MDNR; LMWCC	N/A	Goal 2	This can be included in an enhanced bank erosion survey (A2)

Category F: Habitat for Fish and Wildlife (Page 2 of 2)

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
F6	Restudy & document habitat and fishery potential in each of small lakes and streams in watershed, many of which have not been	L		$50,000	X	Inventory complete	X	**MDNR**; private land owners	Grants; MDNR funds; lake associations	4a	
F7	Evaluate fishery potential in the Luther Millpond and sites upstream of the Luther Dam.	H	$30,000	$30,000	Develop plans for cooperative study with MDNR; Village and Township	Complete Study	Publicize study's results and recommendation	**Ellsworth Twp**.; Village of Luther; Trout Unlimited; MDNR;	Grants; LRBOI; TU; MDNR	1a; 1f	
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.	H	No new costs identified		Develop operation and monitoring plan	C	C	Village of Luther; Ellsworth Twp. MDNR; LMWCC	Village and township funds	2b; 2e	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.	M		Variable: $50,000 to $2 million	Phase 1; create working group; identify long term costs and benefits of maintaining the dam/millpond	Phase 2: identify benefits and costs of fish passage, stream restoration; dam removal 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	Changes in dam operation and/or fish passage may have modest costs; Dam removal and stream restoration would cost up to $2 million

Category G: Recreation, Safety, Navigation and Human Health

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal ref.	Notes
G1	Continue and expand volunteer monitoring for E. coli and other pothential pathogens	H	See task I2	See task I2	Monitoring in place	C	C	**LMWCC;** lake associations		3a; 3b	E. coli monitoring costs are incuded 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.	H	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	
G3	Initiate "adopt a stream" or similar volunteer program for ongoing river clean-up and tree management.	M	No new costs identified		Program in place	C	C	Conservation Districts;	N/A	1c; 1e	
G4	Monitor paddlecraft volume to ensure that such use does not exceed the river's carrying capacity.	L	No new costs identified		Monitoring dates/criteria identified	Program in place	C	LMRCC; Private Landowners		4b; 4d; 4e	
G5	Keep at least one campground open through October to accommodate late-season paddlers	M	Unknown		Campground operational costs and options assessed	C	C	Campground operators	N/A	4b; 4d	Proposed by the public at informational session

Category H: Hydrology, Groundwater and Wetlands

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal Ref.	Notes
H1	Install and monitor permanent gauges throughout watershed to evaluate & report stream flow, water temperature, and high-low water conditions. Investigate emerging technologies for automatic sensors, if	H	variable	$10,000 - $35,000	Permanent gauges in place	C	C	**LMWCC;** Conservation Districts; USFS; USGS; MDNR	USGS; Local donors	2a	$35,000 is estimate for USGS gauging station
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	H	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	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	M		No new costs	X	Impervious surface policies in effect	C	Twp planning comms.	Grants, in-kind labor	1a; 1f; 2d; 3c; 4e	This element of groundwater protection is also included in categories B and C, and in education component (Cat L)
H4	Protect wetland areas from development; initiate programs to educate the public about the role of wetlands in water quality	M		$5,000	X	Wetland program offered to schools and service groups	C	**MDEQ**; MDNR, Twp. Planning comms.; LMWCC	Conservation Districts; Inland Lake Groups; townships	1a;2a; 2d	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	H		unknown	C	C	C	**Legislature**, MDEQ, Twp planning comms.	N/A	2a; 2d; 4f	
H6	Monitor for nitrates in well water, especially at sites with light soils and historic agricultural use	M		unknown	C	C	C	**Health departments**	N/A	2d; 5d	

Category I: Water Quality Monitoring

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal ref.	Notes
I1	Continue & expand volunteer stream monitoring program for biological markers.	**M**	$500	$5,000	Program continues in place	C	C	**LMWCC**; Conservation Districts; MDEQ	Local funds	1a;3b; 3f	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	**H**	$5,000	$50,000	Program continues in place	Neew sites added as appropriate	C	**LMWCC**; Conservation Districts; MDEQ	LMWCC funds; local donotations; volunteer in-kind	Goal 3	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.	**H**	$1,500	$15,000	Database in place	C	C	LMWCC; Conservation Districts	local grant funds; LRBOI 2 pct. Funds; MCD funds for continuing operation	1c; Goal 3	
I4	Continue MDEQ monitoring program to track stream biology.	**H**	No New Costs identified		MDEQ monitoring scheduled	C	C	MDEQ	Exisitng MDEQ funding	3b	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.	**M**	No New Costs identified		Develop and distribute letter of support	C	C	LMWCC	N/A	2a;2d; 5b; 5e	This expands on a portion of item H2

Category J: Invasive Species

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal ref.	Notes
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.	H		Unknown	Task Force created	C	C	ISN groups	N/A	3f; 5e	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.	H		$20,000	Plan in Place	C	C	Local task force; ISN groups	ISN funding; local volunteers	3f;	
J3	Develop and implement plans to control or eradicate invasive phragmites on public and private sites.	M	$1,000	$10,000	Plan in place	C	C	ISN's; townships; property owners; USFS	Private funds	3f	
J4	Research boat-washing methods and promote boat washing throughout the watershed, in cooperation with Manistee County and the Benzie Conservation District.	H	No new costs identified		Demonstrations of boat-washing systems twice annually in watershed.	C	C	Benzie Conservation District; Manistee County	MDNR Invasive Species pathways grant	1a; 3d; 3f	Three mobile boat washing faciliies are available regionally
J5	Develop educational and demonstration facilities for cleaning waders and other fishing gear at popular river entry sites	H	$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	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	M		$15,000	X	Inventory complete	C	**LMWCC**, ISN's	LRBOI grant; in-kind labor	1a, 3f	Could be combined with streambank inventory (A2) for cost savings

