MULLETT LAKE, LOWER BLACK/CHEBOYGAN RIVERS

WATERSHED MANAGEMENT PLAN

2024

Acknowledgements

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Introduction

Northern Michigan is known for its outstanding lakes and streams and our water resources are legendary. We depend on these waters for our livelihood, our recreation, and our traditions. In return, we must be good stewards of these resources and work collaboratively and continually to see that they are protected now and into the future.

"Economically, inland lakes support a recreational industry valued at $15 billion per year and the value of shoreline property is estimated to be worth $200 billion, generating $3.5 billion in tax revenue. Comprehensive water quality monitoring is necessary to inform natural resource management, assess inland lake quality, and protect public health. Although the Michigan Department of Environmental Quality (MDEQ) is the lead state agency responsible for monitoring, assessing, and managing the state's surface water and groundwater, effective water resource management is best achieved through partnerships with other state and federal agencies, local governments, tribes, universities, industry, environmental groups, and citizen volunteers. Wherever possible, the MDEQ strives to organize and direct the resources and energies created by these partnerships through a "watershed approach" to protect the quality and quantity of the state's water resources."

-Michigan Department of Environment, Great Lakes, and Energy Water Resources Division, 2017

The Mullett Lake, Lower Black and Cheboygan Rivers Watershed Management Plan is the result of partnership among an active group of stakeholders under the unifying element of the watershed management plan process. Through this process we have inventoried aquatic resources, collected data, analyzed results, and synthesized the information into this Watershed Management Plan. It includes our shared goals and objectives and implementation tasks designed to restore degraded water resources and protect the pristine lakes and streams of the Watershed.

The Watershed Approach

The watershed approach is an analytical process that considers the abundance, locations, and conditions of aquatic resources in a watershed. It further considers how those attributes support landscape functions and attainment of watershed goals ((Sumner, 2004). Rather than identifying and protecting individual water resources, a watershed approach involves developing a framework for management of an area defined by drainage instead of political or land ownership boundaries.

Watershed management is a widely used and effective approach to managing water resources. The United States Environmental Protection Agency (EPA), the agency responsible for meeting the requirements set forth in the Clean Water Act (1973), describes the watershed approach as:

"…a flexible framework for managing water resources quality and quantity within specified drainage areas, or watershed. This approach includes stakeholder involvement and management actions supported by sound science and appropriate technology. The watershed planning process works within this framework by using a series of cooperative, iterative steps to characterize existing conditions, identify and prioritize problems, define management objectives, develop protection or remediation strategies, and implement and adapt selected actions as necessary. The outcomes of this process are documented or referenced in a watershed plan. A watershed plan is a strategy that provides assessment and management information for a geographically defined watershed, including the analyses, action, participants, and resources related to developing and implementing the plan."

-Environmental Protection Agency, 2008

The Mullett Lake, Lower Black and Cheboygan Rivers Watershed Management Plan (Plan) is the result of applying the watershed approach to managing water resources within the Watershed. The Plan considers the known sources and causes of the priority nonpoint source pollutants, as well as other water quality threats, the areas within the Watershed most impacted by these pollutants, and the measures necessary to protect or enhance water quality throughout the Watershed. The Plan serves as a tool to guide future management efforts based on the needs of the Watershed and capacity of its stakeholders.

Why are these efforts so critical to water quality protection? Moreover, why are they so important in a watershed with so few impairments, such as this one? According to the EPA, nonpoint source pollution is considered the greatest threat to water quality and is the most significant source of water quality impairment in the nation. Therefore, the development and implementation of watershed plans for waters that are not impaired by nonpoint source pollution is, perhaps, the best way to ensure they remain unimpaired. The EPA notes "of particular concern are high-quality waters that are threatened by changing land uses when unique and valuable aquatic resources (e.g. habitat for salmon migration, spawning and rearing) are at serious risk of irreparable harm." (Environmental Protection Agency, 2008)

The Plan is designed to adhere to the EPA nine elements, which must be included in a watershed plan for it to be eligible for funding under the Clean Water Act (Section 319). These elements are designed to ensure the plan is developed appropriately and implemented effectively. Examples of requirements include identifying sources of pollution, engaging stakeholders, and planning for monitoring of progress toward goals. The Plan is intended to adhere to not only the EPA standards, but also to guidelines published by EGLE.

The process for developing the Plan began in 2020 with funding from EGLE, led by the Tip of the Mitt Watershed Council. The Plan was completed with active involvement from the Advisory Committee in 2020-22. The Plan includes the results of detailed nonpoint source pollution inventories and water quality conditions. It also includes implementation tasks, and information and education, monitoring, and evaluation strategies that reflect the current resource conditions within the Watershed.

The Mullett Lake, Lower Black and Cheboygan Rivers Watershed Advisory Committee

Dozens of Watershed stakeholders, including local government officials, natural resource managers, non-profits, and lake association groups, were invited to attend the first Advisory Committee meeting in June of 2020, held virtually.

Subsequent meetings were held quarterly through the development of the Plan, with plans for the Advisory Committee to continue meeting quarterly for years to come. This structure allows us to continue to build relationships, make connections and work together for the betterment and protection of our water resources.

Watershed Partners:

City of Cheboygan

Cheboygan County Planning & Zoning

Cheboygan County Planning Commission

Cheboygan County Road Commission

Cheboygan River Preservation Association (CRPA)

Headwaters-Trout Unlimited (HTU)

Huron Pines (HP)

Little Traverse Bay Bands of Odawa Indians (LTBB)

Little Traverse Conservancy (LTC)

Michigan Department of Environment, Great Lakes, and Energy (EGLE)

Michigan Department of Natural Resources (MDNR)

Mullett Area Preservation Society (MAPS)

Sturgeon for Tomorrow (SFT)

Tip of the Mitt Watershed Council (TOMWC)

University of Michigan Biological Station (UMBS)

CHAPTER 1. WATERSHED CHARACTERIZATION

1.1 Mullett Lake, Lower Black and Cheboygan River Watershed

This Watershed has a wealth of access to some of Michigan's greatest natural resources. The large, high-quality waters of Mullett Lake and surrounding water bodies provide ample habitat for fish. Several large wetlands, such as the Indian River spreads and the Pigeon River spreads, provide important nesting habitat for rare birds. The Inland Waterway, once a trade route, is now a popular recreation destination.

Thousands of residents live and recreate on the Watershed's lakes and streams and thousands more come as tourists to enjoy the opportunities these water resources have to offer. Northern Michigan depends on these vital resources and their protection is critical to the economy and the environment and all living things that depend on it. The combined pressures of human activities and induced change can result in water quality degradation. The continued recreational attractiveness of the area depends almost exclusively on maintaining high water quality in area lakes and streams. Despite the Watershed's largely rural landscape, its water resources are continually threatened by human impacts that negatively impact natural processes and ecosystem functions. Through watershed management, protection, and education efforts we can create and protect healthy, resilient ecosystems.

Figure 1. Cheboygan River

For the purpose of this plan, the Watershed is divided into three major subwatersheds (Figure 2) and their lakes and streams:

MULLETT LAKE DIRECT SUBWATERSHED:

Mullet Lake, Indian River, Mullet Creek, Little Sturgeon River, Crumley Creek, Ballard Creek, Johnson Creek, Twin Lakes Creek, Scott Creek, Mann Creek, Hatt Creek, Silver Creek, Mullett Lake Creek, Roberts Lake, Cochran Lake, Goose Lake, Corey Lake

PIGEON RIVER SUBWATERSHED:

Pigeon River, Little Pigeon River, Cornwall Creek, Grindstone Creek, Nelson Creek, Wilkes Creek, Kimberly Creek, Morrow Creek, Wilkes Creek, Lake Sixteen, McIntosh Creek, Cornwall Flooding, Lost Lake, West Lost Lake, Hemlock Lake, Silver Lake, North Twin Lake, South Twin Lake, Lake Fifteen, Ginsel Lake, Denny Lake, Big Lake, Oley Lake, Ford Lake, Grass Lake, Section Four Lake, Mud Lake, Doe Lake, Hackett Lake, MacAndrews Lake

LOWER BLACK/CHEBOYGAN RIVERS SUBWATERSHED:

Cheboygan River, Black River, Owens Creek, Myers Creek, Laperell Creek, Maxwell Gully, Tannery Gully, Beechnut Creek, Section Seven Creek, Spring Creek, Long Lake Creek, Long Lake, Twin Lakes.

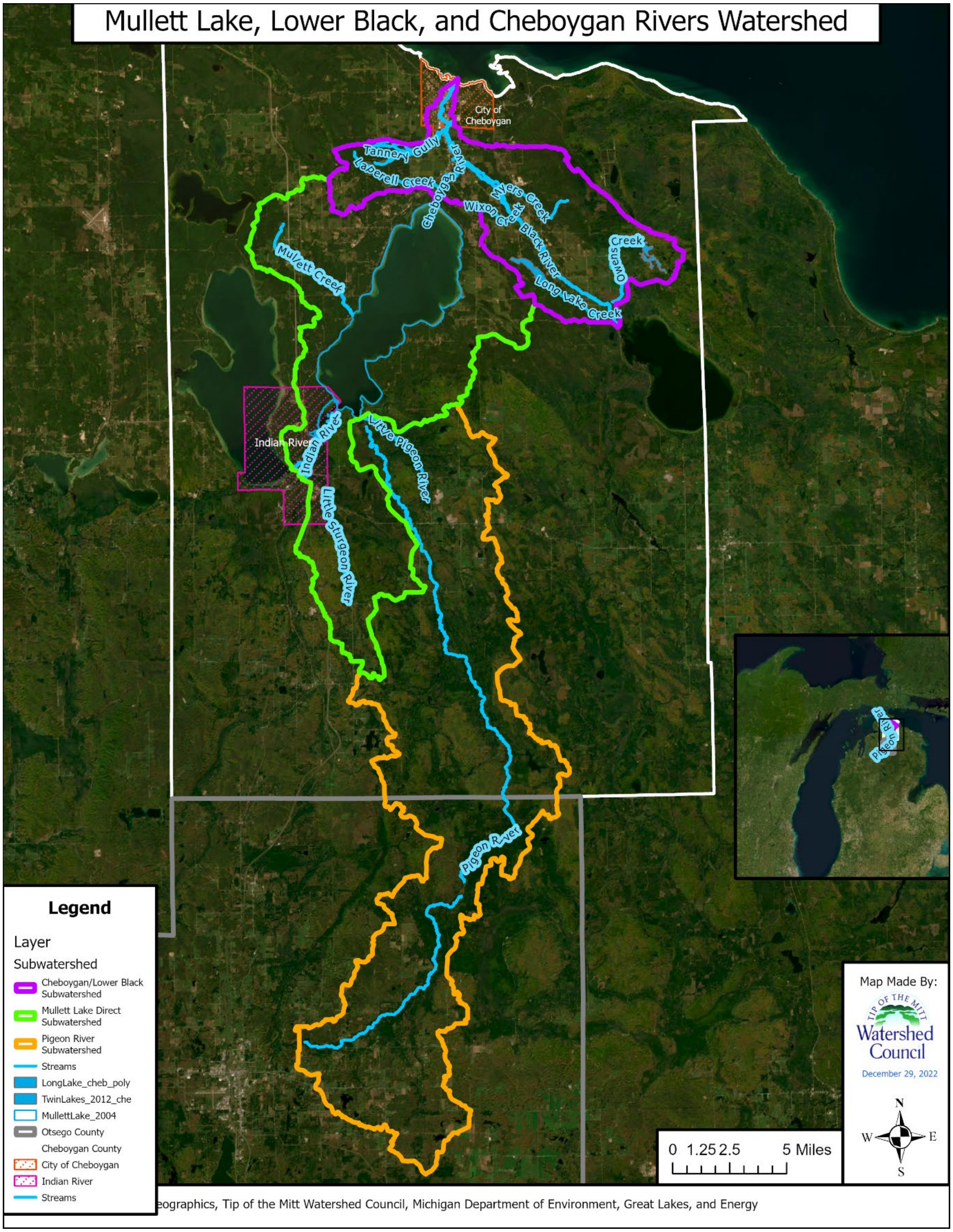

Figure 2. Mullett Lake, Lower Black and Cheboygan Rivers Watershed

1.2 Land Cover

Land cover refers to the material present at the surface of the earth. Land cover may be either a biological (e.g. grassland or pine forest), physical (e.g. lake or parking lot) or chemical (e.g. concrete or asphalt) categorization of the surface. Although land use/land cover can be (and has been) categorized in great detail, there are four basic land use/cover types: urban, agricultural, wetland, and collectively forest/grass/scrub. The type of land and the intensity of its use will have a strong influence on the receiving water resource. Studies have determined the likely inputs of nutrients and other pollutants from different land uses/cover types.

The Watershed encompasses almost 230,000 acres, over half of which is forest/grass/scrub followed by wetlands with the next highest land use (almost 20%). These high-quality waters are protected by the low impact land use types that make up most of the land use (Table 1) (Figure 3). The National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program shows that between 1985 and 2016, the largest change in land cover occurred in forested lands, at an almost 1% loss, and a gain in urban area of 0.5%.

Table 1. 2016 Land cover

	2016 Land Cover							
	LBlack/Cheb		**Mullett Direct**		**Pigeon**		**All Watersheds**	
	Acres	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**
Urban	3,031	8%	3,525	4%	1,698	2%	8,254	4%
Agriculture	7,006	18%	7,474	9%	7,615	7%	22,094	10%
Forest/Grass/Scrub	18,018	46%	39,720	50%	75,145	70%	132,882	58%
Wetland	9,849	25%	12,042	15%	22,457	21%	44,348	20%
Barren	155	0%	96	0%	205	0%	457	0%
Water	1,407	4%	17,107	21%	826	1%	19,340	9%
Totals	**39,466**	**100%**	**79,964**	**100%**	**107,945**	**100%**	**227,375**	**100%**

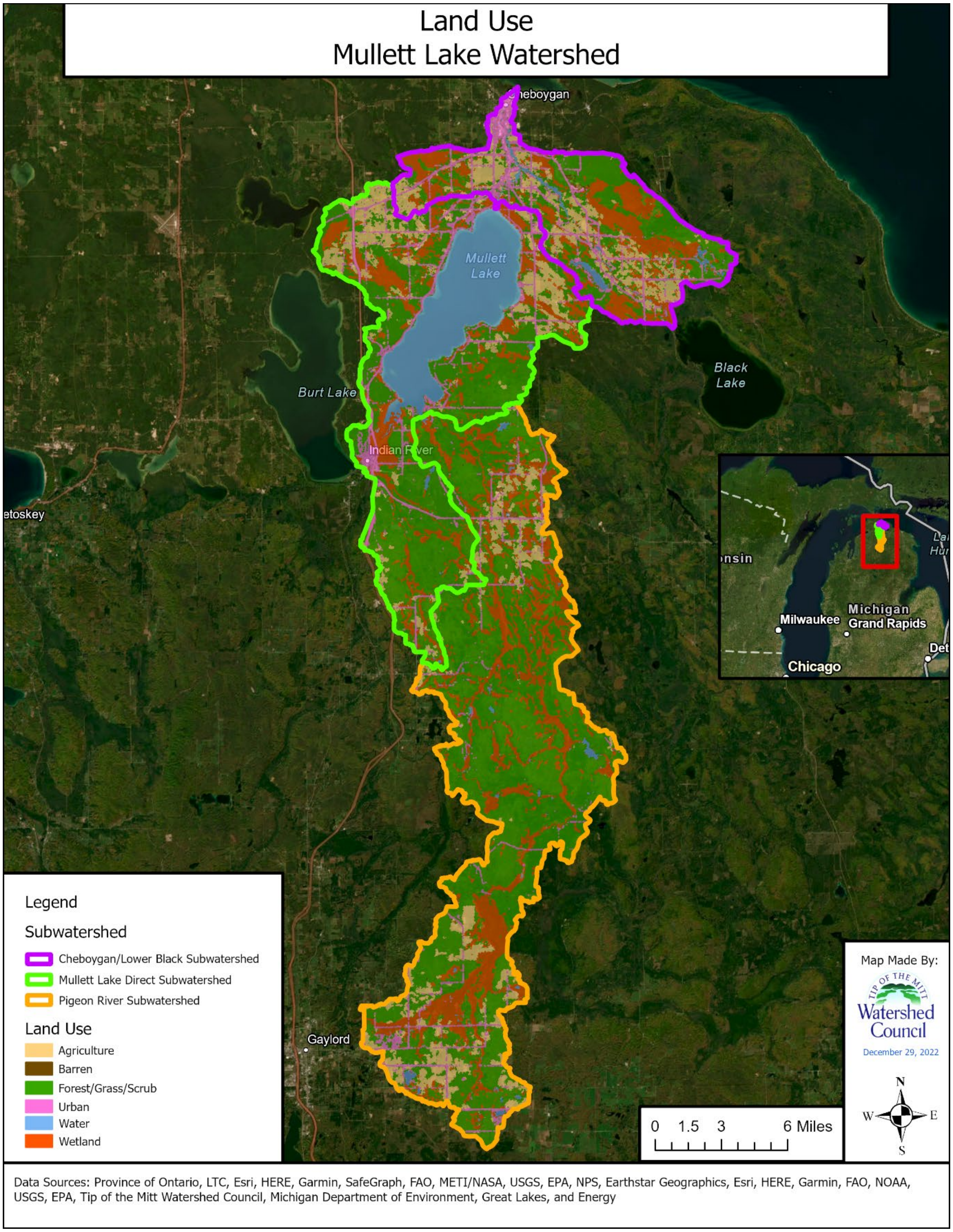

Figure 3. Land use in the watershed

1.3 Inland Waterway

The Mullett Lake Watershed includes the last half of the Inland Waterway, one of Michigan's longest chains of rivers and lakes. It begins with Crooked Lake and extends to Lake Huron via the Crooked River, Burt Lake, Indian River, Mullett Lake, and the Cheboygan River. The Mullett Lake Watershed includes Indian River, Mullett Lake, and Cheboygan River (Figure 5). Historically, the Inland Waterway was used by Native Americans and trappers as a fast route across Northern Michigan instead of the longer, more dangerous passage through the Straits of Mackinac. Today, the Inland Waterway provides recreational boaters with nearly 40 miles of navigable waters, plus direct access to four of Michigan's most beautiful and popular lakes.

Figure 4. Inland Waterway steamer

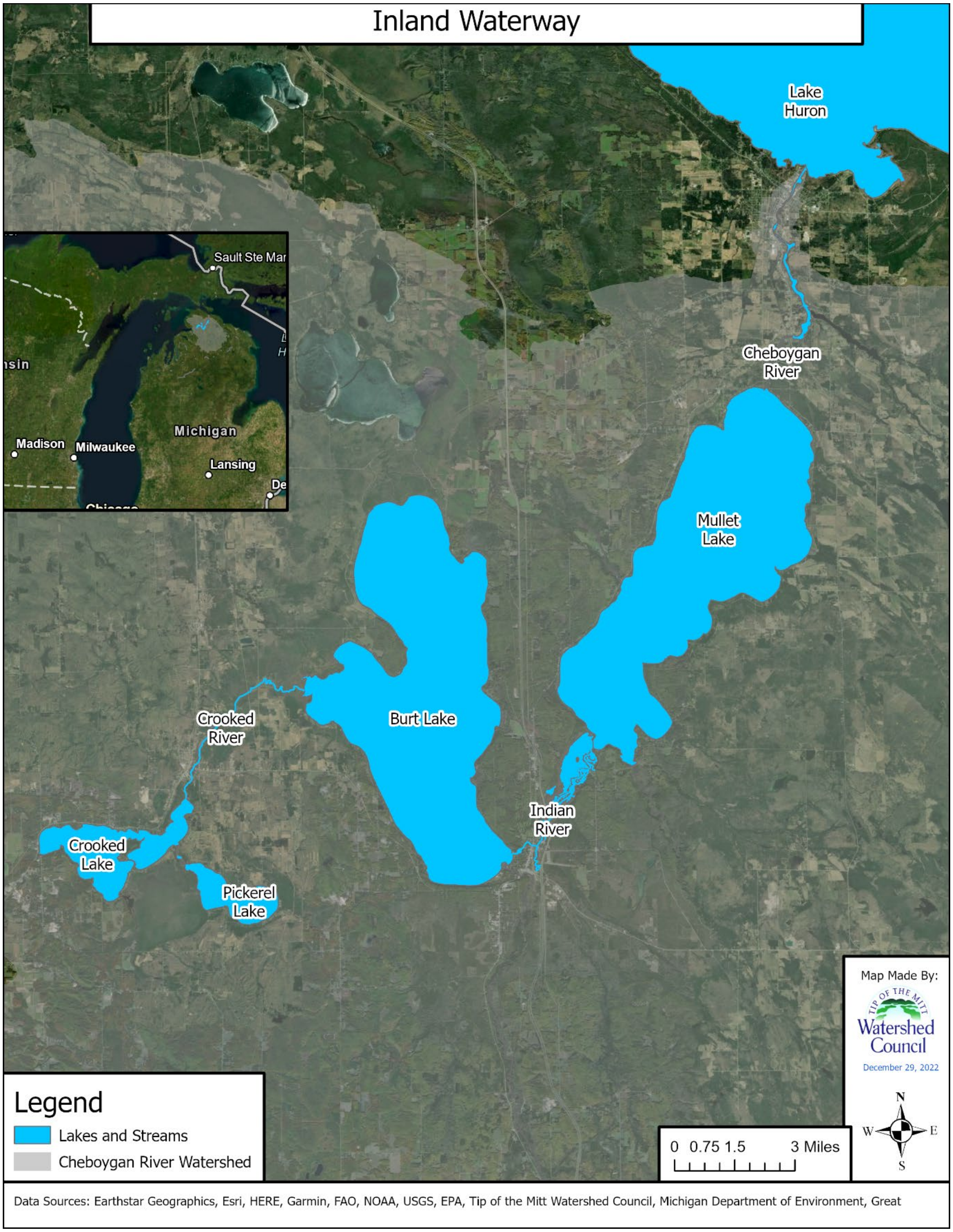

Figure 5. Inland waterway

1.4 Glacial History of the Inland Waterway

The size, depth, and configuration of the lakes and rivers of the Inland Waterway were shaped in large part by the advance and retreat of vast continental glaciers. The last advance of the glaciers, which covered most of Cheboygan and Emmet counties, was known as the Valders Advance. It left behind deposits of till (material carried and deposited directly by the ice) and outwash (till that has been washed, sorted, and deposited by glacial meltwaters). Many of the high hills in Cheboygan River Watershed are deposits of glacial till called moraines. The thickness of the glacial deposits varies from less than 50 feet to more than 600 feet. Outwash deposits are found in the vicinity of Indian River and the headwaters of the Pigeon River.

The deep lakes of the Inland Waterway region were formed when huge blocks of ice were left in the area during glacial retreat. As these huge ice blocks melted they left behind the deep basins which now make up the lakes. As the glaciers receded meltwaters flooded the region. Many of the low-lying wetland areas that border the Waterway, including the Crooked River Marsh, Pigeon River Spreads, and the Indian River Spreads, were once under water. The entire area was part of vast lakes known as Lakes Algonquin and Nipissing, precursors to the modern Great Lakes.

The geology of the region is variable due to its glacial origin. As the glaciers advanced and retreated across the landscape, they deposited the debris scraped from the land surface. In many areas of Northern Michigan, this glacial drift is hundreds of yards thick. It is composed of a mixture of sand, gravel, and rocks in a matrix of silt and clay. These deposits of dolomite, limestone, and shale, overlay limestone bedrock in the watershed. Bedrock is found near the surface in a few areas but is generally more than 300 feet below the surface throughout most of the inland waterway.

The important ground water aquifers of the watershed lie in glacial deposits. The characteristics of these aquifers depend upon the nature and thickness of materials composing the deposits. Silt and clay are less permeable than sand and gravel, and thick deposits have more water holding capacity than thin deposits. Generally, areas of glacial till are less productive aquifers than outwash deposits. Outwash deposits were most commonly formed in glacial meltwater channels and these areas are where most streams are found today.

The generally thick glacial deposits in the watershed result in ample ground water aquifers and a large number of springs and streams with cold, steady, high quality flows of ground water. The bedrock geology and the large amount of limestone in the glacial deposits influences the chemical quality of ground water and most surface waters, resulting in moderately high hardness and alkalinity.

1.5 Soils

Soils are an important watershed feature for the determination of types and intensity of land uses and many aspects of water resource management. Soil is the unconsolidated material within six feet of the surface that has been modified from the "parent" glacial deposits by climate, biological processes, and other environmental factors. Water quality is partially based on the nature of the soils and the slope of the land within the drainage basin. These factors determine potential land use, soil infiltration rates, water-holding capacity and soil erodibility and therefore are directly related to the amount of non-point source pollution in the watershed such as groundwater recharge, septic system performance, and erosion/sedimentation potential.

In the United States, soils are assigned to four hydrologic soil groups, A, B, C, and D. This describes their rate of water infiltration when the soils are not protected from vegetation, are thoroughly wet and receive precipitation from long-duration storms. The hydrologic soil groups in the Watershed include largely A groups, followed by B, C and D. Group A consists of soils that have high infiltration rates even when thoroughly wet, because of sandy or gravelly, well-draining soils. Group B has moderate infiltration rates. Groups C and D have respectively slower infiltration rates when thoroughly wet, due to fine texture or clay-rich soils. Soil descriptions for the subwatersheds are provided in following sections.

1.6 Climate

The local climate for the Watershed varies slightly because of the extensive size and varying topography. In general, summers are mild and winters are snowy and cold. Below are the tables and graphs for Cheboygan, located at the northern part of the watershed and Gaylord at the southern end (Figure 6-9).

1981-2010
Temperature and Precipitation Summary

Mean Annual Temperature (°F)	43.5
Mean Annual Minimum Temperature (°F)	34.5
Mean Annual Maximum Temperature (°F)	52.8
Mean Number of Days per Year that exceed 90°F	2
Mean Number of Days per Year that fall below 32°F	151
Lowest Mean Annual Temperature (°F)	40.9
Highest Mean Annual Temperature (°F)	46.8
Mean Annual Total Precipitation (inches)	30.7
Lowest Mean Total Precipitation (inches)	21.8
Highest Mean Total Precipitation (inches)	40.5
Mean Number of Days/Year with > 0.1" Precip.	68
Mean Number of Days/Year with > 0.25" Precip.	38
Mean Number of Days/Year with > 0.5" Precip.	17
Mean Number of Days/Year with > 1" Precip.	5

Figure 6. Temperature and precipitation summary for Cheboygan (GLISA)

Cheboygan Climate Graph - Michigan Climate Chart

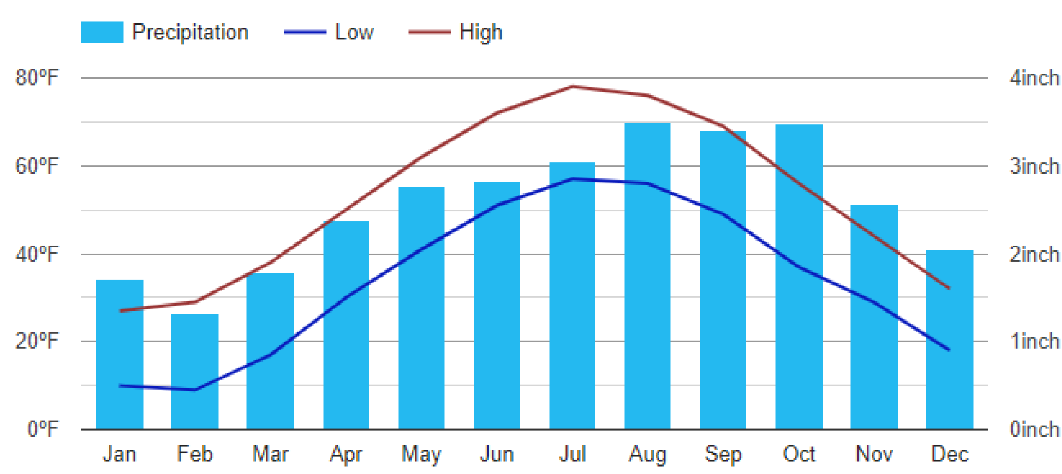

Figure 7. Average temperature and precipitation for Cheboygan (www.usclimatedata.com)

1981-2010
Temperature and Precipitation Summary

Mean Annual Temperature (°F)	43.8
Mean Annual Minimum Temperature (°F)	33.9
Mean Annual Maximum Temperature (°F)	53.7
Mean Number of Days per Year that exceed 90°F	3
Mean Number of Days per Year that fall below 32°F	164
Lowest Mean Annual Temperature (°F)	41.5
Highest Mean Annual Temperature (°F)	46.3
Mean Annual Total Precipitation (inches)	35.3
Lowest Mean Total Precipitation (inches)	28.5
Highest Mean Total Precipitation (inches)	44.0
Mean Number of Days/Year with > 0.1" Precip.	86
Mean Number of Days/Year with > 0.25" Precip.	46
Mean Number of Days/Year with > 0.5" Precip.	19
Mean Number of Days/Year with > 1" Precip.	4

Figure 8. Temperature and precipitation summary for Gaylord (GLISA)

Gaylord Climate Graph - Michigan Climate Chart

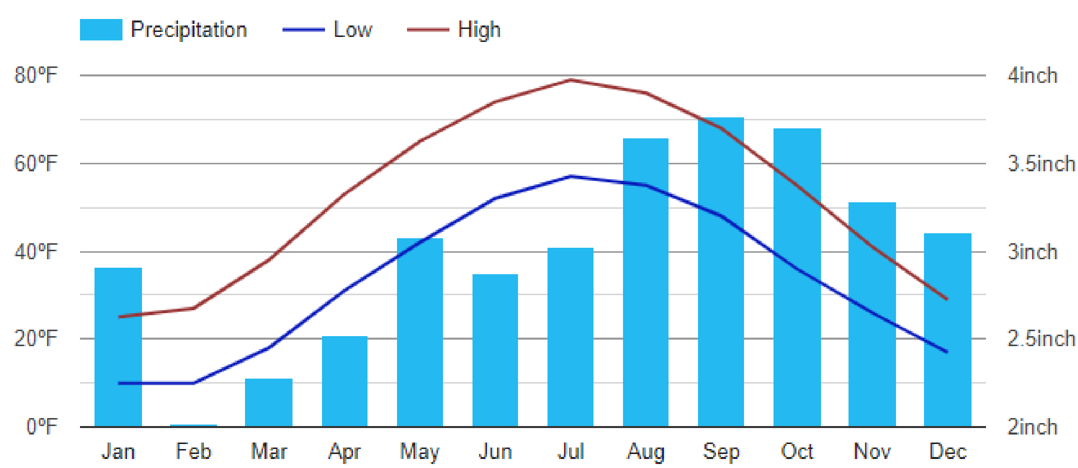

Figure 9. Average temperature and precipitation data for Gaylord (www.usclimatedata.com)

1.7 Groundwater

Groundwater is critically important for water quality and ecosystem integrity of lakes, streams, and wetlands. Rain, melting snow, and other forms of precipitation move quickly into and through the ground throughout much of the Watershed due to highly permeable (sandy) soils. Gravity causes vertical migration of groundwater through soils until it reaches a depth where the ground is filled, or saturated, with water. This saturated zone in the ground is called the water table and can vary greatly in depth. Figure 10 illustrates groundwater recharges areas throughout the Watershed based on their respective infiltration rates.

In watershed areas with steep slopes, hillsides intersect the water table, resulting in groundwater expulsion at the land surface. The exposed water table causes horizontal groundwater movement, which releases to create seeps and springs that then form or contribute water to streams and wetlands. The degree of groundwater contributions to surface waters in the Watershed is illustrated in subwatershed maps found in following sections. The data used to generate the maps are based on the Michigan Rivers Inventory subsurface flux model (MRI-DARCY), which uses digital elevation and hydraulic conductivity—inferred from mapped surficial geology—to estimate spatial patterns of hydraulic potential. The model is used to predict groundwater delivery to streams and other surface water systems because biological, chemical, and physical attributes of aquatic ecosystems are often strongly influenced by groundwater delivery.

The surface waters of the Watershed are dependent upon groundwater inputs. This dependency makes it is extremely important to protect and conserve groundwater resources in the Watershed. The prevailing sandy soils that facilitate groundwater recharge and expedite groundwater transport to surface waters also present a danger to the aquifers, streams, lakes, and wetlands in the Watershed. Although soils are a natural filtration medium, pollutants associated with agricultural activity (e.g., pesticides, herbicides, nutrients) and the urban or residential environment (e.g., metals, automotive fluids, nutrients) can be transported through the ground and contaminate either drinking water supplies or local surface waters fed by groundwater. Furthermore, expanding development, such as road and house construction, alters the hydrologic cycle by replacing natural land cover with impervious surfaces, which impedes infiltration and groundwater recharge. Therefore, protecting groundwater resources must address both the potential for pollutants to reach and contaminate groundwater and the reduction of groundwater recharge due to development.

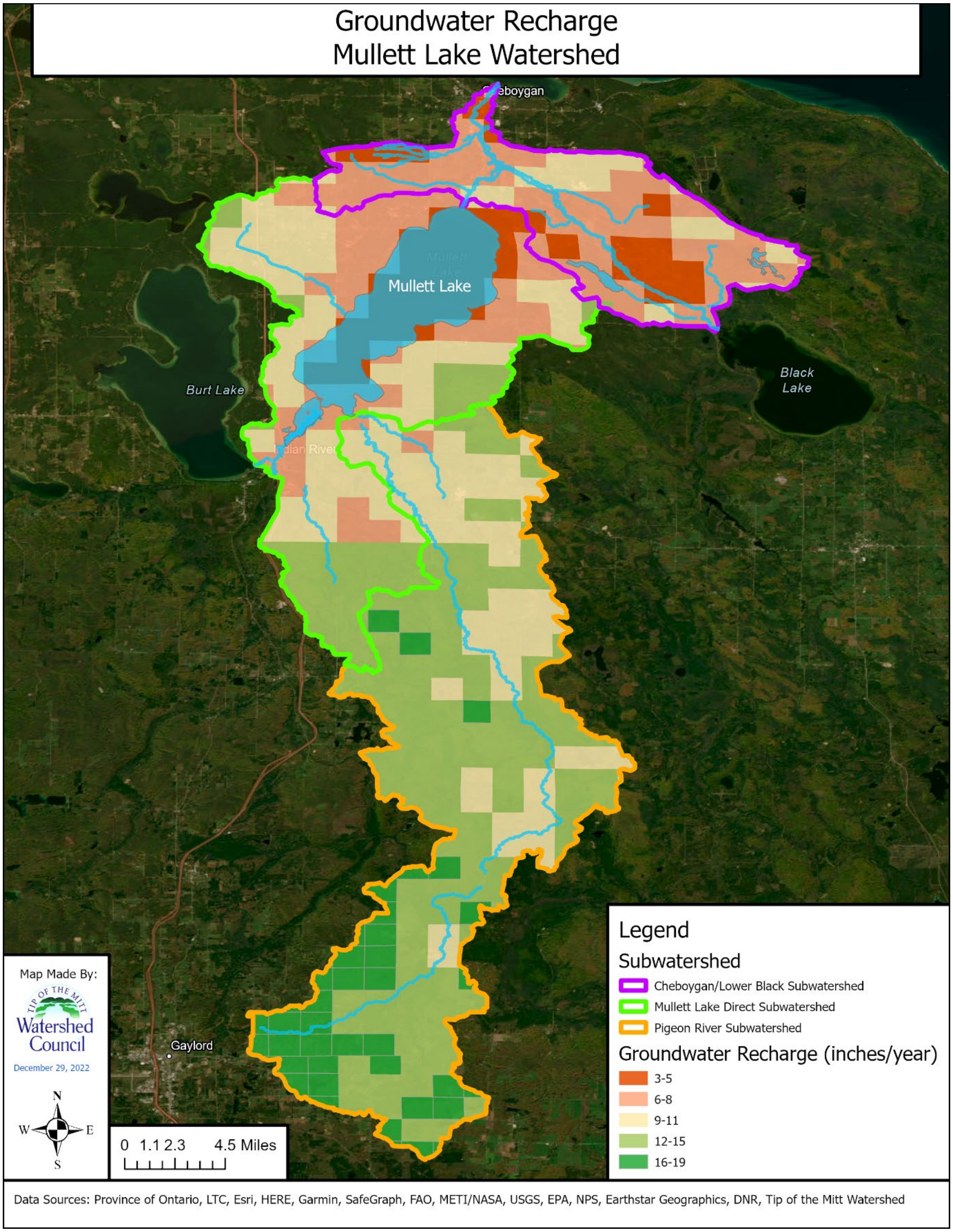

Figure 10. Groundwater recharge

1.8 Drinking Water

Groundwater is the drinking water source for all communities within the Mullett Lake Watershed. Many communities throughout Michigan, in an effort to protect their drinking water systems from many possible contamination sources, have Wellhead Protection Programs (WHPP) and Wellhead Protection Areas (WHPA). These programs are voluntary and designed to be locally initiated and implemented, with EGLE playing a supporting role. The Michigan Rural Water Association (MRWA) provides the expertise of their Groundwater Specialist to aid in the implementation of WHPPs. Michigan also has a Wellhead Protection Grant Program.

A Wellhead Protection Area (WHPA) is defined as the surface and subsurface areas surrounding a water well or well field, which supplies a public water system, and through which contaminants are reasonably likely to move toward and reach the water well or well field within a 10-year time-of-travel. The purpose of developing a WHPP is to identify the WHPA and take the necessary steps to safeguard the area from contaminants. The State of Michigan requires communities to identify seven elements to be included in the WHPP. These elements along with a brief description are below (MRWA 2015).

- **Roles and Responsibilities:** Identify individuals responsible for the development, implementation, and long-term maintenance of the local WHPP.
- **WHPA Delineation:** Determine area that contributes groundwater to the public water supply wells.
- **Contaminant Source Inventory:** Identify known and potential sites of contamination within the WHPA and include in a contaminant source inventory list and map.
- **Management Strategies:** Provide mechanisms that will reduce the risk of existing and potential sources of contamination from reaching the public water supply wells or well field.
- **Contingency Planning:** Develop an effective contingency plan in case of a water supply emergency.
- **Siting of New Wells:** Provide information on existing groundwater availability, the ability of the PWSS to meet present and future demands and the vulnerability of the existing wells to contamination.
- **Public Education and Outreach**: Generate community awareness in the WHPP by focusing on public education and the dissemination of WHPP information.

The City of Cheboygan has a wellhead protection plan (2004) for wellhead protection areas #4, #5, #7, #8 (Figure 11).

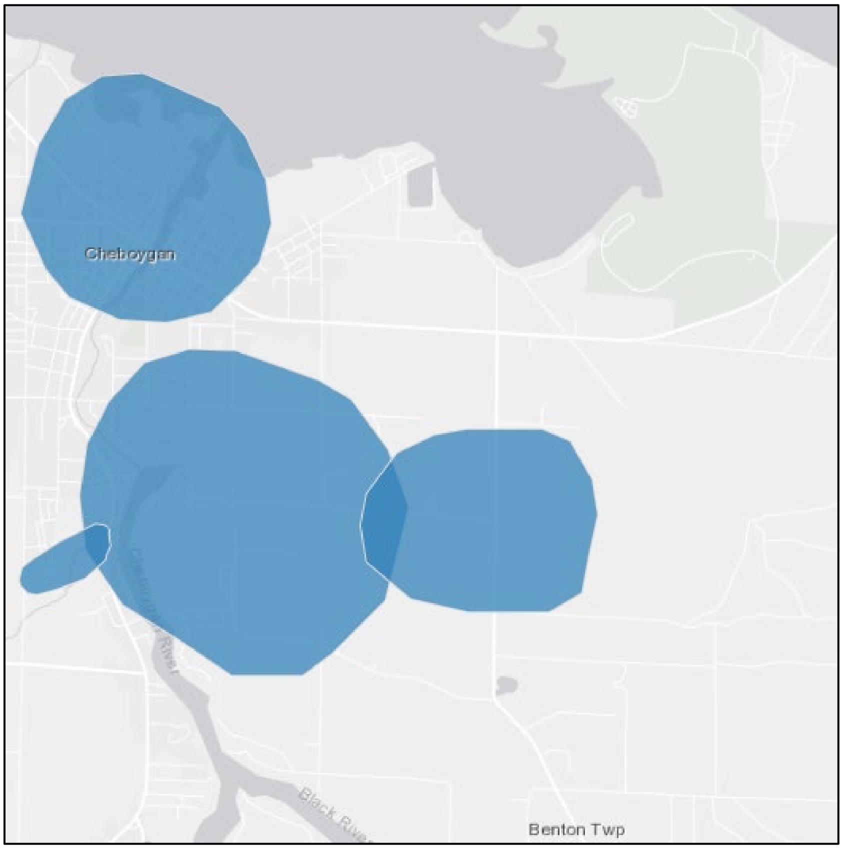

Figure 11. City of Cheboygan wellhead protection areas

1.9 Ecoregion

Ecoregions are regions that have relatively similar ecological systems. Ecoregions display regional patterns of environmental factors, such as climate, vegetation, soils, geology, physiography, and land use: the same factors that determine water quality within a watershed. Adjacent watersheds may or may not be within the same ecoregion.