Category K: Wastewater and Septic Systems

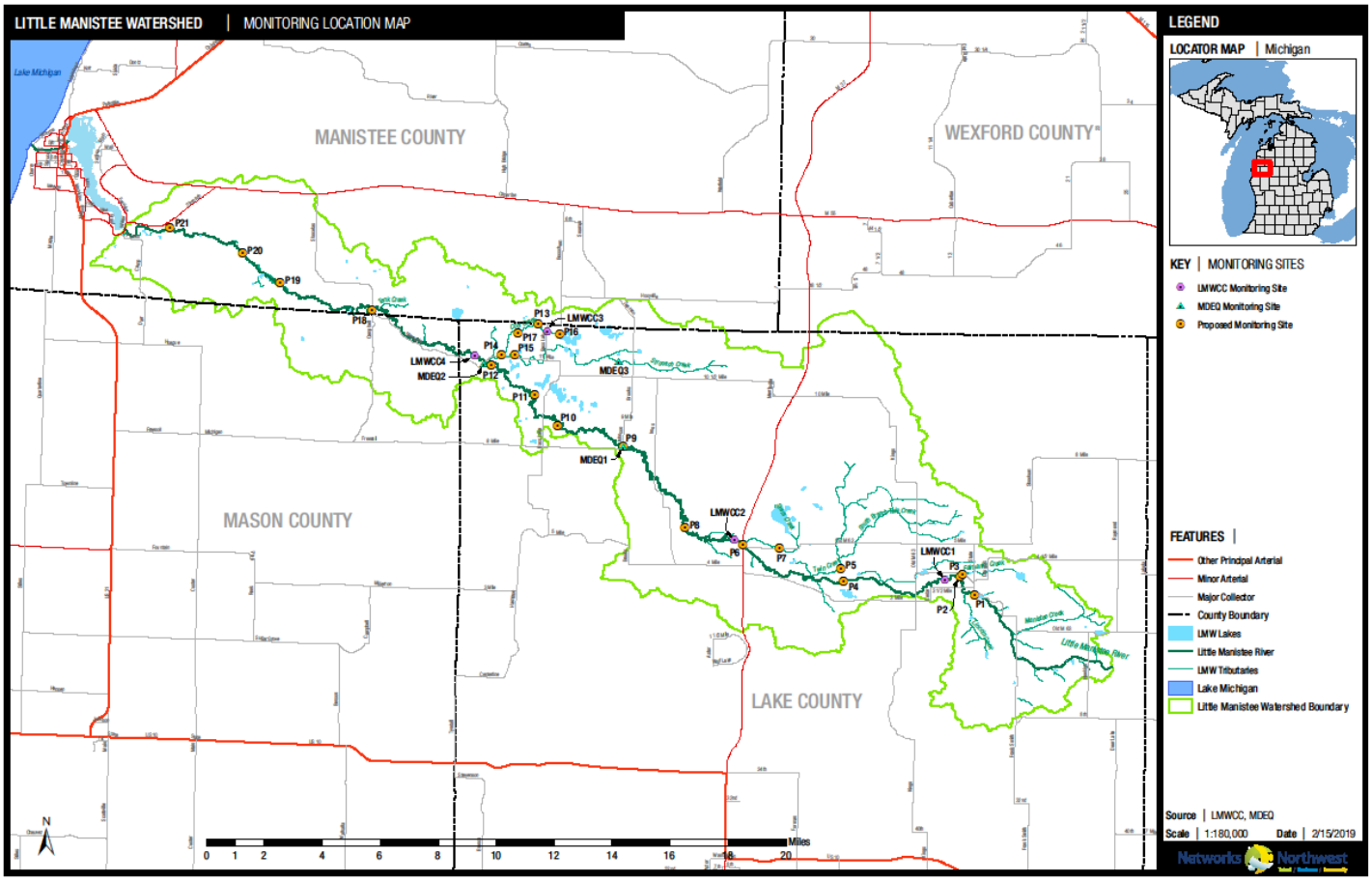
Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal ref.	Notes
K1	Work with local governments to establish and enforce uniform mandatory "inspection-on-sale" regulations for septic systems throughout watershed	H	$300 per inspection	$330,000	County boards asked to consider rule	Rule inplace in Lake and Masoin counties	C	County Commissioners; Health Depts; pumping contractors;	Private inspection fees.	1a; 1f; 3e5e	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	L		Unknown	Proposal communicated to planning commssions	C	C	Planning Commssions; Township Boards of Trustees	N/A	1a; 1f; 5e	
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.	H	Unknown	Unknown	Develop streategy and letters of support; share with regional watersheds	C	C	LMWCC and regional watershed groups; Legislature	N/A	1a; 3e; 5e	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.	M	$5,000 for materials and printing	$5,000	X	Materials developed for distribution	materials shared through townships and health departments	LMWCC. Townships, health departments; pumping contractors	local donors	1a;3e;5e	

Category L: Information and Education (page 1 of 2)

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal ref.	Notes
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	M	Unknown		Establiish working group to consider designs	C	C	MDNR; USFS, Campgrounds Local governments		4b; 4e;5b	
L2	Install educational kiosks or signage at appropriate sites to inform users of Watershed concerns and stewardship opportunities.	M	$1,000 per kiosk	$3,000	one kiosk installed	C	Three kiosks in place	MDNR; USFS, Campgrounds Local governments	Local donations; in-kind volunteer labor	1a; 4b;4c	May include invasive species information and wader-cleaning station at fishing access sites
L3	Develop a list of all riparian property owners for dissemination of edicational and informational materials.	H		$2,000	List in place	List Updated semi-annually	C	County governments	In-kind volunteer labor	1b	
L4	Assign communications element (group or individual) within LMWCC to promote Watershed education through multiple pathways, including in-school programs, local media, public presentations and direct mail.	M	$3,000 per year	$30,000	Commiunicatio n group and strategy inentified	C	C	**LMWCC**; Schools; Libraries	Local foundations; LRBOI	1a; 5e	
L5	Establish a program of 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	M		$5,000	Contact list established; Outreach in place	C	C	LMWCC communication group; local Realtors	Local funds	1a; 1f	

Category L: Information and Education (page 2 of 2)

Task		Pri-ority	Unit Cost	Total Cost (est.)	Milestone 2018-21	Milestone 2022-25	Milestone 2026-28	Potential Project Partners	Potential Funding Sources	Goal ref.	Notes
L6	Maintain updated versions of the WMP on a publicly accessible website, and provide hard copies to libraries in and near the Watershed.	H		$1,000	Plans available	C	C	**LMWCC;** Schools, Libraries		1a; 1b	Ideally, water quality database will be on same website
L7	Create grant-supported project to inform/educate township governments and the public of the role of land use BMP's in maintaning water quality.	H	$40,000	$40,000	Project Planning	Funding secured; project begins	C	LMWCC	Foundation grants; LRBOI		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	M	No new costs	No new costs	Annual review in place	C	C	LMWCC; all partners invited to participate	None Needed	All Goals	Annual review will incude 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 and set Goals and Objectives for the upcoming year(s).	H	No New Costs		Initial meeting scheduled for Feb.2 2018.	Annual Meetings	Annual Meetings	LMWCC; All interested Stakeholders	None Needed	All Goals	Annual review will include progress reports and opportunity to amend the plan



Chapter 6: 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 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 the MDEQ.

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 chart of implementation tasks in Chapter 5.

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 four years (including the year of plan approval); a middle period of four years; and a final three-year period.

For example, in the category of Shoreline/Streambank Issues, 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 2021, continuing that work in the middle segment and completing an additional 10 sites by the end of the third time period in 2028. 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 majority of 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.

This monitoring plan expands on activities that have been in place in the watershed since 2000, adding thermal 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. In a water strategy document prepared in 2016, Michigan's Office of the Great Lakes proposed development and funding of a statewide program to monitor surface and groundwater. 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.

Monitoring Locations

Site No.	Site Description
1	LM below Luther Dam
2	LM above Fairbanks cr.
3	Fairbanks Cr. below Old M63
4	LM above Twin Creek
5	Twin Creek
6	LM above Syers Cr.
7	Syers Cr.
8	LM @Spencer Br.
9	LM @ Johnson Br.
10	LM @ Dewitt's Br.
11	LM @ Poggensee Br.
12	LM above Cool Cr.
13	Cool Cr. @ 18 Mi. br.
14	Cool Cr. above Stronach Cr.
15	Stronach Cr. above Cool Cr.
16	Cool Cr. @ Cool Lake
17	Cool Cr. @ 18 Mi. Br.
18	LM @ 9 Mile Br.
19	LM @ 6 Mile Br.
20	LM @ DNR Weir
21	LM @ Stronach Rd.

Invertebrate sampling sites

MDEQ	LM at Johnson's Br
MDEQ	LM at 10 1/2 MI rd.
MDEQ	Stronach Cr. d/s of Java Rd.
VSMP	Below Queen's Hwy
VSMP	Old Grade Campground
VSMP	Cool Creek
VSMP	Bear Track Campground

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 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

Macroinvertebrate communities in monitored stream sites should score "good" or "excellent" using the MDEQ procedure 51 scoring metrics for wadable streams.

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.

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.