The ecoregion concept is not new, having been described as early as 1905. Subsequently, a number of ecoregion classification schemes have been developed. A widely utilized classification scheme identifying 120 ecoregions throughout the continental United States was developed by the EPA in the 1980s. The Cheboygan River Watershed, of which the Mullet Lake Watershed is included, lies entirely within an ecoregion called "Northern Lakes and Forests" (#50).

The Northern Lakes and Forests ecoregion is characterized by nutrient-poor soils, forests of conifers and northern hardwoods that cover a landscape of undulating till plains, morainal hills, broad lake basins, and extensive sandy outwash plains. Numerous lakes dot the landscape. Farming is not common. Logging and fires in the past have had great impacts on water quality, but the water quality remains high overall. Today, the effects of land use on water quality, especially in streams, are generally minimal. In fact, the portion of this ecoregion at the northern tip of Michigan's lower peninsula contains lakes that tend to have summer concentrations of total phosphorus less than five parts per million. Few other areas in the upper Midwest have lakes with such high-water quality.

1.10 Fisheries

The Watershed includes some of the greatest fisheries within the state, including approximately 46 miles of Blue-Ribbon trout streams. Although many segments of coldwater streams are classified as designated trout streams, some are considered Blue Ribbon trout streams because they meet higher standards. These include their capacity to support stocks of wild resident trout, are large enough to permit fly casting but shallow enough to wade, produce diverse insect life and good fly hatches, have earned a reputation for providing a quality trout fishing experience and have excellent water quality. The only Blue-Ribbon trout stream within the Watershed is the Pigeon River. Additional fisheries information can be found in the subwatershed sections.

1.11 Impoundments

Alverno Dam

The Alverno dam is located south of Cheboygan on the Lower Black River. It is approximately five miles downstream from Black Lake. The dam was built in 1905 and is operated today by Black River Hydro Limited Partnership, licensed by the Federal Energy Regulatory Commission with their license set to expire in 2041.

The facility consists of a powerhouse located on the eastern riverbank that is integral with a 360-foot-long earth-filled dam. The dam includes a concrete spillway along the western riverbank. A three-foot wide abandoned log chute and fish ladder is located adjacent to the spillway. The impoundment formed by the dam extends approximately 2.5 miles upstream, just below the Smith Rapids and has a normal surface area of 80 acres and a gross storage capacity of 480 acre-feet. The powerhouse generates 3.8 gigawatt hours (GWh) annually.

Approximately two miles upstream from the Alverno project is natural flow constriction in the Black River, known as Smith's Rapids. These rapids are a constriction in the river-the river bottom rises significantly and the width of the river and floodplain decreases. Though the Smith Rapids influences watershed hydrology it has been difficult to decipher at which flows the hydraulic control shifts between the dam and the rapids. At some moderate to low flow levels, operation of the dam has a direct influence on the water surface elevation of Black Lake.

Cheboygan Dam

Cheboygan started as a lumbering community in 1844. The Cheboygan River, the Inland Waterway and several of its tributaries were used for transporting logs from the lumbering regions upstream. Due to the high gradient of the Cheboygan River, there was a need to create a dam to raise the water level for moving raw lumber down river to the sawmills in the City of Cheboygan for processing.

Today, the Cheboygan Dam produces hydroelectric power. The hydroelectric power production (8.8 GWh annually) is owned and managed by the Great Lakes Tissue Company while the regulation of the water flow is managed by the MDNR. The dam consists of a powerhouse with four turbine bays, a navigation lock, natural earth embankment, a six-bay spillway, fish ladder (at spillway), and water pump house intake. The Cheboygan Dam operates under an exempt license, which does not require periodic renewal, due to the construction of the dam being prior to 1935.

The Dam is the first barrier upstream from Lake Huron, though due to the lock it is not a complete barrier. It inhibits several native species from being able to navigate upstream but some invasive species, such as sea lamprey, are able to get upstream.

Figure 12. Cheboygan dam. Locks (not pictured) are located further to the northeast. (Michigan Interactive)

OTHER DAMS

There are three other impoundments within the watershed that are utilized for recreational purposes by the MDNR.

- The Cornwall Creek flooding is an earthen dam built in 1966. It is 33 feet high and holds 1740 acre-ft of water. It flows into the Pigeon River. It is listed as a high-hazard dam by EGLE. The DNR is seeking funding for a dam assessment.
- Roberts Lake is an earthen dam built in 1948. It is 7 feet high and holds 93 acre-ft. It flows into the Little Sturgeon River.
- Echo Lake Dam is an earthen dam built in 1971. It is 16 feet high and holds 120 acre-ft. It flows into the Little Pigeon River.

1.12 Aquatic Invasive Species

Aquatic invasive species are non-native species introduced to an aquatic ecosystem that causes environmental and/or economic harm. Aquatic invasive species have come to the forefront of issues impacting our lakes, streams, and wetlands.

The Watershed, like many other watersheds, is infested to varying degrees with aquatic invasive species. Some species have been in the Watershed for decades while others are more recent invaders. Furthermore, some invasive species are on the verge of entering the Watershed as they continue to spread. The Great Lakes also remain a potential source of invasive species for inland lakes as many species spread via connecting waterways. The following species are all present within the Watershed. While there are many others that are not included here, these species are featured because of their prevalence or the threat they pose.

Zebra mussels

Zebra mussels (*Dreissena polymorpha)* are freshwater mollusks that have had a profound impact on the Great Lakes and inland lakes since their introduction in the late 1980s. The sheer number of zebra mussels in combination with their feeding habits has caused severe disruptions in aquatic ecosystems. As filter feeders, each zebra mussel is capable of filtering a liter of water per day; thus, removing almost every microscopic aquatic plant and animal (phytoplankton and zooplankton). The effect of this filtration is increased water transparency, which shows that water has become clearer in lakes infested with the mussels. Increased water clarity allows sunlight to penetrate to greater depths and results in increased growth of rooted aquatic vegetation and bottom-dwelling algae.

Zebra mussels are thought to be in all of the lakes within the Watershed. Exceptions may include smaller, isolated lakes without a connecting waterway to an infested lake.

Quagga mussels

Quagga mussels (*Dreissena rostriformis bugensis)* are freshwater mollusks similar in appearance to zebra mussels. A distinguishing characteristic between the two is when quaggas are placed on a surface they fall over as they lack a flat underside (hinged side), whereas zebra mussels remain stable on the flattened hinge side (Figure 13). Quagga mussels are commonly found in waters more than 90 ft. deep, while zebra mussels are usually found at depth of less than 50 ft. Unlike zebra mussels, quagga mussels can live and thrive directly on a muddy or sandy bottom. They also tolerate a wider range of extremes in temperature and water depth than zebra mussels and spawn at colder temperatures.

The only known occurrences of quagga mussels within the Watershed are in Mullett Lake.

Figure 13: Quagga mussel (left) and zebra mussel (Michigan Sea Grant)

Eurasian watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*) is a plant native to Europe and Asia that was first documented in North America in the mid-1940s. Since its introduction, it has spread to more than 40 states in the United States and to three Canadian provinces.

As Eurasian watermilfoil takes hold in a lake, it causes problems for the ecosystem and for recreation. It tolerates lower temperatures and starts growing earlier than other aquatic plants, quickly forming thick underwater stands of tangled stems and vast mats of vegetation at the water's surface. These dense weed beds at the surface can impede navigation. Eurasian watermilfoil also displaces and reduces native aquatic plant diversity, which is needed for a healthy fishery. Infestations can also impair water quality due to dissolved oxygen depletion as thick stands die and decay.

A key factor in the species' success is its ability to reproduce through both stem fragmentation and underground runners. Eurasian watermilfoil spreads to other areas of a water body by fragmentation. A single stem fragment can take root and form a new colony. Locally, it grows by spreading shoots underground.

Eurasian watermilfoil is widely distributed throughout the Watershed.

Phragmites

Phragmites (*Phragmites australis*), also known as the common reed, is an aggressive wetland invader that grows along the shorelines of water bodies or in water several feet deep. It is characterized by its towering height of up to 14 feet and its stiff wide leaves and hollow stem. Its feathery and drooping inflorescences (clusters of tiny flowers) are *purplish* when flowering and turn whitish, grayish, or brownish in fruit. Eventually, *Phragmites* become the sole dominant plant in many of these wetlands at the expense of native plants and animals that depend on these native habitats.

There are many occurrences of *Phragmites* within the Watershed. Those documented in the Midwest Invasive Species Information Network (MISIN) note phragmites along Indian River and the mouth of the Cheboygan River. While there are likely more stands elsewhere in the Watershed, they have not been documented.

Purple loosestrife

Purple loosestrife (*Lythrum salicaria*) is an invasive wetland plant. Imported in the 1800s for ornamental and medicinal uses, purple loosestrife poses a serious threat to wetlands because of its prolific reproduction. Native to Europe and Asia, purple loosestrife can be identified by its purple flowers which bloom from June to September. Purple loosestrife produces square woody stalks 4 to 7 feet high. Leaves are heart or lance shaped and flowers have 5 to 7 petals.

Due to the long flowering season, purple loosestrife plants have the ability to produce millions of seeds each year. In addition to seeds, purple loosestrife can also produce vegetatively by sending up shoots from the root systems. The underground stems can grow up to a foot each growing season.

Purple loosestrife is widely distributed throughout the Watershed.

Curly-leaf pondweed

Curly-leaf pondweed (*Potamogeton crispus)* is a perennial, submerged aquatic plant that is native to Eurasia. It tolerates fresh or slightly brackish water and can grow in shallow, deep, still, or flowing water. It generally grows in 3-10 feet of water. Curly-leaf pondweed tolerates low water clarity and will readily invade disturbed areas.

The only known occurrences of curly-leaf pondweed within the Watershed is in Mullett Lake.

Sea lamprey

Sea Lamprey (*Petromyzon marinus)* are primitive, jawless fish native to the Atlantic Ocean. In 1921, lampreys appeared in Lake Erie for the first time, arriving via the Welland Canal, which was constructed for ships to avoid Niagara Falls on their way up the St. Lawrence Seaway. Shortly thereafter, sea lamprey quickly populated all of the upper Great Lakes. The sea lamprey is an aggressive parasite with a toothed, funnel-like sucking mouth and rasping tongue that is used to bore into the flesh of other fish to feed on their blood and body fluids. Sea Lamprey contributed to the collapse of many fish species such as lake trout and Lake Whitefish.

The Cheboygan River is the only tributary to the upper Great Lakes where sea lamprey are known to complete their entire life cycle. The Pigeon, Sturgeon, and Maple Rivers provide nursery habitat for larval sea lamprey. Burt and Mullett Lakes provide feeding grounds for juvenile sea lamprey. Adult sea lamprey spawn and die in the Pigeon, Sturgeon and Maple Rivers (Johnson et. al, 2016).

Sea lamprey have been controlled in the Inland Waterway since the 1970s using applications of lampricide. The Pigeon River is currently treated with lampricide approximately once every four years. As of 2020 it has been treated 16 times, with treatment to occur again in 2024 or 2025. An experimental method of sterile male releases started in 2017 and preliminary results have shown great success with a reduced recruitment of about 80%. This method is expected to continue into the near future and expand to watersheds outside of the Cheboygan River Watersheds (Figure 14).

The USFWS coordinates all sea lamprey assessments. The USGS, Hammond Bay Biological stations conducts research, in partnership with USFWS, in the Cheboygan River Watershed.

The known occurrences of sea lamprey within the Watershed are:

- Cheboygan River
- Pigeon River
- Laperell Creek
- Meyers Creek
- Mullett Lake

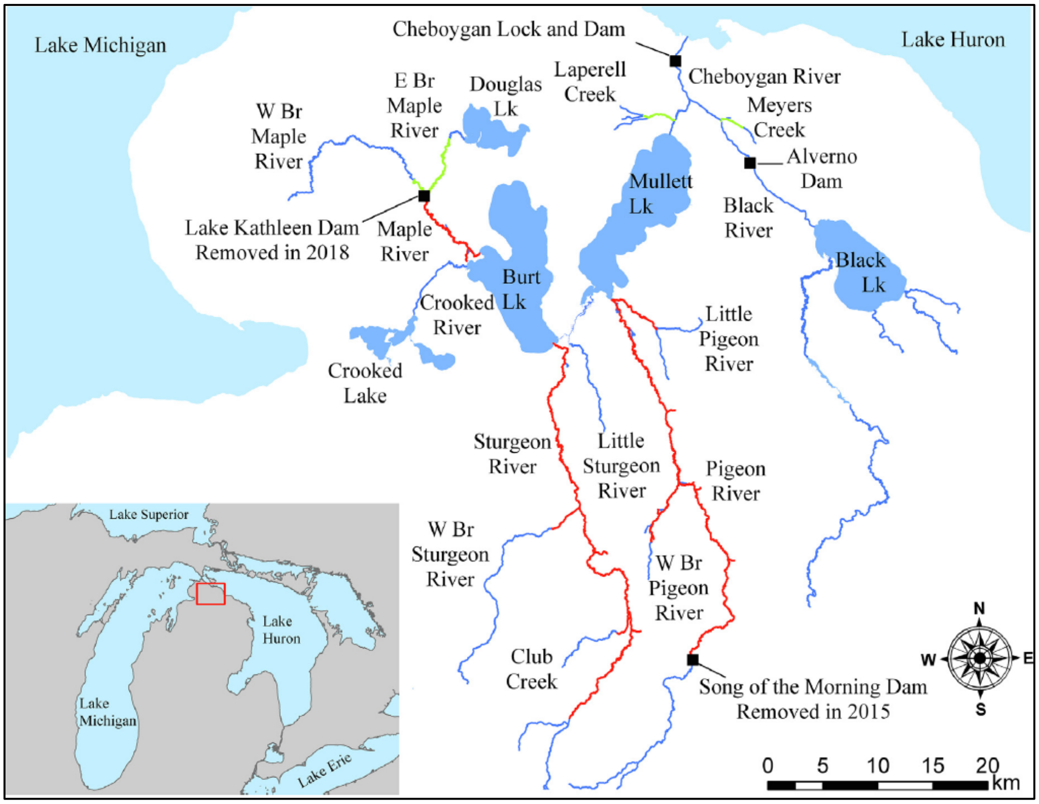

Figure 14. Cheboygan River Watershed lampricide treatments

Threatened and Endangered Species

Several notable threatened and endangered species inhabit the Mullett Lake Watershed. The species listed represent only a small portion of the total that are considered threatened, endangered, or species of concern. More information on these and other species can be found in Appendix A. It is also important to note that the following information oftentimes applies to the entire Cheboygan River Watershed, of which the Mullett Lake Watershed is included.

1.13 Fish

Lake Sturgeon (*Acipenser fulvescens*) is a state threatened species in Michigan. Populations in Michigan were estimated to be in the hundreds of thousands, but are since believed to be at 1% of their former size (Hay-Chmielewski and Whelan 1997). This is due to exploitation and habitat degradation and loss. Lake sturgeon would have been common throughout the lower reaches of the Cheboygan River Watershed and probably common in Black, Burt, and Mullett lakes. The species still exists today in each lake, with the largest population found in Black Lake. Hay-Chmielewski and Whelan

(1997) consider the Cheboygan River Watershed as highly suitable for future lake sturgeon rehabilitation and enhancement.

Threats to restoration of this fish are physical barriers to migration, loss and degradation of spawning and nursery areas, and fishing pressures (Rochard et al. 1990). Declining water quality, invasive species (such as sea lamprey, zebra mussels, round gobies), and contaminants are additional threats in the Great Lakes (Hay-Chmielewski and Whelan 1997). Stream conservation practices, such as maintaining or establishing sufficient riparian buffers or natural flows, and chemical pollution and exotic species control are important steps to managing for sturgeon populations. Mullett Lake was last surveyed in 2010 and will be surveyed again in 2024 by the MDNR and the Little Traverse Bay Bands of Odawa Indians (LTBB).

Figure 15. Lake sturgeon on Burt Lake (LTBB)

In addition to lake sturgeon, several other fish species of threatened, endangered, or species of concern have been documented within the Watershed, including the pugnose shiner, channel darter and cisco. The pugnose shiner is classified as endangered in Michigan. It inhabits clear vegetated lakes and vegetated pools and runs of low gradient streams and rivers. They appear to be extremely intolerant to turbidity. The channel darter is classified as endangered within the state. It inhabits rivers and large creeks in areas of moderate current over sand and gravel substrates. Cisco, also known as Lake Herring, is a threatened species in Michigan. Cisco often live in deep, oligotrophic lakes that possess good amounts of cold and highly oxygenated waters. This species has recently been found in Douglas and Burt lakes and is probably common in many other small inland lakes that possess these characteristics.

1.14 Reptiles

The eastern massasauga rattlesnake has special concern status in Michigan. The state's only venomous snake species, they inhabit damp lowlands, including river bottom woodlands, shrub swamps, bogs and fens, marsh borders, sedge meadows, and moist prairie, but may be found in upland meadows and woodlands in summer. They are considered uncommon and local, but are widely distributed across Michigan's Lower Peninsula.

The Cheboygan River Watershed is home to five species of turtles. Two of these (wood and Blanding's) are species of special concern in Michigan. Blanding's turtles inhabit clean, shallow waters with abundant aquatic vegetation and soft muddy bottoms over firm substrates. This species is found in ponds, marshes, swamps, bogs, wet prairies, river backwaters, embayments, sloughs, slow-moving rivers, and lake shallows and inlets. Habitat loss and road crossing mortality are the major causes of mortality for the Blanding's turtle. Wood Turtles are found primarily in or near moving water and associated riparian habitats. Their populations have been reduced primarily through mortality from crossing roads and from pet collection.

1.15 Birds

The state-threatened common loon breeds on the lakes, while stream edges are popular habitat types for several species of shorebirds and wading birds, such as great blue herons. Great blue heron rookeries are also listed as a natural feature of concern in the Mullett Lake Watershed. These rookeries contain groups of nests and are located in wooded wetlands with large trees.

1.16 Invertebrates

The Mullett Lake Watershed is also home to two endangered invertebrates, the Hungerford's crawling water beetle (*Brychius hungerfordi*) and the Eastern pondmussel (*Ligumia nasuta*). The Hungerford's crawling water beetle has been found in Mullett Creek. This species prefers cool water and well-aerated streams with a sand, gravel, and cobble bottom (Figure 16). The Eastern pondmussel inhabits lakes, ponds, and river mouths, preferring fine sand to mud substrates. The Slippershell (*Alasmidonta viridis*) is a threatened mussel that can be found in creeks and headwaters of rivers in sand or gravel substrates and occasionally, can be found in larger rivers and lakes and in mud substrates.

Figure 16. Hungerford's crawling water beetle (Roger M. Strand)

1.17 Plants

Michigan monkey-flower (*Mimulus michiganensis*) is a federal and state-listed endangered species. Nearly all known populations of the monkey-flower occur near present or past shorelines of the Great Lakes. Recreational and residential development is the main threat to this aquatic and semi-aquatic species. Increased construction along lakes and streams has destroyed monkey-flower habitat, including three known populations of the flower. Because the monkey-flower needs flowing spring water, road construction and other activities that affect water drainage also affect the species. Michigan monkey-flowers now survive at only 12 sites in Michigan. Two-thirds of the plants are on private property.

Occurrences of Michigan monkey-flower are often very localized, sometimes consisting of small but dense patches restricted to small seeps, springs, and depressions, whereas others are comprised of numerous patches of plants widely dispersed along small streams and spring-fed seeps within northern white cedar swamps. Large to moderately sized populations occur in the Watershed.

Wild rice (*zizania palustris*) is an annual plant that is thought to have once been abundant through Michigan but has been nearly extirpated in northern Michigan. Reasons for the decline are due to shoreline development, increased recreation and predation herbicide application, and climate change. Wild rice prefers shallow water with mucky or muddy bottom where there is a slight current.

Wild rice is known to occur in Mullett Lake, Pigeon River and Indian River. There is a statewide effort underway to protect and restore this species, as it's a culturally significant species to the Anishinaabe people and is a vital resource for migratory birds and other wildlife.

1.18 Wetlands

It is important to include wetlands in watershed plans because of the important role they play in ecosystem function and watershed dynamics. Wetlands are a product of and have an influence on watershed hydrology and water quality. Wetlands contribute to healthy watersheds by influencing important ecological processes.

Wetlands are the link between land and water. They are transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils, and vegetation, making these areas very important features of a watershed.

- Environmental Protection Agency, n.d.

The Watershed includes a variety of wetland types. In general, wetlands provide many ecological services including water quality protection through recycling of nutrients and filtration of pollutants. They help to mitigate flooding, while recharging groundwater. They provide habitat for countless wetland-dependent species. And lastly, they play a critical role in reducing the impacts from climate change by sequestering carbon.

In a 1990 report to Congress, the Michigan Department of Natural Resources (MDNR) and the U.S. Department of the Interior estimated that Michigan had lost approximately 50% of its original wetland resource base. According to EGLE, the Watershed pre-settlement conditions included an estimate 40,000 acres of wetlands, as compared to 34,071 acres remaining as of 2005 (a 15% loss of wetlands or 5,929 acres). In addition, the average size of wetlands has decreased during this time from 25.5 acres to 19.5 acres. (The Mullett Lake/Lower Black River Watershed Landscape Level Wetland Functional Assessment, EGLE, November 2020).

In Michigan, wetlands are beginning to be considered in the context of watershed management planning and the creation of municipal master plans. Wetland restoration and enhancement are increasingly becoming popular tools, in lieu of traditional best management practices, to enhance the overall ecological health and surface water quality of a watershed. Understanding the overall historic impact of wetland loss and degradation can assist local planners and resource managers in sighting future development as it lends new importance to the wetlands that remain. Figure 17 shows the wetlands lost from 1800 to 2005.

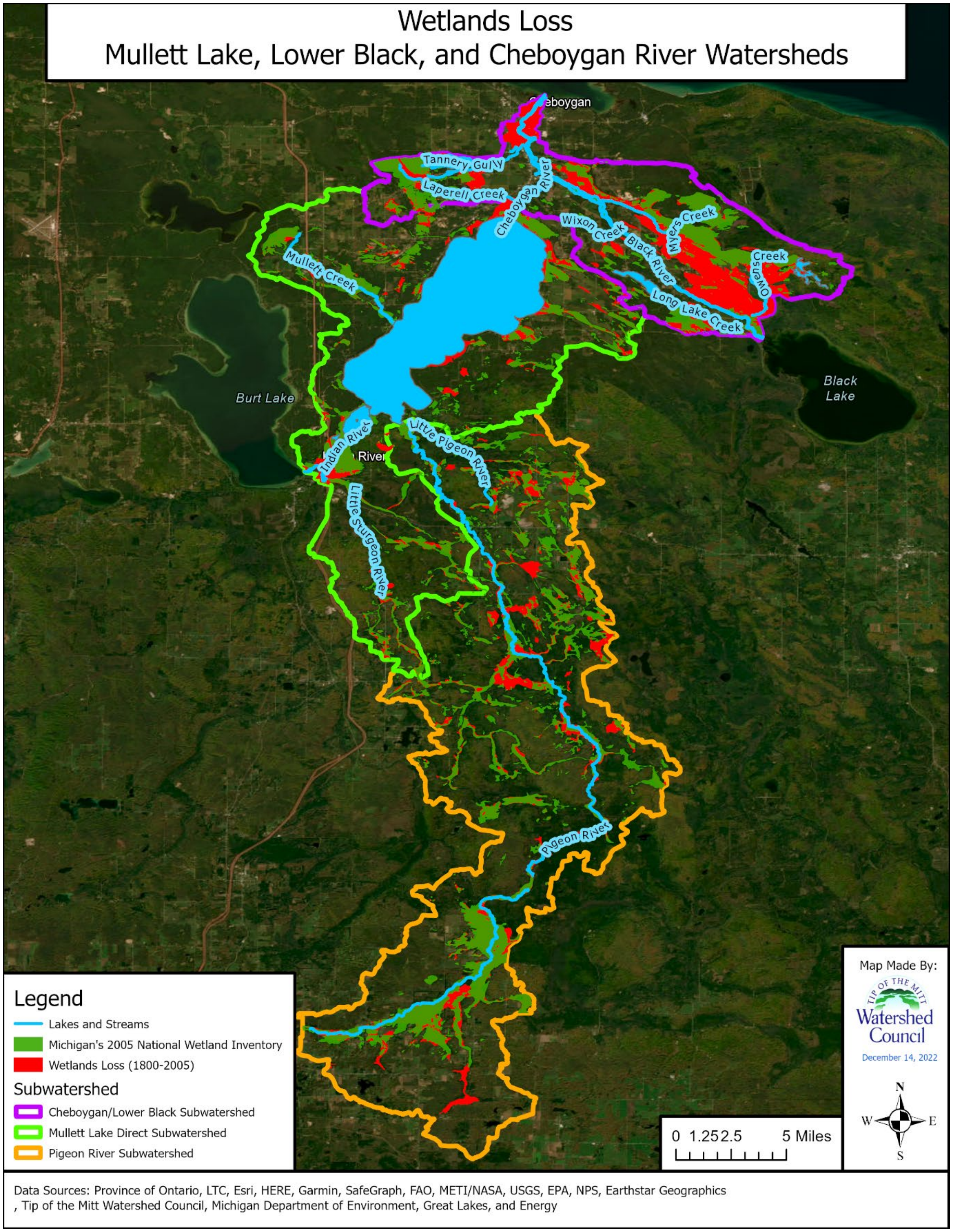

Figure 17. Wetlands loss from 1800-2005

The Watershed has several high-quality wetland areas: the Indian River spreads, Pigeon River spreads, and Mullett Creek wetlands to name a few. Further review of wetlands can be found in the Resource Inventory chapter.

1.19 Cultural History

Long before the arrival of Europeans, the northern portion of Michigan's Lower Peninsula was most recently home to the Anishinaabe. The total population of the Anishinaabe in this region at that time is not known, although the summer population has been estimated to range somewhere between 30,000 and 100,000.

The Anishinaabe made their home here for hundreds of years, maintaining villages along the Lake Michigan shoreline and along the Inland Waterway. These northern villages were primarily occupied with the tribes traveling to rivers along the southern coast of Lake Michigan during winter. After the spring maple syrup season was completed, the tribes returned north to the Little Traverse Bay, Cross Village, and the Inland Waterway. These villages were connected by a series of footpaths which allowed natives to travel overland (many of today's roads and highways roughly follow these paths). More important than footpaths for travel were the waterways, because large distances could be covered quickly. Native Americans utilized the Inland Waterway, in part, as a means of traveling from Lake Huron to Little Traverse Bay, avoiding the perilous journey through the Straits of Mackinac and around Waugoshance Point. The name Cheboygan likely originated from an Anishinaabe word meaning "a body of water connecting another body of water" though the exact word and translation are unknown. Using birch bark canoes well adapted for rough waters and light enough to carry on portages, Native Americans could quickly travel from Little Traverse Bay to hunting grounds, seasonal fishing spots, and neighboring villages along the Crooked River, Burt Lake, Indian River, Mullett Lake, and the Cheboygan River.

The marshes, bogs, and swamps along the Inland Waterway are rich in plants that were utilized by the Anishinaabe for fiber, medicines, and foodstuffs. Bulrushes, grasses, cattails, and sedges found in today's marshes were extensively harvested for baskets, shelter, fish nets, and clothing. Sphagnum moss, a common plant of many wetland environments, was stuffed into boots and clothing for insulation and wetland shrubs such as red-osier dogwood and some common mosses were used for dyes. Numerous wetland plant species were used for their medicinal properties: Labrador tea for the treatment of ulcers, willow for indigestion, balsam fir for headaches, and tamarack for burns.

Waterfowl, which were attracted to the vast wetlands in the area, gathered in great numbers during both the spring and fall migratory seasons and were a primary source of food. Freshwater mussels and clams were harvested from shallow waters and numerous types of fish, from whitefish to lake sturgeon were netted or speared throughout the warm months.

1.20 Population

The Watershed today includes a few small towns and villages, but overall the Watershed is mostly rural and lightly populated. Riparian areas tend to be more developed with both permanent and seasonal residences. Population of Cheboygan County, in which this watershed largely resides, is 25,435. The population density of the townships within the watershed can be found in Figure 18.

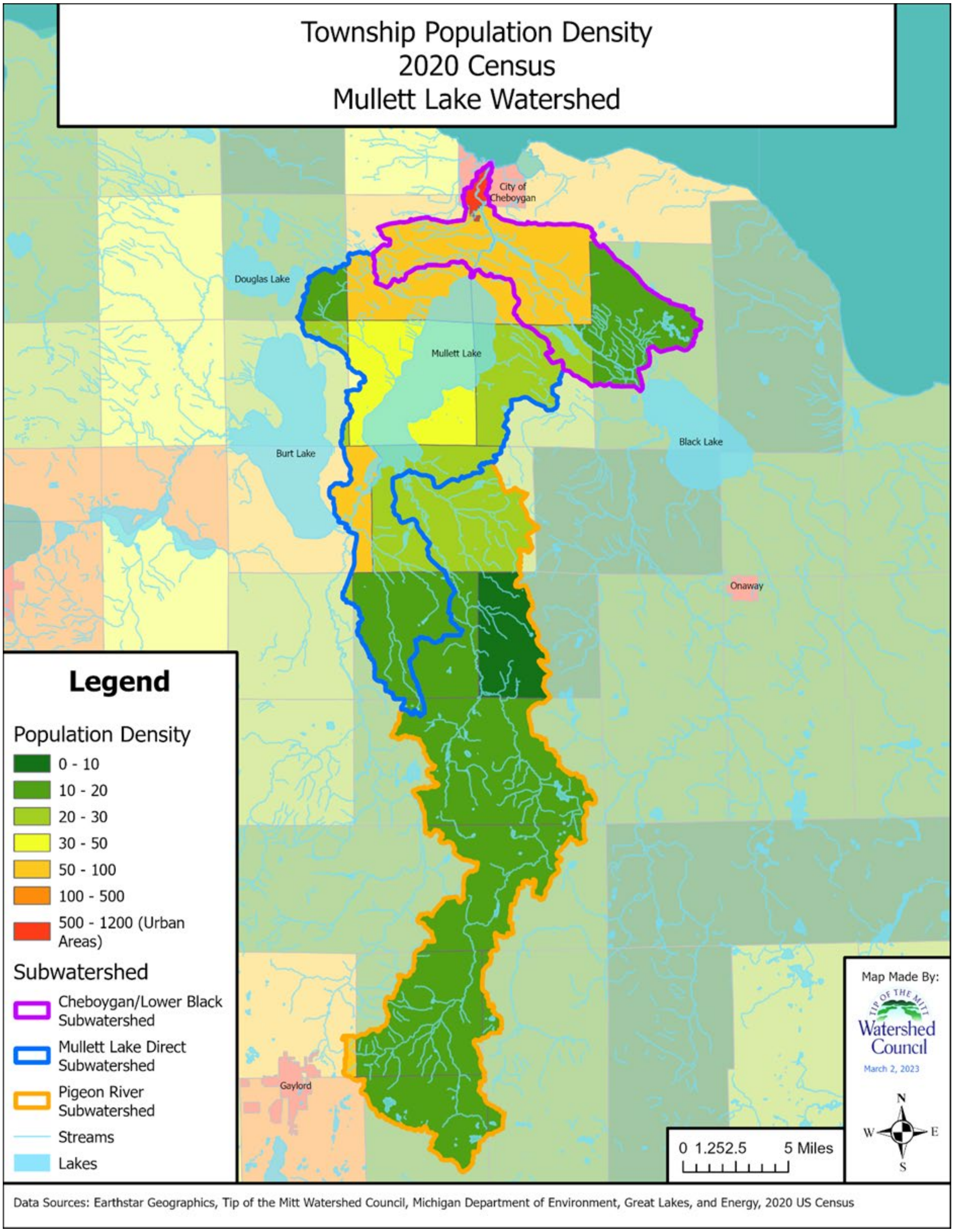

Figure 18. Watershed population density

1.21 Enbridge Line 5

Line 5 is a 645-mile petroleum pipeline owned and operated by Enbridge Energy, Limited Partnership. The line runs from Superior, Wisconsin, across Michigan's Upper Peninsula, through Northern Michigan, down to the thumb region, and over to Sarnia, Ontario. Line 5 is 30 inches in diameter, except when crossing the Straits of Mackinac, where it divides into two 20-inch diameter pipes. The line became operational in 1953 and carries up to 540,000 barrels or 22.7 million gallons of light crude oil, synthetic crude, and natural gas liquids per day.

In the Northern Lower Peninsula, Line 5 crosses the Indian River, Little Sturgeon River, Pigeon River, and Upper Black River and traverses within a few miles or less from many sparkling inland lakes, including Paradise, Burt, Mullet, and Douglas (Figure 19).

Enbridge monitors these river crossings through a combination of patrols, depth of cover surveys, and site visits. In particular, depth of cover surveys are conducted every 10 years at minor crossings and every 5 years at major crossings.

According to Enbridge, about 30% of the volume carried by Line 5 (35,000 barrels per day) is delivered to Marathon's Detroit refinery as well as refineries in Ohio. In addition, Enbridge claims Line 5 delivers 65% of the propane that heats Upper Peninsula homes, and 55% of Michigan's propane needs.

The pipeline in the Straits of Mackinac was authorized under Public Act 10 by the Michigan Department of Conservation, which predated both EGLE and the Michigan Department of Natural Resources (MDNR). An easement was granted to Lakehead Pipeline Company, Inc. in 1953 for the pipeline. In 2020, the State of Michigan revoked the easement for violation of the public trust doctrine, and was terminated based on Enbridge's persistent, and incurable violations of the easement's terms and conditions.

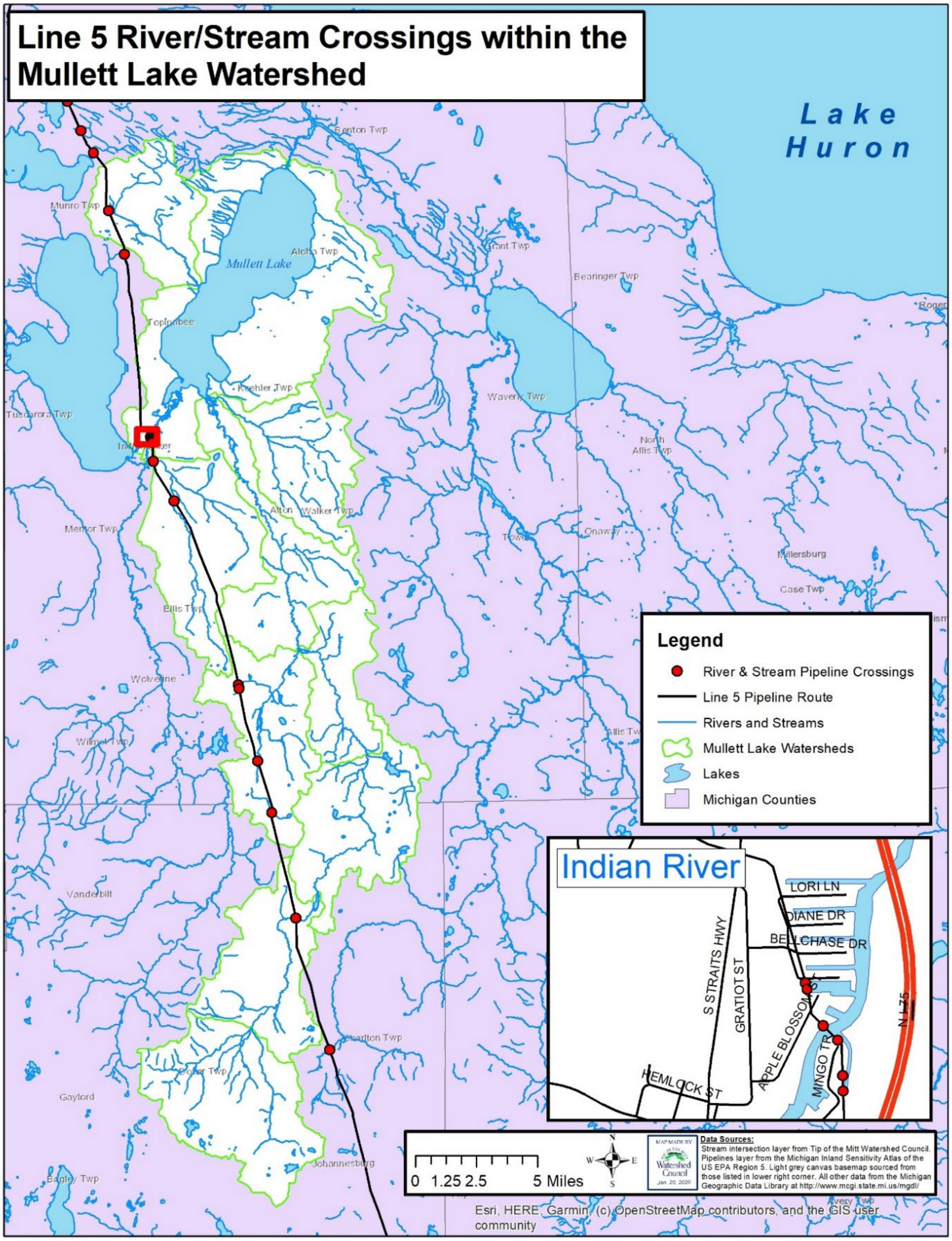

Figure 19. Line 5 crossings in the Watershed

1.22 Zoning

TOMWC produced a Local Ordinance Gaps Analysis for Cheboygan County in 2014. The Gaps Analysis is a review of all the water-related ordinances for the county. The purpose was to evaluate existing ordinances against what should be in place to best protect water resources, and offer recommendations and suggested actions to help local governments strengthen any areas that need improved. It covers ordinances at not only the county level, but also for cities, townships, and villages in the county (Figure 22). A plan was then created for each jurisdiction to enact needed ordinances and improve weaknesses; including a prioritization based not only on need but also the ability to enact or improve quickly due to assets available in specified locations. An example of the analysis can be seen in Figure 20. The full Gaps Analysis can be found on TOMWC's website.

As part of Plan development, a review was conducted of local government ordinances in the watershed. Since Cheboygan County has not updated their master plan since the 2014 Gaps report, the recommendations still stand. As the County works towards reviewing and updating their master plan, the Watershed Council recommends an emphasis on climate resiliency. The City of Cheboygan updated its master plan and ordinance in 2018 and showed some positive improvements to the language. Both the City and the County don't have any requirements for shoreline protection and is an area of improvement. The full summary of recommendations can be found in Appendix B.

Shorelines
POSSIBLE SCORE: 60
TOTAL SCORE: 8, WEAK

There is very little included in the City's Zoning Ordinance that refers to shoreline protection for either the Great Lake's coastline or inland streams. This is something that should be addressed because the City has great potential to impact these water resources. Shorelines are vital areas to the health of water resources, as noted in the Literature Review.

The Zoning Ordinance does address marinas in section 154.070. This is the Waterfront-Marina District, which places limits on the types of land use and buildings that can be erected within such an area (154.070). This district is "designed to accommodate recreational boating along with activities and services related to harbor and waterway improvements, thereby facilitating navigation and providing safe and economical waterfront, recreational development." (154.070) In addressing where boat repair and maintenance activities can take place, it requires engine and hull repair to take place in completely enclosed buildings, or enclosed with a six feet high masonry wall or 10 foot wide greenbelt [154.070(C)(1)]. It does not have strict requirements for fueling stations, in terms of spill containment, but all boat fuel stations must be located at least 200 feet from any residential district [154.0708(C)(2)].

Shorelines: RECOMMENDATIONS

SUGGESTED ACTION: Require waterfront setbacks and Natural Vegetation Strips for waterfront properties on lakes and streams. Prohibit invasive species from being used in the vegetation strip.

SUGGESTED ACTION: Restrict boat repair and maintenance activities in marinas to clearly marked areas, to prevent contaminants and debris from falling into the water and limit the spread of invasive species. Also, require marina fueling stations to have spill containment equipment that is stored in a clearly marked location. Require a spill contingency plan and post emergency phone numbers in a prominent location. Finally, signs of leakage or spillage should be investigated immediately, and cleaned up in accordance with applicable Best Management Practices (BMPs).

Figure 20. Example from the Cheboygan County Gaps Analysis

As a designated Natural River of Michigan, the Pigeon River is subject to the Natural River Zoning Ordinance. That ordinance, while only covering within 400 feet directly adjacent to the rivers and streams, does provide some degree of protection which otherwise does not exist in Cheboygan County. Land change, earth moving and placement of structures are regulated within this zone. Below is a map (Figure 21) of the rivers and streams protected by this ordinance.