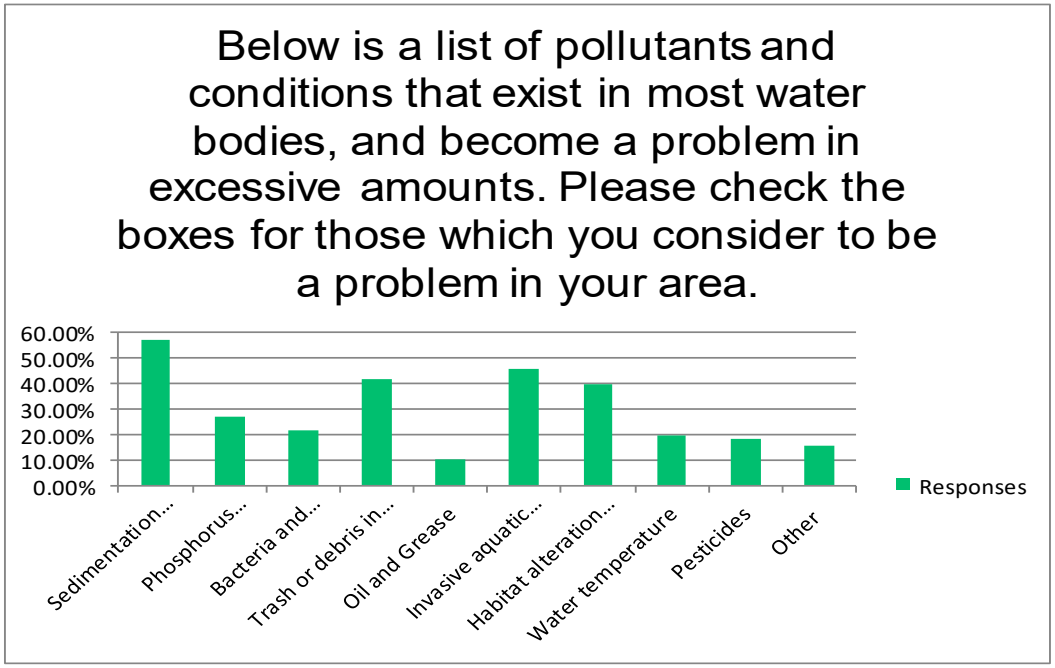
The WMP seeks to improve coordination by tasking the LMWCC with the responsibility to collect, organize and distribute data generated by the member entities. In addition, it is a goal to organize all water quality data on a single Website available to the public.

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.

Chapter 7: 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 the Michigan Department of Environmental Quality and the United States Environmental Protection Agency 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 1 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.

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.

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 (See Chapter 3). 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 (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:

1) The impact of land use practices and regulations on water quality – including ground water

2) Limiting the introduction and spread of invasive species.

3) Management of onsite 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 2018.

A social indicators survey was widely distributed to watershed stakeholders to assist in development of the educational component. 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.

1) 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 effects.

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, limitations 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, 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 are at risk of leaching all the way to the water table if not carefully applied at rates that can be taken up by the vegetation. The same 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 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 Little Manistee Watershed Conservation Council 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 (Category L in Chapter 5) 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.

2) 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 germinata* ("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 milfoil 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 ISN resources available to the public include print materials and the opportunity for group presentations and plant identification by network staff.

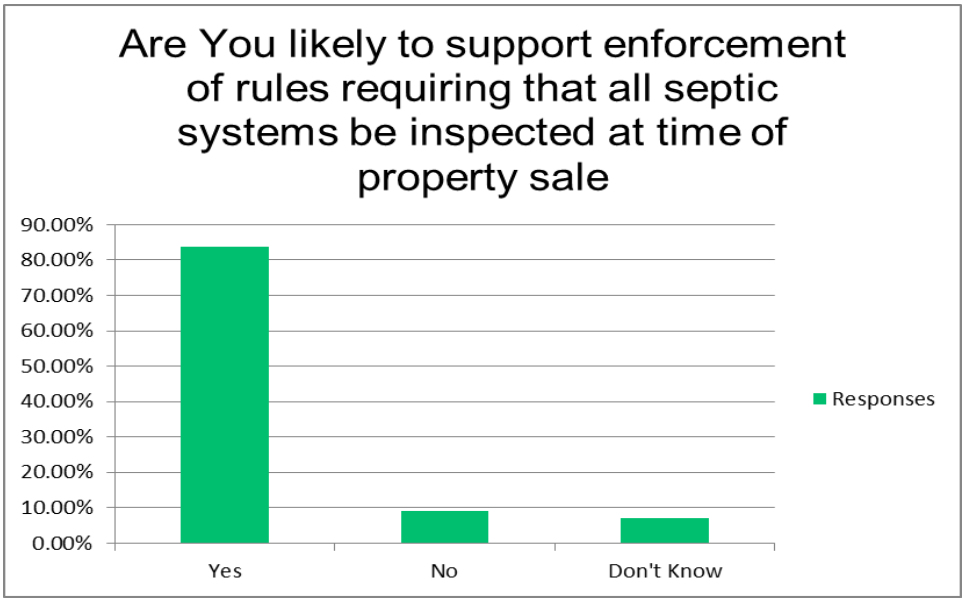
The Clean Boats, Clean Waters program, sponsored by Michigan Sea Grant, provides informational materials and instructional forums to educate boaters on ways to detect and remove weeds and other invaders before launching into new waters. Generally, the advice is that any vessel which has not been out 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.

3) Management of onsite wastewater systems (septic tanks and drain fields)

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.

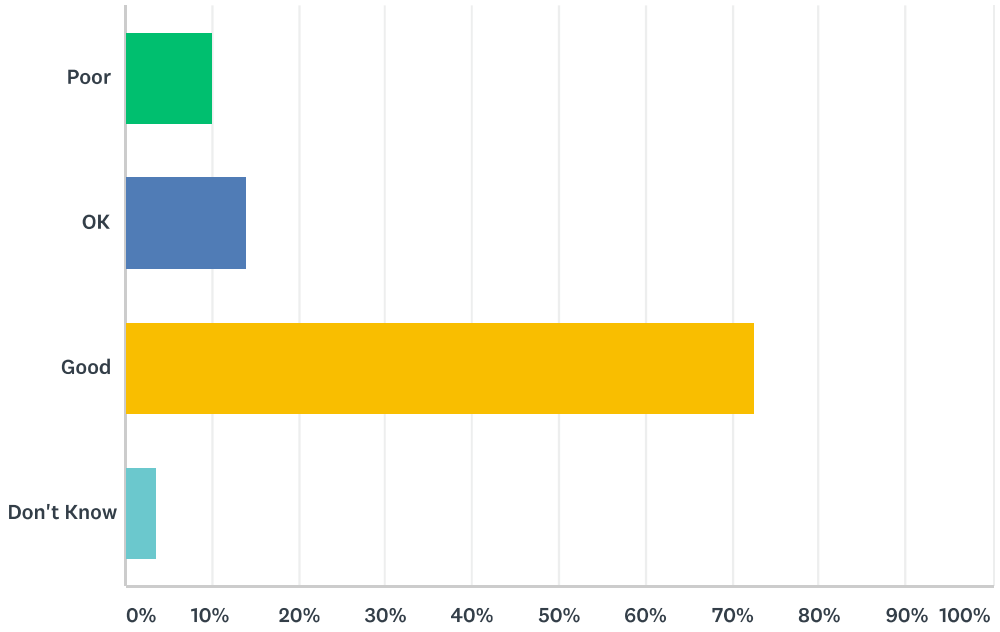
Information is readily available on wastewater BMP’s, but this information has not been communicated effectively to all property owners. To improve this communication, the LMWCC will work with health departments to develop clear and simple information sheets, which can then be included on lake association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

The WMP also supports 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.