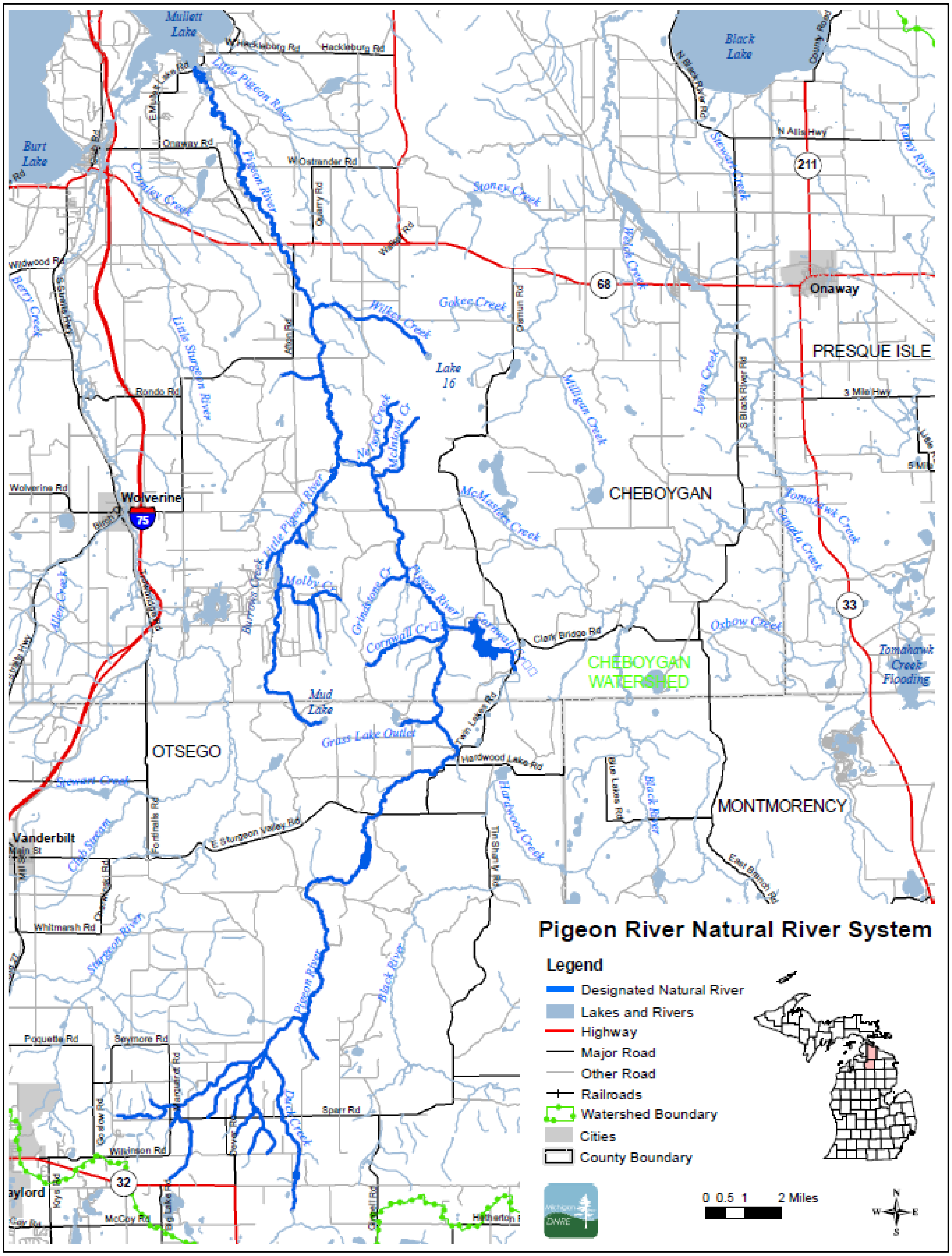

Figure 21. Designated natural river

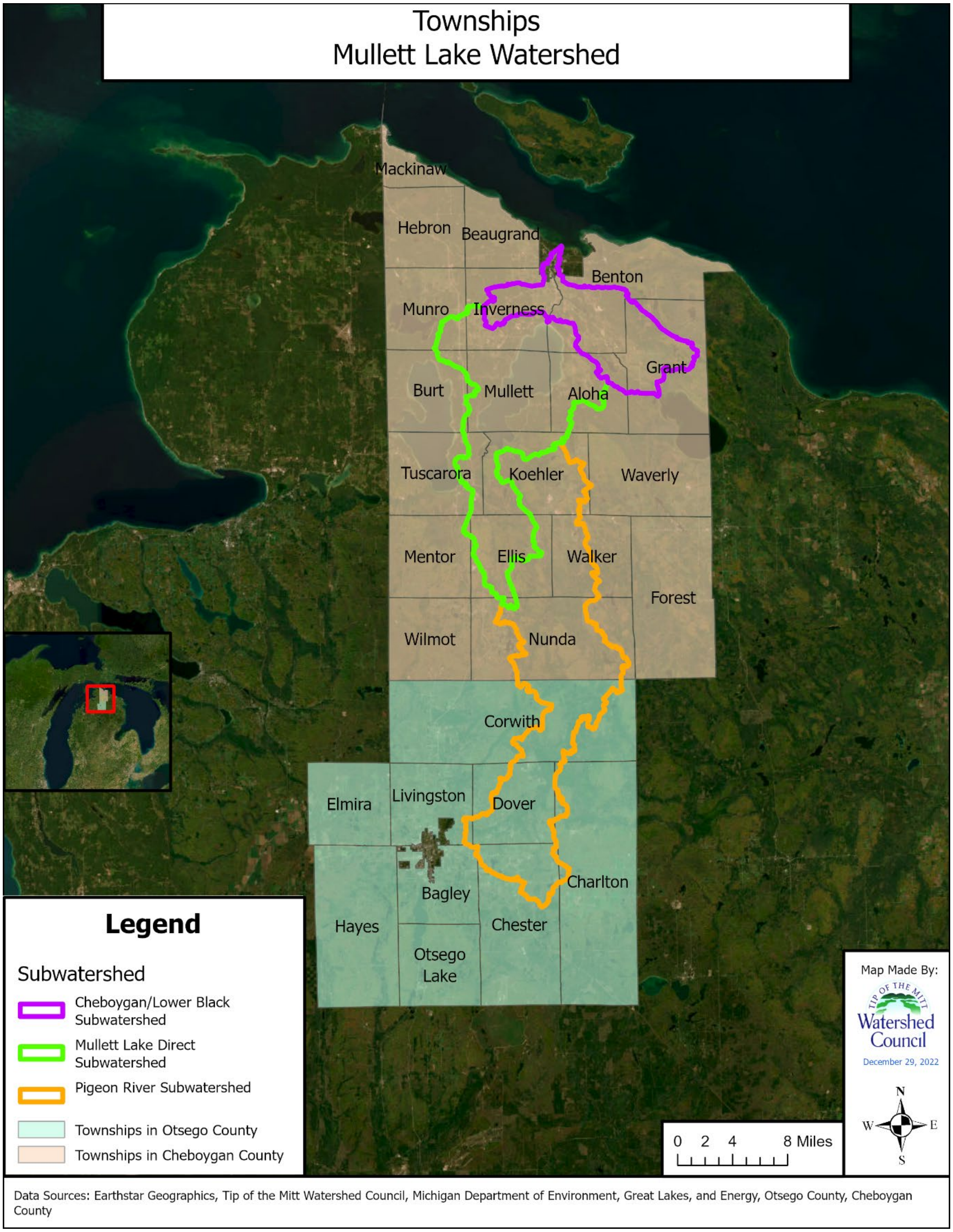

Figure 22. Townships in the Mullett Lake, Lower Black and Cheboygan Rivers Watershed

1.23 Watershed Organizations

The below information includes both general descriptions about these organizations as well as highlights of their recent efforts toward watershed protection.

Huron Pines

Huron Pines is a nonprofit conservation organization whose mission is to conserve the forests, lakes, and streams of Northeast Michigan to ensure healthy water, protected places, and vibrant communities. They manage invasive species, protect land, reconnect rivers and streams, and provide education opportunities. To date, Huron Pines has replaced 9 road stream crossings in the Watershed on Mullett Creek, Pigeon River, and tributaries to the Pigeon River.

Little Traverse Bay Bands of Odawa Indians

The Little Traverse Bay Bands of Odawa Indians is a federally reaffirmed tribe with a robust natural resources department whose service area covers the 1836 ceded territory. They work to protect the environment for the next seven generations through surveys, assessments, protection, and restoration.

Little Traverse Conservancy

The mission of the Little Traverse Conservancy is to protect the natural diversity and beauty of northern Michigan by preserving significant land and scenic areas, and fostering appreciation and understanding of the environment. Their service area includes Chippewa, Mackinac, Emmet, Cheboygan, and Charlevoix counties.

LTC has protected over 8,000 acres of land through direct acquisition, conservation easements on private lands, working forest reserves, and assist projects with local units of government throughout the Watershed. They are actively working with landowners within the Watershed who are in the process of donating conservation easements on their lands.

Mullet Lake Area Preservation Society (MAPS)

The Mullett Lake Area Preservation Society's mission to preserve and protect Mullett Lake is pursued with financial support of the Mullett Lake community in collaboration with TOMWC, Cheboygan County government and the Michigan DNR.

MAPS efforts include lake monitoring and support of lake stewardship by educating members and supporting their efforts to protect Mullett Lake shorelines. These shorelines critical to lake health, are surveyed for possible erosion and septic system leakage. Best practices for designing, developing and maintaining lakefront shorelands are promoted and cost shared with lake property owners. Septic system maintenance is promoted locally through education and in collaboration with county government. MAPS also partners with other lake associations in a tri-county area to address invasive species prevention and removal.

The Northern Inland Lakes Citizens Fishery Advisory Committee

The Northern Inland Lakes Citizens Fishery Advisory Committee, established in 2009, provides an excellent opportunity for citizens to become involved with natural resource management within the Cheboygan River Watershed through a multi-agency, multi-organization partnership. Public involvement through the advisory committee, one of its member organizations, or other citizen groups provides the opportunity to open a dialogue on natural resources issues and promotes the exchange of experiences, ideas, and proposals among individuals, communities, interest groups, and government agencies. Numerous opportunities exist for concerned citizens to become involved in issues affecting the Watershed; citizens are encouraged to take advantage of these opportunities for participation.

Tip of the Mitt Watershed Council

Tip of the Mitt Watershed Council is a not-for-profit organization that is dedicated to protecting the lakes, streams, wetlands and groundwater of Northern Michigan through respected advocacy, innovative education, thorough research, water quality monitoring and restoration actions.

TOMWC has worked extensively on monitoring efforts throughout the Watershed since its inception, however, only one restoration project. A list of efforts undertaken over the last 20 years can be found in Table 2.

In addition, TOMWC has performed many of shoreline assessments, and designed and coordinated numerous bioengineering and greenbelt projects for shoreline properties. TOMWC has developed and distributed many educational and outreach materials that pertain to invasive species, shoreline management, water quality, and other topics that relate to watershed protection.

Table 2. TOMWC Mullett Lake Watershed projects (2002-2022)

Project Title	Waterbody
Aquatic Plant Survey	Mullett Lake
	Long Lake
Shoreline Survey	Mullett Lake
Tributary Monitoring	Indian River
	Little Sturgeon River
	Pigeon River
	Mullett Creek

	Cheboygan River
Comprehensive Water Quality Monitoring	Mullett Lake
	Long Lake
	Twin Lakes
	Cheboygan River
	Indian River
	Little Sturgeon River
	Pigeon River
Volunteer Lake Monitoring	Mullett Lake
	Long Lake
	Twin Lakes
Volunteer Stream Monitoring	Mullett Creek
	Milligan Creek
	Pigeon River
Greenbelt Workshop	Mullett Lake
Native Plants Garden	Cheboygan River

1.24 Previous Watershed Management Efforts

Mullett Lake Watershed Planning Project

In 2002, a watershed plan was written by the TOWMC and MAPS to protect the high-quality water resources in the watershed. Specific goals are as follows:

- Maintain navigation in the rivers and lake by reducing any sediment inputs.
- Protect the diversity of aquatic habitats within the Mullett Lake Watershed by reducing the contribution of sediment, nutrient, and toxic pollutants (warm water fishery and other aquatic species and wildlife).
- Maintain the excellent recreational partial and total body contact opportunities in the rivers and lake by reducing sediment and nutrient contributions.
- Reduce sediment and nutrient loads which threaten to harm habitat conditions for the cold-water fishery in Mullett Lake and its tributaries.

Mullett Creek Watershed Management Plan

The Mullett Creek Watershed Management Plan provides a watershed-based management approach for improving water quality and preserving the ecological integrity of Mullett Creek. Water quality concerns in the watershed include nutrient pollution, excessive sedimentation, high bacteria concentrations, and elevated water temperatures. The stream ecosystem is also under threat from aquatic invasive species and habitat loss. Stressors affecting the Mullett Creek ecosystem include: agricultural operations, residential land use, road-stream crossings, and beaver dams.

This plan was written by TOMWC and the University of Michigan Biological Station (UMBS) and was revised in 2012.

Cheboygan River Watershed Habitat Partnership

The Cheboygan River Watershed Habitat Partnership was created to bring together several agencies and organizations dedicated to the protection of the Watershed's natural resources. These partners developed this conservation plan in an effort to devise strategies to preserve biological diversity throughout the Watershed in a comprehensive and complementary manner. The planning team identified a set of ecological targets and values that provide the basis for conservation activities in the Watershed. These targets are: bogs, fens and hardwood -conifer swamps, Michigan monkey-flower, Hungerford's crawling water beetle, lakes and associated wetlands, lakes and streams in karst terrain, ground water-driven streams and riparian corridors, and wildlife corridors and core habitat. Despite historical and ongoing impacts from human activities, these targets and the ecological processes that support them remain relatively intact. The overall healthy condition of the conservation targets is reflected in the "Good" biodiversity health assessment rank.

The primary sources of stress impacting the conservation targets are residential development, roads and utilities, dams, increased imperviousness, and shoreline alteration and hardening. While these threats are projected to increase given continued expansion of residential, commercial, and recreational development in the region, numerous opportunities exist to minimize the impacts of human activities and to educate both residents and visitors to the Watershed on the importance of natural resource protection. The planning team identified 16 strategies to address threats to the conservation targets. Six of these were selected for immediate development and implementation: stabilizing and upgrading road/stream crossings, coordinated land protection, establishing and enforcing sound planning and zoning, implementing shoreline best management practices (BMPs), promoting economic benefits of resource protection, and retrofitting existing developed areas to reduce polluted stormwater runoff.

Cheboygan River/Lower Black Watershed Management Plan Initiative

The mission of the Cheboygan River/Lower Black River Watershed Initiative was to ensure high water quality and provide for the protection of wildlife by reducing amounts of nutrients, sediments, and toxic pollutants entering the River system. The Cheboygan River/Lower Black River Watershed Initiative determined that there are five designated uses that are threatened: Warm and Coldwater Fisheries, Aquatic Life and Wildlife, Recreation Total/Partial Body Contact, Navigation, Public Water Supply.

1.25 Mullett Lake Direct Subwatershed

The Mullett Lake Watershed is the area that drains into Mullett Lake. This area includes:

- Indian River
- Little Sturgeon River
- Pigeon River
- Little Pigeon River
- Mullett Creek

Landscape, Soils, and Groundwater

The Mullett Direct subwatershed (Figure 23) begins at Indian River which flows out of Burt Lake. It flows through the urbanized village of Indian River. Once the river goes under I-75, it flows through a low, natural wetland area and opens up to the Indian River spreads, which boasts a diversity of plants and wildlife, before entering Mullett Lake. The Little Sturgeon River originates in mostly forested location. A large stretch of the River is privately owned by the Little Sturgeon Trout Club. It crosses under I-75 and discharges into the Indian River. Along the northwestern part of Mullett Lake, the headwaters of Mullett Creek originate in an area with several agricultural parcels. Other tributaries that discharge to Mullett Lake are Mullett Creek, Hatt Creek, and Ballard Creek. Elevation in the subwatershed averages around 200 m, with the highest elevation being northeast of Mullett Creek at around 275 meters. The soils are largely group A which have high infiltration rates.

The degree of groundwater contributions to surface waters in the Mullett Lake Direct Watershed is illustrated in Figure 24.

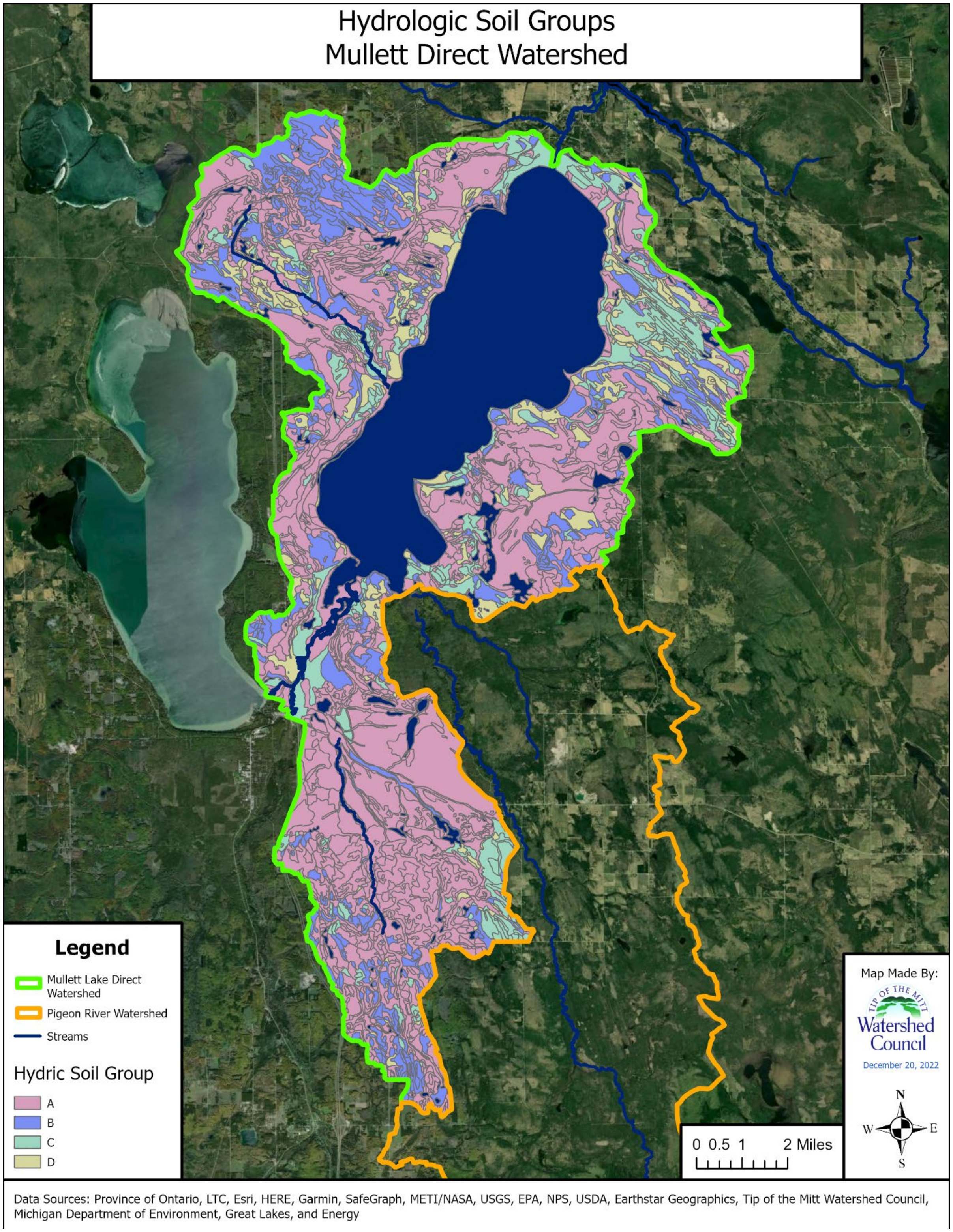

Figure 23. Hydrologic soil groups in the Mullett Direct subwatershed

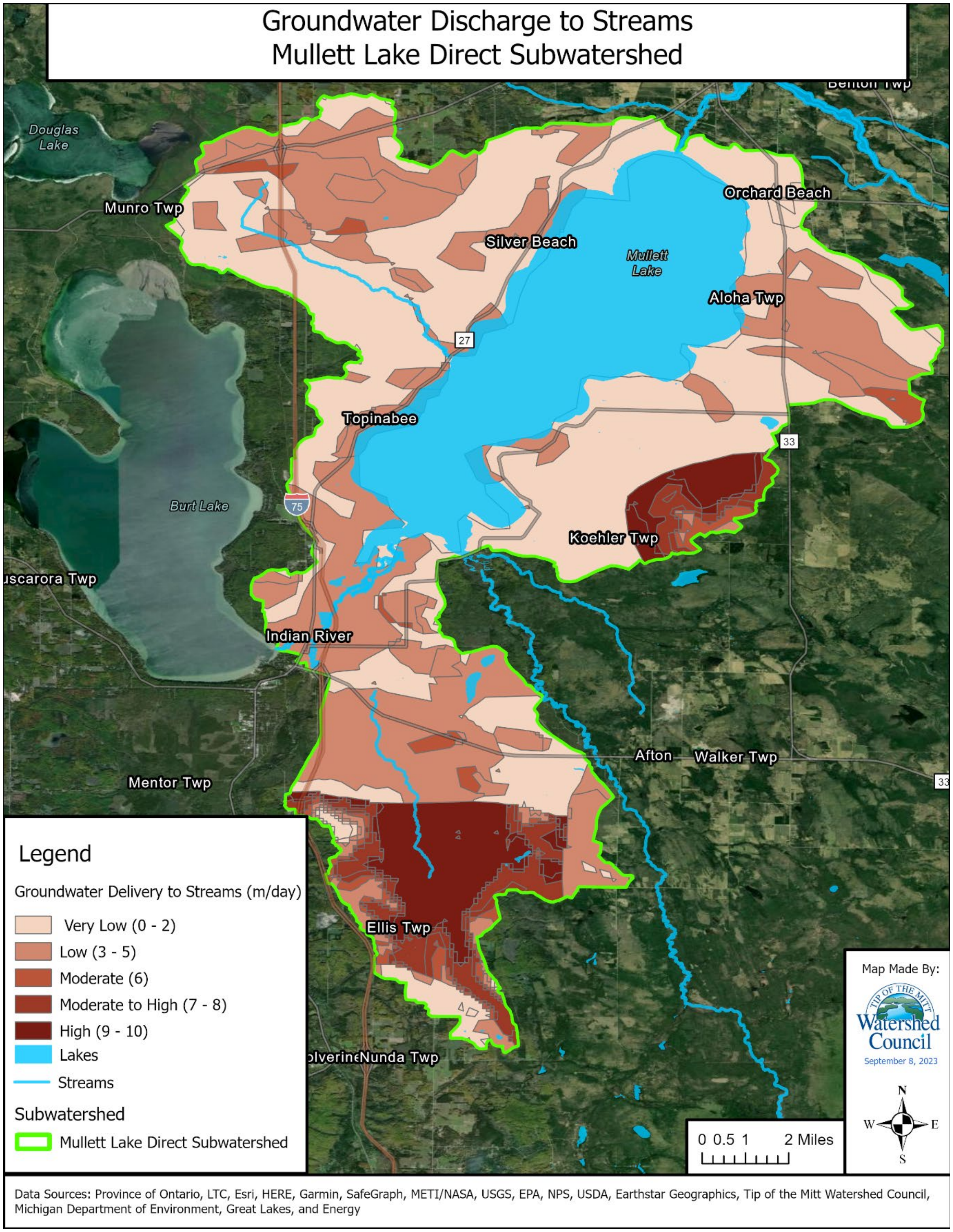

Figure 24. Groundwater discharge to streams

MULLETT LAKE

Primary Inflows: Indian River, Pigeon River, Little Pigeon River, Mullett Creek
Primary Outflows: Cheboygan River
Surface Area: 16,630 acres
Shoreline: 28 miles
Maximum Depth: 145 feet

Mullett Lake is a large, deep, high quality lake located just east of I-75 in Cheboygan County. Mullett Lake is part of northeast Michigan's Inland Waterway and is the state's fifth largest lake, with a surface area of 16,630 acres. The lake is considered oligotrophic and is an excellent fishery. Most of the homes that reside on the lake are seasonal homes. Mullett Lake lies within six townships: Aloha, Benton, Inverness, Koehler, Mullett, and Tuscarora, and is under the auspices of the Cheboygan County Zoning Ordinance.

Located within Mullett Lake's Watershed area are the unincorporated communities of Indian River and Topinabee. The Watershed is easily accessible by Interstate 75 and is primarily a water-based recreation area. The Watershed is mostly forested, with lesser amounts of agricultural and urban areas.

INDIAN RIVER

Primary Inflow: Burt Lake, Little Sturgeon River
Primary Outflow: Mullett Lake
Length: 3.9 miles

The Indian River is Mullett Lake's largest tributary. The unincorporated village of Indian River covers a significant portion of its watershed near the river's outlet from Burt Lake. The village contains approximately 700 homes and 150 businesses, and is completely served by individual septic systems and wells. While many of the homes only receive seasonal use, it appears that ever-increasing numbers are being converted to year-round use. There are efforts underway to install a sewer system that will reach close to 400 properties once completed. A large number of wells are artesian, indicating the presence of a clay layer beneath the village.

The river and its watershed lie within Koehler, Ellis, and Tuscarora Townships. Two roads, expressway I-75 and highway M-27, and a railroad cross the river. Dense residential development is present, adjacent to the river upstream from I-75. The shoreline has been greatly altered with piers, bulkheads, and filled areas. In some areas, dredged canals extend inland as far as 1,000 feet from the river. Most of the town of Indian River lies within the Indian River Watershed. Approximately 200 residences are located within a 300-foot corridor of the river or its canals. Several marinas and commercial businesses are also located in this area.

Downstream from I-75, the stream flows through the Indian River Spreads, which is the largest inland cattail marsh in northern Michigan. The spreads are considered an important area for fish spawning, marsh and shore birds, waterfowl, and other wildlife.

Other portions of the Indian River watershed are mostly forested, with conifers in lowland areas and mixed forests in upland areas. Most of the watershed was formerly covered by the waters of the post-glacial Great Lakes. However, two "islands" of moraine deposits are found in the east and west ends of the watershed. The highest point is found in the west end, where the elevation reaches 894 feet, 300 feet above the river. The river itself occupies an outreach channel, and the topography along the banks varies from flat to gently sloping. The glacial deposits vary in thickness from 200 to more than 30 feet.

Land ownership along the river is mostly private. However, approximately 37 percent of the riverfront is owned by state and township governments. This public land is located in the Indian River Spreads.

The average discharge volume of the Indian River is 568 cubic feet per second (cfs). It is nearly four times larger than the Pigeon River. The Indian River's surface drops less than one foot between Burt and Mullett Lakes. Since 1948, the U.S. Army Corps of Engineers has maintained a channel for navigation five feet deep and thirty feet wide under authorization of the Rivers & Harbors Act. The channel is marked by navigation aids. The Sturgeon River was formerly a tributary of Mullett Lake, emptying into the Indian River, but its channel was diverted into Burt Lake to facilitate navigation on the Inland Waterway.

LITTLE STURGEON RIVER

Primary Inflow: groundwater
Primary Outflow: Indian River
Length: 10 miles

The Little Sturgeon River's watershed occupies portions of three townships: Ellis, Koehler, and Tuscarora. The watershed is mostly forested; however, some cleared and agricultural land is found in the southern portions of the watershed. The greatest residential development is found in this area, along Shooks, Afton, and Rondo Roads, as well as the western portion of the town of Indian River.

The elevation of the headwaters of the Little Sturgeon is 869 feet, the stream descends 276 feet in 12 miles for an average gradient of 23 feet per mile. The greatest elevation in the watershed, 1,017 feet in the west-central portion, rises nearly 300 feet above the stream. The northern half of the watershed, and all but the upper portions of the Little Sturgeon and Johnson Creek, lie in areas which were inundated by higher stages of the

Great Lakes. Steep-sided terraces are found along the Little Sturgeon and Crumley Creek in the vicinity of M-68. The Little Sturgeon River flows for a short distance through the abandoned streambed of the Sturgeon River before discharging into the Indian River. The channel of the Sturgeon was diverted to Burt Lake in 1886 to improve navigation on the Indian River.

A large amount of state-owned land is located within the Little Sturgeon Watershed. More than eight miles of this stream system flows through state land. The major private landowner is the Little Sturgeon Trout Club, which owns five miles of stream frontage along the lower Little Sturgeon and its tributaries, Crumley Creek and Twin Lakes Creek. A footbridge and concrete dam are located in this area. Except for the portion of the river that flows through the town of Indian River, most of the private land ownership occurs as large tracts.

COCHRAN LAKE

Primary Inflow: groundwater
Primary Outflow: tributary to Roberts Lake
Surface Area: 28 acres
Shoreline: .83 miles
Maximum Depth: 15 feet

Cochran Lake is a small natural waterbody located approximately three miles east of Indian River and lies within Koehler township. The lake is about 2 acres in size and its deepest location is approximately 15 feet deep. The substrate is primarily sand and detritus and aquatic vegetation is common in the warmer months. It is surrounded entirely by public land. The lake has no inlet, while the outlet of Cochran Lake is a small intermittent tributary which flows to Roberts Lake.

ROBERTS LAKE

Primary Inflow: tributary from Cochran Lake
Primary Outflow: Twin Lakes Creek
Surface Area: 68 acres
Shoreline: 1.67 miles
Maximum Depth: 5 feet

Roberts Lake is a small impoundment located about 2.5 miles southeast of Indian River and lies within Koehler township. It has approximately 54 acres of surface area, and is only about five feet at its deepest point. The lake bottom is primarily composed of detritus and woody debris are common in the lake. The outlet of Roberts Lake is a small tributary, Twin Lakes Creek, which flows into Crumley Creek, which in turn flows into the Little Sturgeon River, a tributary to the Indian River. Roberts Lake water levels are regulated by a spillway on the south end maintained by MDNR Fisheries Division. It is completely surrounded by public land.

MULLETT CREEK

Primary Inflow: groundwater
Primary Outflow: Mullett Lake
Length: 9 miles

The surface watershed of Mullett Creek drains approximately 10,250 acres. The permanent mainstream of Mullett Creek, downstream from south Extension Road, near the old town of Riggsville, is eleven miles long. The stream has numerous small permanent and intermittent tributaries, and the total length of this stream system's surface channels is approximately 25 miles. The streamflow averages between 9 cfs during dry conditions and 83 cfs during spring melt.

The elevation of the intermittent headwaters of Mullett Creek is 853 feet, and the stream descends 259 feet per mile. Most of this elevation drop occurs in the northern half of the stream. Downstream from the second I-75 crossing the stream gradient averages only 6.78 feet per mile. The greatest elevation in the watershed is 910 feet.

Public lands are found in Munro Township (University of Michigan Biological Station property), and in Mullett Township, where 1.5 miles of the stream flows through state land. The lower two miles of Mullett Creek are navigable by canoe. There are no lakes within the Mullett Creek Watershed, and the Creek is unimpounded. The creek drains substantial areas of agricultural land in its upper watershed. In this area, the creek is narrow and is generally paralleled by streambank wetlands and is clear and cool. In the lower portion of its watershed, the creek is approximately 35 feet wide, shallow, with a dark organic bottom. Emergent vegetation is common, and the water is stained brown from wetland drainage. Mullett Creek may support brook trout in its upper reaches, while the lower portion of the creek appears more suited to warm-water fish.

1.26 Pigeon River Watershed

The Pigeon River Watershed drains into Mullett Lake. This area includes:

- Pigeon River
- Little Pigeon River
- Kimberley Creek
- Wilkes Creek
- Shade Creek
- Duck Creek

Landscape, Soils, and Groundwater

Most of the Pigeon River Watershed is forested with hardwoods and has the most state land of any of the subwatersheds. It also has some agriculture parcels that are primarily in hay production. The soils are largely Type A- well drained soils, with poorly drained soils located at the headwaters of the Little Pigeon River (Figure 25). This subwatershed has an average elevation of 700 feet, but increases as it gets closer to the headwaters of the Pigeon River where elevation reaches around 900 feet. The headwaters of the Pigeon River subwatershed originate just north of the City of Gaylord and meanders north.

The degree of groundwater contributions to surface waters in the Pigeon River Watershed is illustrated in Figure 26.

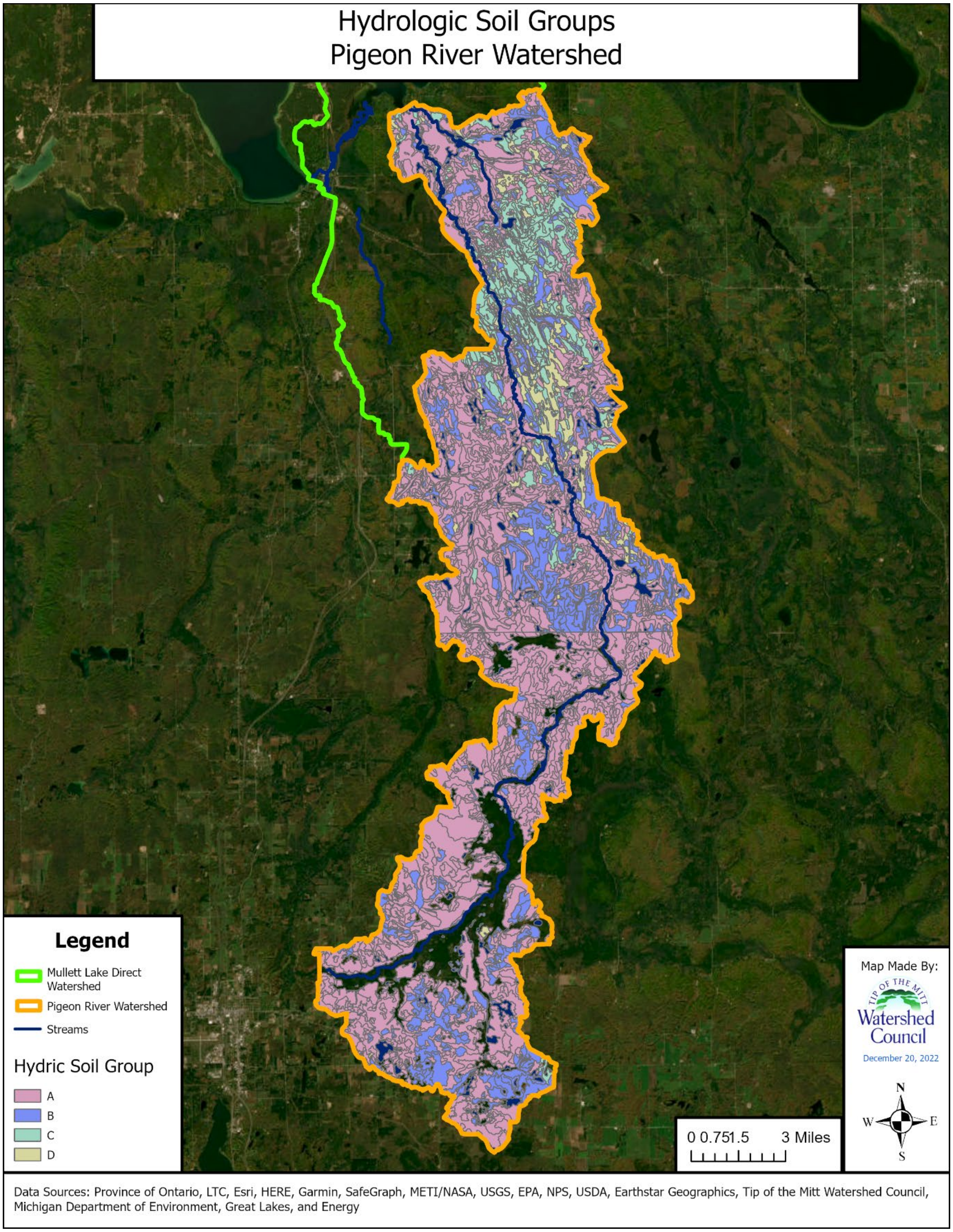

Figure 25. Hydrologic soil groups in the Pigeon River subwatershed

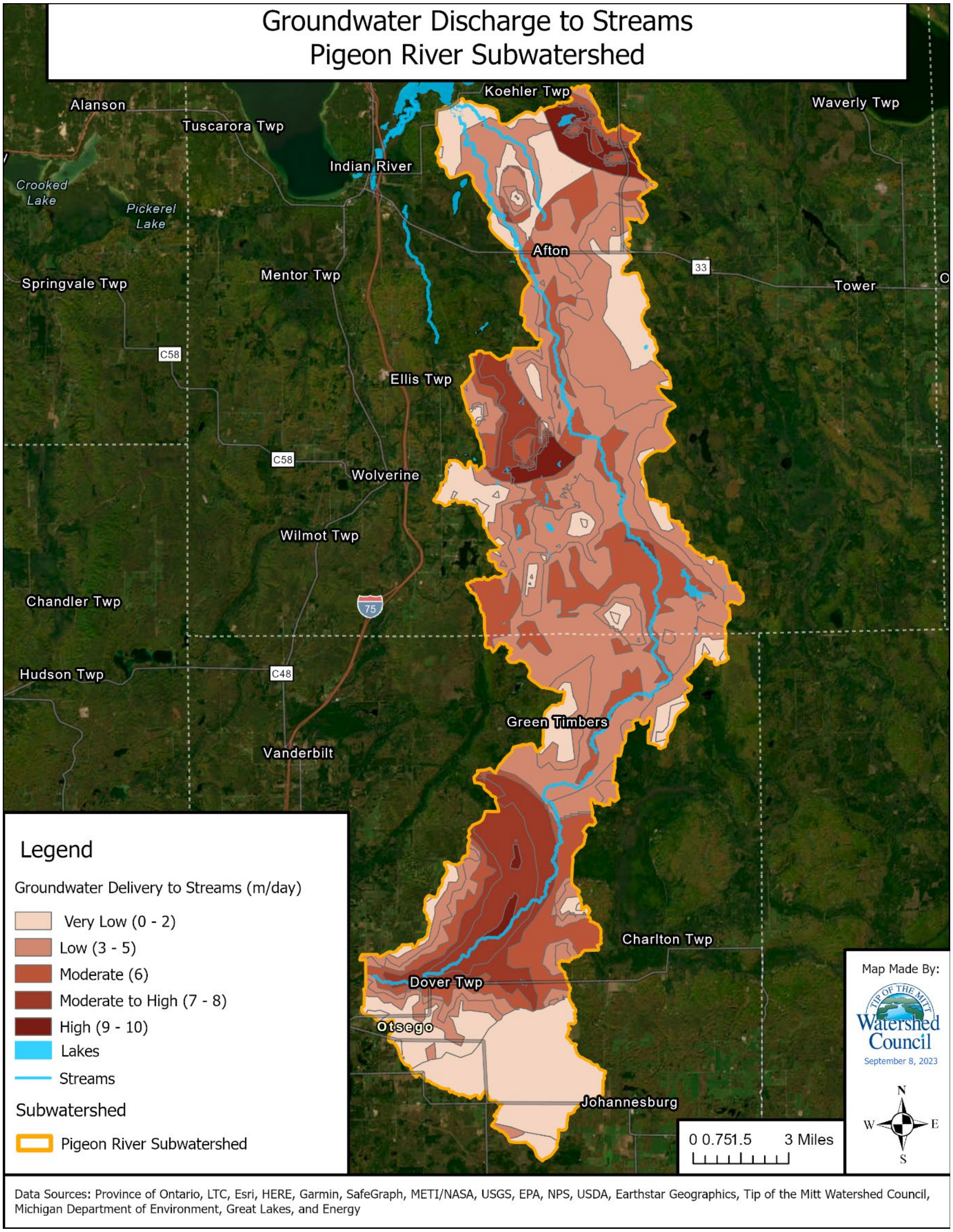

Figure 26. Groundwater delivery to streams

PIGEON RIVER

Primary Inflow: groundwater
Primary Outflow: Mullett Lake
Length: 132 miles, including tributaries

The surface watershed of the Pigeon River is approximately 91,000 acres. The length of the mainstream of the Pigeon River is 48 miles. Numerous tributaries bring the total length of the channel system to 132 miles.

The largest tributary of the Pigeon River is the Little Pigeon (southwest), not to be confused with the Little Pigeon (northeast) that discharges right at the mouth of the Pigeon River into Mullett Lake. Other large tributaries of the Pigeon include the South Branch of the Pigeon River, and Wilkes, McIntosh, and Cornwall Creeks. The average discharge of the Pigeon River at its mouth is 152 cfs.

The Pigeon River Watershed is found in both Cheboygan and Otsego Counties. In Cheboygan County, it includes portions of Nunda, Ellis, Walker, and Koehler Townships. In Otsego County, it includes portions of Corwith, Dover, and Charlton Townships. There are numerous stream crossings with many being private roads.

Most of the watershed of the Pigeon River is forested. Agricultural areas are found near the headwaters along M-32. Much of the development along the stream system is seasonal homes. Hydrocarbon development occurs in some portions of the watershed, mostly concentrated in the lower portion.

The portion of the Pigeon River from the headwaters, approximately 5 miles east of Gaylord, to Song of the Morning Ranch Road flows mostly through private land. Between Song of the Morning Ranch Road and Pigeon River Road the river flows through the Pigeon River Country State Forest, and most of the stream frontage is in public ownership. The remainder of the stream downstream to Mullett Lake flows again through mostly private lands.

The greatest elevation of the river's headwaters is 1,200 feet, on the South Branch of the Pigeon. The river drops 600 feet to the elevation of Mullett Lake for an average stream gradient of 12 feet per mile. In one portion of the river, between Munger Road and M-68, the river's gradient increases to 27 feet per mile.

The greatest elevation in the watershed is 1,400 feet northwest of Lake Fifteen. The altitude drops approximately 375 feet to the river over a distance of 1.5 miles in this area. The stream channel and a large portion of the watershed north of Munger Road lie in the area of inundation by the post-glacial Great Lakes. As a result, steep sided terraces are found near the river in some places.

The State of Michigan recognizes the Pigeon River as being navigable for a distance of 40 miles upstream from its mouth, which includes nearly the entire river. In 1982 the river and its tributaries were designated a wild and scenic river by the Natural Resources Commission. The river is regarded as one of the state's outstanding trout streams and recreational resources.

Nineteen inland lakes are located within the Pigeon River subwatershed. Twenty-eight impoundments are located on the Pigeon River system, ranging in size from small beaver ponds to the 295-acre Cornwall Creek Flooding. Many of the impoundments are privately owned. The largest private impoundment, the Lansing Club Pond, was the site of an uncontrolled drawdown of water in July 1984 and in 2008 there was a mechanical failure that caused the floodgates to open. In both instances, tons of silt was released which seriously damaged the river's ecosystem, and may have impacted Mullett Lake's water quality. The dam was finally removed in 2015 and has rebounded to a near natural state.

LITTLE PIGEON RIVER

Primary Inflow: groundwater
Primary Outflow: Mullett Lake
Length: 30 miles, including tributaries

The surface watershed of the Little Pigeon River is approximately 10,200 acres. The permanent mainstream of the Little Pigeon, including the headwaters area known as Kimberly Creek, is approximately 12 miles long. The stream has several permanent and intermittent tributaries, and the total length of the stream system's surface channels totals about 30 miles. Other named tributaries in the system are the North and Middle Branches of the Little Pigeon, Silver Creek, and Morrow Creek. The river's average discharge is estimated to be 21 cfs.

The stream's watershed occupies portions of three townships: Koehler, Ellis, and Walker. The stream system has 21 crossings of 10 different public and private roads. The watershed is mostly forested, especially in the northern half, however, there is a significant amount of cleared and agricultural lands in the southern portion of the watershed. The greatest residential development occurs along M-68, M-33, Walker and Montgomery Roads; and the small communities of Afton, Legrand, and the Fingerboard Corner are located in this area.

The elevation of the Little Pigeon's headwaters lies at 905 feet, near Fingerboard Corner. The stream descends 312 feet to Mullett Lake in 9.5 miles, for an average stream gradient of 32 feet per mile. The headwater portions of these streams generally have the steepest gradients.

The greatest elevation in the watershed – 985 feet – is found on Blats Hill, northwest of Afton, and again southeast of Fingerboard Corner. Most of the stream channels and the watershed lie at an elevation of less than 740 feet, the level which was once inundated by the post-glacial Great Lakes. The influence of lacustrine processes is evidenced in this area by the presence of steep-sided terraces along the Little Pigeon and some of its tributaries. Steep topography is also found in the vicinity of stream channels northwest of Afton and northeast of Legrand.

Silver Lake is a shallow, 78-acre lake which is fed by groundwater and drained by Silver Creek. The lake was formerly owned by the Detroit Area Boy Scout Council, but is now surrounded by small tracts.

CORNWALL CREEK FLOODING

Primary Inflow: groundwater
Primary Outflow: Cornwall Creek
Surface Area: 295 acres
Shoreline: 5.45 miles
Maximum Depth: 25 feet

Cornwall Creek Flooding is located approximately 15 miles east of the town of Wolverine on Cornwall Creek, a tributary to the Pigeon River. The dam was built in 1966 and created a 295 acre impoundment. The original purpose of construction was to build a "trout lake" in the area. The structure is owned by DNR Fisheries Division, who are financially responsible for the mandatory safety inspections, and maintenance, of the dam.

Water depth is between 10 and 20 feet deep. The littoral zone has emergent and submergent aquatic vegetation, and there is a large amount of flooded timber and stumps. The bottom substrate is primarily muck with some sand. There is no shoreline development around the flooding since the entire shoreline is state land. The riparian zone is dominated by a variety of conifer and hardwood trees. Gas powered motors are prohibited on the flooding.

1.27 Lower Black/Cheboygan Rivers Subwatershed

The Lower Black and Cheboygan Rivers subwatershed is the area that drains into Lake Huron. This area includes:

- Cheboygan River
- Lower Black River
- Long Lake

Landscape, Soils, and Groundwater

The Lower Black/Cheboygan Rivers subwatershed is the lowermost part of the entire Cheboygan River Watershed. It is comprised of forest and agricultural lands, as well as urban land use in the City of Cheboygan which is at the outlet of the Cheboygan River. Twin Lakes and Long Lake are found in the southeastern portion of the watershed and discharge into the Lower Black River, which flows out of Black Lake. Other tributaries to the Lower Black River are Meyers Creek, Wixom Creek, and Owens Creek. The community of Alverno can be found about halfway along the Lower Black River near the Alverno dam. The lower half of the Cheboygan River flows through the highly urbanized area of Cheboygan. Tributaries that flow into the Cheboygan River are Maxwell Gully, Tannery Gully, Laperell Creek and Section 7 Creek. The elevation of the watershed ranges from 650-750 feet and has very little variation in slope. Soils are well drained or moderately well drained on the outer watershed boundaries (Figure 27). There are large tracts of poorly drained soils located at the southeastern portion of the subwatershed and most of Cheboygan consists of poorly drained soils.

The degree of groundwater contributions to surface waters in the Lower Black/Cheboygan Rivers Watershed is illustrated in Figure 28.

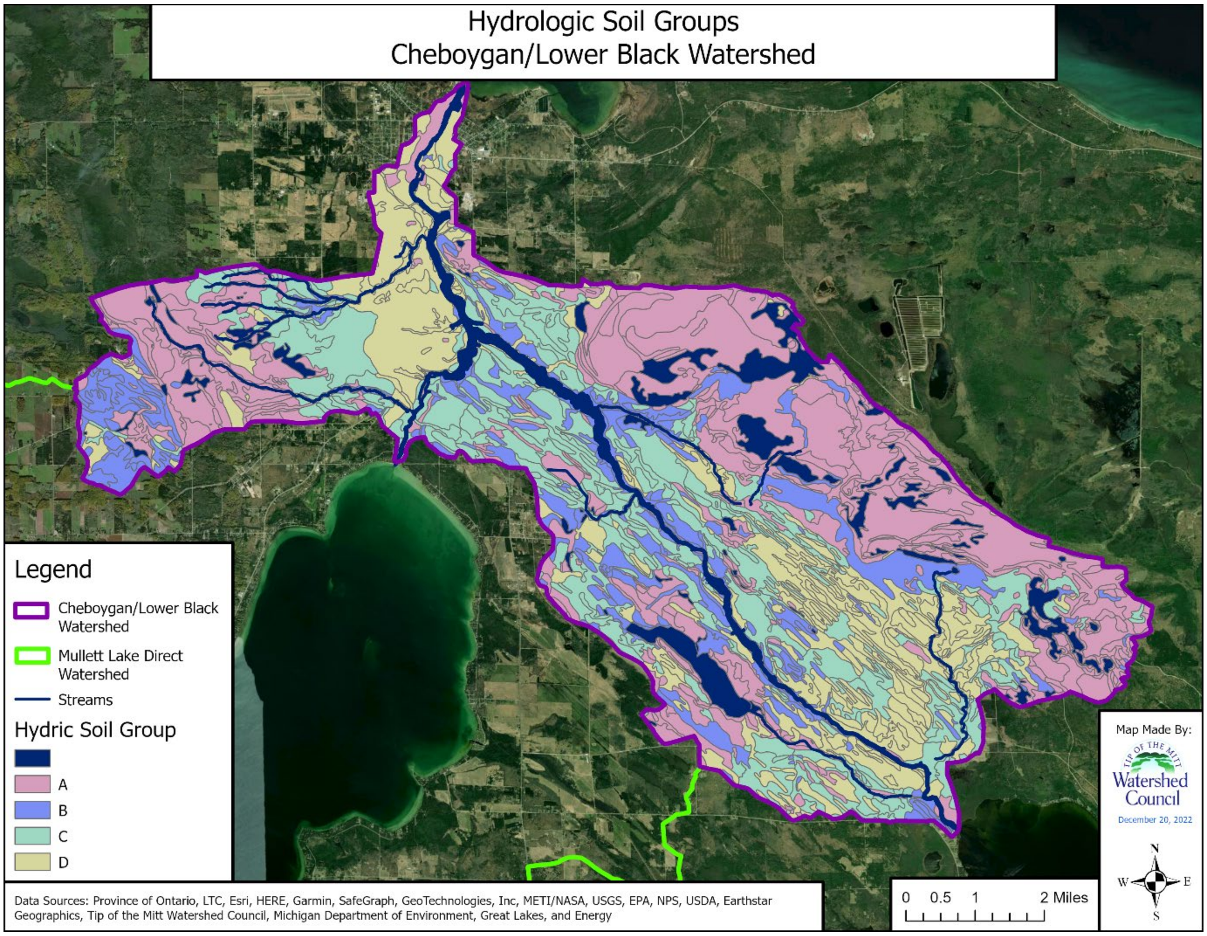

Figure 27. Hydrologic soil groups in the Lower Black/Cheboygan subwatershed

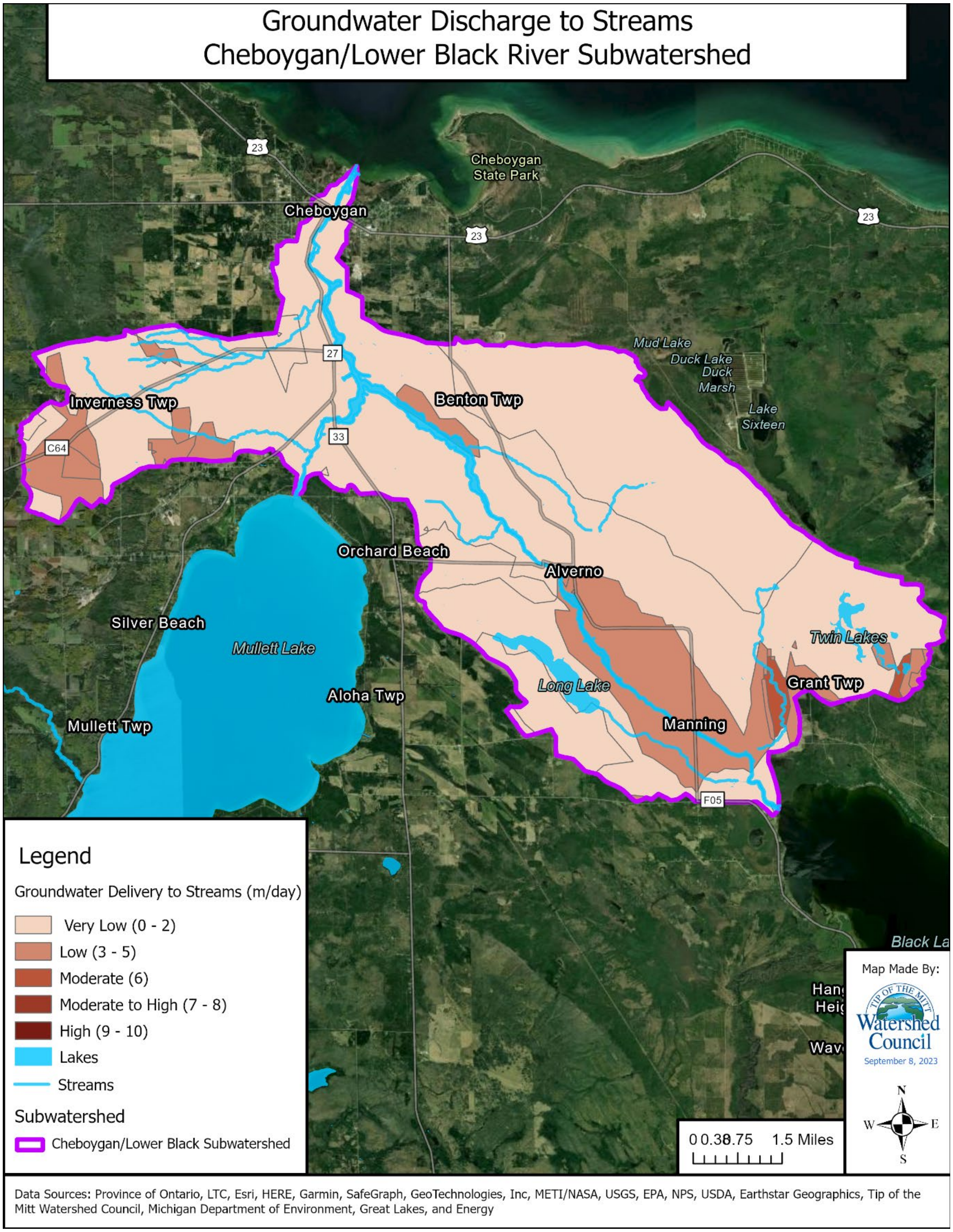

Figure 28. Groundwater delivery to streams

CHEBOYGAN RIVER

Primary Inflow: Mullett Lake
Primary Outflow: Lake Huron
Length: 7 miles

Cheboygan River (the fifteenth largest river in the state) flows roughly seven miles from its source of Mullett Lake through the City of Cheboygan to discharge into Lake Huron. The upper part of the river is separated from the lower by the Cheboygan Dam. Above the dam the Cheboygan River is wide and deep for two and a half miles to its junction with Black River. The remaining two and a half miles to Mullett Lake is littered with stumps and snags. The Cheboygan River's mean streamflow as recorded by the United States Geological Survey (USGS) from 1942 to 1982, near Cheboygan is 1461 cfs. Throughout this period the peak streamflow fluctuated from a low of 1000 cfs in 1958 to a high of 2000 cfs in 1980.

The Port of Cheboygan is located at the mouth of the Cheboygan River, as it enters Lake Huron. It is a deep-water sea port that can accommodate domestic vessels and international vessels such as oil tankers, freighters, research vessels, car ferries, and recreational boaters. Commercial docks receive primarily petroleum products.

The port has been dredged several times since 1871, with the last major dredge occurring in 1939 when a turning basin was created to allow large freighters the ability to turn around. Maintenance dredging occurs as needed.

LOWER BLACK RIVER

Primary Inflow: Black Lake
Primary Outflow: Cheboygan River
Length: 10.5 miles

The Lower Black River flows from its origin of Black Lake approximately 4.3 miles to a small private dam, Alverno, where water flow is restricted significantly due to rapids. Below the dam the shore widens and the river is shallow for about 2.75 miles, then becomes wide and deep as it continues its course another 2.5 miles to merge with the Cheboygan River.

According to USGS data, the mean stream flow between 1942-1974 was 419 cfs. There is one very high gradient reach located about two miles downstream from Black Lake, which extends downstream to the area currently impounded by Alverno Dam. Due to the proximity of Black Lake and the local geology, warmwater habitat with low to moderate hydraulic diversity is common throughout the 11-mile segment.

When water is slowed at a dam, it also drops most of the sediment that it has carried. In this manner, the impoundment acts a giant sediment trap, capturing the silts and sands that are deposited. Alverno Dam on the Lower Black River is an example of a dam that impounds a previously high-gradient reach of river. Downstream of the dam, the changes to substrate can vary, depending upon the flow regime.

The Lower Black River is a warm water system, and is primarily managed through fisheries regulations. Lake sturgeon spawning has been reported in the area below Alverno Dam. Accordingly, the fishing season in the Lower Black River is restricted from Alverno Dam down to Mograin Bridge which allows no fishing from April 1 to May 15 to protect spawning lake sturgeon as well as northern pike, muskellunge, and walleye.

LONG LAKE

Primary Inflow: groundwater
Primary Outflow: Long Lake Creek
Surface Area: 392 acres
Shoreline: 5.45 miles
Maximum Depth: 61 feet

Long Lake is located between Mullett and Black Lakes in northern Cheboygan County. It is a popular lake for swimmers, boaters, and anglers alike. It is narrow, long, and relatively deep. Long Lake is composed of three distinct basins: the northwest, central, and southeast basins. The deepest point in Long Lake is 61 feet, which is located in the northern end of the southeast basin. The northwest and central basins are shallower with maximum depths of approximately 35 and 30 feet, respectively. Long Lake is 392 acres in size and is oligotrophic.

There are no significant inlets to the lake. The outlet of Long Lake flows into the Lower Black River. There is no lake level control structure. The outlet is intermittent and lacks flow during drier periods of the year. The shoreline of Long Lake is mostly developed and private. The bottom substrate of Long Lake is primarily sand and marl.

TWIN LAKES

Primary Inflow: groundwater
Primary Outflow: Owens Creek
Surface Area: 211 acres
Shoreline: 8.9 miles
Maximum Depth: 73 feet

Twin Lakes stands apart from other lakes in the region in that it consists of a group of ten interconnected water bodies. Twin Lakes is located in the northeast part of Cheboygan County about fifteen miles southeast of Cheboygan. These interconnected lakes are approximately 200 acres in size and have no inlets. Twin Lakes Outlet flows from the northwestern lake basin over a small water control structure that was built by the Twin Lakes Association in the 1950s. which has a three-foot head associated with this structure. The outlet flows to Owens Creek which eventually flows into the Lower Black River. Board manipulation at the outlet can increase water levels in channels between the basins, which allows for easier boating accessibility between lakes.

The lake basins of Twin Lakes are relatively deep, with the northern-most basin reaching a depth of 75 feet deep, while the other basins reach from 25-45 feet deep. These basins stratify thermally and dissolved oxygen is variable from the top to bottom during summer months. Bottom substrate is primarily muck, sand, and marl. The Lake is oligotrophic.

The majority of the land around Twin Lakes is privately owned except a parcel of state-owned land in the southern basins. The lake riparian zone is heavily forested, with homes and cottages throughout the basin. A small, rustic, 11 site campground exists between lakes basins 2 and 3.

CHAPTER 2.
WATER QUALITY STANDARDS, DESIGNATED & DESIRED USES

The Environmental Protection Agency's Handbook for Developing Watershed Plans to Restore and Protect Our Waters describes water quality standards and designated uses as follows:

• Water quality standards set the goals, pollution limits, and protection requirements for each waterbody. Meeting these limits helps to ensure that waters will remain useful to both humans and aquatic life. Standards also drive water quality restoration activities because they help to determine which waterbodies must be addressed, what level of restoration is required, and which activities need to be modified to ensure that the waterbody meets its minimum standards.

• Standards are developed by designating one or more beneficial uses for each waterbody, establishing a set of measurable criteria that protect those uses and implementing policies and procedures that keep higher-quality waters from degrading.

• Designated or beneficial uses are descriptions of water quality expectations or water quality goals. A designated use is a legally recognized description of a desired use of the waterbody, such as aquatic life support, body contact recreation, fish consumption, or public drinking water supply. State and tribal governments are primarily responsible for designating uses of waterbodies within their jurisdictions.

• Two types of criteria are used to measure whether standards are being met. Numeric criteria set numeric limits for water quality parameters; narrative criteria are nonnumeric descriptions of desirable or undesirable water quality conditions.

2.1 State Water Quality Standards

EGLE monitors the waters of the State on a five-year rotating watershed cycle to facilitate effective watershed management. Michigan has 57 major watersheds based on the USGS's 8-digit Hydrologic Unit Codes (HUC). Water quality assessment efforts focus on a subset (approximately 20%) of these major watersheds each year. The Mullett Lake Watershed, included in the Cheboygan Watershed (HUC#04070004), was last assessed by EGLE in 2020, and is scheduled to be assessed every 5 years.

The State of Michigan has developed water quality standards (WQS) under Part 4 of the Administrative Rules issued pursuant to Part 31 of the Natural Resources and Environmental Protection Act (1994 PA451, as amended). These standards can be found in Table 3. These standards are set to ensure that surface waters maintain their pollution limits and protection requirements. This helps will assessing which restoration activities are needed or what activities (point or non-point source) will need to be adjusted to meet the standards. The State uses quantitative and narrative water quality standards to help determine if designated uses are impaired. If a waterbody has multiple designated uses, the most restrictive standards apply. Additionally, if a water body has higher water quality than the standards require, they must be maintained at the higher quality.

Table 3. Michigan Water Quality Standards

Parameter	Water Quality Standards	Designated Uses Affected
Dissolved Solids	Not to exceed 500 mg/L monthly average or 750 mg/L at any time as a result of controllable point sources	All
pH	Between 6.5 to 9.0	All
Taste or odor producing substances	The surface waters of the state shall contain no taste-producing or odor-producing substances in concentrations which impair or many impair their use for a public, industrial, or agricultural water supply source or which impair the palatability of fish as measured by test procedures approved by the department.	Public Water Supply* Industrial Water Supply Agricultural Water Supply Fish Consumption
Toxic substances (selected shown here; see rule for complete listing)	DDT and metabolites: below 0.00011 µg/L Mercury, including methylmercury: below 0.0013 µg/L PCBs (class): below 0.00012 µg/L 2,3,7,8 - TCDD: below 0.0000000031 µg/L	All but navigation
Radioactive substances	Pursuant to U.S. nuclear regulatory commission and EPA standards	All but navigation
Plant nutrients	Phosphorus: 1 mg/L maximum monthly average for permitted point source discharges. Regulation for surface waters is limited to the following narrative standard from Rule 60 (323.1060): "nutrients shall be limited to the extent necessary to prevent stimulation of growth of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the waters of the state."	All
Microorganisms	30-Day Geometric Mean: below 130 *E. coli* per 100 ml	Total body contact
	Daily Maximum Geometric Mean: 300 *E. coli* per 100 ml	Total body contact
	Daily Maximum Geometric Mean: below 1,000 *E. coli* per 100 ml	Partial body contact
	Human sewage discharges (treated or untreated) below 200 fecal coliform per 100 ml 30-day mean or 400 fecal coliform per 100 ml in 7 days or less	Total body contact

<table>
<tr><td rowspan="2">Dissolved oxygen</td><td colspan="12">Minimum 7 mg/L for coldwater designated streams, inland lakes, and Great Lakes/connecting waters; minimum 5 mg/L for all other waters</td><td>Cold water fishery</td></tr>
<tr><td colspan="12">Minimum 5 mg/L daily average</td><td>Warm water fishery</td></tr>
<tr><td rowspan="10">Temperature</td><td colspan="12">Natural daily and seasonal temperature fluctuations shall be preserved:</td><td rowspan="4">Cold water fishery
Other indigenous aquatic life and wildlife</td></tr>
<tr><td colspan="12">Maximum monthly averages for inland lakes (°F):</td></tr>
<tr><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>P</td><td>O</td><td>N</td><td>D</td></tr>
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<tr><td colspan="12">Maximum monthly averages for warm water streams in this watershed (°F):</td><td rowspan="3">Warm water fishery</td></tr>
<tr><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>P</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td>38</td><td>38</td><td>41</td><td>56</td><td>70</td><td>80</td><td>83</td><td>81</td><td>74</td><td>64</td><td>49</td><td>39</td></tr>
<tr><td colspan="12">Maximum monthly averages for cold water streams in this watershed (°F):</td><td rowspan="3">Cold water fishery</td></tr>
<tr><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>P</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td>38</td><td>38</td><td>43</td><td>54</td><td>65</td><td>68</td><td>68</td><td>68</td><td>63</td><td>56</td><td>48</td><td>40</td></tr>
</table>

**All surface waters of the state that are identified in the publication "Public Water Supply Intakes in Michigan," dated December 9, 1999, are designated and protected as public water supply sources at the point of water intake and in such contiguous areas as the department may determine necessary for assured protection.*

2.2 Designated Uses

The State of Michigan has established a set of designated uses that can be measured for impairment based on the water quality standards described in the previous section. Rule 100 (R323.1100) of the water quality standards states that all surface waters of the State are designated for, and shall be protected for, eight particular uses (Table 4).

Table 4: Surface water designated uses of the State

Designated Use	General Definition
Agriculture	Livestock watering, irrigation, and crop spraying
Navigation	Navigation of inland waters
Warmwater fishery	Supports warmwater species
Coldwater fishery	Support coldwater species
Other Indigenous aquatic life and wildlife	Supports other indigenous animals, plants, and macroinvertebrates
Partial body contact recreation	Supports boating, wading, and fishing activities

Total body contact recreation	Supports swimming activities between May 1 to October 31
Public water supply*	Surface waters meet human cancer and non-cancer values set for drinking water
Industrial water supply	Water utilized in industrial or commercial applications
Fish Consumption	There is a statewide, mercury-based fish consumption advisory that applies to all of Michigan's inland lakes, including those within the Mullett Lake Watershed.

**All surface waters of the state that are identified in the publication "Public Water Supply Intakes in Michigan," dated December 9, 1999, are designated and protected as public water supply sources at the point of water intake and in such contiguous areas as the department may determine necessary for assured protection.*

The Mullett Lake Watershed includes both coldwater and warm water fisheries. The coldwater fishery designation differs from the warmwater fishery because there are different water quality standard levels for dissolved oxygen, water temperature, and other chemical, physical, and biological parameters. The coldwater fishery lakes and streams are considered "Designated Trout Streams" or "Designated Trout Lakes" for the State of Michigan.

The Coldwater Fishery designated use only applies to MDNR designated coldwater streams. Coldwater lakes and streams in the State of Michigan are defined under section R323.1100 as:

(4) All inland lakes identified in the publication entitled *Coldwater Lakes of Michigan*, as published in 1976 by the department of natural resources, are designated and protected for coldwater fisheries. (5) All Great Lakes and their connecting waters, except for the entire Keweenaw waterway, including Portage lake, Houghton county, and Lake St. Clair, are designated and protected for coldwater fisheries. (6) All lakes listed in the publication entitled "Designated Trout Lakes and Regulations," issued September 10, 1998, by the director of the department of natural resources under the authority of part 411 of 1994 PA 451, MCL 324.41101 et seq., are designated and protected for coldwater fisheries. (7) All waters listed in the publication entitled "Designated Trout Streams for the State of Michigan," Director's Order No. DFI-101.97, by the director of the department of natural resources under the authority of section 48701(m) of 1994 PA 451, MCL 324.48701(m) are designated and protected for coldwater fisheries.

Coldwater streams and lakes within the Watershed (Table 5) are therefore designated and protected for coldwater fisheries.

Table 5. Coldwater lakes and streams

Subwatershed	Coldwater Streams	Coldwater Lakes
Mullett Lake Direct	Mullett Creek, Mullett Lake Creek, Little Sturgeon River, Indian River, Crumley Creek, Unnamed Creek (2)	Mullett Lake
Pigeon River	Pigeon River, Little Pigeon River, Wilkes Creek, Kimberley Creek, Nelson Creek, McIntosh Creek, McPhee Creek, Grindstone Creek, Cornwall Creek, Unnamed Creek (3+)	
LBlack/Cheboygan River	Cheboygan River	

***As listed in the EGLE WRD Staff report (August 2017)**

The status of a designated use in a watershed can be <u>met, impaired, threatened, or under review/unknown</u>. The use is unimpaired if the available physical and analytical data indicates that all applicable WQS are being consistently met. If the available physical and analytical data indicates that WQS are not being consistently met, then the designated use is considered to be impaired. If an assessment unit is expected to not meet a particular designated use within the next two years (Integrated Report listing cycle), it is identified as threatened. A use that is designated as under review or unknown means there is insufficient physical or analytical data available to determine a status for the use, and additional studies are necessary.

The Clean Water Act (CWA) requires Michigan to prepare a biennial report on the quality of its water resources as the principal means of conveying water quality protection/monitoring information to the United States Environmental Protection Agency (EPA) and the United States Congress. The Water Quality and Pollution Control in Michigan, Sections 303(d), 305 (b), and 314 Integrated Report (Integrated Report) (EGLE 2020), satisfies the listing requirements of Section 303(d) and the reporting requirements of Section 305(b) and 314 of the CWA. The Section 303(d) list includes Michigan water bodies that are not attaining one or more designated uses and require the establishment of Total Maximum Daily Loads (TMDLs) to meet and maintain Water Quality Standards.

No water bodies in the Mullett Lake, Lower Black and Cheboygan River Watershed are listed as impaired or threatened in the Michigan 2020 Integrated Report due to nonpoint sources in the Watershed (Integrated Report, found on EGLE's website). However, several water bodies are listed as not meeting the fish consumption designated use because of state fish consumption advisories that have been issued due to elevated fish tissue levels of mercury and PCBs in some species due to atmospheric deposition of these pollutants. This issue is being addressed at the state and regional levels and is beyond the scope of this Watershed Management Plan.

While the majority of assessed surface waters in the Mullett Lake Watershed are currently meeting all of the designated uses of the State, it should be noted that the Watershed remains vulnerable to nonpoint source pollution and other environmental stressors. Existing and future activities will invariably create risk of degradation to some or all of the designated uses and it is critical to enact preventative and restorative actions to ensure future use of watershed resources.

2.3 Desired Uses

Outside of the designated uses of the state, the Watershed has several desired uses. A summary can be found in Table 6.

Table 6. Desired Uses

Desired Use	Explanation
Aesthetics	The Watershed should retain its natural beauty and biodiversity
Recreation	Waters should support the ability to recreate: fishing (including consumption), boating, hiking, camping, birding, etc.
Drinking water	Most of the Watershed residents rely on groundwater for drinking
Habitat	Waters should support a healthy fishery and wild rice habitat

CHAPTER 3. WATER QUALITY

Water quality data for the Watershed, as evaluated below, is data collected by TOMWC under an approved Quality Assurance Project Plan (QAPP) as a part of this Watershed Plan project, unless otherwise noted. Where there were data gaps, data was obtained from EGLE, TOMWC's Comprehensive Water Quality Monitoring Program (CWQMP) or Volunteer Lake Monitoring Program, and the District Health Department Number 4 (Figure 29). Summaries of the most common water quality parameters that are reviewed are provided below. Approved and draft water quality QAPP's can be found in Appendix C.

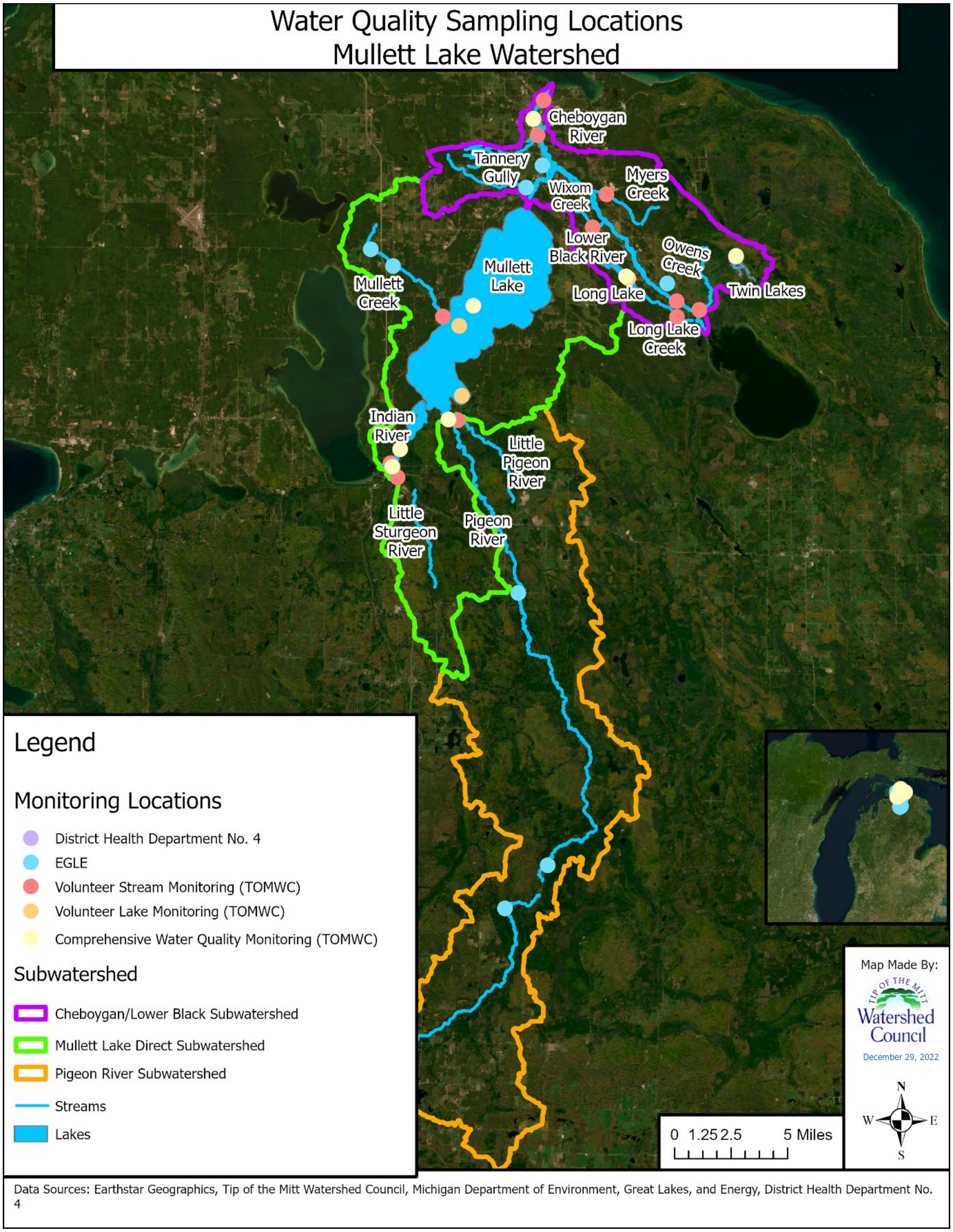


Figure 29. Water quality sampling locations

3.1 Alkalinity, Hardness, and pH

Parameter Description

Alkalinity, Hardness, and pH are important indicators for the acid neutralizing capacity (ANC) of lakes, utility of water, and suitability for aquatic life. pH is a measurement of the acidity or alkalinity of a water body. Distilled water has a pH of 7.0 and is considered pH neutral. Acidic waters have a pH below 7.0, while alkaline waters have a pH above 7.0. EGLE water quality standard for pH is 6.5 to 9.0. Outside of this range, the acidity or alkalinity of the water can become harmful to freshwater organisms. Due to the alkaline limestone bedrock of the region, pH is typically between 7.5 and 8.5.

Alkalinity is a measurement of a water body's pH buffering capacity. It is measured in equivalent mg/L calcium carbonate ($CaCO_3$). The EPA recommendation for aquatic life is that alkalinity stays above 20 mg/L $CaCO_3$; otherwise, the pH of the water will be highly vulnerable to changes that could become harmful to aquatic life. Waters in the region typically have high alkalinity due to limestone bedrock rich in CaCO3.

Hardness is a measure of the concentration of cations in a water body, such as magnesium, calcium, and iron. Soft water will have low concentrations of these cations, while hard water has high concentrations. Hardness is affected by both geology and pollution in a water body. Hard water can be a nuisance to industry and utilities, as it leaves a scale on equipment and is difficult to clean (hence why many homes use water softeners). Hardness is measured in equivalent mg/L $CaCO_3$. The USGS applies the following classification to water hardness: 0 to 60 mg/L $CaCO_3$ is soft water, 61 to 120 mg/L $CaCO_3$ is moderately hard, 121 to 180 mg/L $CaCO_3$ is hard, and greater than 180 mg/L $CaCO_3$ is very hard.

Summary

Alkalinity, Hardness, and pH data for the Watershed's surface waters indicate the water contains relatively high amounts of calcium carbonate ($CaCO_3$), which makes it moderately alkaline with a high buffering capacity (i.e. acid neutralizing), and hard water. Monitoring results show that pH stays fairly consistent, between 7.5-8.5, for all streams, rivers, and lakes.

3.2 Conductivity and Chloride

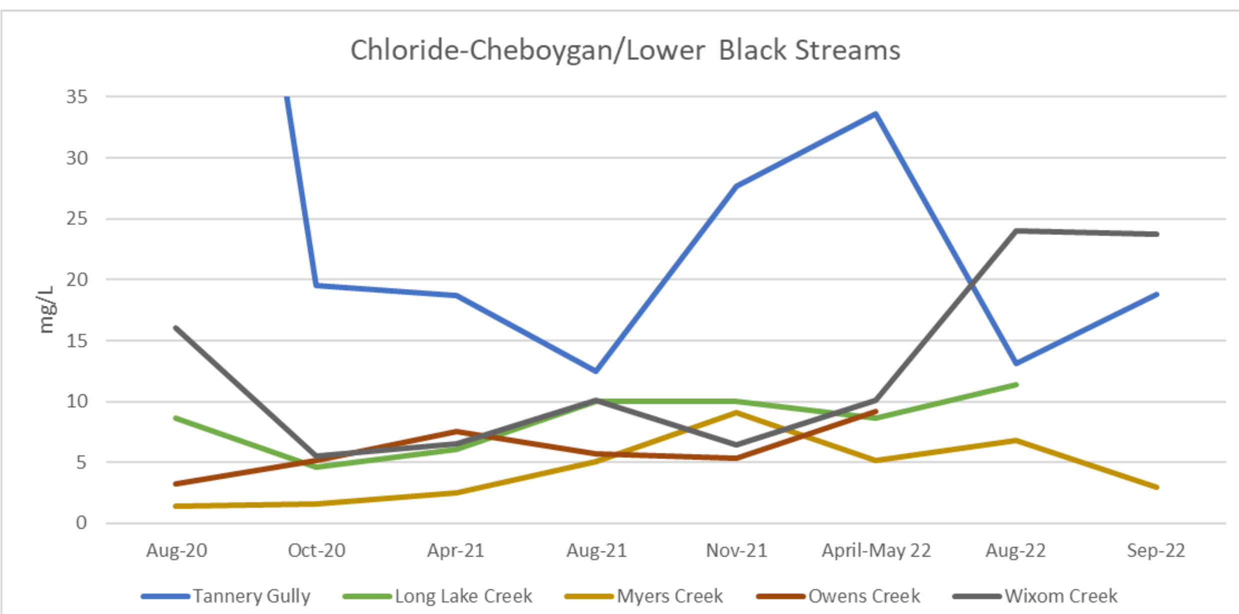
Parameter Description

Conductivity is a measure of the ability of water to conduct an electric current, which is dependent upon the concentration of charged particles (ions) dissolved in the water. It is measured in micro-Siemens per centimeter (µS/cm²). Specific conductance is simply conductivity standardized to a temperature of 25 degrees Celsius. Chloride, a component of salt, is a negatively charged particle that contributes to the conductivity of water. Chloride is a "mobile ion," meaning it is not removed by chemical or biological processes in soil or water. Chloride is measured in mg/L. Many products associated with human activities contain chloride (e.g., deicers, water softeners, fertilizers, and bleach). Conductivity and chloride levels in lakes and streams tend to increase as population and human activity in a watershed increase. Research shows that both conductivity and chloride levels in surface waters are good indicators of human disturbance in a watershed, particularly from urban land use (Jones and Clark 1987, Lenat and Crawford 1992, Herlihy et al. 1988).

EGLE's water quality standard for chloride is 125 mg/L for waters designated as a public water supply source at the point of intake. Although there is no standard for specific conductance, higher values can signify an increased likelihood of water quality impairment. Michigan has recently set limits for chloride in surface waters at 320 mg/L for aquatic maximum value.

Summary

Of the streams that discharge into the Cheboygan and Lower Black Rivers, Tannery Gully has the highest chloride and conductivity (Figure 30, Figure 31). This stream goes through the most urban area of all the streams monitored for this plan. The remaining streams, of which discharge directly to the Lower Black River, have similar chloride and conductivity levels to one another.



Tannery Gully result for August 2020 is 93.64 mg/L

Figure 30. Chloride in Cheboygan/Lower Black streams

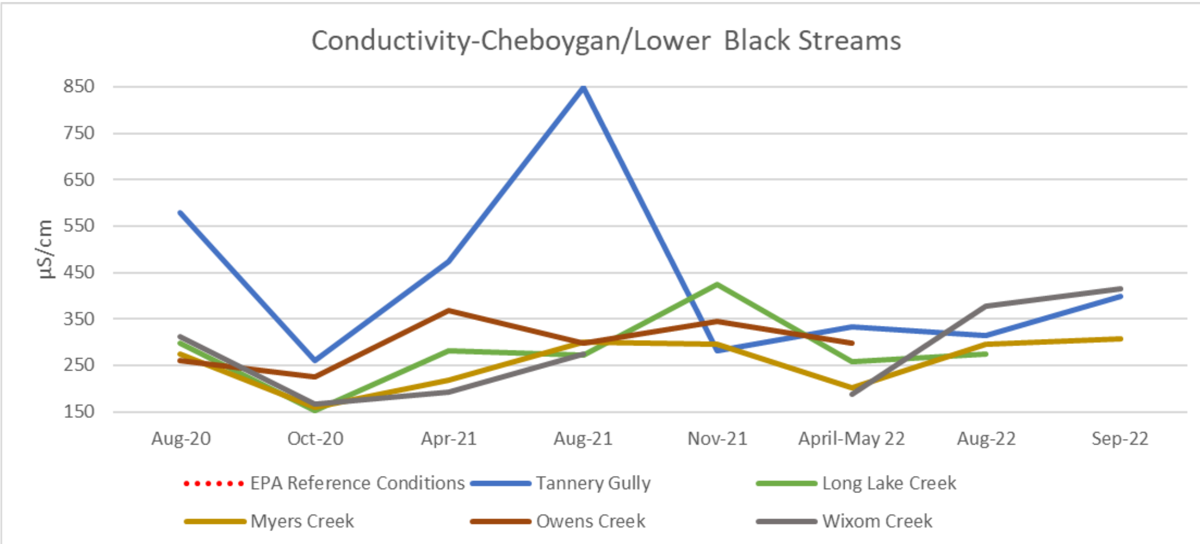


Figure 31. Conductivity in Cheboygan/Lower Black Streams

Of the streams that discharge into Mullett Lake, directly or indirectly, Mullett Creek has the highest chloride. All three streams have similar conductivity (Figure 32, Figure 33).