Q1 For Canoeing, kayaking or other boating:

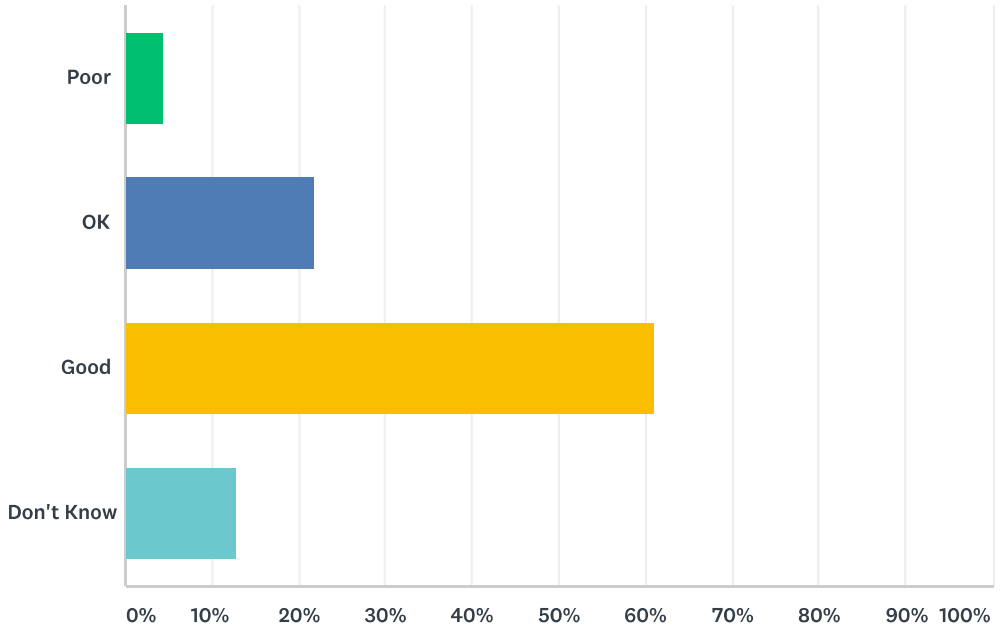
Answered: 201 Skipped: 3



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

Q2 For eating locally caught fish:

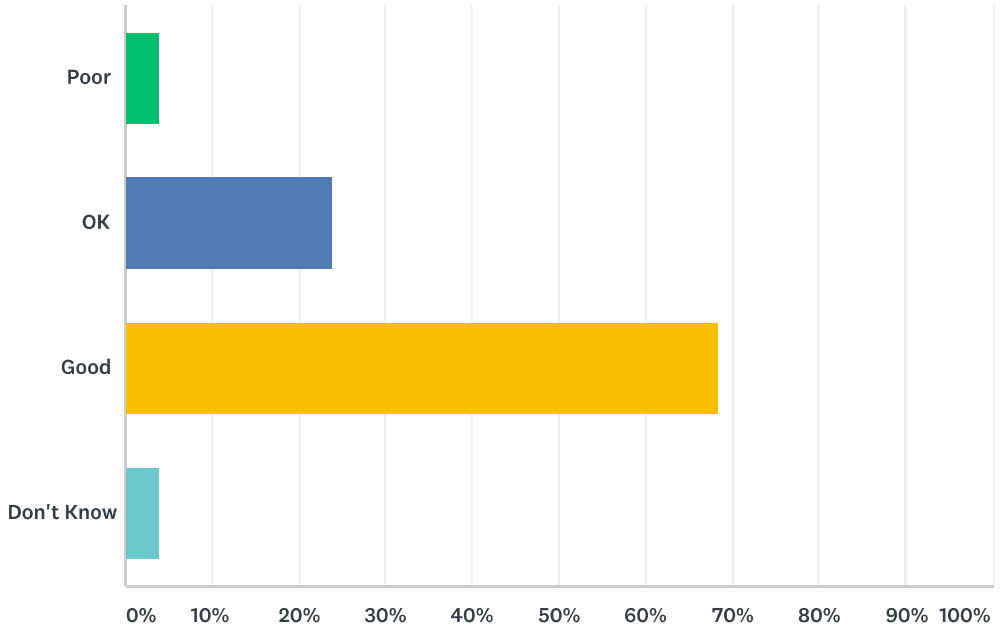
Answered: 203 Skipped: 1



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

Q3 For swimming or wading:

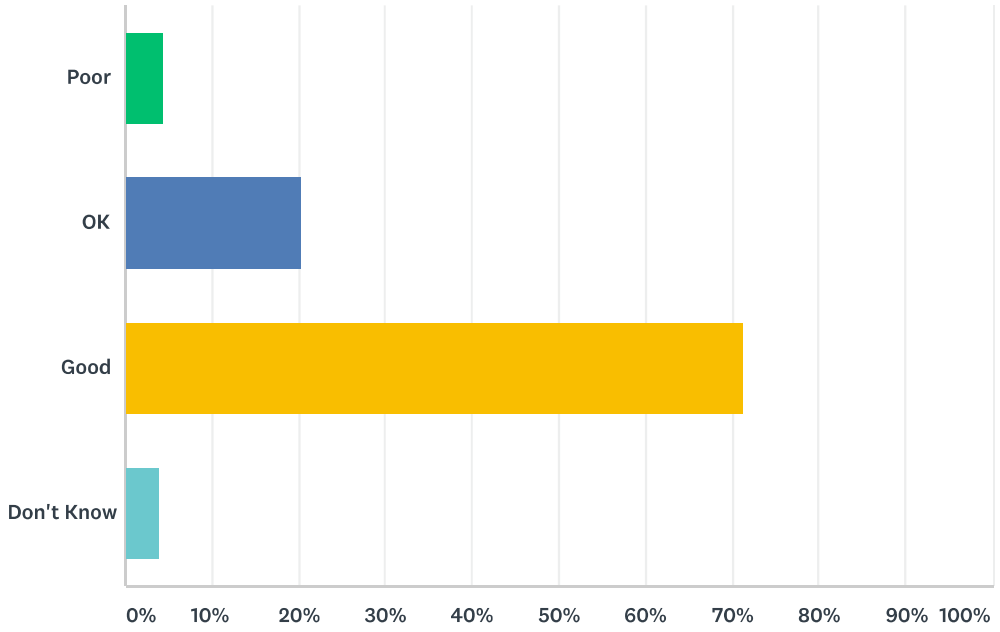
Answered: 202 Skipped: 2



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

Q4 For picnicking and family activities:

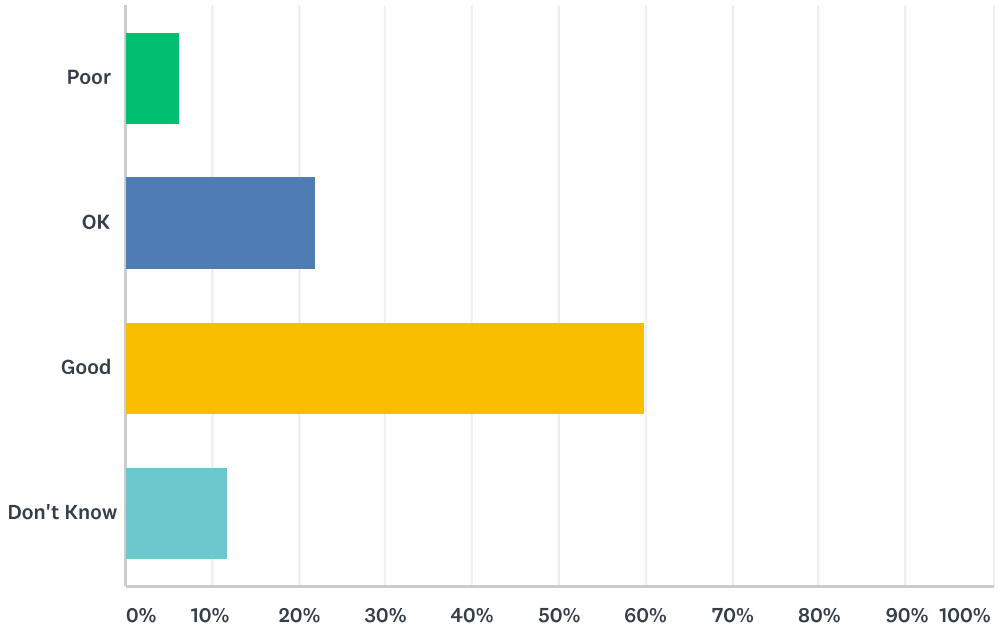
Answered: 203 Skipped: 1



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

Q5 For high quality fishing and fish habitat:

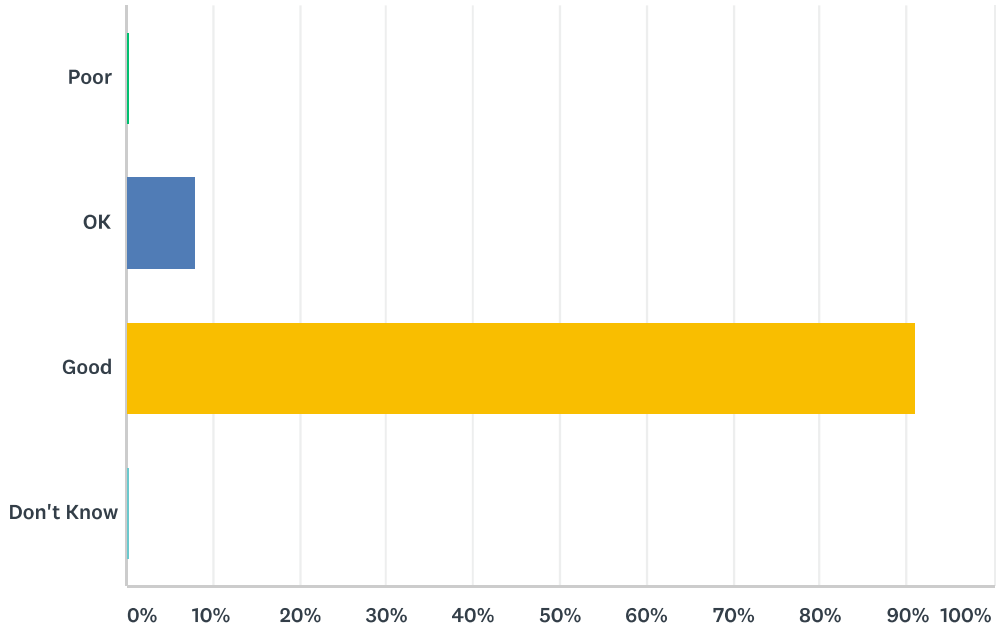
Answered: 204 Skipped: 0



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

Q6 For scenic beauty:

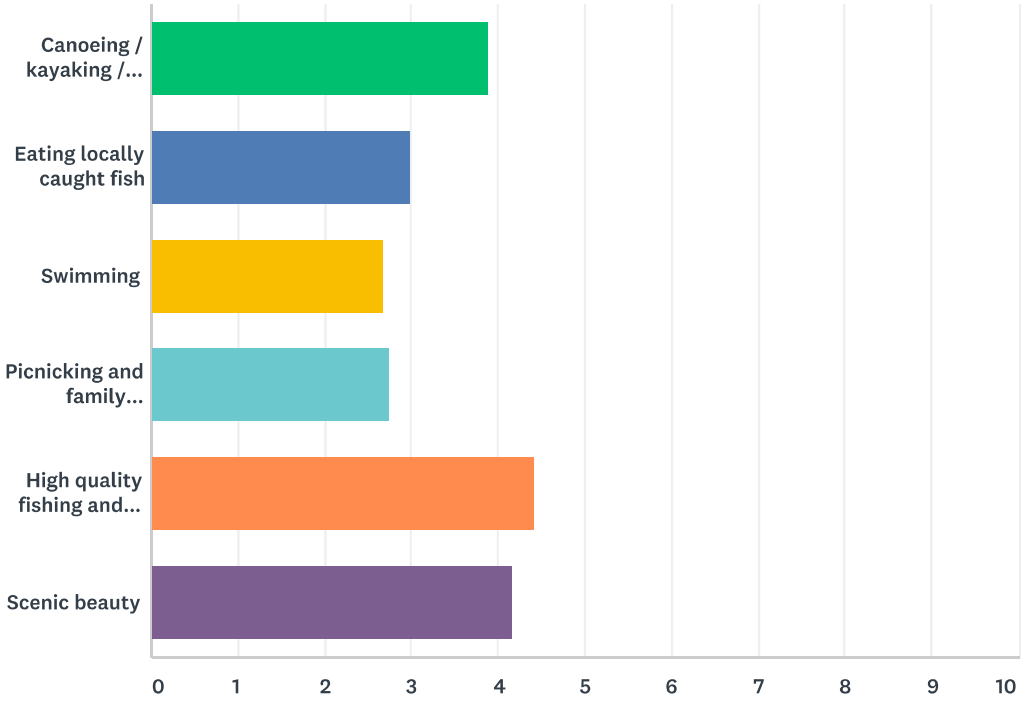
Answered: 201 Skipped: 3



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

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

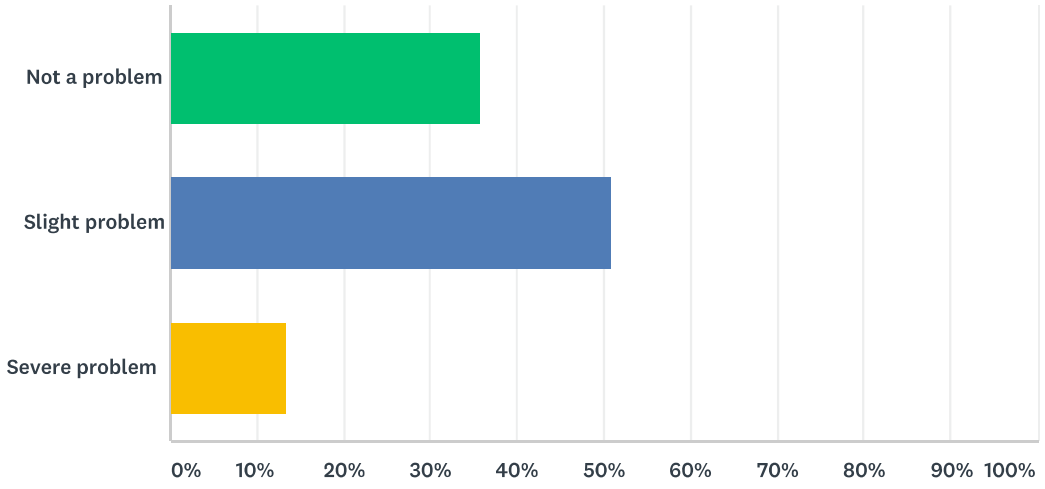
Answered: 197 Skipped: 7



	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

Q8 Soil erosion and fertilizer runoff from farm fields:

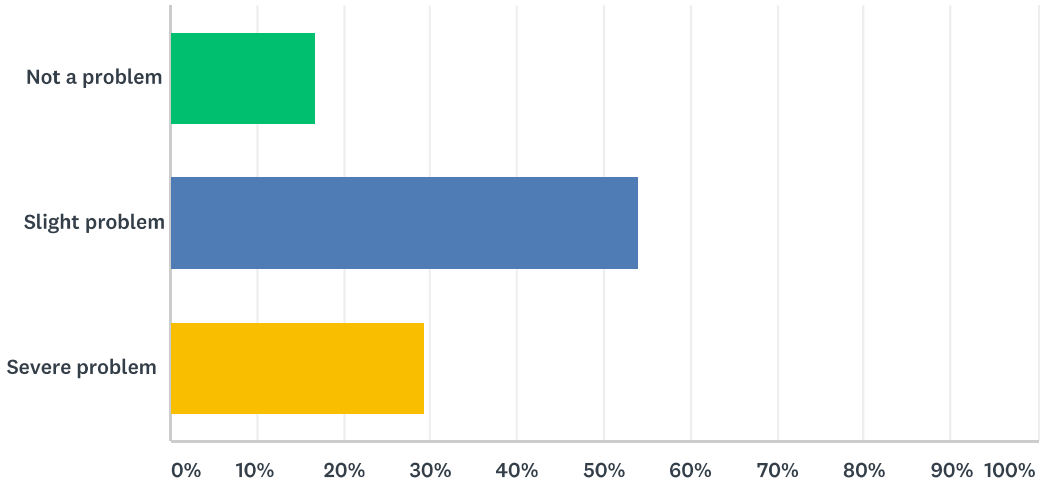
Answered: 193 Skipped: 11



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

Q9 Soil erosion from shorelines and streambanks:

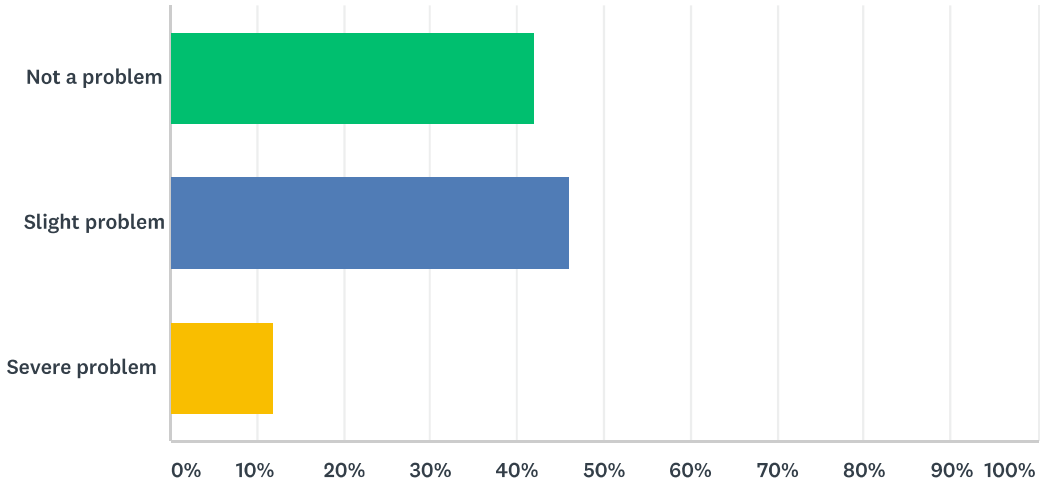
Answered: 191 Skipped: 13



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

Q10 Excessive use of lawn fertilizers and/or pesticides:

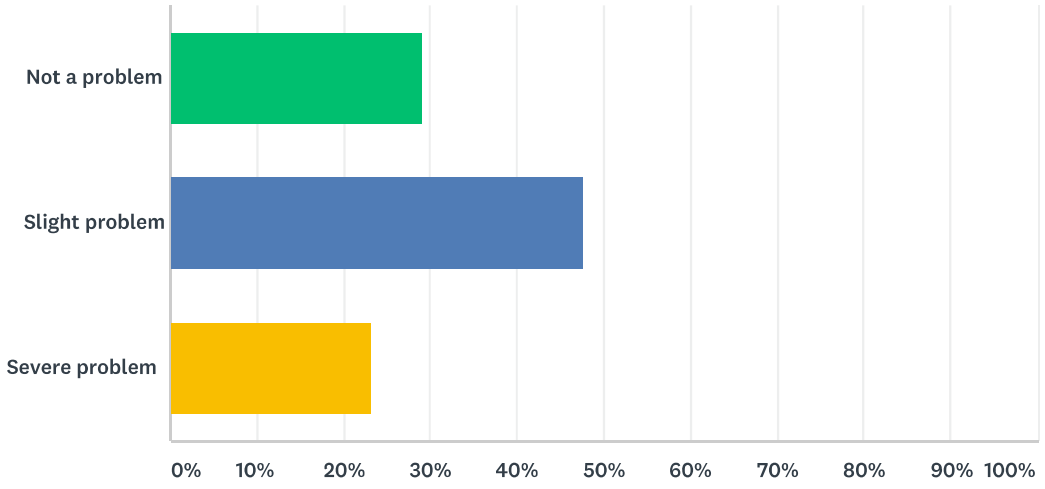
Answered: 193 Skipped: 11



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

Q11 Improperly maintained septic systems:

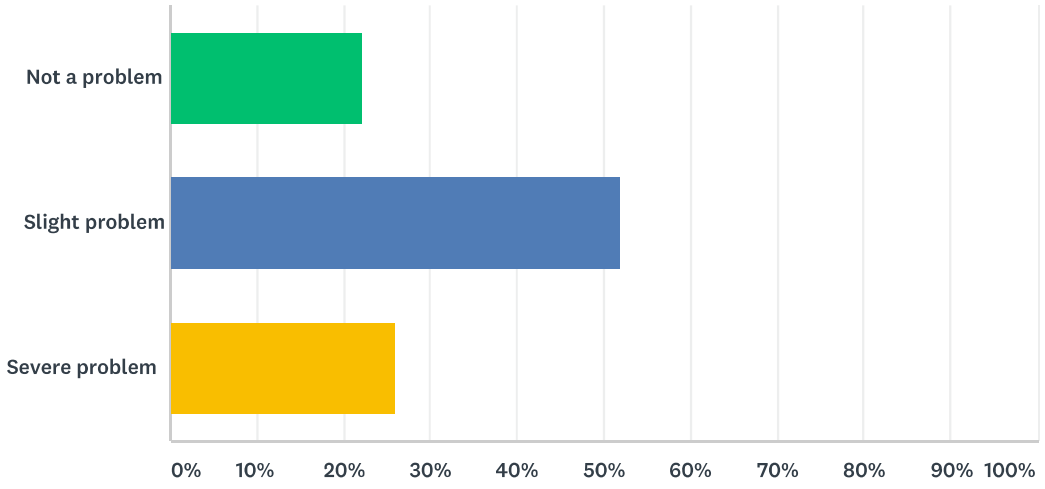
Answered: 193 Skipped: 11



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

Q12 Erosion and stormwater runoff from public roads:

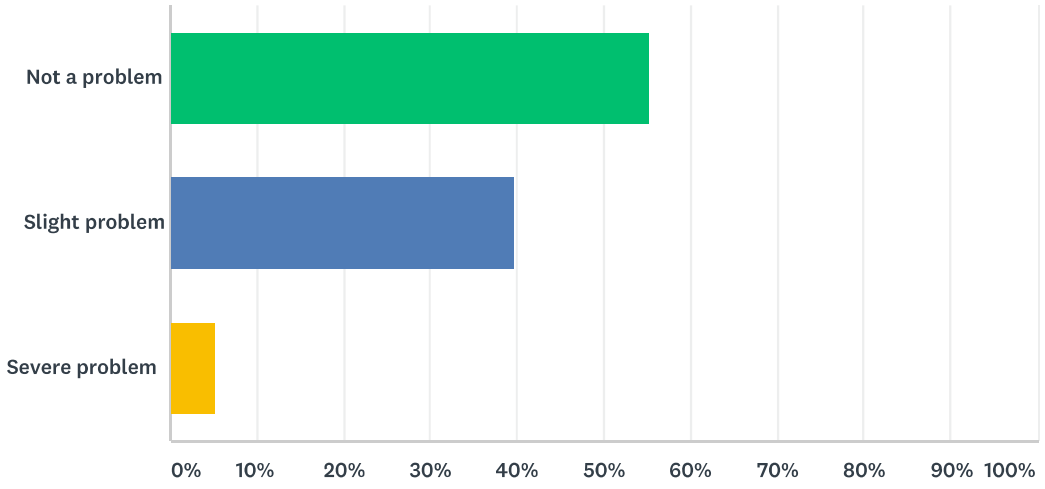
Answered: 193 Skipped: 11



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

Q13 Droppings from geese, ducks and other waterfowl:

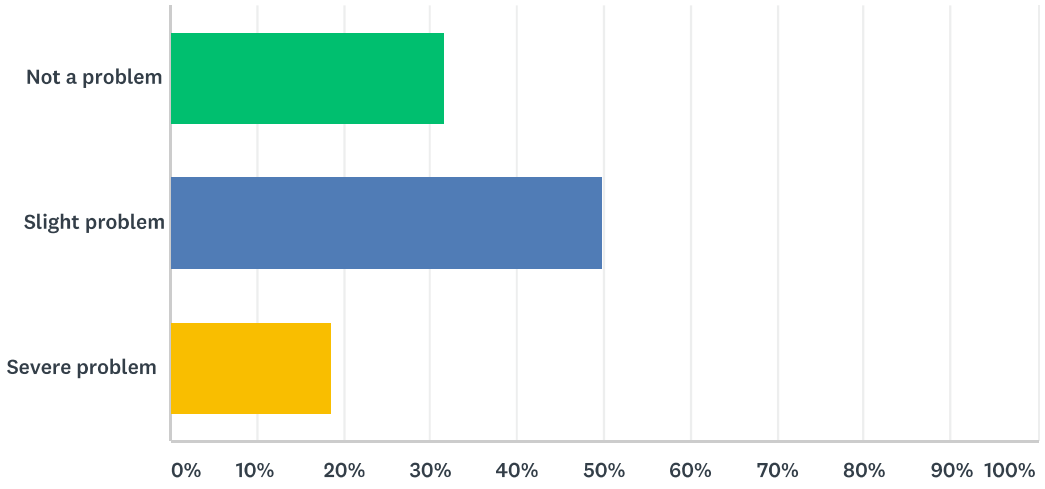
Answered: 194 Skipped: 10



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

Q14 Removal of shoreline and streambank vegetation:

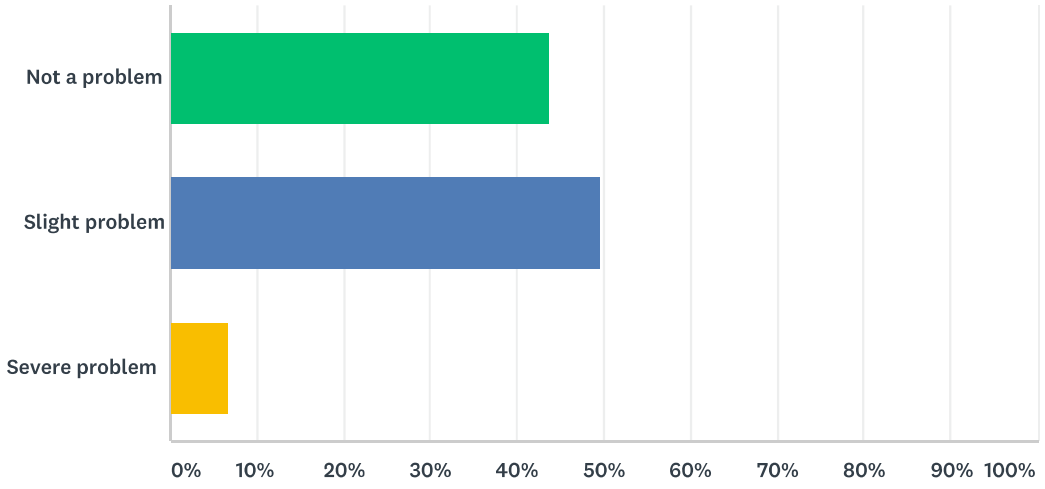
Answered: 193 Skipped: 11



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

Q15 Recreational and tourism activities:

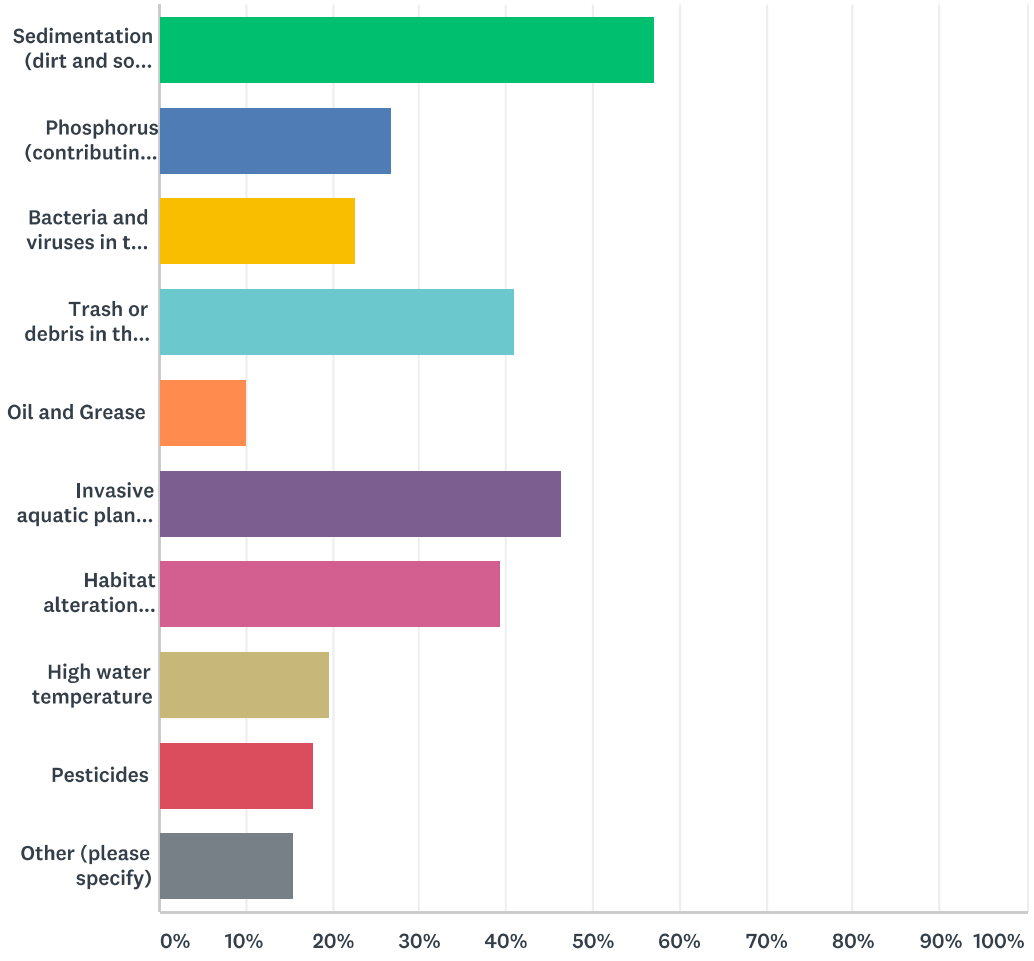
Answered: 194 Skipped: 10



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

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.