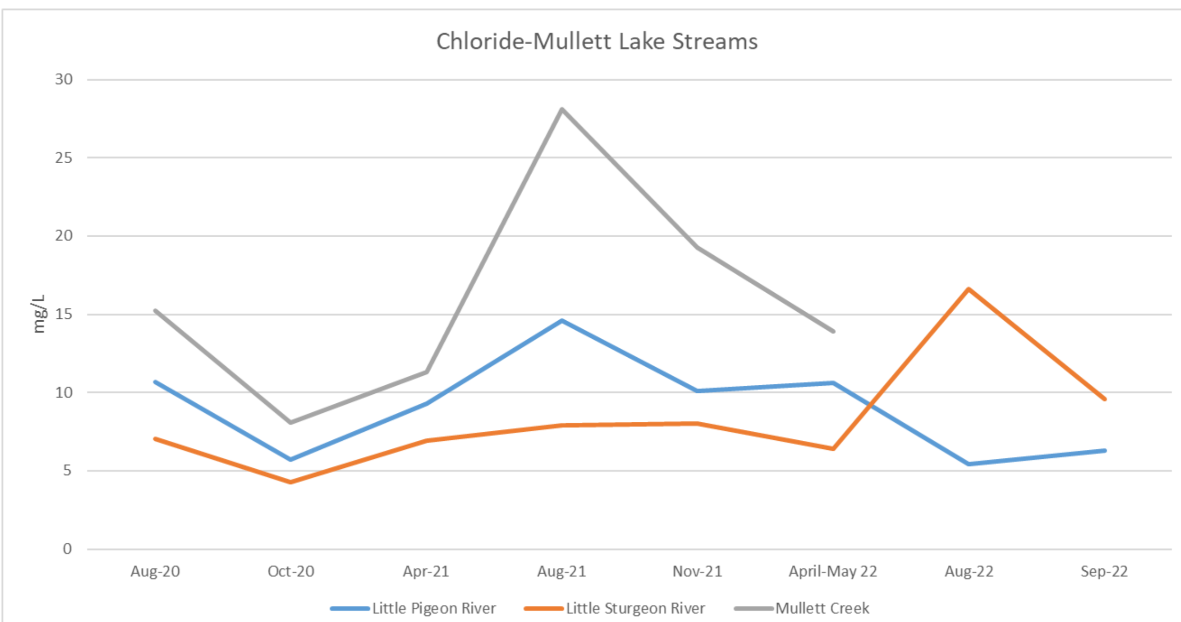


Figure 32. Chloride in Mullett Lake streams

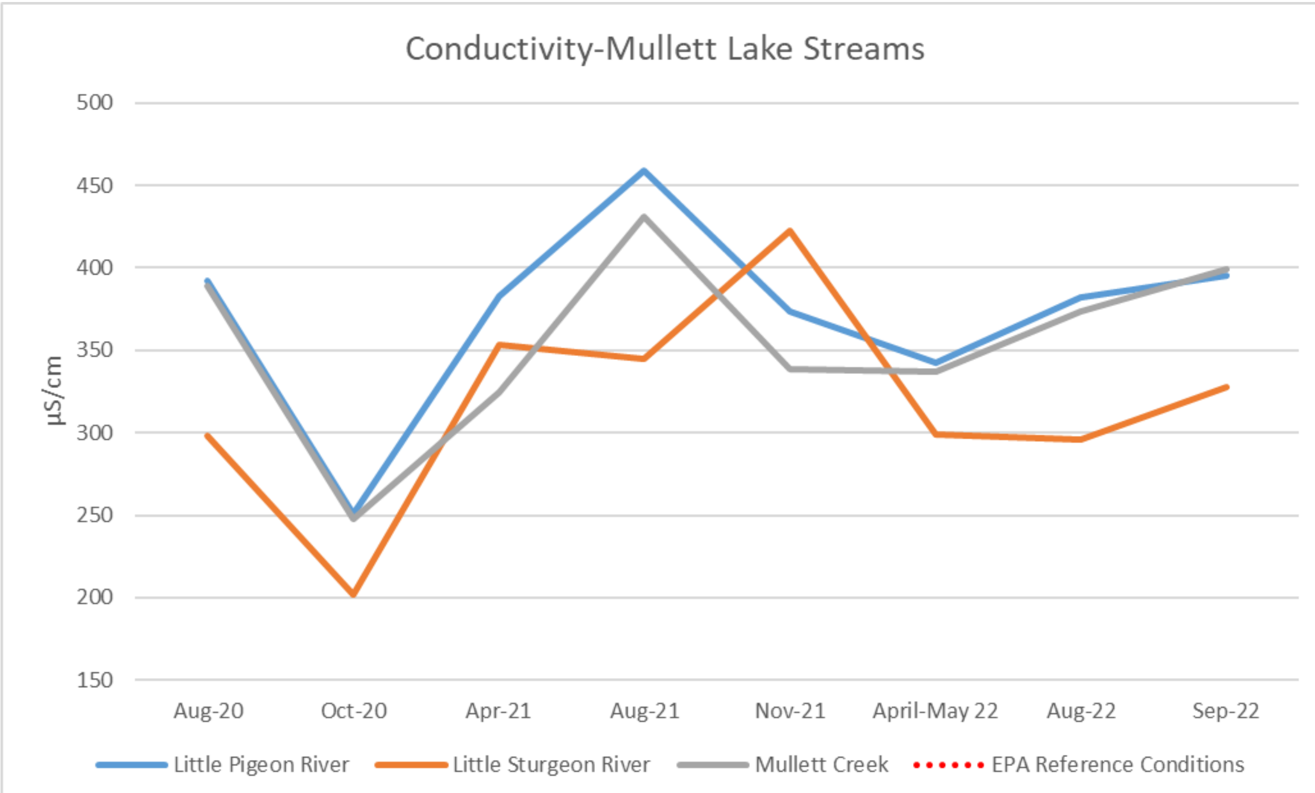


Figure 33. Conductivity in Mullett Lake streams

The rivers in the watershed have lower chloride levels than is found in the streams, with Indian River having the highest of the three. They all have very similar conductivity levels (Figure 34, Figure 35).

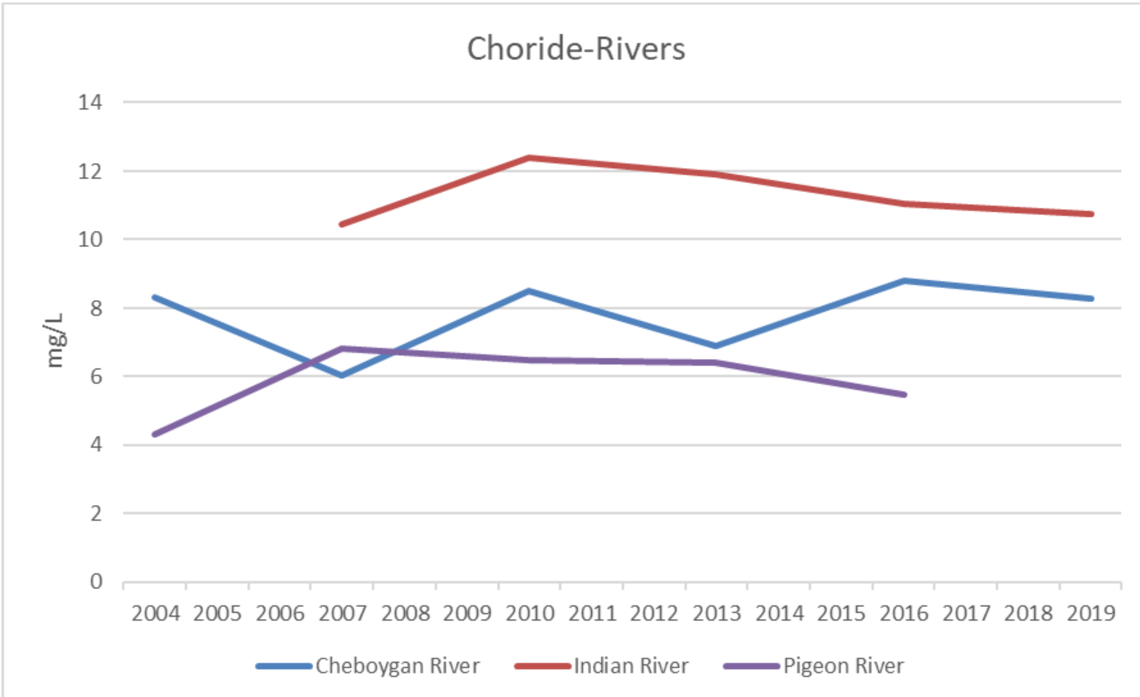


Figure 34. Chloride in Rivers

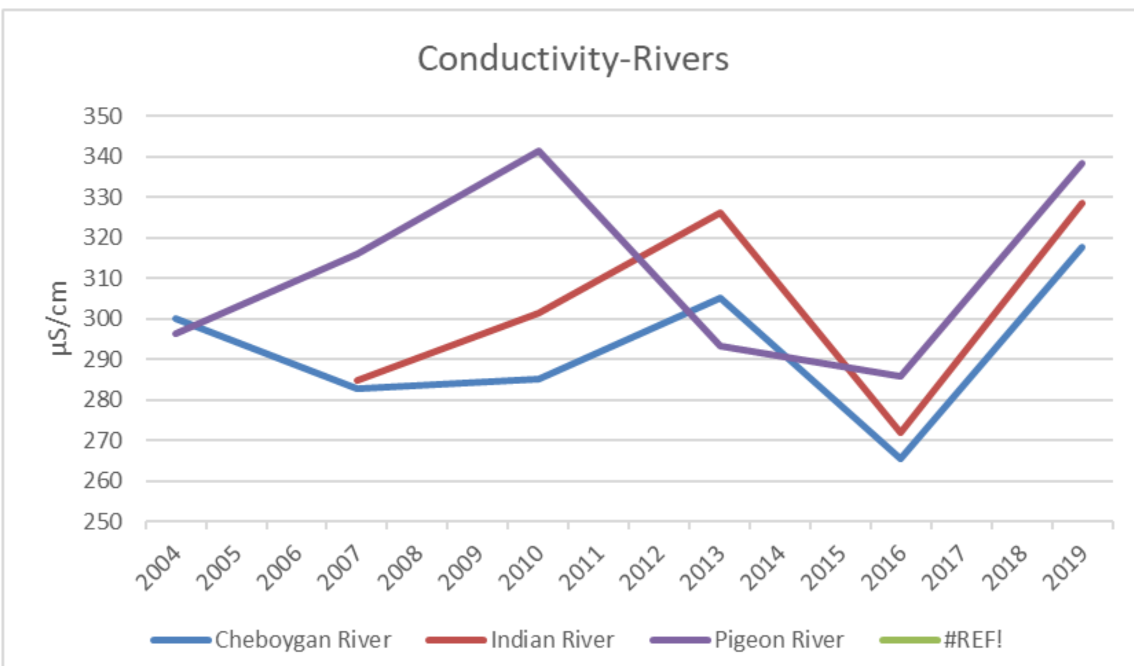


Figure 35. Conductivity in Rivers

Mullett Lake has the highest chloride levels of all the lakes in the watershed. Twin Lakes is, however, showing an increasing trend (Figure 36). Conductivity levels are relatively stable for all the lakes, with Mullett Lake having the highest conductivity (r squared value 0.85) (Figure 37).

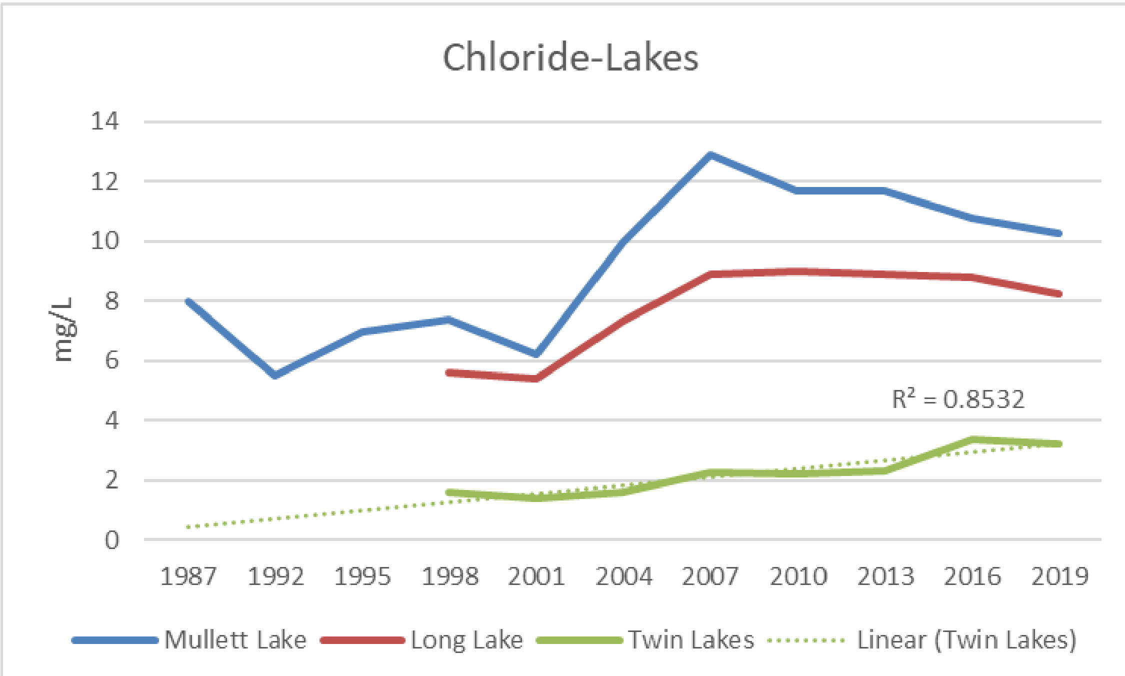


Figure 36. Chloride in lakes

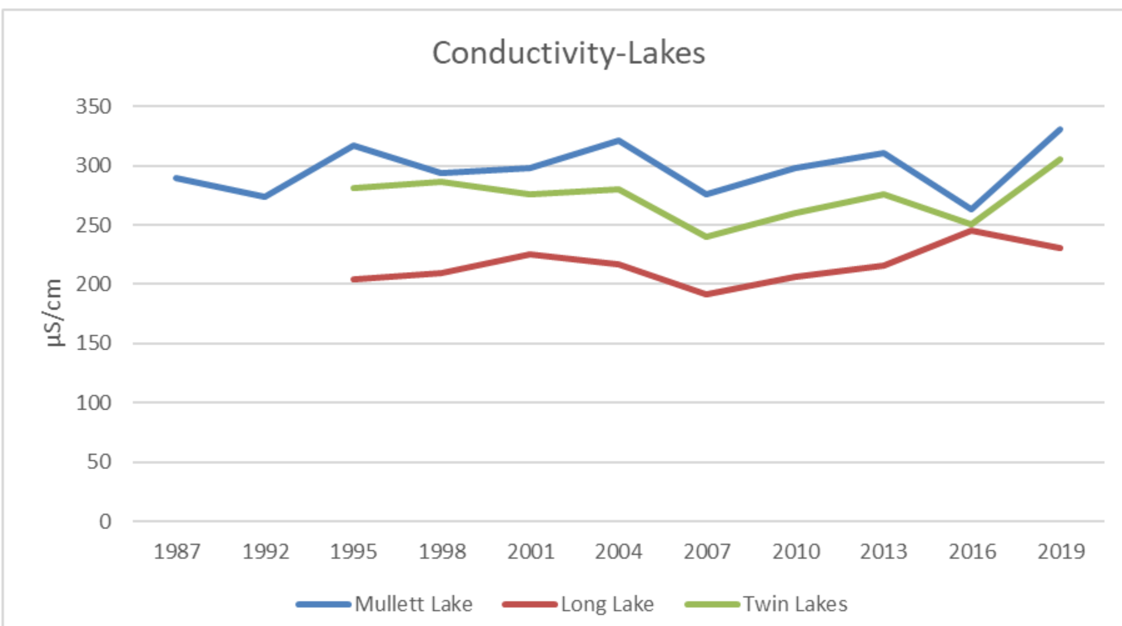


Figure 37. Conductivity in lakes

3.3 Dissolved Oxygen & Temperature

Parameter Description

Water temperature can be used to help assess habitat suitability for aquatic organisms and be used to determine if and when a lake is stratified. Dissolved oxygen is one of the most important parameters monitored for assessing water quality. Oxygen is required by almost all organisms, including those that live in the water. Oxygen dissolves into the water from the atmosphere and through photosynthesis of aquatic plants and algae. State law requires that a minimum of 7 mg/L be maintained in lakes and streams designated as a cold-water fishery, and 5 mg/L for warmwater lakes. However, the hypolimnion (depths below the thermocline) of stratified lakes can have low oxygen due to aerobic decomposition and limited replenishment; these instances aren't necessarily indicative of impairment.

Summary

Lakes

Mullett Lake is designated as a coldwater fishery; therefore, it requires dissolved oxygen readings of greater that 7 mg/L. The range of dissolved oxygen readings taken through the CWQMP range on average from 10-12 mg/L. Long Lake and Twin Lakes are both classified as a warm water fishery, needing dissolved oxygen readings of greater than 5 mg/L. Long Lake dissolved oxygen ranges on average between 8.5-12 mg/L, and Twin Lake averages from 7-12 mg/L.

Streams

All of the rivers and streams within the watershed have dissolved oxygen about 7 mg/L on average, with the exception of one. Mullett Creek has had two sampling events that were about 3 mg/L and had the lowest average dissolved oxygen readings of all the streams monitored for this plan at 7-9 mg/L. This is still above the state standards.

3.4 Nutrients: Phosphorus and Nitrogen

Parameter Description

Nutrients are chemicals needed by organisms to live, grow, and reproduce. Nutrients occur naturally and can be found in soils, water, air, plants, and animals. Phosphorus and nitrogen are essential nutrients for plant growth and important for maintaining healthy, vibrant aquatic ecosystems. However, excess nutrients from sources such as fertilizers, faulty septic systems, and stormwater runoff lead to nutrient pollution, which can have negative impacts on surface waters. Lakes and streams in the region are typically phosphorus limited, meaning that added phosphorus increases growth of aquatic plants and algae while added nitrogen may not increase growth. It has been estimated that one pound of phosphorus could stimulate 500 or more pounds of algae growth. Therefore, heavy phosphorus inputs to lakes and streams can result in nuisance algae and plant growth, which could, in turn, degrade water quality and alter the natural lake ecosystem.

Due to the negative impacts that phosphorus can have on surface waters, legislation was first passed in Michigan to ban phosphorus in soaps and detergents and more recently, phosphorus use in fertilizers has been regulated. Michigan water quality standards do not include a numerical standard for nutrient concentration limits for surface waters. Regulation for surface waters is limited to the following narrative standard from Rule 60 (323.1060): "nutrients shall be limited to the extent necessary to prevent stimulation of growth of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the waters of the state." However, a total phosphorus concentration of 12 micrograms per liter (μg/L) or less for streams in the Northern Michigan ecoregion is considered the reference condition by the EPA "because it is likely associated with minimally impacted conditions, will be protective of designated uses, and provides management flexibility" (EPA, 2001). The EPA reference condition for total nitrogen in the same ecoregion is 440 μg/L or less. In addition, Michigan drinking water standards require that nitrate-nitrogen concentrations be less than 10 mg/L.

Summary

Total nitrogen (TN) and total phosphorus (TP) levels are highest in Mullett Creek of the Mullett Lake streams (Figure 38, Figure 39). The Little Pigeon River is showing an increasing trend in total nitrogen. On average Mullett Creek and Little Pigeon River have levels higher than the EPA reference conditions for both TN and TP.

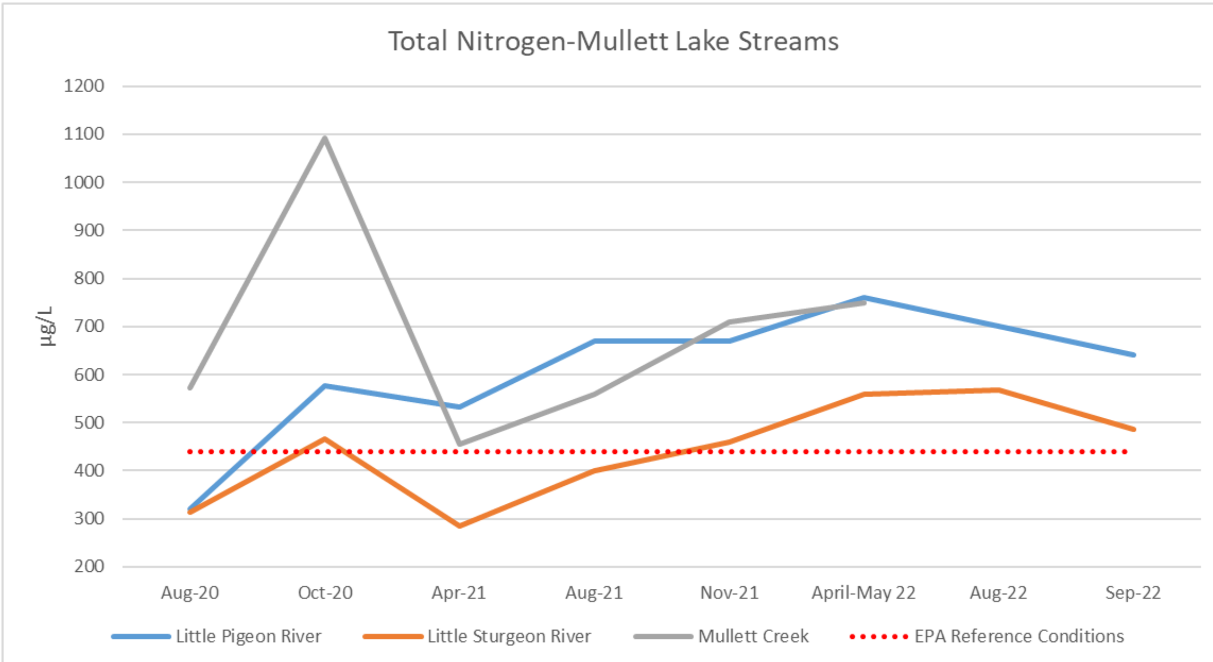


Figure 38. Total nitrogen in Mullett Lake streams

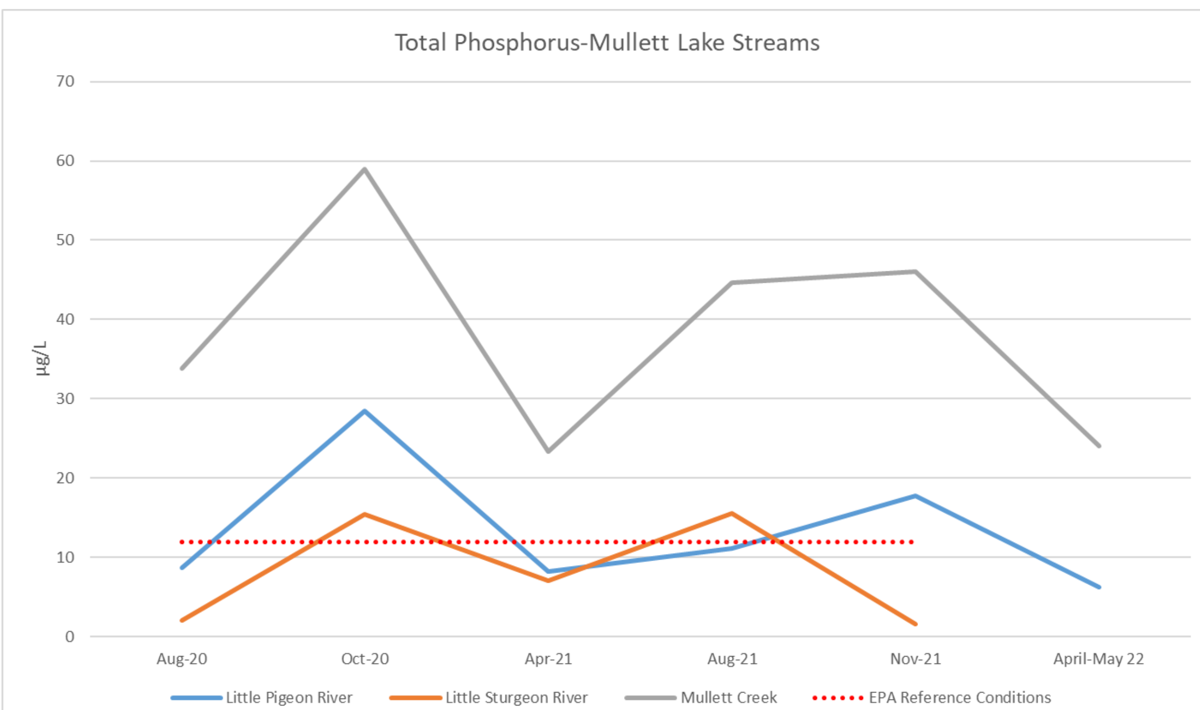


Figure 39. Total phosphorus in Mullett Lake streams

TN and TP for all streams in the Cheboygan/Lower Black watershed consistently exceed EPA reference conditions (Figure 40, Figure 41). They are also typically higher than results from the Mullett Lake streams.

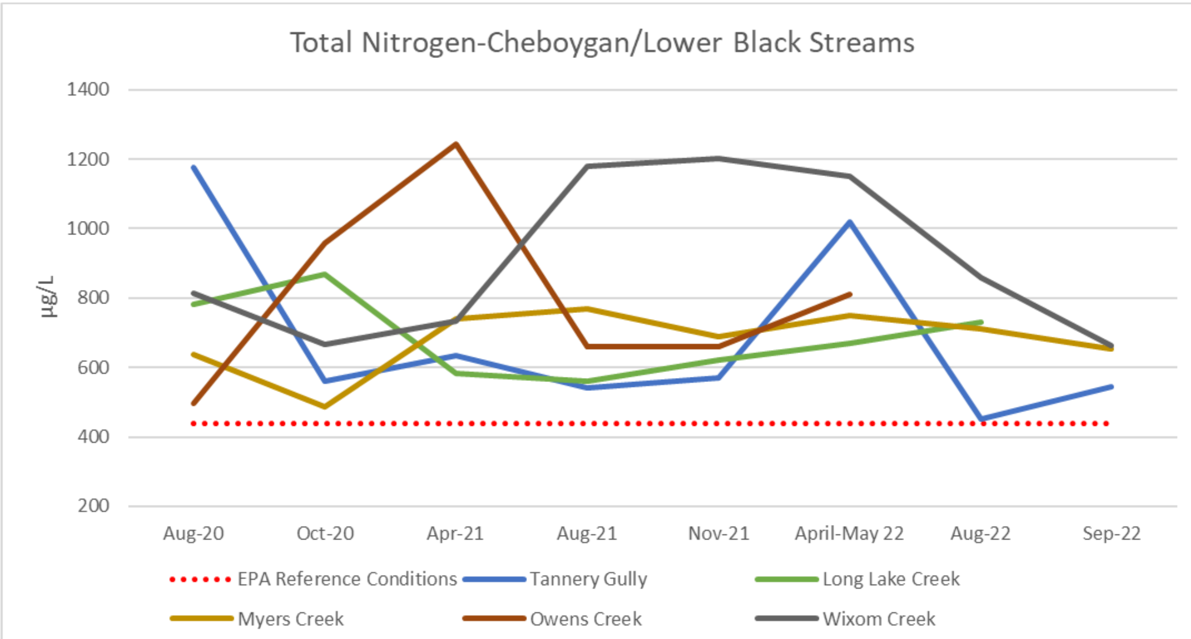


Figure 40. Total nitrogen in Cheboygan/Lower Black streams

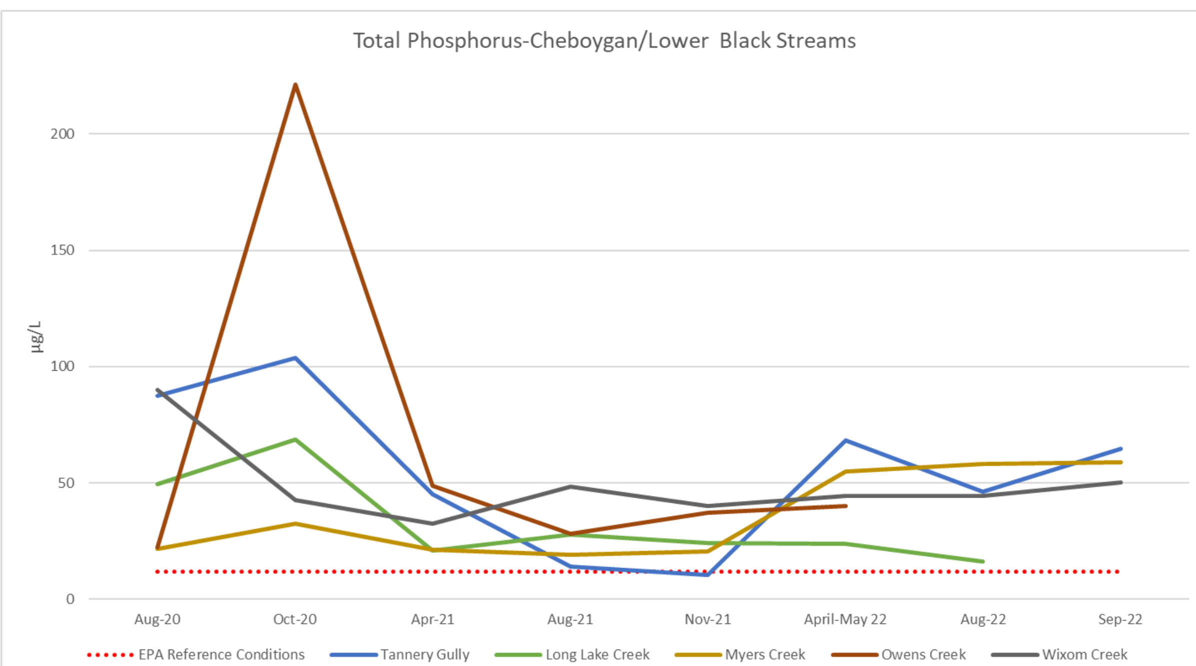


Figure 41. Total phosphorus in Cheboygan/Lower Black streams

TN and TP data for rivers has been collected as part of TOMWC's CWQMP. There was a dip in both TN and TP concentrations from 2008 to 2014, and remain below EPA reference conditions (Figure 42, Figure 43). The exception to this is the Pigeon River which exceeded TN in 2019 and TP in 2004.

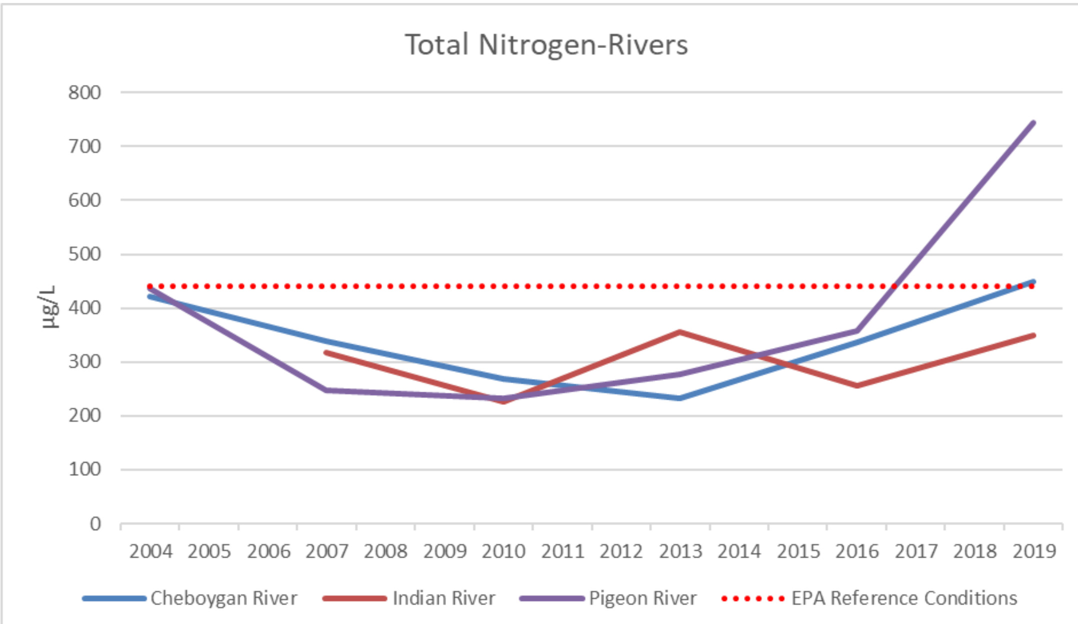


Figure 42. Total nitrogen in rivers

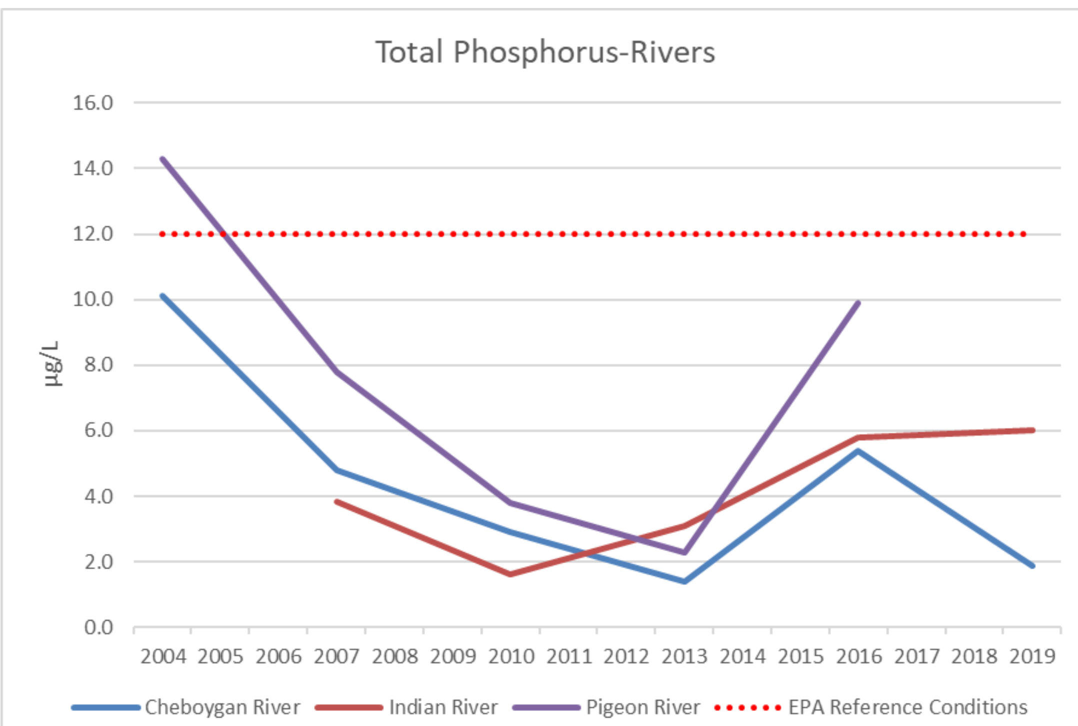


Figure 43. Total phosphorus in rivers

Nutrient loading for the streams was difficult to compare with data inconsistencies, but with the information given we can tell that Mullett Creek and the Little Sturgeon River are contributing the highest nutrient loads (Figure 44, Figure 45) These results are similar to what was found in the Mullett Lake Tributary Monitoring report (Appendix D), where it was found that Mullett Creek and the Pigeon River contributed "disproportionally high nutrient loadings" to Mullett Lake.

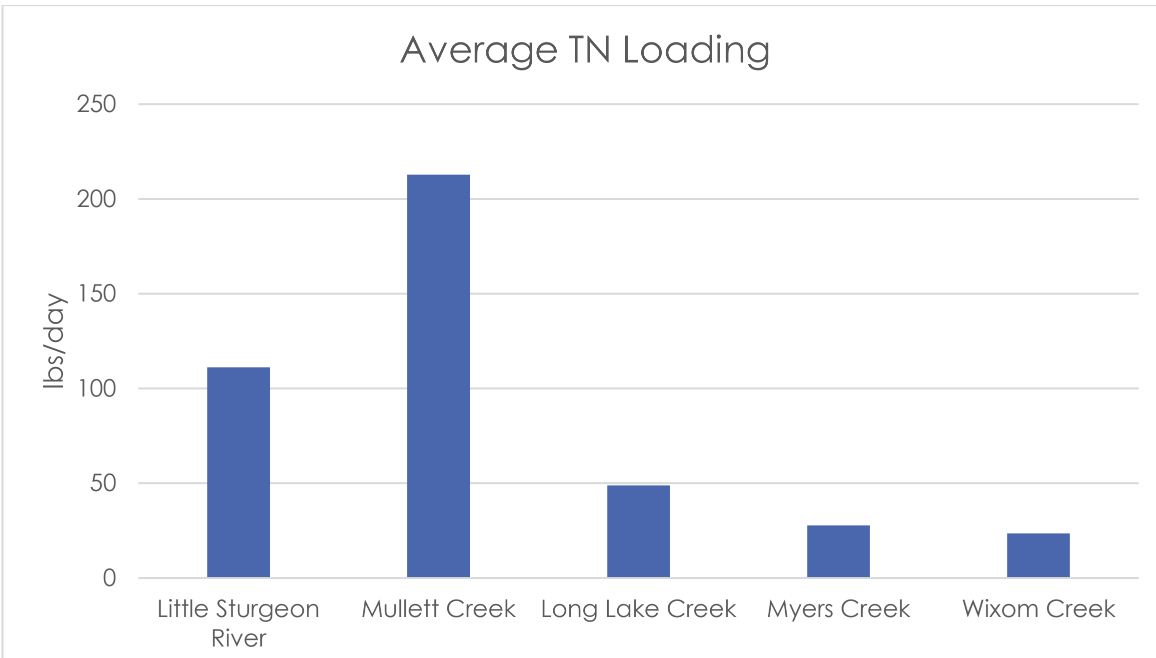


Figure 44. Average TN loading

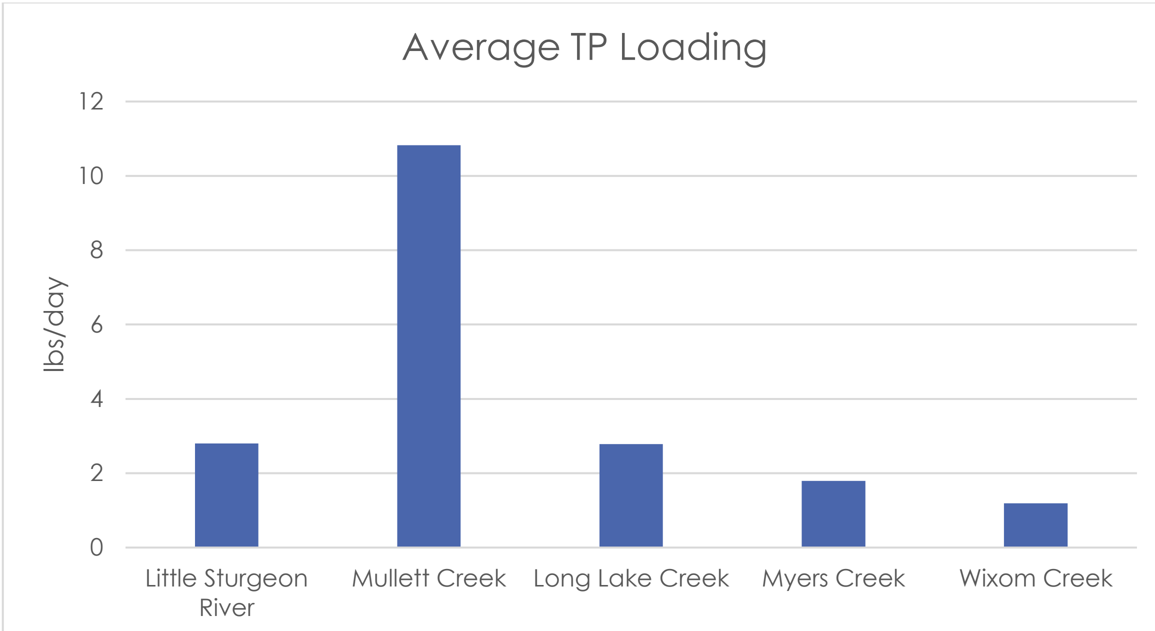


Figure 45. Average TP loading

TN and TP for lakes within the watershed are relatively stable and remain, on average, below EPA reference conditions (Figure 46, Figure 47).

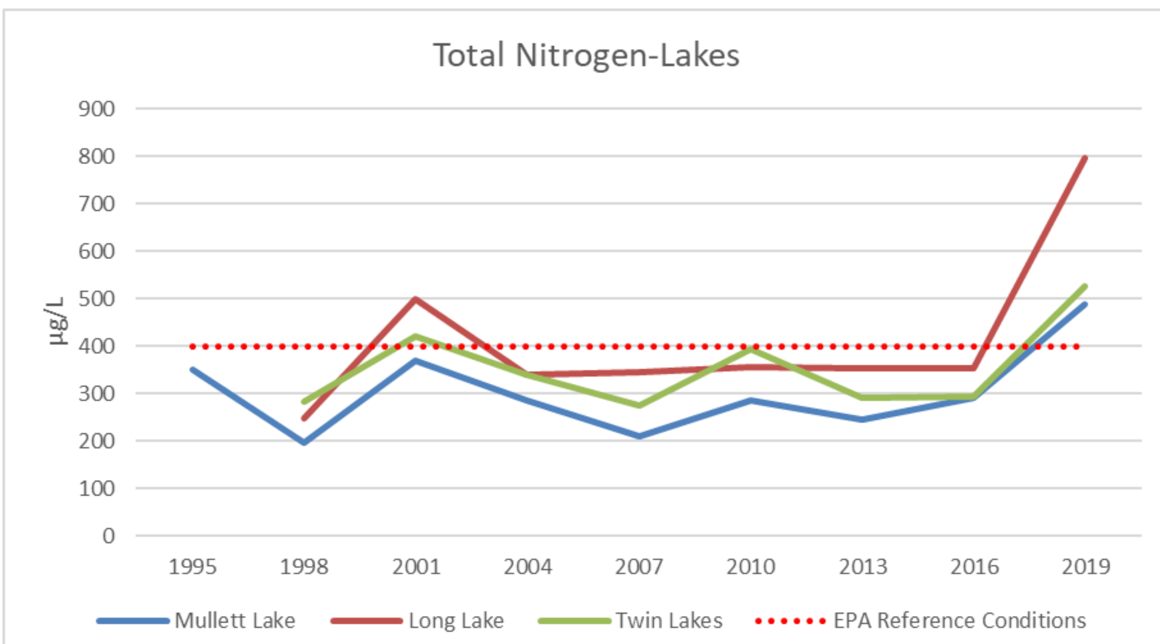


Figure 46. Total nitrogen in lakes

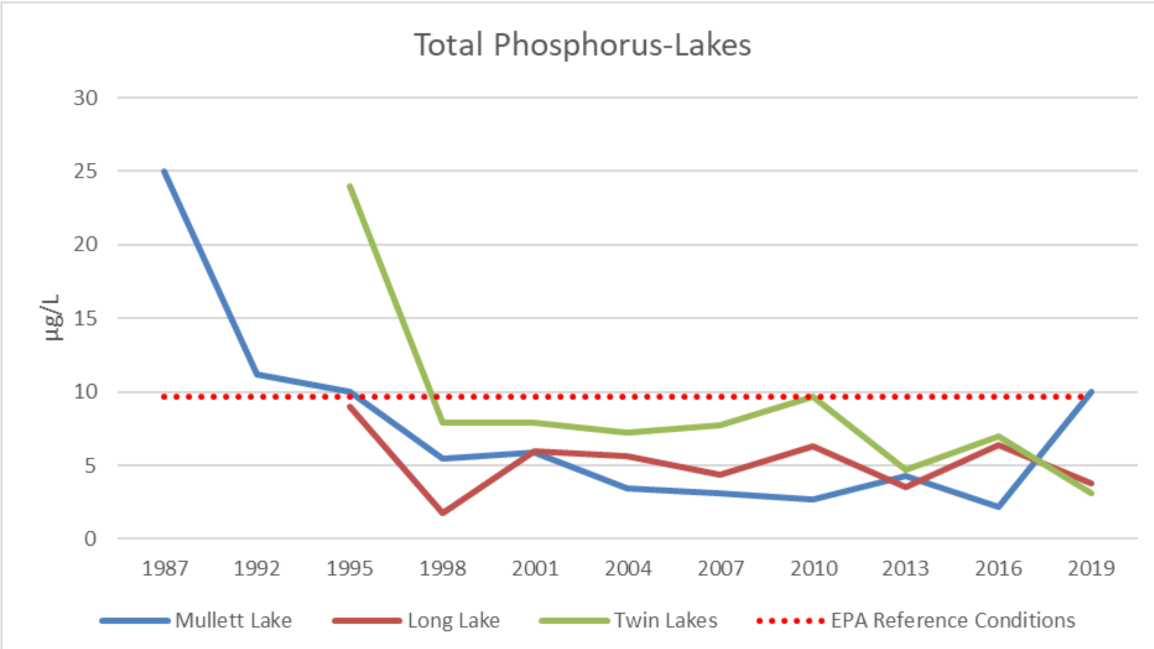


Figure 47. Total phosphorus in lakes

3.5 Water Clarity and Trophic Conditions

Parameter Description

Water clarity is a simple and valuable way to assess water quality. The clarity of water is principally determined by the concentration of algae or suspended and dissolved solids in the water. An eight-inch disc with alternating black and white quadrants, called a Secchi disc, is used to measure water clarity by noting the depth at which the disc disappears. Water samples are often collected in conjunction with the Secchi disc measurement for chlorophyll-a analysis; chlorophyll-a is a pigment found in green plants. Chlorophyll-a data provide an approximation of the amount of algae in the water, which is useful for determining whether changes in water clarity are caused by sediments or algae.

Water clarity, chlorophyll-a, and phosphorus data are used to determine the biological productivity, or trophic status, of a lake. The Trophic Status Index (TSI) is a tool developed by Bob Carlson, Ph.D. from Kent State University that utilizes these data to place a water body on a scale of biological productivity (). TSI values range from zero to 100: lower values (0-38) indicate an oligotrophic or low productive system, medium values (39-49) indicate a mesotrophic or moderately productive system, and higher values (50+) indicate a eutrophic or highly productive system (Table 7). Lakes with greater water clarity and smaller phytoplankton populations would score on the low end of the scale, while lakes with greater turbidity and more phytoplankton would be on the high end.

Oligotrophic lakes are characteristically deep, clear, nutrient poor, and with abundant oxygen. On the other end of the spectrum, eutrophic lakes are shallow, nutrient rich, and full of productivity. A highly productive eutrophic lake could have problems with oxygen depletion whereas the low-productivity oligotrophic lake may have a lackluster fishery. Mesotrophic lakes lie somewhere in between and are moderately productive.

Table 7. Trophic state

Trophic State	TSI	Chl-a (µg/L)	Secchi (ft)	TP (µg/L)
Oligotrophic	<40	<2.6	>13.1	<12.0
Mesotrophic	40-50	2.6-7.3	6.6-13.1	12.0-24.0
Eutrophic	50-70	7.3-56.0	1.6-6.6	24-96
Hypereutrophic	>70	>56	<1.64	>96

*Carlson, R.E. and J. Simpson. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. 96 pp.

Depending upon variables such as age, depth, and soils, lakes are sometimes naturally eutrophic. However, nutrient and sediment pollution caused by humans can lead to the premature eutrophication of a lake, referred to as "cultural eutrophication". A lake that undergoes cultural eutrophication can affect the fisheries, cause excess plant growth, and result in algal blooms that can be both a nuisance and a public health concern.

Summary

Mullett Lake is a large, oligotrophic lake. Long Lake and Twin Lakes are also classified as oligotrophic. Trophic state index (TSI) for Mullett Lake has remained relatively stable since 2000 (Figure 48). Long Lake TSI values have ranged from 32 to 38 and has been steadily increasing since 2013 (Figure 49). Twin Lakes TSI values are fairly stable and range from 32 to 42 (Figure 50). This data (secchi depth and chlorophyll *a*) has been collected through TOMWC's Volunteer Lake Monitoring Program, currently operating under a draft QAPP.

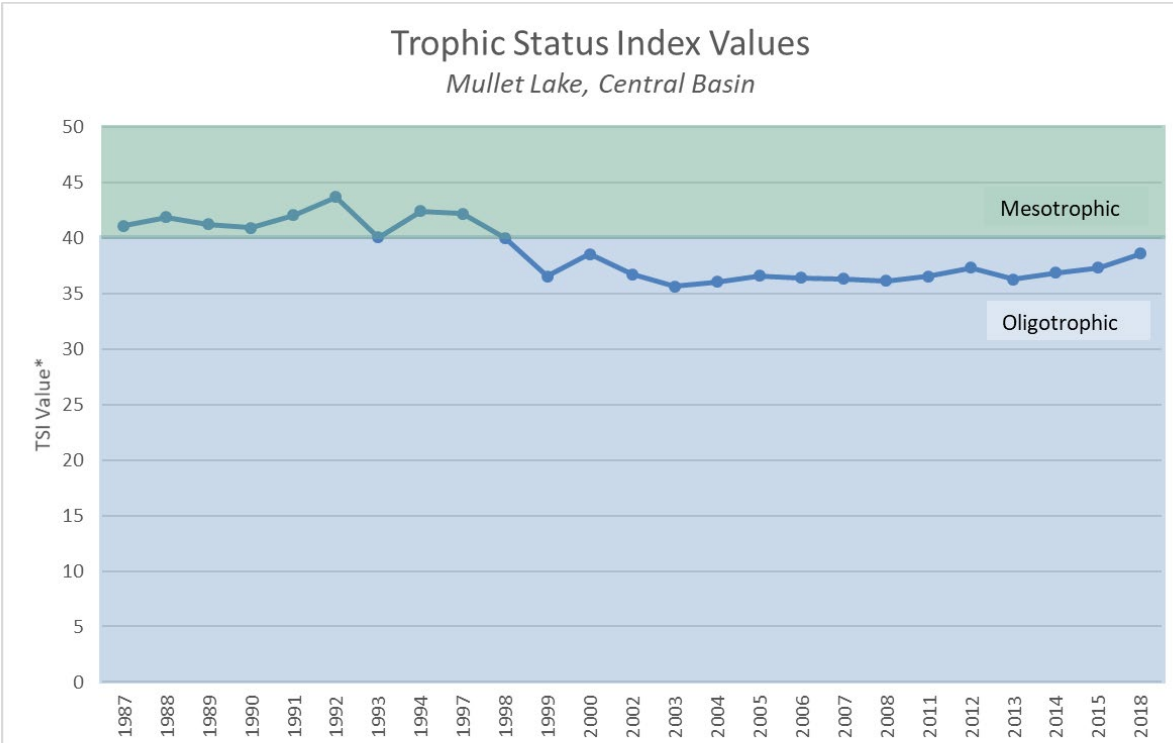


Figure 48. Trophic Index Mullett Lake

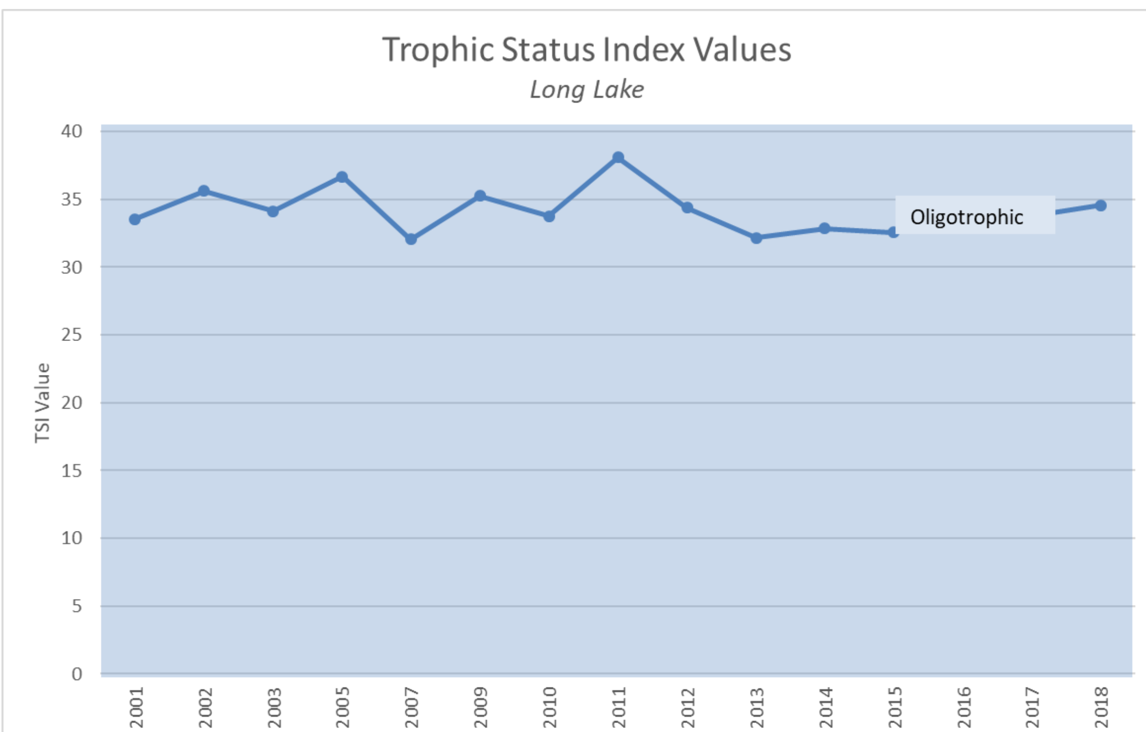


Figure 49. Trophic Index Long Lake

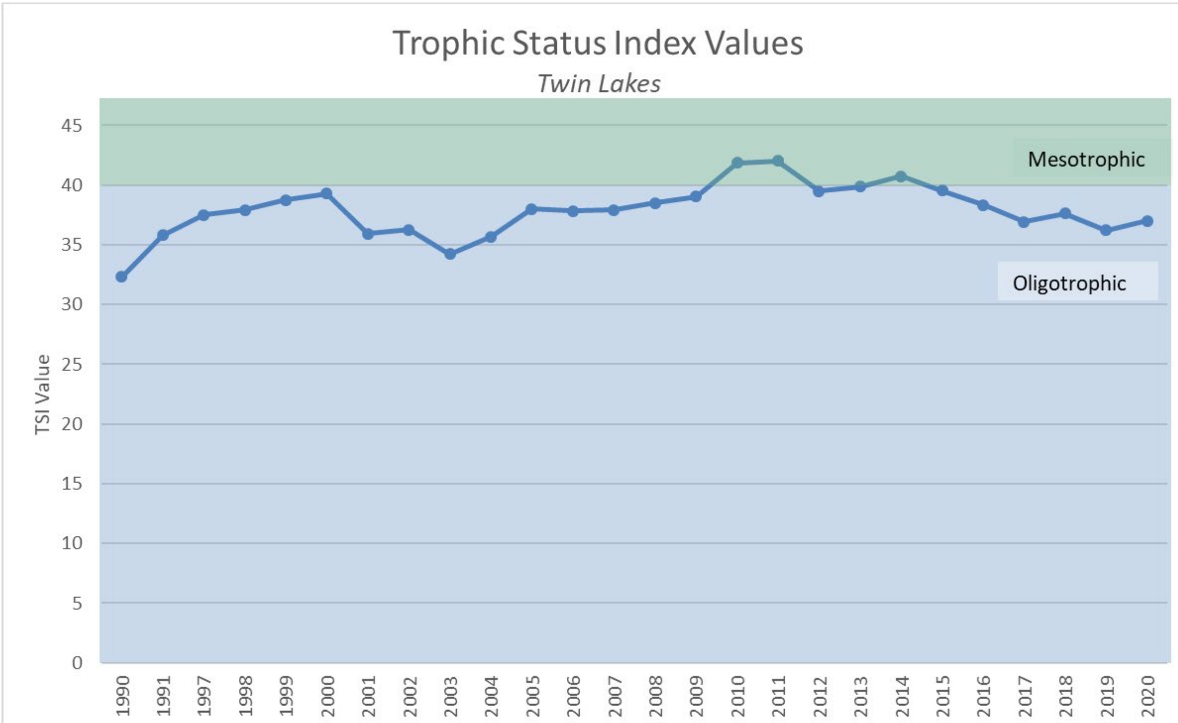


Figure 50. Trophic Index Twin Lakes

3.6 Bacteriological Monitoring

Parameter Description

Monitoring for harmful pathogens in a water body is typically performed by monitoring Escherichia coli (E. coli) bacteria at popular access points during the summer. The measurement is the number of E. coli in a 100mL water sample. E. coli bacteria usually do not pose a direct danger, but are rather indicators of the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans that originate in human and animal digestive systems. Thus, their presence in surface waters indicates that pathogenic microorganisms might also be found and that there may be health risks associated with full body contact.

Rule 62 (R 323.1062) of EGLE Part 4 Water Quality Standards does have a provision for E. coli concentrations in surface water: "All waters of the state protected for total body contact recreation shall not contain more than 130 Escherichia coli per 100 milliliters, as a 30-day geometric mean." Rule 62 also states: "At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 E. coli per 100 milliliters." In addition, the Daily Maximum Geometric Mean for partial body contact is 1,000 E. coli per 100 ml.

Summary

The District Health Department Number 4 monitors some public beaches in the summer months. Sampling typically occurs once a week from mid-June until the end of August on primary beaches, and secondary beaches, or those not as heavily used, are sampled twice in the summer. Results are received from the lab in 24-48 hours.

There was one beach closure at Aloha State Park in July 2022 that had a result of 509.992 E. coli per 100 mL as a 30-day geometric mean.

3.7 Biological Monitoring

Parameter Description

TOMWC

Biological data are collected primarily by sampling macroinvertebrate communities in streams. Healthy streams typically have a high diversity of macroinvertebrates, especially taxa sensitive to pollution. Biological data were assessed using three metrics: 1) total taxa = the total number of macroinvertebrate families found at a site; 2) EPT taxa = the number of families belonging to three insect orders that are largely intolerant of pollution (mayflies, stoneflies, and caddisflies); and 3) sensitive taxa = the number of macroinvertebrate families that are the most intolerant of pollution (those that rate 0, 1, or 2 in PhD William Hilsenhoff's family-level sensitivity classification system). Streams are assigned grades A (excellent) through E (very poor) based on a system that utilizes all 3 index scores.

EGLE

EGLE assesses sites using procedure 51. The macroinvertebrate and fish communities were assessed and scored with metrics that rate water bodies from excellent (+5 to +9) to poor (-5 to -9). Scores from +4 to -4 are rated acceptable. Negative scores in the acceptable range are considered tending towards a poor rating, while positive scores in the acceptable range are tending towards an excellent rating. Habitat evaluations are based on 10 metrics, with a maximum total score of 200. A station habitat score of >154 is characterized as having excellent habitat, 105-154 is good, 56-104 is marginal, and <56 is poor. Where available, macroinvertebrate community scores are used to determine attainment of the Other Indigenous Aquatic Life and Wildlife (OIALW) designated use (EGLE WRD Staff Report, 2017).

Summary

TOMWC Data Summary

As part of TOMWC's Volunteer Stream Monitoring program, which operates under an approved QAPP, there are two streams in the watershed where macroinvertebrate collection occurs. As is evident in Figure 51, the Pigeon River has yearly average scores that remain relatively constant with an average "A" grade. Mullett Creek scores fluctuate widely, from 52 to 90, over the 15 years that data has been collected. It still receives a "B" grade overall.

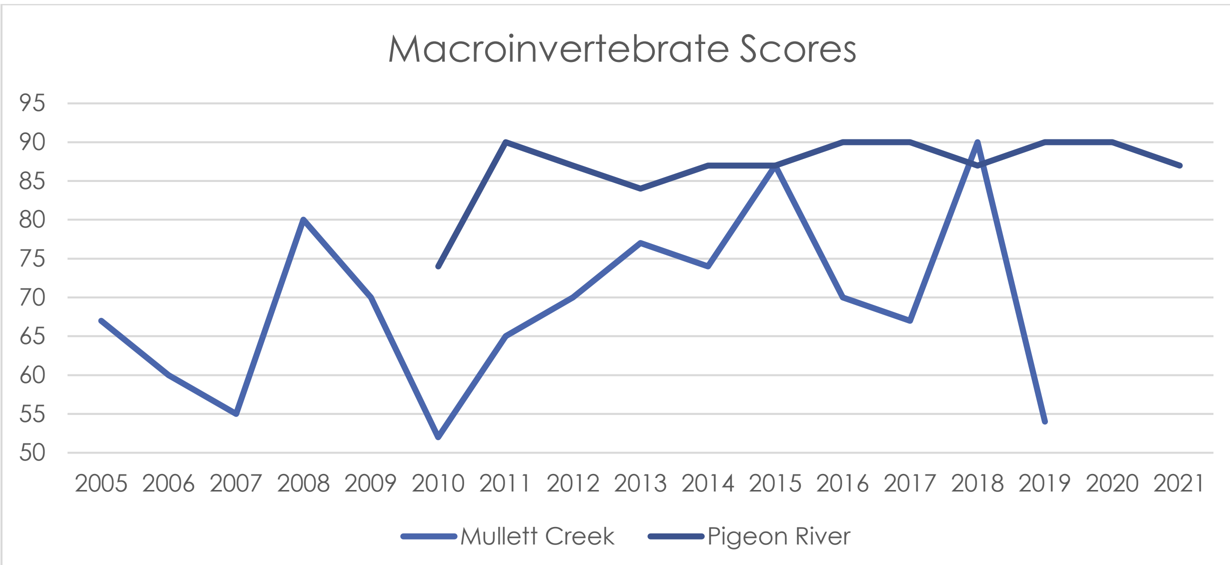


Figure 51. Yearly average macroinvertebrate scores from VSM

EGLE Data Summary

When sampled in 2015 by EGLE staff, Pigeon River and Mullett Creek met the OIALW designated use. When compared to the 2010 survey, the habitat score improved slightly but the macroinvertebrate community rating has declined from excellent (5) to acceptable (1) (Table 8).

Table 8. EGLE habitat and macroinvertebrate rank

Waterbody	Site	Habitat Rank	Macro Rank
Pigeon River	Old Vanderbilt Road	Excellent	Excellent
Pigeon River	Sturgeon Valley Road	Good	Excellent
Pigeon River	Pigeon River Road	Excellent	Excellent
Mullett Creek	South Extension Road	Good	Acceptable

3.8 Water Quality Summary

This chart summarizes the water quality parameters that were assessed as a part of this watershed management plan, and if those monitoring events meet EPA reference conditions (Table 9). "Some" is defined as 25% and 99% that fall within reference conditions, "Few" is defined as less than 25% that fall within reference conditions.

Table 9. Water quality summary

Site Name	Physical			Chemical			Biological	
	ph	DO	Sp Cond	Chloride	TN	TP	E. Coli	Macros
Mullett Lake								
Twin Lakes								
Long Lake								
Little Pigeon River								
Little Sturgeon River								
Long Lake Creek								
Mullett Creek								
Myers Creek								
Owens Creek								
Tannery Gully								
Wixom Creek								
Pigeon River								
Indian River								
Cheboygan River								
Lower Black River								
All monitoring events met reference conditions								
Some monitoring events met reference conditions								
Few monitoring events met reference conditions								
No Data								

CHAPTER 4.
RESOURCE INVENTORIES

Data collected for the following resource inventories were done under an approved QAPP that can be found in Appendix E.

4.1 Estimated Pollutant Loads

Pollutant loading rates were calculated using EPA's Spreadsheet Tool for Estimating Pollutant Loads (STEPL). This tool calculates nutrients (N/P), biological oxygen demand (BOD), and sediment loads by land use type within a watershed. Annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water, as influenced by factors like land use. The annual sediment load (sheet and rill erosion only) is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio.

All these parameters occur naturally in the ecosystem-but are harmful in abundance. The following table is an estimate of pollutant loads by land use type. Of the three major subwatersheds, Lower Black/Cheboygan has the most estimated NPS impacts Table 7.

Table 10. Percentage of land use impacts by subwatershed

Subwatershed	Size (ac)	Urban	Cropland	Pastureland	Forest
LBlack/Cheboygan	37,885	**11%**	**6%**	**25%**	57%
Pigeon River	108,442	5%	4%	10%	**81%**
Mullett Direct	62,753	10%	5%	16%	70%

Pastureland is contributing the most nitrogen and BOD, urban contributes the most phosphorus, and sediment is mostly contributed by cropland (Table 11).

Table 11. Estimated pollutant loads by land use type

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	54,829	**8,446**	209,378	1,262
Cropland	23,312	5,108	48,417	**1,964**
Pastureland	**85,305**	7,676	**272,087**	1,289
Forest	14,656	7,161	35,915	454
Feedlots	3,894	778	5,192	0
Septic	6,068	2,377	24,778	0
Total	188,065	31,549	595,768	4,969

The subwatersheds are listed below in order from largest to smallest. The bold numbers are the subwatersheds that are contributing the most pollution per acre. The Lower Black/Cheboygan subwatershed is contributing both the most nitrogen and the most BOD. This is likely due to the soils in that subwatershed having lower infiltration rates and a higher percentage of urban area. The Pigeon River watershed is contributing the highest phosphorus and sediment load (Table 12).

Table 12. Estimated pollutant loading by subwatershed

Watershed	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Pigeon River	63,624.38	**11,870.49**	197,116.09	**1,778.10**
Mullett Direct	57,891.47	9,819.30	185,571.51	1,659.51
LBlack/Cheboygan	**66,550.06**	9,858.78	**213,079.56**	1,531.84

4.2 Agricultural Inventory

The Watershed has 22,094 acres of agricultural landcover, representing 9.72% of the total Watershed area (Table 13). Of the agricultural landcover, 17,642 acres (79.85%) is cropland while 4,421 acres (20.01%) is pasture or hay (Table 14). The most common agricultural activities include producing corn and hay. In 1985, the Watershed had 21,557 acres of agricultural landcover representing 9.48% of the total Watershed area. Between 1985 and 2016, agricultural landcover increased by 538 acres (0.24%) (Table 15). Agricultural pollutant loads can be found at the beginning of this chapter (Table 11).

Table 13. Agriculture acreage by subwatershed

Subwatershed	Size (acres)	Agriculture (acres)	Agriculture (%)
Mullett Lake Direct	79,964	7,474	9.35%
Pigeon River	107,945	7,615	7.05%
LBlack/Cheboygan Rivers	39,466	7,006	17.75%
Total	227,375	22,094	9.72%

Table 14. Agriculture type by subwatershed

Subwatershed	Total Agriculture Acreage	Cropland (acres)	Cropland (%) *	Pasture / Hay (acres)	Pasture / Hay (%) *
Mullett Lake Direct Drainage	7,474	5,473	73%	2,001	27%
Pigeon River	7,614	6,896	90%	702	9%
LBlack/Cheboygan Rivers	7,006	5,281	75%	1,725	25%
Total	22,094	17,650	80%	4,428	20%

**As a percentage of total agricultural land in subwatershed.*

Table 15. Agriculture land use change by subwatershed

Subwatershed	Agriculture Change 1985-2016 (acres)	Agriculture Change 1985-2016 (%) *
Mullett Lake Direct	223	3%
Pigeon River	275	4%

LBlack/Cheboygan Rivers	40	1%

**As a percentage of subwatershed agricultural 2016 landcover acreage.*

Potential for water quality impacts was using scoring criteria. Scores >5.5 are high potential, 4-5 moderate potential, 3-3.5 low potential, and <2.5 very low potential. Information on how the scores were derived can be found in Appendix E.

Seven farms in the Watershed are verified by the Michigan Agriculture Environmental Assurance Program (MAEAP). This is average for all the watersheds within TOMWC's service area. MAEAP is a voluntary program, implemented by the Conservation District that ensures farms are engaging in pollution prevention practices that are cost-effective, pollution minimizing, and complying with environmental regulations. The MAEAP program promotes scientific farming standards designed to protect natural resources, including minimizing fertilizer use and safe storage of fuel and chemicals.

It is important to note that while there are only seven MAEAP verified farms in the Watershed, there are several farms that have taken steps to improve environmental protections on their farm but do not meet all MAEAP standards to be verified.

Mullett Lake Direct

The Mullett Lake Direct has 7,474 acres of agricultural landcover, representing 9.35% of the total drainage area. Of the agricultural landcover, 73.23% is cropland while 26.77% is pasture or hay. The majority of agriculture activity is on the northeastern side of the lake (Table 14.). The most common agriculture practice noted was hay, followed by grains and cows. From 1985 to 2016, the subwatershed had an increase of 223 acres, or 2.98% of agricultural land.

There is a total of 1,332 agricultural parcels in this subwatershed. Of those parcels, only one was determined to have a high nonpoint source potential. One parcel was found to have moderate potential, and 17 were found to have low potential for nonpoint source pollution. The remaining parcels had very low impact. This is due to its proximity to water, steep slopes, mowing, and livestock access.

Mullett Creek has historically had issues from agricultural runoff from a dairy farm upstream. Results from a 2007 Mullett Lake Tributary study (Appendix D) indicated that Mullett Creek "contributed disproportionately high amounts of nutrients". A resident on Mullett Creek mentioned that the stream that was suspected to contribute to these increased bacteria and nutrient levels no longer has cattle as of early 2022 (Tassava, pers. comm.)

Pigeon River Subwatershed

The Pigeon River subwatershed has 7,614 acres of agriculture landcover, representing 7.05% of the total drainage area. Of the agricultural landcover, 90.57% is cropland while 9.22% is pasture or hay. The majority of agriculture activity is in the northeast corner of the Watershed by the Little Pigeon River. The dominate crop in this subwatershed is hay, with some corn and animals. From 1985 to 2016, the subwatershed had an increase of 275 acres, or 3.61% of agricultural land.

There are a total of 938 agricultural parcels in this subwatershed. Of those parcels, there were no high nonpoint source potential parcels, and two moderate. Only ten parcels were rated as low potential and the remaining were very low.

Lower Black/Cheboygan River Subwatershed

The Lower Black/Cheboygan River subwatershed has 7,006 acres of agriculture landcover, representing 17.75% of the total drainage area. This is the largest percentage of all the subwatersheds. Of the agricultural landcover, 75.36% is cropland while 24.62% is pasture or hay. Agriculture activity is spread fairly evenly throughout the subwatershed, but the highest potential impact can be found in the middle, or the lower half of the Lower Black River. The most common agricultural activities include growing hay and corn. Some parcels also had animals from 1985 to 2016, the subwatershed had an increase of only 40 acres, or 0.57% of agricultural land.

There is a total of 1,584 agricultural parcels in this subwatershed. Of those parcels, one was rated as high nonpoint source potential, 18 properties rated were as moderate, and 43 were rated as low. This is more than the other subwatersheds, as is evident in Figure 52. These were rated as such primarily for steep slopes, mowing, and erosion. The remaining parcels have very low potential (Table 16). The worst of these areas were those that are producing corn around the Twin Lakes area.

Table 16. Nonpoint source potential by subwatershed

	LBlack/Cheboygan Rivers			Mullett Lake Direct			Pigeon River		
NPS Potential	**Agricultural Acres***	**# Properties**	**% of Agriculture**	**Agricultural Acres***	**# Properties**	**% of Agriculture**	**Agricultural Acres***	**# Properties**	**% of Agriculture**
High	0	0	0%	82	1	0%	0	0	0%
Moderate	169	9	1%	196	1	1%	0	0	0%
Low	2053	48	10%	1764	22	5%	208	3	0%
Very Low	18467	1527	89%	37109	1308	95%	67577	945	100%
Total	20689	1584		39147	1332		67786	948	

**agricultural acreage for this survey was determined by parcels*

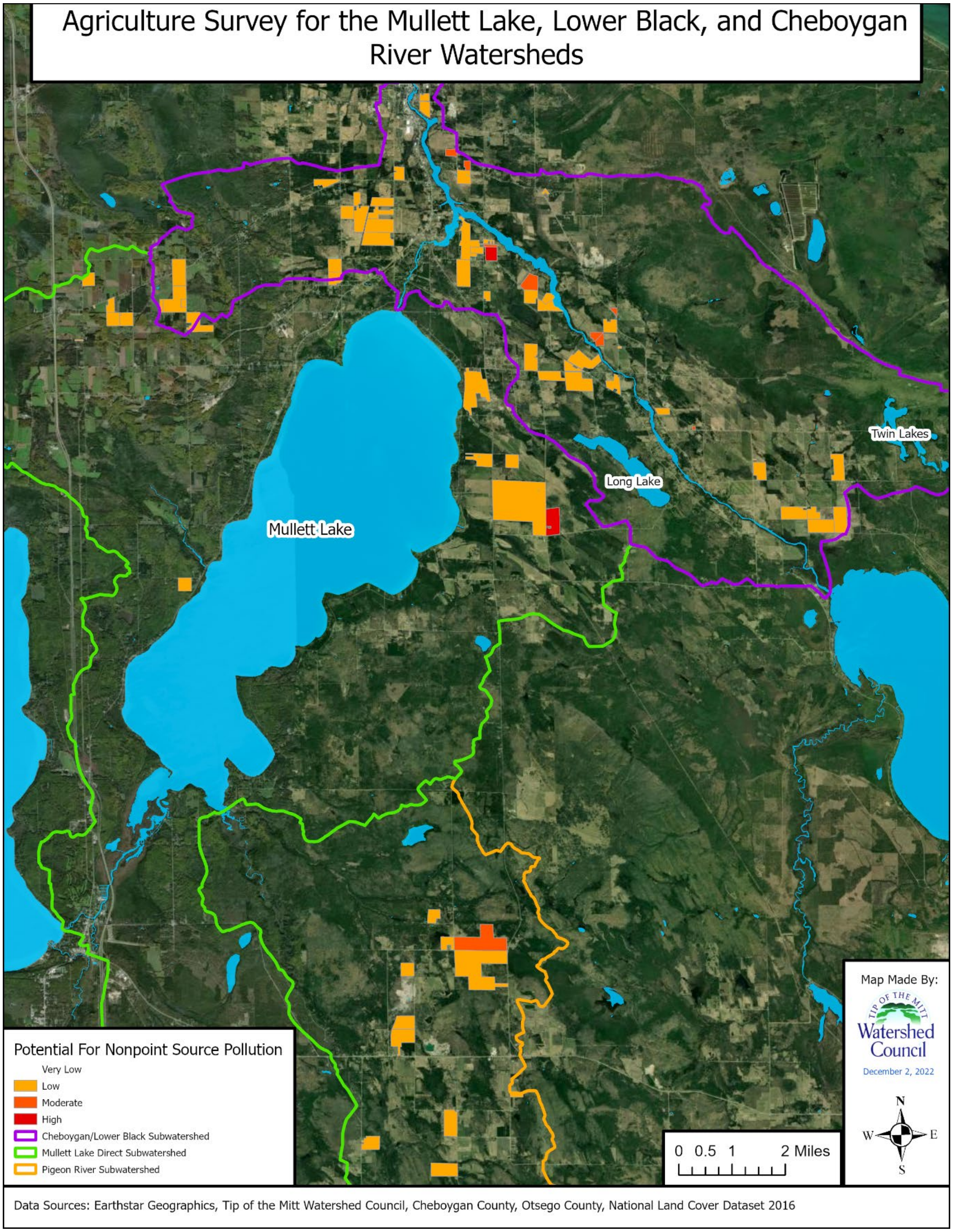


Figure 52. Agriculture parcels rate low, moderate, and high.

4.3 Forestry Inventory

At a combined 132,882 acres, upland forests, shrublands, and grasslands together make up the majority (58.44%) of the watershed. This landcover type has been stable since 1985, when it made up 59.27% of the watershed. An additional 40,224 acres (17.69% of the watershed) of wetlands also have forest or shrubs as the predominant landcover. However, these will not be included in the forestry analysis as they have been addressed elsewhere in the plan and are not generally considered productive forestry lands. The State of Michigan is the largest single owner of forest land within the watershed, making up nearly half of all forestland in the watershed. The remaining forest land is largely private owned, but other forest landowners include land conservancies and local units of government (Table 17).

Forest management under any of the listed entities varies from preservation minded to harvest oriented. Maintenance of unique forest types including old-growth, late-successional, and minimally-altered communities is essential for the ecological health of Northern Michigan. However, timber harvesting and other extraction-oriented activities are essential to the economic health of Northern Michigan. Applying sustainable and ecologically-minded forest management principles to harvest operations can provide a balance between economic gains and ecological integrity.

Table 17. Forest ownership in the Watershed

Ownership Type	Acres	Percentage of Forestland
Private	65,417	49.23%
State of Michigan	65,411	49.22%
County	58	0.04%
City & Township	128	0.10%
Land Trust/Conservancy	1864	1.40%
Conservation District	4	0.00%
Total	**132,882**	**100.00%**

This forestry inventory aims to identify potential nonpoint pollution sources resulting from forestry practices. Although damage to water resources can vary greatly depending on the situation, the most common issues resulting from forestry activities are surface disturbance and the resultant soil loss and erosion, causing sedimentation of waterways. Some water quality laws aim to reduce the risk of sedimentation and other damage to waterways. In Michigan, Parts 301 and 303 of P.A. 451 help to protect streams, rivers, and wetlands from direct ford crossings, filling/ dredging, or damming.

Private Forest Lands

Beyond the above regulations, a great deal of discretion is given to the land owner or the logging company to avoid sensitive areas and implement best management practices, or BMPs. BMPs are voluntary actions taken by the landowner to help minimize impacts to natural resources like soils and water. Stewardship principles and ethics vary amongst landowners, and little has been done to evaluate private landowner attitudes towards minimizing water resource impacts, especially when such efforts would result in a reduced timber harvest. However, there are currently six voluntary programs available in Michigan (listed below) aimed at incentivizing landowners to protect water, soil, and other natural resources through the development of forest management plans, which typically include recommendations to follow forestry best management practices. Many private consulting foresters also prepare forest management plans for government sponsored incentive programs.

Incentive Programs for Private Forest Lands

- Forest Stewardship Program – DNR

The program offers cost-share for the development of a forest management plan (including BMPs) with the help of a private consulting forester. The plan can then be used for enrollment in tax- incentive programs like the Commercial Forest Program (CFP) or Qualified Forest Program (QFP). Landowners can also get a sign that gives public recognition of their conservation efforts.

- American Tree Farm System – American Forest Foundation (AFS)

The program guides landowners in creating a forest management plan, which can be used for enrollment in tax- incentive programs like the CFP or QFP. It also requires members to follow all state designated BMPs for forest management, and landowners receive a sign that gives public recognition of their conservation efforts.

- Michigan Agriculture Environmental Assurance Program (MAEAP) – Michigan Department of Agriculture and Rural Development (MDARD)

Requires landowners to develop a management plan and follow Michigan BMPs. The management plan can be used for enrollment in tax- incentive programs like the CFP or QFP. Landowners also receive a sign that gives public recognition of their conservation efforts. Currently, there are no MAEAP certified forestlands within the Mullett Lake watershed.

- Environmental Quality Incentives Program (EQIP) – NRCS

Offers cost-share to landowners to help fund conservation-oriented practices, including the development of forest management plans, planting trees and shrubs, creating early successional habitat, marking timber in preparation for sale, and other practices.

- Commercial Forest Program (CFP) – DNR

This program reduces property taxes on private lands with at least 40 contiguous acres of forest. A forest management plan (including BMPs) is required to enroll, but compliance with the plan is not enforced. Landowners must allow public access for hunting, fishing, and trapping.

- Qualified Forest Program (QFP) – MDARD

This program reduces property taxes on private lands with at least 20 contiguous acres of forest. A forest management plan (including BMPs) is required to enroll. Allowing public access is not a requirement on land enrolled in the QFP.

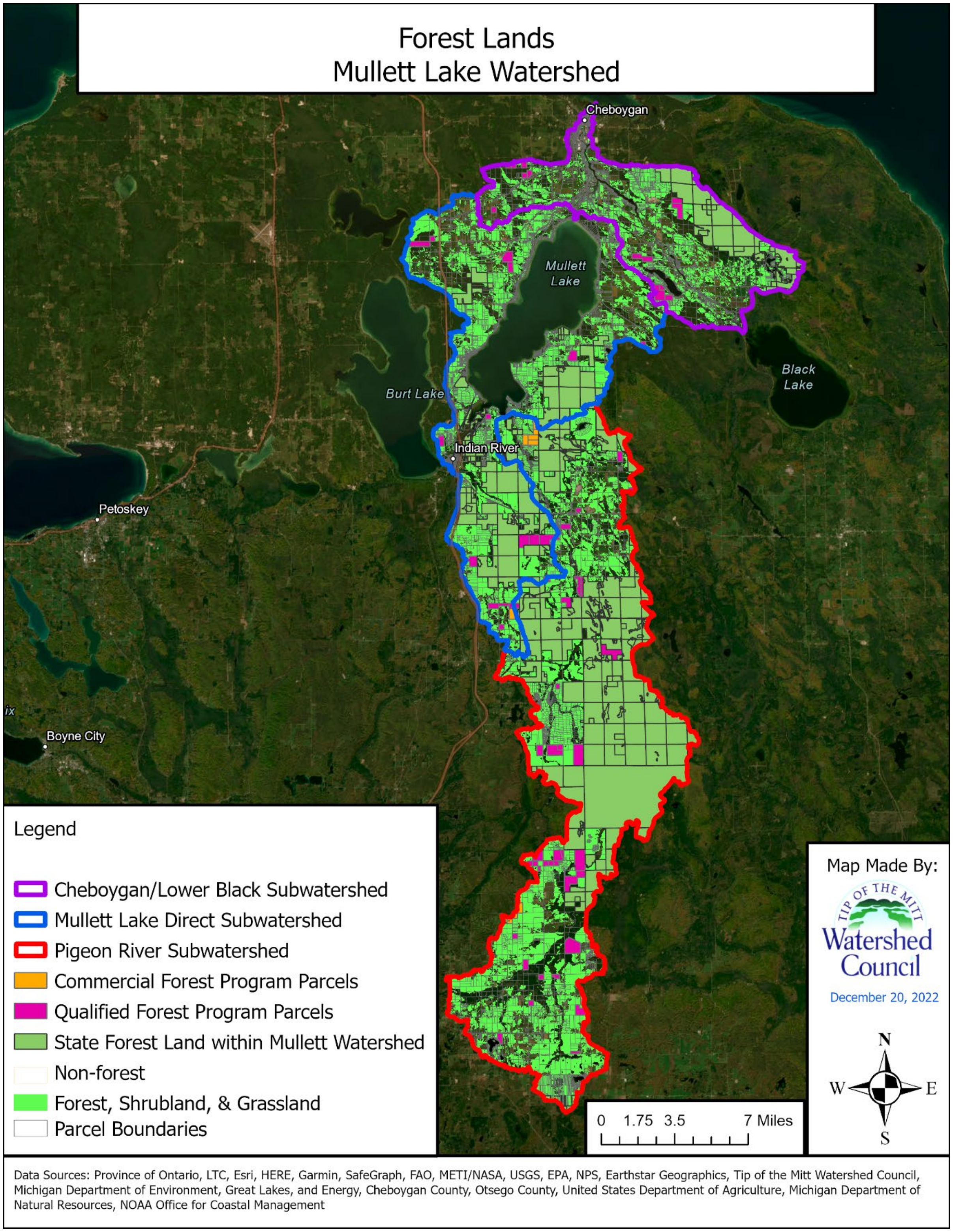


Figure 53. Forest, shrubland, and grassland in the Watershed, including state and private forest land.