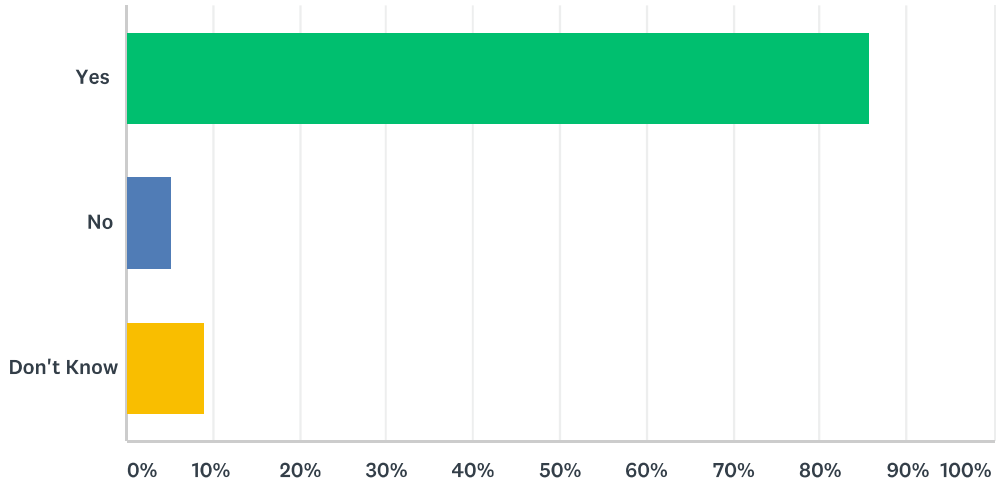
Answered: 168 Skipped: 36



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

Q18 Education and voluntary action by property owners

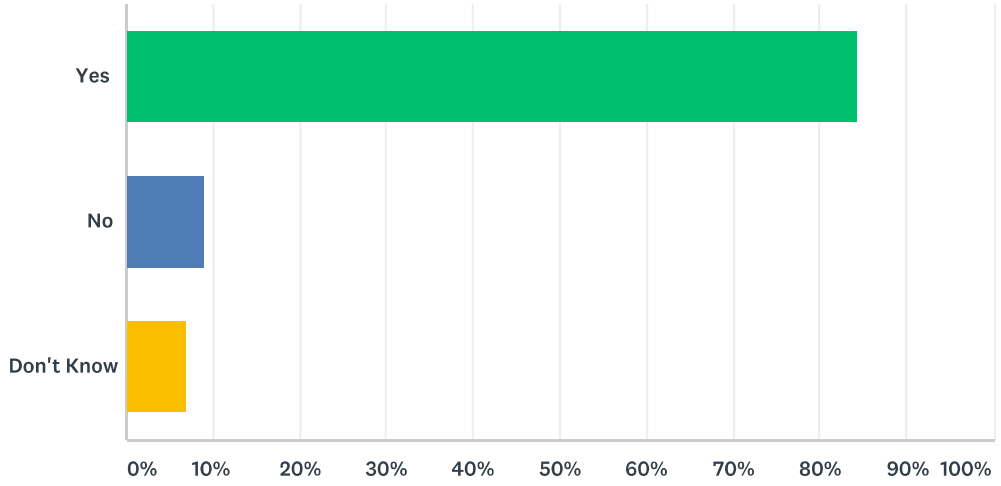
Answered: 190 Skipped: 14



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

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

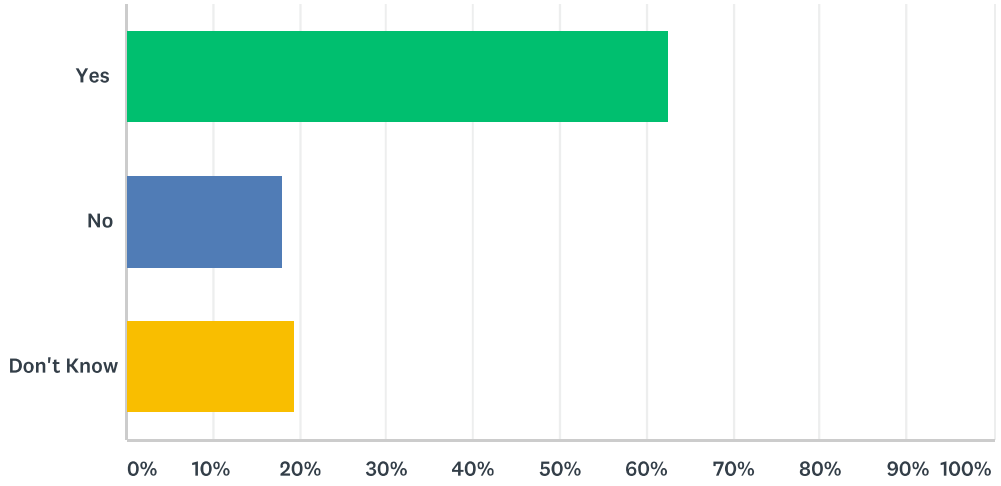
Answered: 190 Skipped: 14



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

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

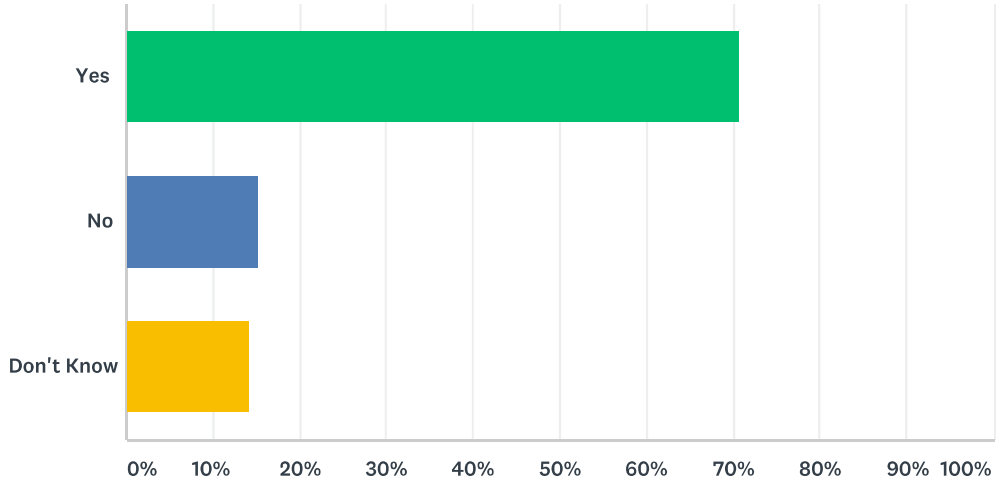
Answered: 190 Skipped: 14



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

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

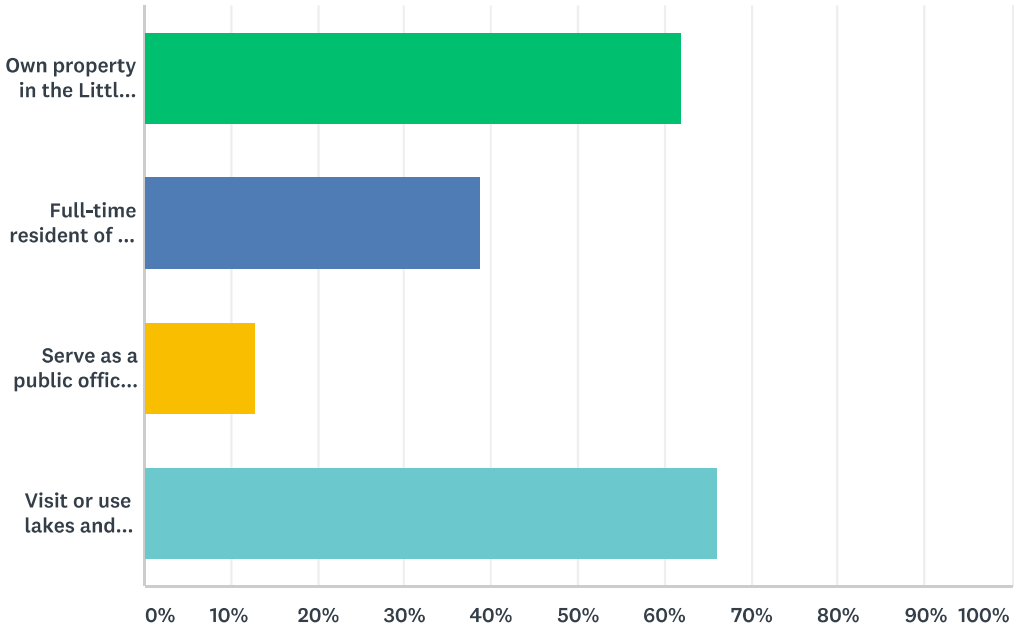
Answered: 191 Skipped: 13



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

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		