Many owners of private forest lands are enrolled in more than one of the above forest incentive programs. Typically, a landowner may work through one of the first four programs (listed above) to develop a forest management plan, which will then allow them to enroll in one of the tax incentive programs (CFP or QFP). For example, the CFP and QFP together drove demand for 84% of the forest management plans created through the DNR's Forest Stewardship Program in fiscal year 2021 (Mike Smalligan [DNR], pers. comm. 2/15/2022). Because of this overlap, and because spatial data was not shared by some of the other programs, we are only reporting acres enrolled in the CFP and QFP programs. Currently, 6,018 acres of private forest land within the watershed is covered by one of these two programs (Table 18).

Table 18. Forest programs by subwatershed

Subwatershed	Commercial Forest Program		Qualified Forest Program	
	Parcels	**Acres**	**Parcels**	**Acres**
Pigeon River	11	598	36	3,469
Mullett Lake Direct	2	125	21	1,614
LBlack/Cheboygan Rivers	0	0	12	936
Total	13	723	69	6,018

Protections Along Designated Natural Rivers

In addition to the above incentive programs, the Pigeon River and many of its tributaries have been designated as a "natural river" by the state. The natural river designation carries with it many protections for water quality related to development such as minimum building setbacks and construction regulations, but it also has forestry-related protections. As such, a streamside buffer of 100 feet is required for all logging along the Pigeon River and its tributaries. Logging is still permitted within these buffers, but loggers must leave more trees than outside the buffer (i.e. no clear-cuts to the water's edge), which provides greater water protection along these streams.

Public Forest Lands

No national forest land is located within the Watershed, so our analysis of forestry on public lands focused on state forests. A meeting with State of Michigan Forest Resources Division officials was conducted as part of the initial information gathering process. The management goals of the DNR were outlined. Sustainability is paramount in many aspects of their operation, including forest productivity and protecting soil and water resources. All state forests are independently certified as sustainably managed by both the Forest Stewardship Council and the Sustainable Forestry Initiative.

The publication *Michigan Forestry Best Management Practices for Soil and Water Quality* (DNR and EGLE 2018) serves as a guide for implementation of best management practices (BMPs) and outlines water resource regulations that apply to logging operations on state forest land. Although the state government does little of the timber harvesting themselves, their contracted logging companies are held to these standards through DNR planning and through contract negotiation, selection, and oversite. One such BMP is the designation of Riparian Management Zones (RMZs), also known as buffer strips, filters strips, or streamside management areas or zones. An RMZ occurs on both sides of perennial or intermittent streams and around the perimeter of bodies of open water (e.g. open water wetlands or lakes) where extra precaution is used in carrying out forest management practices including timber-harvesting activities. Michigan's standard RMZ minimum width is 100 feet measured from the top of the bank or the ordinary high-water mark of a lake or on each side of a stream.

According to *Michigan Forestry Best Management Practices for Soil and Water Quality*:

> *One of the purposes of an RMZ is for water quality protection to provide an area of vegetation to interrupt water flow and to trap and filter out suspended sediments, nutrients, chemicals, and other polluting agents before they reach the body of water. An RMZ also provides shade to small streams, thus reducing thermal pollution.*

The part of the RMZ nearest the stream bank can also provide an important contribution to the aquatic food chain. As trees die within the RMZ, all or portions of them may fall over into the adjacent stream. This dead material provides aquatic habitat known as large woody structure (LWS). Naturally occurring LWS in lakes and streams provides essential areas of shaded cover for fish, amphibians and aquatic insects, and can provide platforms for reptiles to bask and regulate their temperature. In developing a management plan for the RMZ, consider leaving some late successional trees (both coniferous and deciduous) within the RMZ that have the potential to provide LWS to a lake or stream.

Michigan's BMPs do allow for forest management activities within the RMZ. These include equipment operation and timber harvesting. The key is ensuring the water quality protection function of the RMZ is maintained throughout and after the harvesting operation.

Forestry Inventory Methods

A desktop GIS analysis was used to prioritize locations for the field-based component of the forestry inventory. Parcels of public forest land were split along soil type (SSURGO data) and each sub-parcel was evaluated for a variety of factors, including erosion susceptibility of the soils, slope, presence of water or wetlands within half a mile, presence of designated natural rivers, and whether the sub-parcel had been logged within the last growing season. For the field component of the forestry inventory, we targeted these recently logged sites with a watershed-wide windshield survey, and to a lesser degree, survey on foot. The windshield survey concentrated on state forest land because it is publicly accessible, has regular timber sales, and spatially explicit data was available for recent timber sale locations. However, while traveling to public forest sites in the Watershed, we also looked for forestry activity on private lands along public roads. Datapoints and waypoints along the survey route were recorded using an iPad tablet equipped with a GPS receiver and the ArcGIS Field Maps app. The waypoints were converted into a line format to show the survey route. Specific survey locations were inspected more closely, with pictures taken, and an in-depth assessment of water resource implications was carried out. These survey locations are included on the map and listed below.

Results

During the windshield survey, we covered over 65 miles of forest roads. While we did not encounter forestry activities on private lands in our survey, forest management on state forest lands in the Watershed was found to have very little impact on aquatic resources. While rutting and soil compaction were common on sites that had recently been logged, there was usually no evidence of erosion. Soils were typically sandy, and most of the precipitation is likely seeping into the soil rather than flowing across the surface of the land. Among recently logged sites, only minor erosion was observed and only at one logging site (Figure 54). However, there were three sites along Ford Lake Road with moderate erosion that was not associated with logging activity. Two of these sites had a vegetated buffer of approximately 125 feet between the erosion site and the river, and thus are unlikely to represent water quality concerns (Figure 56). The third site, however, was within 10 feet of the west side of the Pigeon River adjacent to the bridge where Ford Lake Road crosses the river. Deep ruts in soft mucky soils were created by heavy equipment during the bridge’s construction, which appears to have taken place within the last year or two (not pictured).

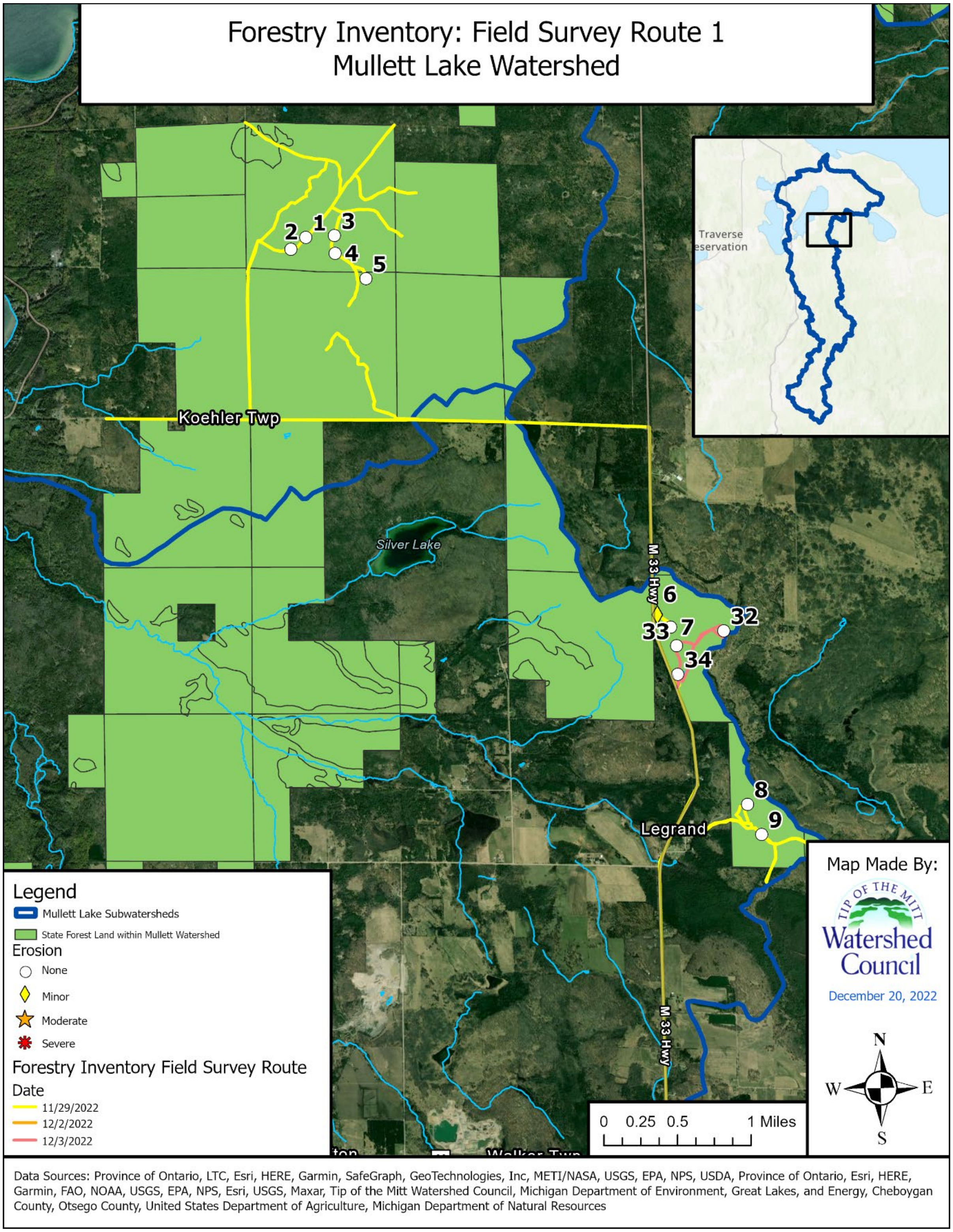


Figure 54. Field survey route 1

Figure 55. Survey point 5 on field survey route 1

Figure 56. Minor erosion was present along a haul road at one logged site (survey point 6). This was the only recently logged site where we observed any erosion.

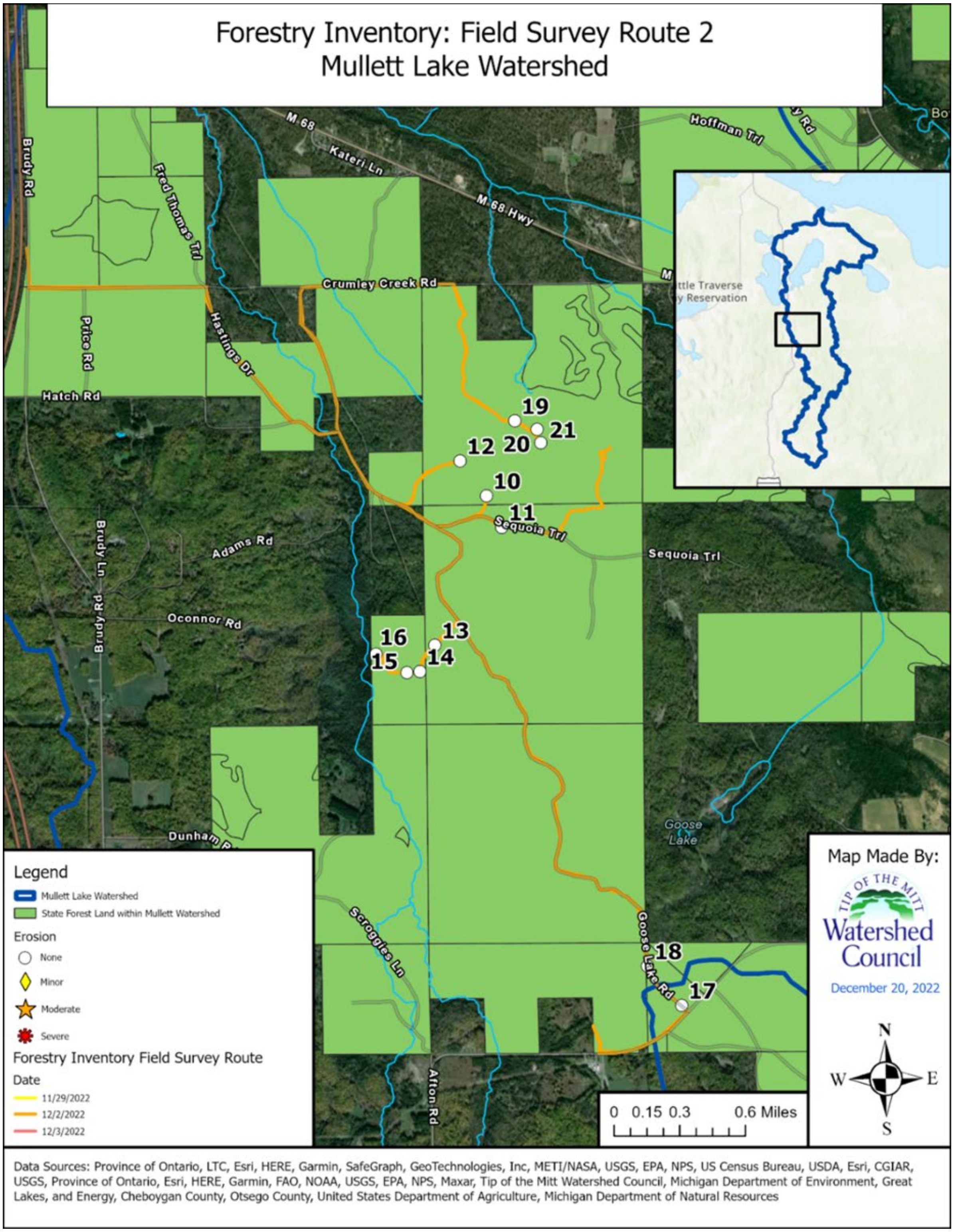


Figure 57. Forestry inventory route 2

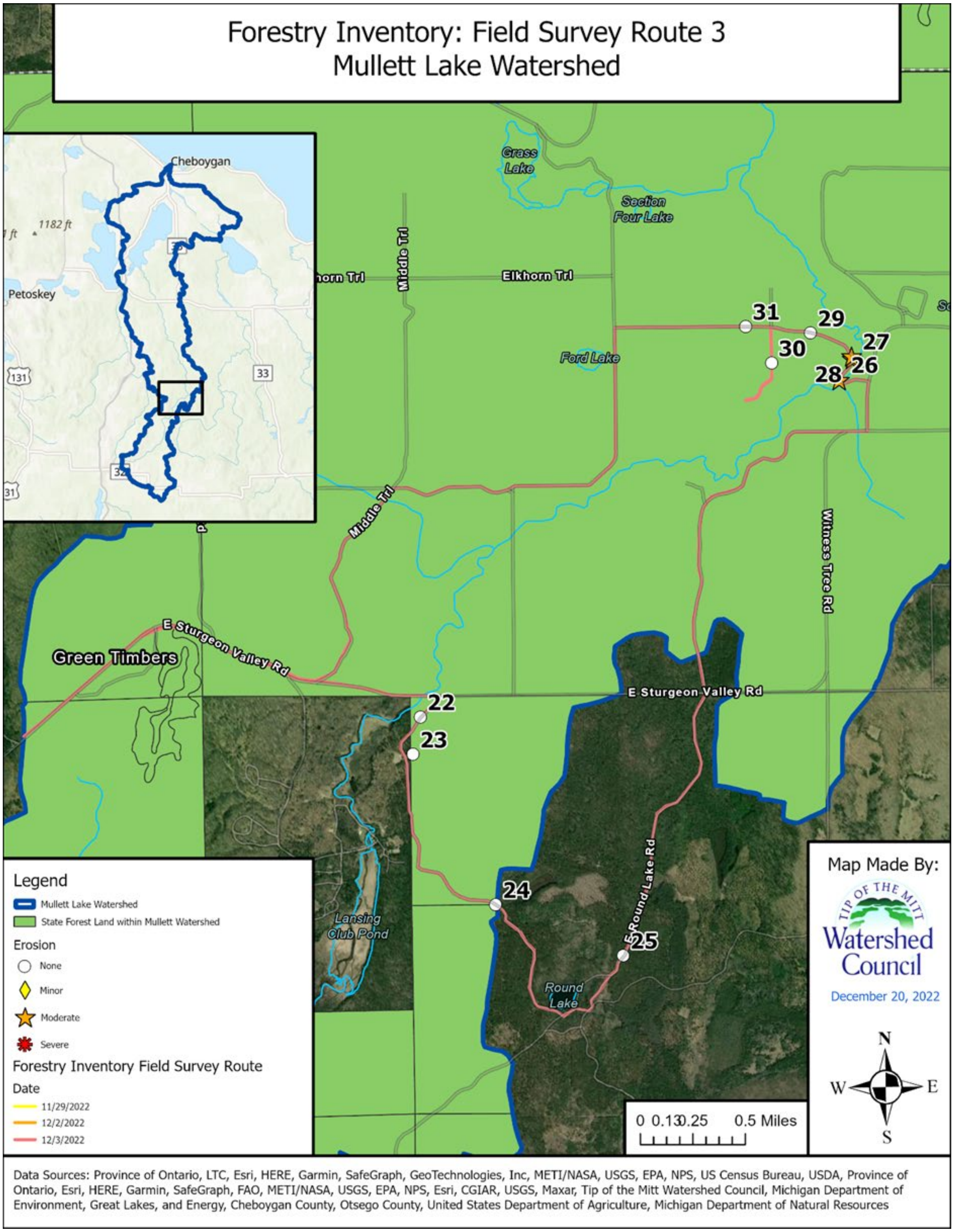


Figure 58. Field survey route 3

Figure 59. Ford Lake Road survey points 27 (top) and 28 (bottom)

4.4 Landscape Level Wetland Functional Assessment

The landscape level wetland functional assessment (LLWFA) tool was developed by EGLE staff in conjunction with cooperating state and local agencies, universities, and nongovernmental organizations. It enables users to identify existing wetlands and the functions those wetlands currently perform. The LLWFA tool also enables the user to identify historical or former wetlands (i.e., areas of hydric soils that are not currently wetlands) and the functions they would likely perform if restored. Restoring lost wetland functionality shows great promise in addressing the systemic cause of much of the nonpoint source pollution occurring in the state.

Application of the LLWFA indicates that wetland resources in the Watershed have changed drastically since pre-settlement, with both wetland acreage and function decreasing significantly.

The LLWFA is, in essence, a screening tool for identifying wetland types and their functions, including:

Flood Water Storage:

This function is important for reducing the downstream flooding and lowering flood heights, both of which aid in minimizing property damage and personal injury from such events.

Streamflow Maintenance:

Wetlands that are sources of groundwater discharge that sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. All wetlands classified as headwater wetlands are important for streamflow.

Nutrient Transformation:

Wetlands that have a fluctuating water table are best able to recycle nutrients. Natural wetlands performing this function help improve local water quality of streams and other watercourses.

Sediment and Other Particulate Retention:

This function supports water quality maintenance by capturing sediments with bonded nutrients or heavy metals. Vegetated wetlands will perform this function at higher levels than those of non-vegetated wetlands.

Shoreline Stabilization:

Vegetated wetland along all waterbodies (e.g. estuaries, lakes, rivers, and streams) provide this function. Vegetation stabilizes the soil or substrate and diminished wave action, thereby reducing shoreline erosion potential.

Stream Shading:

Wetlands that perform water temperature control due to the proximity to streams and waterways. These wetlands generally are Palustrine Forested or Scrub-Shrub.

Conservation of Rare and Imperiled Wetlands:

Wetlands that are considered rare either globally or at the state level. They are likely to contain a wide variety of flora and fauna, or contain threatened or endangered species.

Ground Water Influence:

Wetlands categorized as High or Moderate for Groundwater Influence are areas that receive some or all of their hydrologic input from groundwater reflected at the surface. The Darcy model was the data source utilized to determine this wetland/groundwater connection, which is based upon soil transmissivity and topography. Wetlands rated for this function are important for maintaining streamflow and temperature control in waterbodies.

Fish Habitat:

Wetlands that are considered essential to one or more parts of fish life cycles. Wetlands designated as important for fish are generally those used for reproduction, or feeding.

Waterfowl/Waterbird Habitat:

Wetlands designated as important for waterfowl and waterbirds are generally those used for nesting, reproduction, or feeding. The emphasis is on the wetter wetlands and ones that are frequently flooded for long periods.

Shorebird Habitat:

Shorebirds generally inhabit open areas of beaches, grasslands, wetlands, and tundra and undertake some of the longest migrations known. Along their migration pathway, many shorebirds feed in coastal and inland wetlands where they accumulate fat reserves needed to continue their flight. Common species include plovers, oystercatchers, avocets, stilts, and sandpipers. This function attempts to capture wetland types most likely to provide habitat for these species.

Interior Forest Bird Habitat:

Interior Forest Birds require large forested areas to breed successfully and maintain viable populations. This diverse group includes colorful songbirds such as; tanagers, warblers, vireos that breed in North America and winter in the Caribbean, Central and South America, as well as residents and short-distance migrants such as: woodpeckers, hawks, and owls. They depend on large forested tracts, including streamside and floodplain forests. It is important to note that adjacent upland forest to these riparian areas are critical habitat for these species as well. This function attempts to capture wetland types most likely to provide habitat for these species.

Amphibian Habitat:

Amphibians share several characteristics in common including wet skin that functions in respiration and gelatinous eggs that require water or moist soil for development. Most amphibians have an aquatic stage and a terrestrial stage and thus live in both aquatic and terrestrial habitats. Aquatic stages of these organisms are often eaten by fish and so for certain species, successful reproduction may occur only in fish-free ponds. Common sub-groups of amphibians are salamanders, frogs, and toads. This function attempts to capture wetland types most likely to provide habitat for these species.

Carbon Sequestration:

Wetlands are different from other biomes in their ability to sequester large amounts of carbon, as a consequence of high primary production and then deposition of decaying matter in the anaerobic areas of their inundated soils.

Pathogen Retention:

Wetlands can improve water quality through natural processes of filtration for sedimentation, nutrients, and *Escherichia coli (E. coli)*. *E. coli* is a sub-set of fecal coliforms whose presence in water indicates fecal contamination from warm-blooded animals. The presence of *E. coli* indicates that contamination has occurred and other harmful pathogens may also be present.

Wetland restoration activities could possibly lead to water quality improvements in the Watershed. It is important to remember that the LLWFA is intended as a first-level or coarse-scale assessment of wetland location, condition, and function. A subsequent step in the watershed planning process is to ground-truth the data from the LLWFA. The LLWFA provides a general picture of wetland extent and function within a watershed that can be used to identify trends in wetland condition and function, identify initial restoration locations, and form the basis of a wetland inventory.

Based on the results of the LLWFA for the Mullett Lake Watershed, thousands of acres of wetland complexes have been identified as performing valuable ecological functions currently or at some point in the future upon restoration. Table 19 summarizes the results from the LLWFA and includes a comparison of original function-acres and current function-acres. It is important to note, however, that in many cases it appears the acreage has increased since pre-settlement. The discrepancy can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.

According to the EGLE Wetland Map Viewer, 170,900 acres within the Watershed are categorized as having high potential for wetland restoration, regardless of wetland function. The Pigeon River Watershed has 5,836 acres, the Lower Black/Cheboygan Rivers Watershed 137,335, and the Mullett Direct Watershed 4,080. This can be seen in Figure 61.

Wetlands capturing flood water at significant levels would include wetlands along streams and rivers. Wetlands are sources of groundwater discharge that sustain streamflow in the watershed. Such wetlands are critically important for supporting aquatic life in streams. Vegetated wetlands along all water bodies (e.g. estuaries, lakes, rivers, and streams) provide this function. Vegetation stabilizes the soil or substrate and diminishes wave action, thereby reducing shoreline erosion potential (Tiner, 2002). Vegetated wetlands along lakes, streams, or rivers provide a buffer to shorelines that would otherwise be more vulnerable to erosion. Wetlands that are along rivers, streams, and lakes that are vegetated perform this function at highly significant level. Wetlands in a headwater position within a watershed, which are outflowing to other surface water, perform this function at a more moderate rate. Maps of these wetland functions can be found in Appendix G.

Table 19. LLWFA

Function	Potential Significance	Pre-settlement Acreage	Current Acreage	% Change in Acreage
Flood Water Storage	High	21,281.68	18,287.49	-14
	Moderate	17,652.68	14,479.13	-18
	TOTAL	38,934.37	32,766.62	-16
Streamflow Maintenance	High	23,580.05	22,186.00	-6
	Moderate	28,137.39	26,816.20	-5
	TOTAL	51,717.44	49,002.21	-5
Nutrient Transformation	High	33,369.99	32,658.88	-2
	Moderate	6,630.57	1,412.28	-79
	TOTAL	40,000.55	34,071.16	-15
Sediment and Retention of Other Particulates	High	21,636.94	18,602.72	-14
	Moderate	14,491.93	14,574.90	1
	TOTAL	36,128.87	33,177.62	-8
Shoreline Stabilization	High	18,110.67	15,811.73	-13
	Moderate	12,633.15	14,933.50	18
	TOTAL	30,743.82	30,745.23	0
Fish Habitat	High	48,625.40	50,744.59	4
	Moderate	3,370.18	2,200.70	-35
	TOTAL	51,995.59	52,945.29	2
Stream Shading	High	9,832.37	6,217.79	-37

	Moderate	3,710.60	5,456.97	47
	TOTAL	13,542.97	11,674.76	-14
Waterfowl/Waterbird Habitat	High	778.39	5,519.69	609
	Moderate	22,267.32	5,836.99	-74
	TOTAL	23,045.71	11,356.69	-51
Shorebird Habitat	High	0	162.89	N/A
	Moderate	40,000.55	33,823.03	-15
	TOTAL	40,000.55	33,985.92	-15
Interior Forest Bird Habitat	High	4,182.16	4,980.24	19
	Moderate	35,812.16	27,418.69	-23
	TOTAL	39,994.32	32,398.93	-19
Amphibian Habitat	High	15,477.52	16,367.80	6
	Moderate	4,452.60	2,900.34	-35
	TOTAL	19,930.13	19,268.14	-3
Carbon Sequestration	High	3,669.54	2,893.59	-21
	Moderate	29,700.44	28,715.45	-3
	TOTAL	33,369.99	31,609.04	-5
Ground Water Influence	High	4,530.62	3,460.96	-24
	Moderate	48,838.35	47,172.43	-3
	TOTAL	53,368.97	50,633.39	-5
Conservation of Rare and Imperiled Wetlands & Species	High	N/A	32,897.94	N/A
	Moderate	N/A	6,827.70	N/A
	TOTAL	N/A	39,725.64	N/A

**Increases in the predicted percent change functional capacity in the functions above can be attributed to the mapping differences in the two wetland layers and may not represent the current conditions on the ground.*

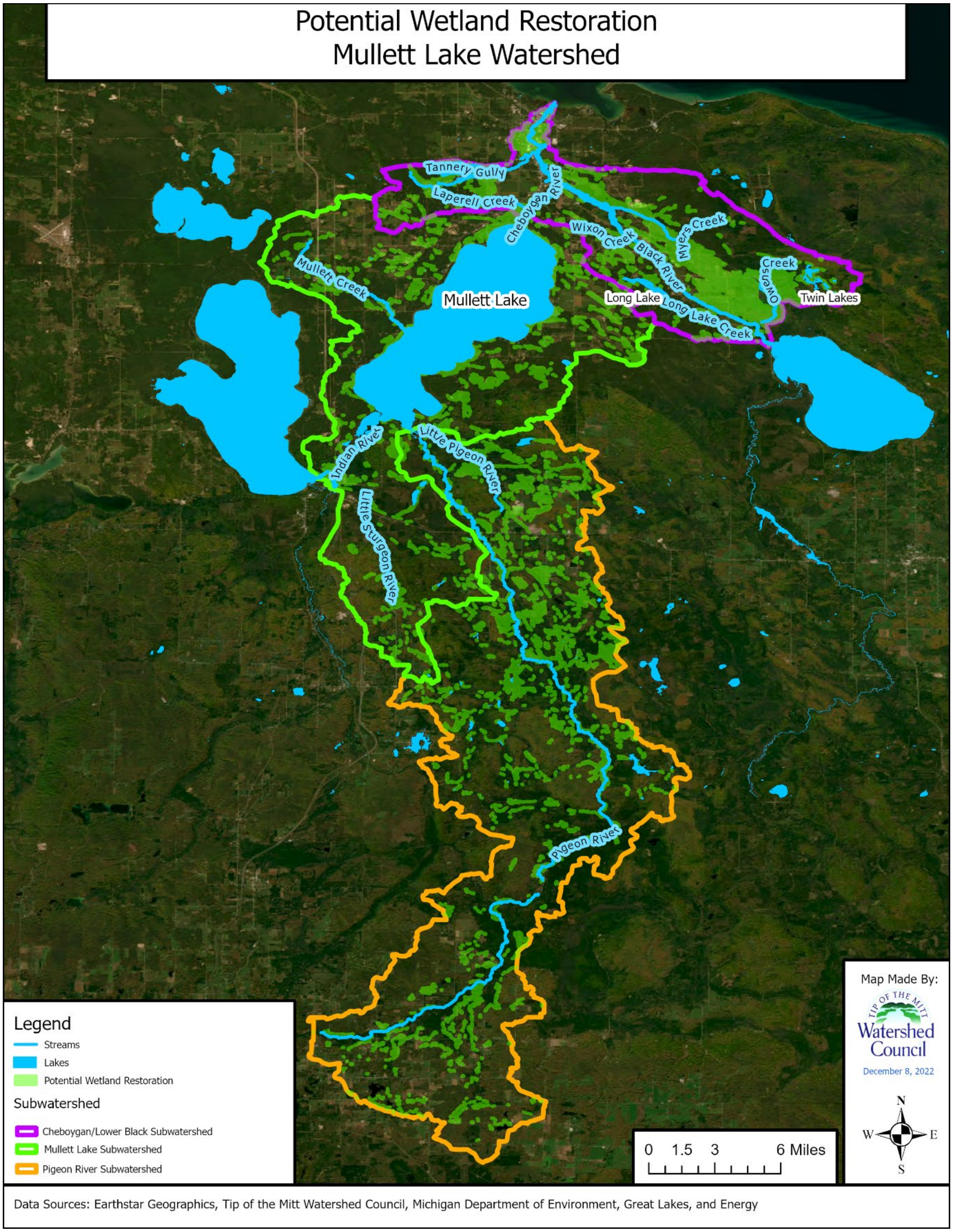


Figure 61. Potential wetland restoration sites

4.5 Road/Stream Crossing Inventories

Road/stream crossings (RSX) that are improperly designed or installed, structurally failing, or no longer accommodate current stream conditions can impact stream health. They can affect stream hydrology, prevent fish and other aquatic organisms from accessing up-and downstream reaches, increase water temperatures, and are sources of nutrients, sediments, bacteria, heavy metals, and other nonpoint source pollutants. In Northern Michigan, sediments pose the greatest threat to rivers and streams. Sedimentation can adversely impact fish and aquatic organisms by degrading their habitat and reducing water quality.

RSX inventories serve as a useful watershed management tool. They help to identify sediment pollution entering surface waters from poorly designed, maintained, or aging infrastructure; fish passage barriers due to perched culverts or velocity barriers; and altered stream hydrology due to inadequately designed or installed crossings. Therefore, identifying failing or deficient RSXs is critical to resource management. Regular inventorying of RSXs allows road commissions and resource managers to note change in stream and structure conditions over time. Furthermore, by applying the Great Lakes Road/Stream Crossing protocol, RSXs can be ranked as minor, moderate, or severe as a means of prioritizing them for improvements or replacement.

During 2021, 263 RSXs were inventoried throughout the Watershed. The inventory included utilizing the Great Lakes Road/Stream Crossing protocol and corresponding field form (Appendix C). Additional information collected includes photographs of the site, a site sketch, whether it is considered a priority site, whether a future visit is recommended, and if any invasive species were observed at the site. All data collected during the inventory was then entered into the Great Lakes Stream Crossing Inventory Access database. The database includes formulas built into each record as a means to rank each site with respect to the erosion and fish passage, and calculates a severity rating (minor, moderate, and severe).

Results of the RSX inventory were uploaded to the Great Lakes Stream Crossing Inventory site (https://great-lakes-stream-crossing-inventory-michigan.hub.arcgis.com/), where you can find stream crossing data across Michigan. This regional effort to collect all stream crossing data for the Great Lakes basin was initiated by the MDNR, USFS, Wisconsin DNR, and Trout Unlimited.

Figure 62. Culvert outlet on the Little Pigeon River (LPR15)

The Pigeon River subwatershed had the most severe and moderate sites, despite having the lowest number of total crossings as compared to Mullett and Lower Black/Cheboygan Rivers (Table 20). It also had the most sites that are a barrier to fish passage (Table 21).

Table 20. RSX ranking by subwatershed

Subwatershed	Severe	Moderate	Minor	Total
Mullett Lake Direct	11	35	42	88
Pigeon River	24	36	15	75
LBlack/Cheboygan Rivers	9	33	58	100

Table 21. RSX fish passage barrier

Subwatershed	Not a Barrier	Barrier at high flows	Barrier at most flows	Barrier
Mullett Lake Direct	1	21	10	12
Pigeon River	8	6	16	38
LBlack/Cheboygan Rivers	0	20	16	8

Total	9	47	42	58

**Sites assessed for passability*

Pollutant loading estimates for sediment were calculated applying the formulas that accompany the Great Lakes Stream Crossing Inventory. Pollutant loading estimates for phosphorus and nitrogen was determined by applying an overall phosphorus concentration of 0.0005 lbP/lb of soil and a nitrogen concentration of 0.001 lbN/lb of soil. Soil texture is determined and a correction factor is used to better estimate nutrient holding capacity of the soil. Sand is the dominant soil texture for the Watershed, thus a correction factor of 0.85 was used.

Pigeon River and Lower Black/Cheboygan Rivers subwatershed contribute the most pollutant loadings from failing or undersized RSX's (Table 22).

Table 22. RSX pollutant loading estimates by subwatershed

Subwatershed	Sediment Tons/year	Phosphorus lbs/year	Nitrogen lbs/year
Mullett Lake Direct	97.1	82.5	140.3
Pigeon River	195.9	166.5	283.1
LBlack/Cheboygan Rivers	156.2	132.8	225.7
Total	**449.2**	**381.82**	**649.094**

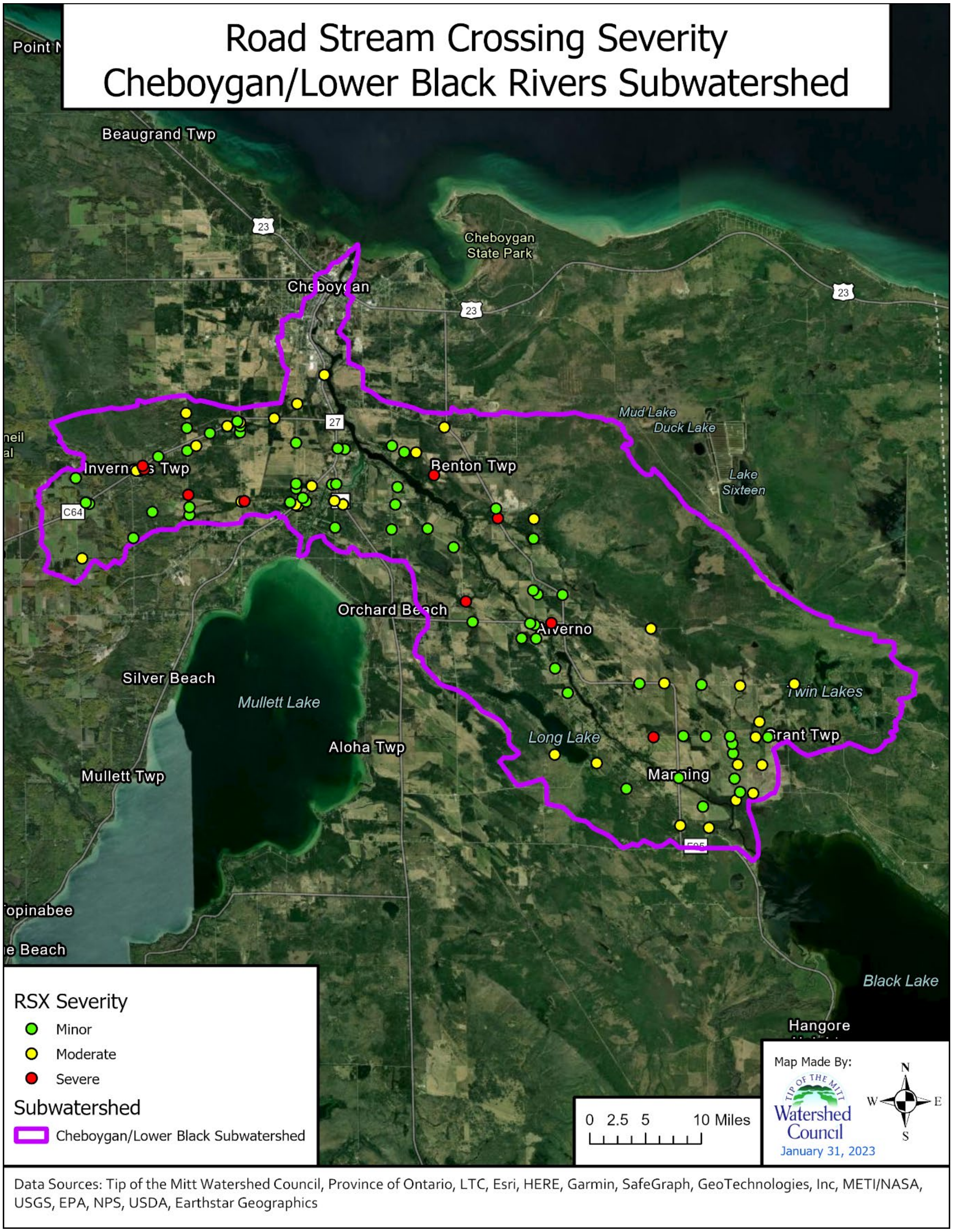


Figure 63. Lower Black/Cheboygan subwatershed road/stream crossing inventory

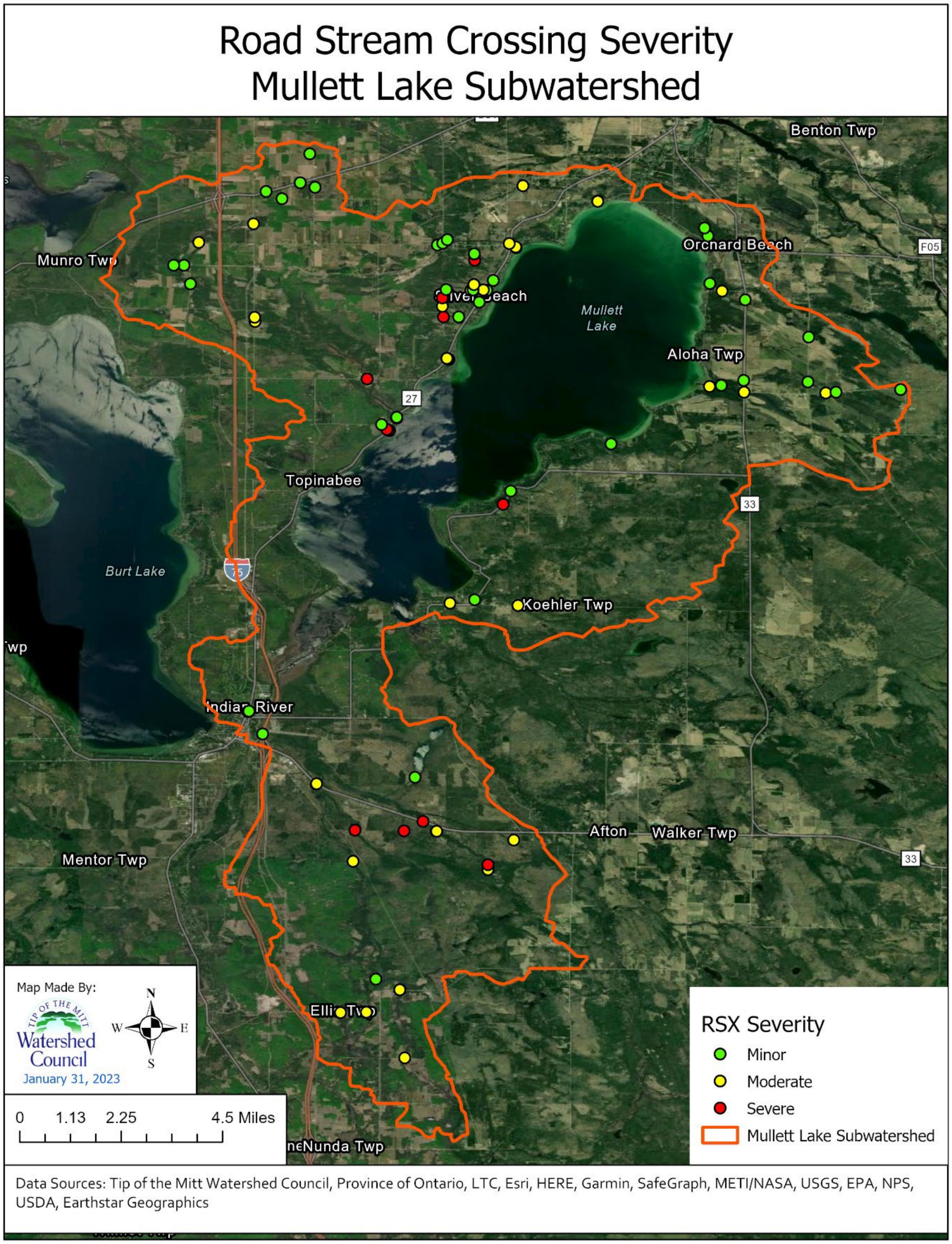


Figure 64. Mullett Lake subwatershed road/stream crossing inventory

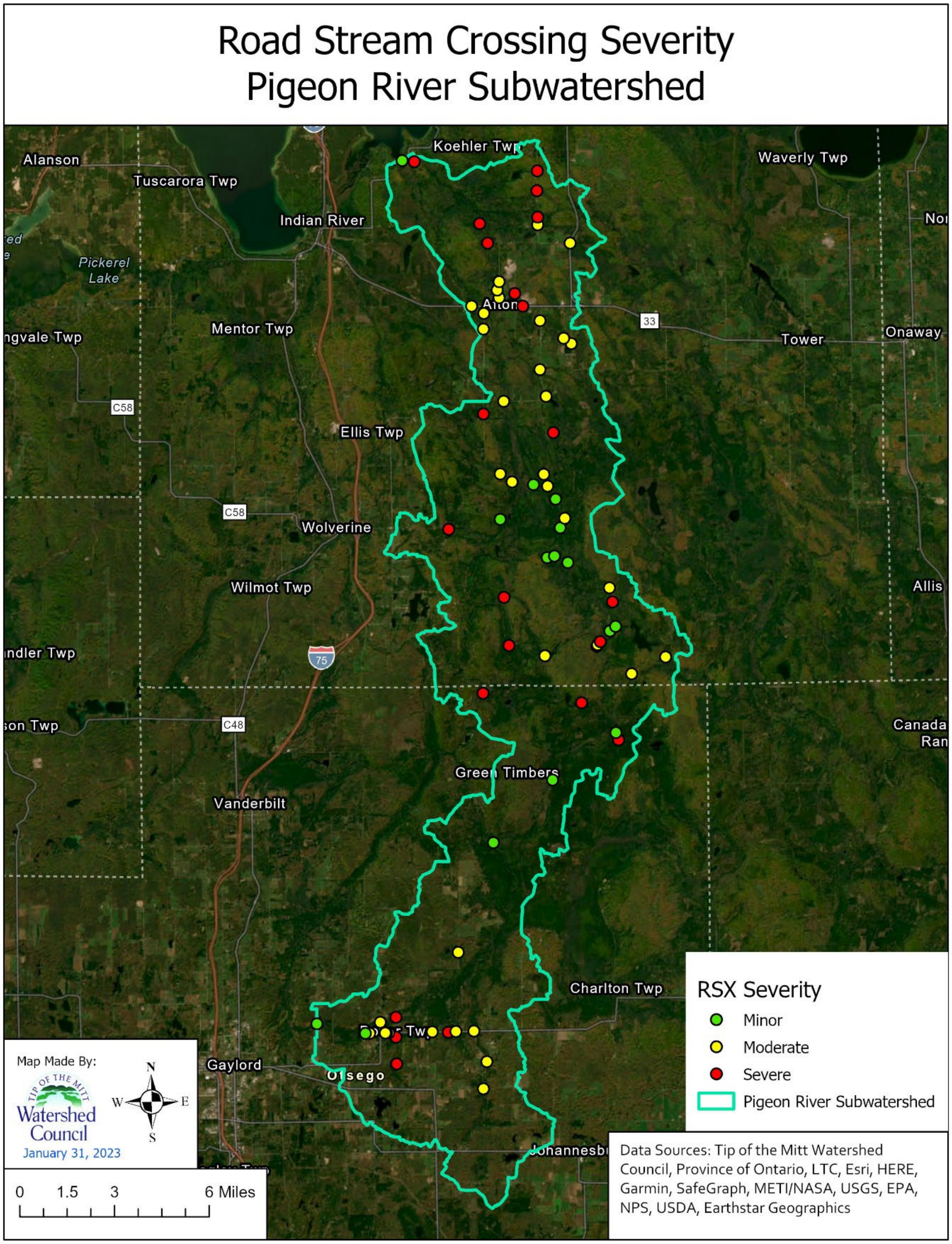


Figure 65. Pigeon River subwatershed road/stream crossing inventory

4.6 Shoreline Surveys

Background

Shoreline surveys are an important lake management tool used extensively on lakes in the Northern Lower Peninsula of Michigan. These surveys involve assessing shoreline properties to document conditions or activities that have the potential to affect water quality and the lake ecosystem. Shoreline surveys commonly include an assessment of:

- *Cladophora* algae growth as a nutrient pollution indicator,
- Erosion
- Alterations (e.g., seawalls)
- Greenbelts (i.e., shoreline vegetation)
- Emergent aquatic plants
- Wetlands
- Tributary inlets and outlets

Survey results provide the means to carry out follow-up actions that address problems in shoreline areas. Through actions such as on-site consultations, problems in shoreline areas that threaten the water quality can be identified and corrected. These solutions are often simple and low cost, such as regular septic system maintenance, shoreline plantings, proper lawn care practices, and low impact development along the shoreline. Problems in shoreline areas can be prevented by promoting education and awareness of the survey and ecologically friendly approaches to shoreline property management. Periodic repetition of shoreline surveys is important for identifying new and chronic problem sites, determining long-term trends in near-shore nutrient inputs, greenbelts, erosion, and shoreline alterations associated with land-use changes, and for monitoring and assessing the success of remedial actions.

In 2016, TOMWC completed a comprehensive shoreline survey for Mullett Lake, and in 2021 surveys were conducted on Long Lake and Twin Lakes. Data for each Lake is summarized in Table 23.

Shoreline Development Impacts

Lake shorelines are the critical interface between land and water, where human activity has the greatest potential for degrading water quality. Developing shoreline properties for residential, commercial, or other uses invariably has negative impacts on the lake ecosystem. During the development process, the natural landscape is altered in a variety of ways: vegetation is removed, the terrain is graded, utilities are installed, structures are built, and areas are paved. These changes to the landscape and subsequent human activity in the shoreline area have consequences on the aquatic ecosystem. Nutrients from wastes, contaminants from cars and roads, and eroded soils are among some of the pollutants that reach and negatively impact the lake following shoreline development.

Nutrient pollution can create a recreational nuisance, adversely impact aquatic ecosystems, and lead to conditions that pose a danger to human health. Although nutrients are necessary to sustain a healthy aquatic ecosystem, excess can result in nuisance and potentially harmful algal and aquatic plant growth. Excessive aquatic macrophyte growth (i.e., vascular aquatic plants) and heavy algal blooms that form mats and scum at the lake's surface can become a recreational nuisance. Algal blooms also pose a public health risk as some species produce toxins, including hepatotoxins (toxins that cause liver damage) and neurotoxins (toxins that affect the nervous system). Furthermore, excess algal and aquatic plant growth can degrade water quality by depleting the ecosystem's dissolved oxygen stores. Decomposition of dead algae and plant material reduces dissolved oxygen supplies due to the aerobic activity of decomposers, which is particularly problematic in the deeper waters of stratified lakes. The problem becomes particularly acute during nighttime respiration, when plants compete with other organisms for a limited oxygen supply.

Surface waters receive nutrients through a variety of natural and cultural (human) sources. Natural sources of nutrients include stream inflows, groundwater inputs, surface runoff, organic inputs from riparian (shoreline) areas, and atmospheric deposition. Springs, streams, and artesian wells are often naturally high in nutrients due to the geologic strata they encounter and wetland seepages may discharge nutrients at certain times of the year. Cultural sources include septic and sewer systems, fertilizer application, and stormwater runoff from roads, driveways, parking lots, roofs, and other impervious surfaces. Poor agricultural practices, soil erosion, and wetland destruction also contribute to nutrient pollution. Furthermore, some cultural sources (e.g., malfunctioning septic systems and animal wastes) pose a potential health risk due to exposure to bacteria and viruses.

Severe nutrient pollution is detectable through chemical analyses of water samples, physical water measurements, and the utilization of biological indicators (a.k.a., bio-indicators). Chemical analyses of water samples can be effective, though costlier and more labor intensive than other methods. Typically, water samples are analyzed to determine nutrient concentrations (usually forms of phosphorus and nitrogen), but other chemical constituent concentrations can be measured, such as chloride, which are related to human activity and often elevated in areas impacted by malfunctioning septic or sewer systems. Physical measurements are primarily used to detect leachate from these systems, which can cause localized increases in water temperature and conductivity (i.e., the water's ability to conduct an electric current). Biologically, nutrient pollution can be detected along the lakeshore by noting the presence of *Cladophora* algae.

Cladophora is a branched, filamentous green algal species that occurs naturally in small amounts in Northern Michigan lakes. Its occurrence is governed by specific environmental requirements for temperature, substrate, nutrients, and other factors. *Cladophora* is found most commonly in the wave splash zone and shallow shoreline areas of lakes and can also be found in streams. It grows best on stable substrates such as rocks and logs, though artificial substrates such as concrete or wood seawalls are also suitable. *Cladophora* prefers water temperatures of 50 to 70 degrees Fahrenheit. Consequently, the optimal time for its growth and thus, detection, in Northern Michigan lakes is generally during the months of May, June, September, and October.

The nutrient requirements for *Cladophora* to achieve large, dense growths are typically greater than the nutrient availability in the lakes of Northern Michigan. Therefore, shoreline locations where relatively high concentrations of nutrients, particularly phosphorus, are entering a lake can be identified by noting the presence of *Cladophora*. Documenting the size and density of *Cladophora* helps interpret causal factors on an individual basis. However, the description has limited value when making year-to-year comparisons at a single location or estimating the relative amount of shoreline nutrient inputs because growth features are greatly influenced by current patterns, shoreline topography, size, distribution of substrate, and the amount of wave action on the shoreline. Rather, the presence of any significant growth at a single site over several years is the most indicative of elevated nutrient concentrations in shoreline areas. It can reveal the existence of chronic nutrient loading problems, help interpret the cause of the problems, and assess the effectiveness of any remedial actions. Comparisons of the total number of algal growths can reveal trends in nutrient inputs due to changes in land use or land management practices.

Erosion along the shoreline has the potential to degrade a lake's water quality. Stormwater runoff through eroded areas and wave action along the shoreline contribute sediments to the lake, which negatively impacts the lake ecosystem. Sediments clog the gills of fish, aquatic insects, and other aquatic organisms. Excessive sediments smother fish spawning beds and fill interstitial spaces that provide habitat for a variety of aquatic organisms. While moving through the water column, sediments absorb sunlight energy and increase water temperatures. In addition, nutrients adhere to sediments that wash in from eroded areas.

Shoreline greenbelts are essential for maintaining a healthy aquatic ecosystem. A greenbelt consisting of a variety of native woody and herbaceous plant species provides habitat for near-shore aquatic organisms as well as terrestrial animals. Greenbelts naturally function to control erosion by stabilizing the shoreline with plant root structures that protect against wave action and ice. The canopy of the greenbelt provides shade to near-shore areas, which helps to maintain cooler water temperatures and higher dissolved oxygen levels. In addition, greenbelts provide a mechanism to reduce overland surface flow and absorb pollutants carried by stormwater from rain events and snowmelt.

Tributaries have great potential for influencing a lake's water quality as they are one of the primary conduits through which water is delivered to a lake from its watershed. Inlet streams may provide exceptionally high-quality waters that benefit the lake ecosystem, but conversely have the potential to deliver polluted waters that degrade the lake's water quality. Outlet streams flush water out of the lake, providing the means to remove contaminants that have accumulated in the lake ecosystem. With regards to shore surveys, noting the location of inlet tributaries is beneficial when evaluating shoreline algae conditions because nutrient concentrations are generally higher in streams than in lakes. The relatively higher nutrient levels delivered from streams often lead to heavier *Cladophora* and other algae growth in nearby shoreline areas.

Responsible, low-impact shoreline property development, and best management practices are paramount for protecting water quality. Maintaining a healthy greenbelt, regular septic tank pumping, treating stormwater with rain gardens, correcting erosion sites, and eliminating fertilizer, herbicide, and pesticide application are among many low-cost best management practices that minimize the impact of shoreline properties on lake water quality. Living in harmony with the lake and practicing responsible stewardship are vitally important for sustaining a healthy and thriving lake ecosystem.

Table 23. Summary of shoreline survey results

Lake Name	Survey Date	*Cladophora**	Heavy Algae*	Erosion*	Poor Greenbelts*	Alterations*
Mullett Lake	2016	44%	<1%	12%	59%	93%
Long Lake	2021	24%	0%	16%	39%	95%
Twin Lake	2021	0%	0%	<1%	3%	XXX

**Percentages are in relation to number of parcels on the lake shore, except for "heavy algae," which is the percent of only parcels that had Cladophora growth. Erosion is the percentage of parcels with moderate to severe erosion and poor greenbelts include those in the poor or very poor categories.*

MULLETT LAKE

During the summer of 2016, TOMWC conducted a shoreline survey on Mullett Lake to document conditions that have the potential to impact water quality. Funding for this project was provided by the Mullett Area Preservation Society (MAPS). The 2016 survey examined nutrient pollution, greenbelt health, shoreline alterations and shoreline erosion at all 1,293 properties on Mullett Lake and found slight improvements from a survey conducted in 2008 (Table 24).

Development and Shoreline Vegetation

Of all shoreline properties, 86% were considered developed. Over half (59%) of all shoreline properties contained little to no vegetation (beyond manicured lawn) growing at water's edge. These 2016 results are similar to results from 2008, where 86% of all parcels were considered developed and 64% of shoreline properties showed little to no vegetation at water's edge. These data suggest Greenbelt status along the Mullett Lake shoreline has increased slightly since the 2008 survey. Lack of vegetation on shoreline property is variable around the lake, however poor greenbelts are highlighted along the northern and southeastern shoreline. Healthy greenbelts are also variable around the lake, and are partially concentrated along the southwestern shoreline.

Erosion and Shoreline Alterations

Erosion was documented along the shoreline of 471 properties (36%), which was increased from the 2008 survey (158 properties, 12%). A majority of these erosion areas (329 out of 471 shoreline properties) were identified as "minor" erosion. Meaning, exposed soils were present or contained a gully up to 1" deep. Shoreline alterations were also more prevalent in 2016 (984 shorelines, 76%) than in 2008 (754 shorelines, 58%). A majority of identified shoreline alterations (808 of 984 shorelines, 82%) were identified as cobble and boulder riprap.

Nutrients and *Cladophora*

The number of shoreline areas with signs of nutrient pollution has decreased, relative to the 2008 survey. *Cladophora*, an algal indicator of nutrient pollution, was documented at 44% of all properties, down from 59% in 2008. Compared to other lakes in the region, Mullett Lake has a relatively high number of parcels exhibiting Cladophora growth.

Trends

Table 24. Survey comparison of Mullett Lake shoreline surveys

Survey Parameter	**2008 Survey Results**		**2016 Survey Results**	
	Properties	**%**	**Properties**	**%**
***Cladophora* Algae Presence**	758	59%	564	**44%**
Poor Greenbelts (score 0-2)	822	64%	769	**59%**
Erosion	158	12%	471	**36%**

Shoreline Alterations	**754**	**58%**	**984**	**76%**

It was noted at a watershed advisory council meeting that there has been an increase in the amount of development around the lake since the 2016 survey was completed.

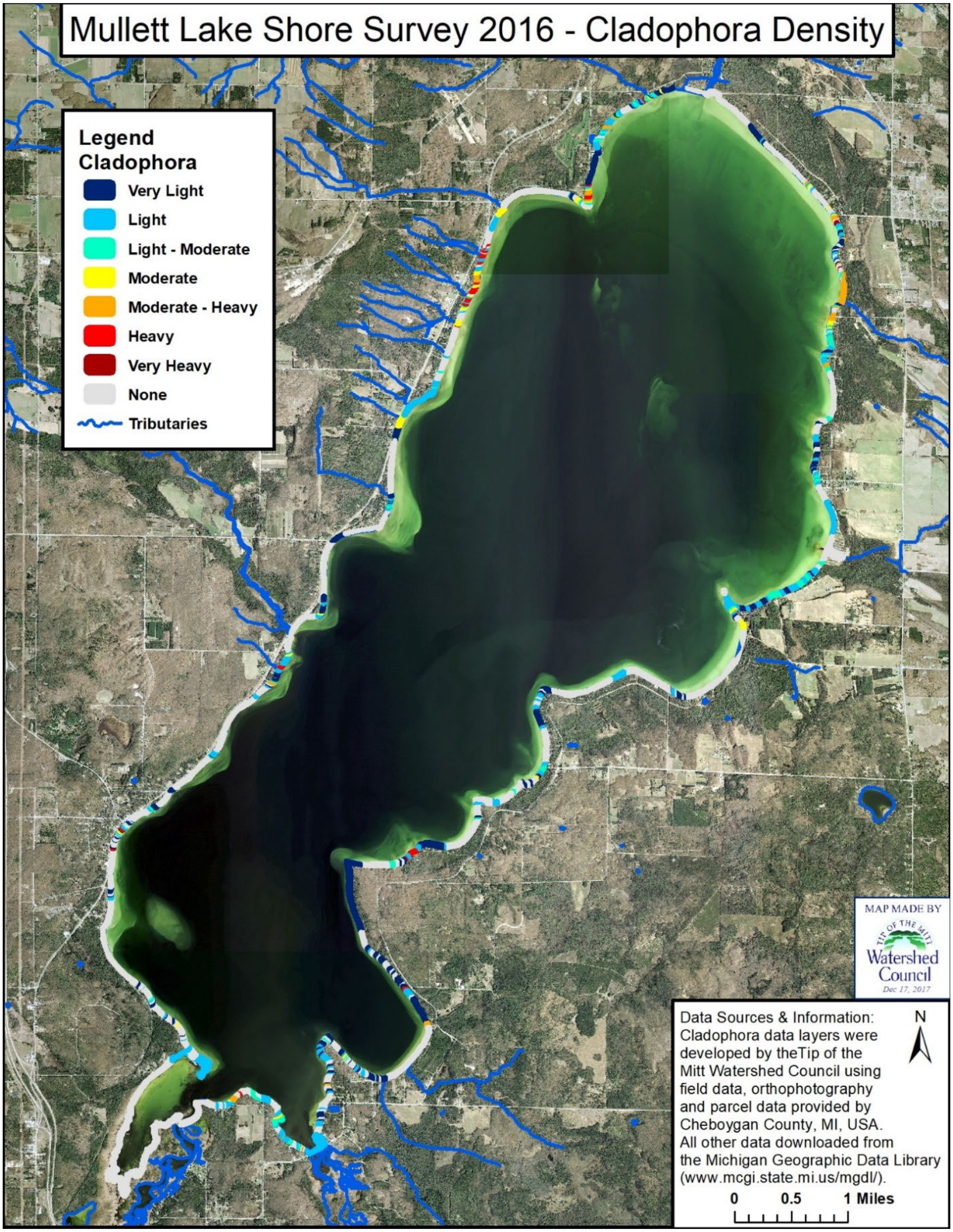


Figure 66. Cladophora algae density results Mullett Lake

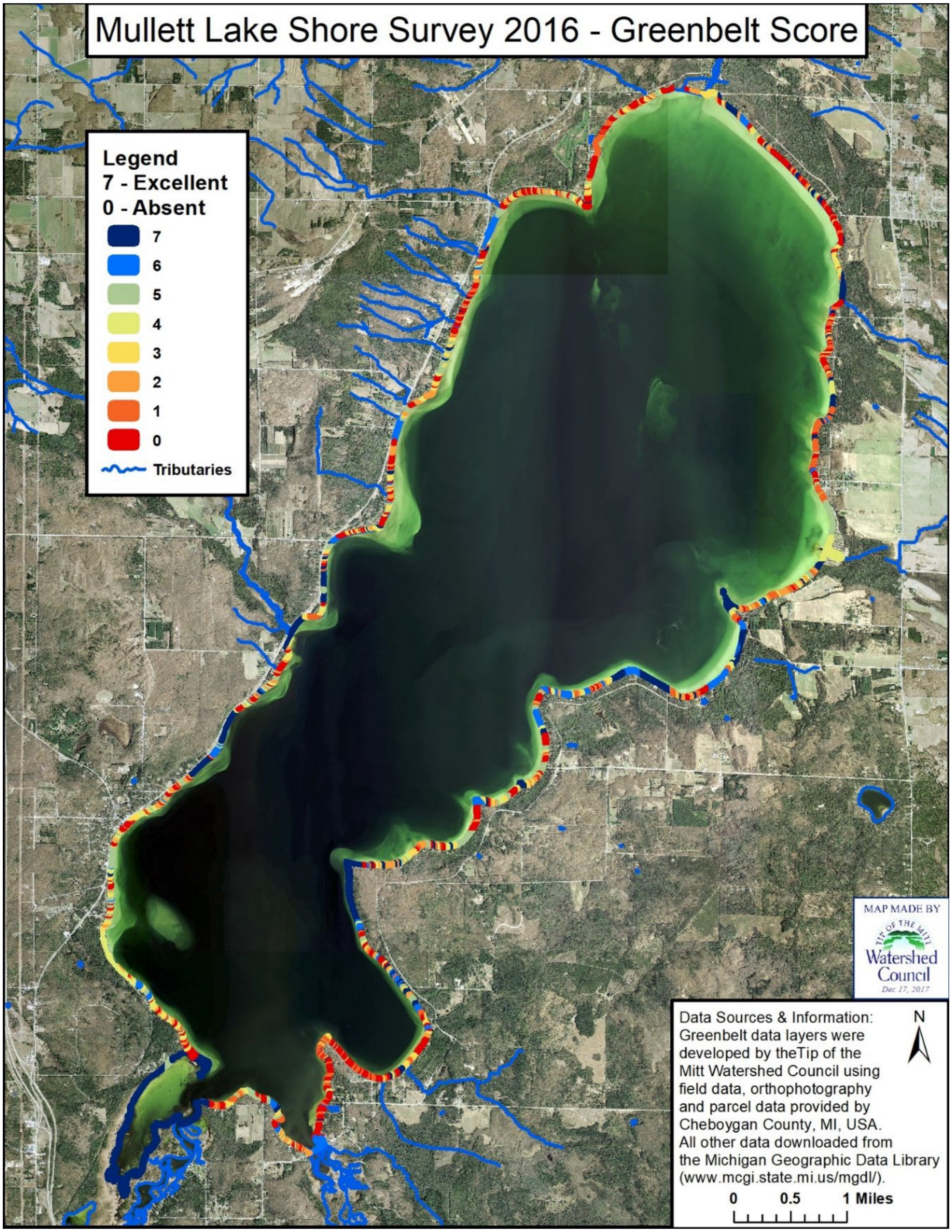


Figure 67. Greenbelt score totals results for Mullett Lake

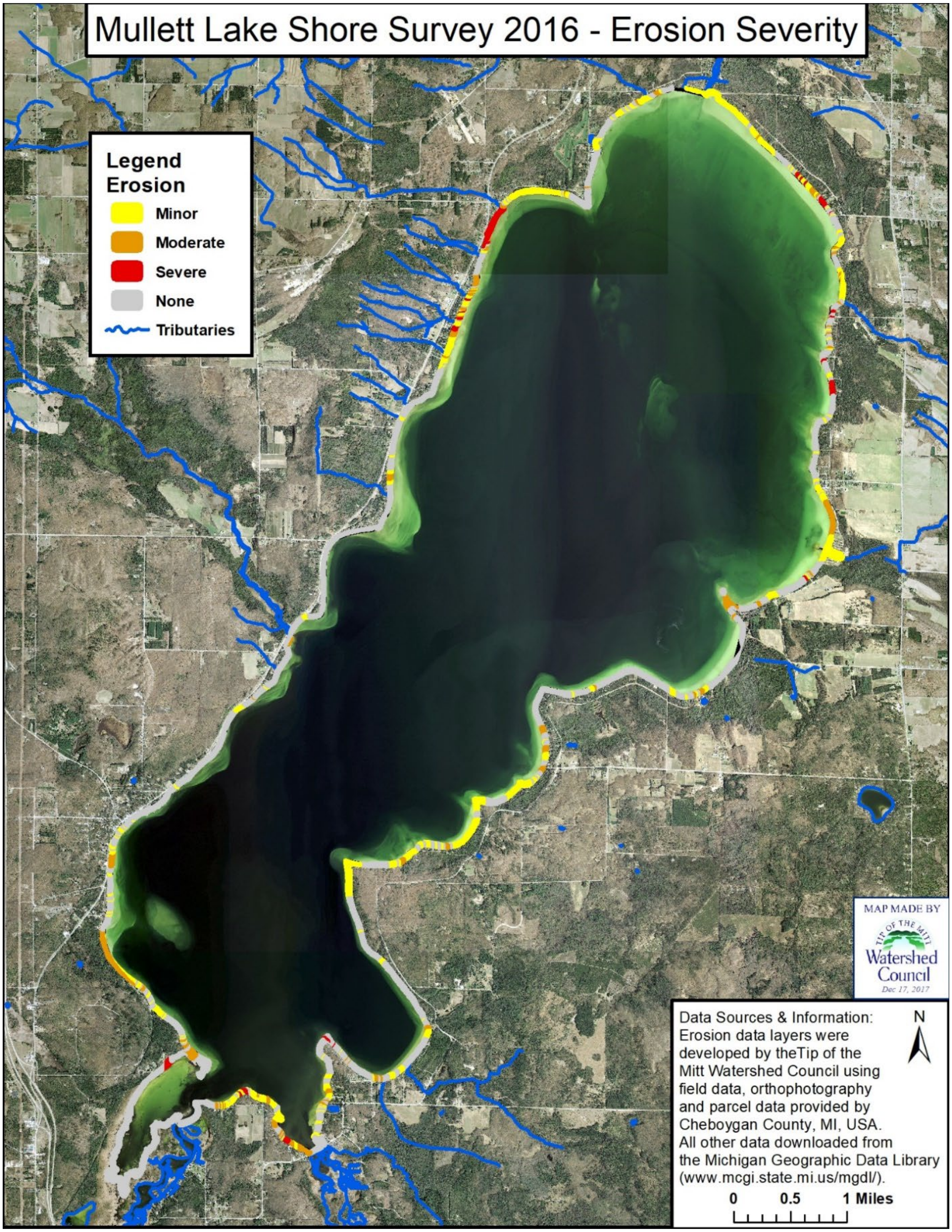


Figure 68. Shoreline erosion severity results for Mullett Lake

LONG LAKE

In 2021, TOMWC conducted a shoreline survey of Long Lake. The survey examined nutrient pollution, greenbelt health, shoreline alterations and shoreline erosion at all 212 properties on the Lake.

Development, Alterations, and Shoreline Vegetation

Of all shoreline properties, 76% were considered developed (Figure 69). Shoreline alterations were identified at 66% of parcels. Almost half of identified shoreline alterations (48%) were identified as mixed boulder and rock rip-rap and another 11% had a wood or steel bulkhead. Substrate is primarily sand. Most of the shoreline parcels had presence of aquatic vegetation, with most being submergent. There were some parcels that also had floating and emergent vegetation. Cladophora, an algal indicator of nutrient pollution, was documented at 24% of all properties (Figure 70).

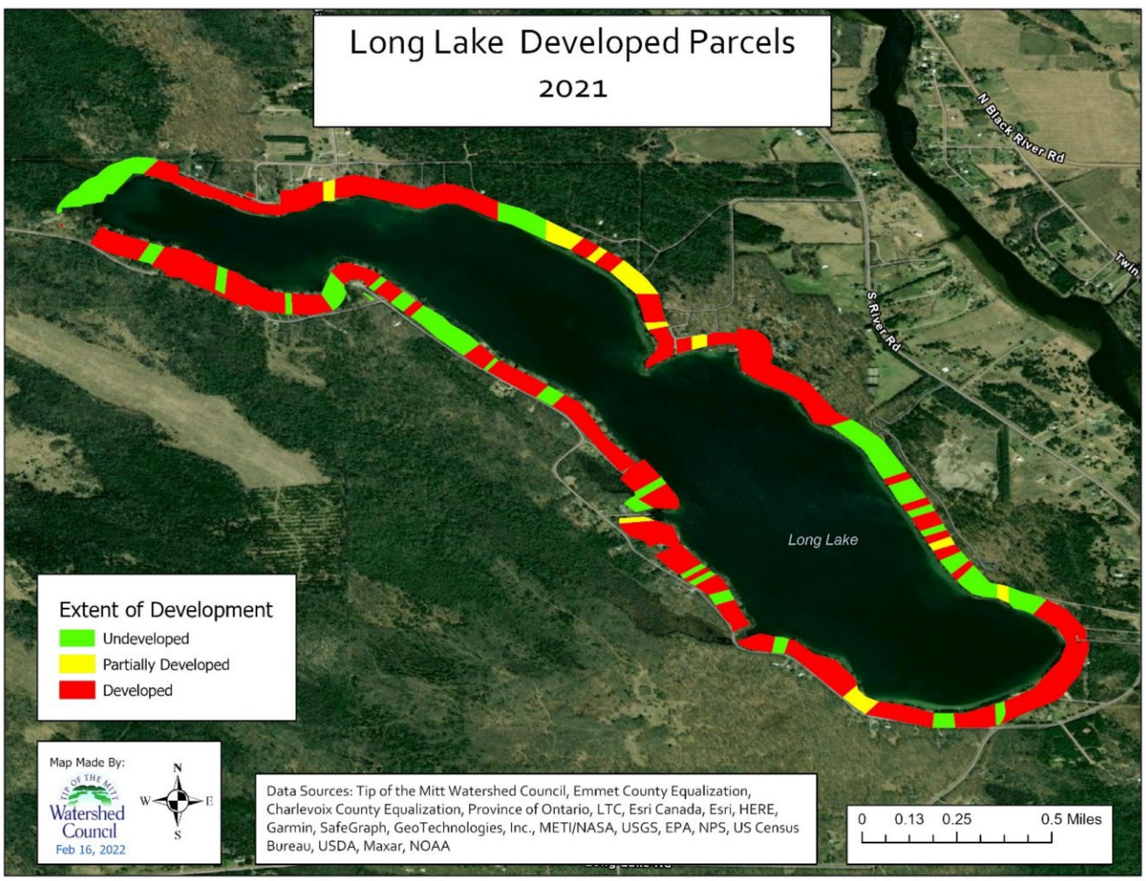


Figure 69. Long Lake developed parcels

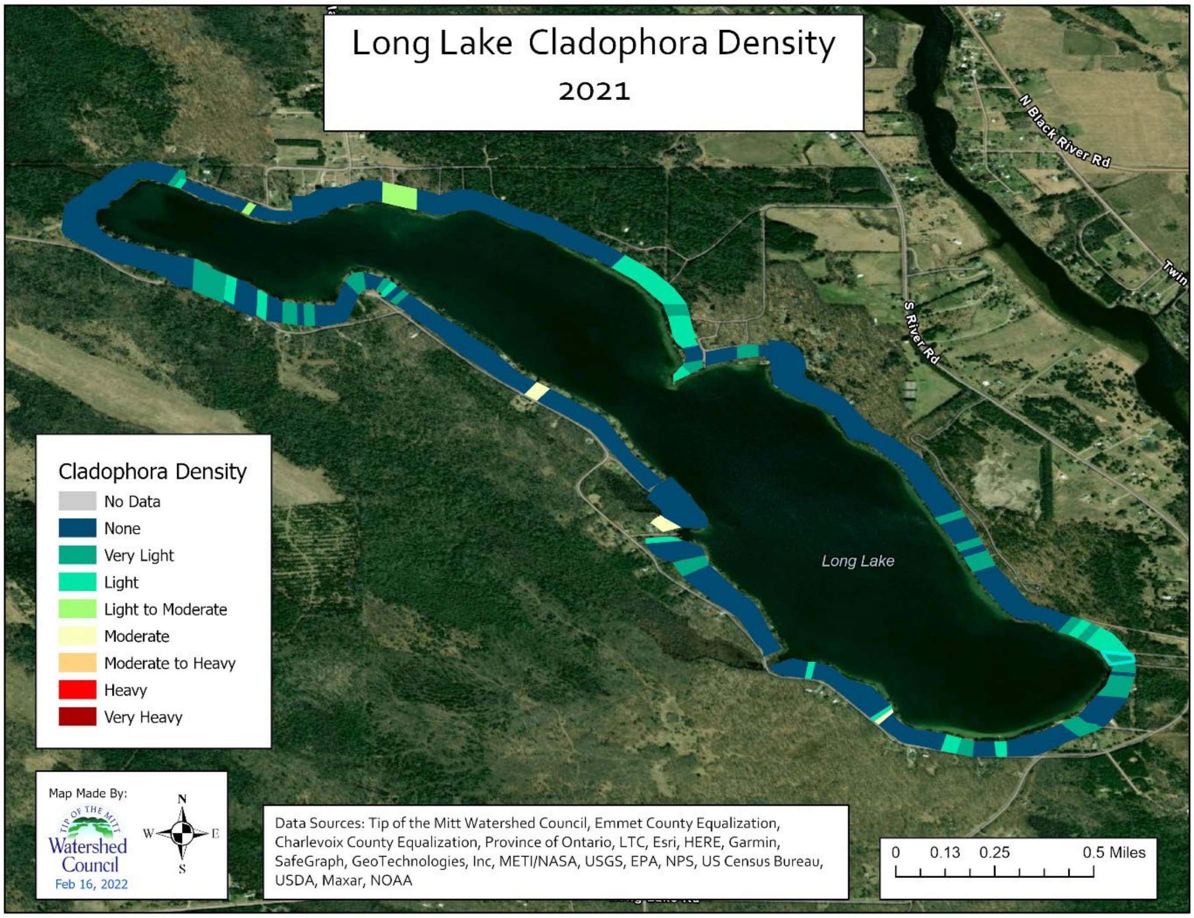


Figure 70. Cladaphora Density on Long Lake

Erosion and Greenbelts

Erosion was found along the shoreline of 51 properties (24%) and is fairly spread out along the shoreline (Figure 71). 16 properties had "light" erosion, which means exposed soils with gullies up to one inch deep. 24 properties were identified as "moderate" erosion which means there are exposed soils with gullies 1-6 inches deep, and/or banks are undercut by less than 6 inches. 11 properties had heavy erosion which is indicated by exposed soils with gullies greater than 6 inches in depth and/or undercut banks greater than 6 inches and severe slumping or tree fall. Greenbelt scores were well spread across all categories (Table 25). There is almost an almost even split between the categories of very poor/poor to good/excellent. There are two distinct locations where there are large tracts of healthy greenbelt, located on the northeast side. 43% of the shoreline parcels have a greenbelt that extends more than a quarter of the length of shoreline (Figure 72).

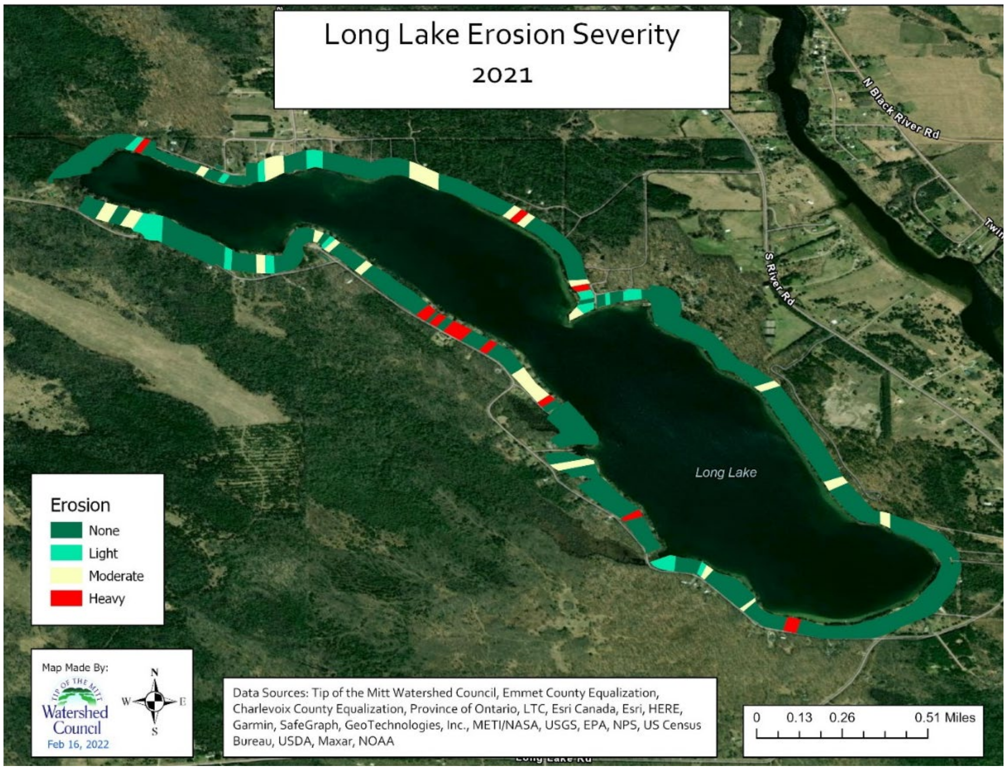


Figure 71. Erosion on Long Lake

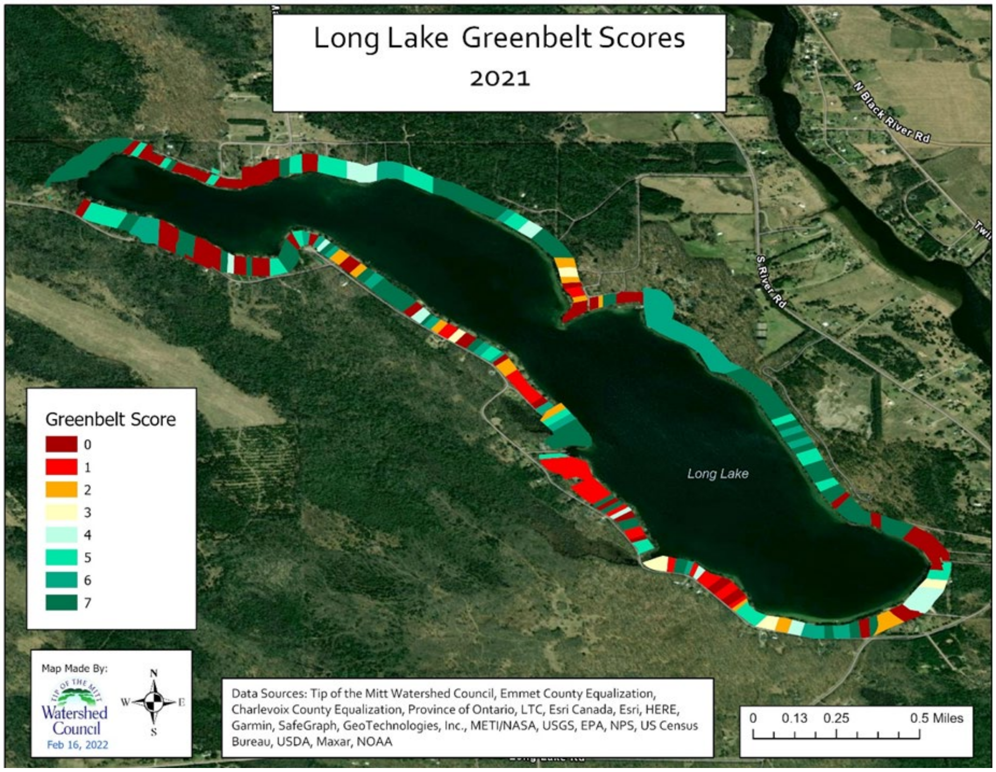


Figure 72. Long Lake greenbelt scores

Table 25. Long Lake shoreline scores

Category	# of parcels	%
Very Poor	58	27%
Poor	39	18%
Moderate	14	7%
Good	44	21%
Excellent	57	27%

TWIN LAKES

In 2021, TOMWC conducted a shoreline survey of Twin Lakes. The 2021 survey examined nutrient pollution, greenbelt health, shoreline alterations and shoreline erosion at all 180 properties on the Lake.

Development, Alterations, and Shoreline Vegetation

Of all shoreline properties, 71% were considered developed (Figure 73). There were only three shoreline alterations-one parcel with rip rap, and two with wooden bulkheads. Nearly all properties (94%) had emergent vegetation present with a combination of submergent and floating vegetation and substrate was comprised of soft-bottom (muck and marl), and sand. *Cladophora*, an algal indicator of nutrient pollution, was not found at any properties.

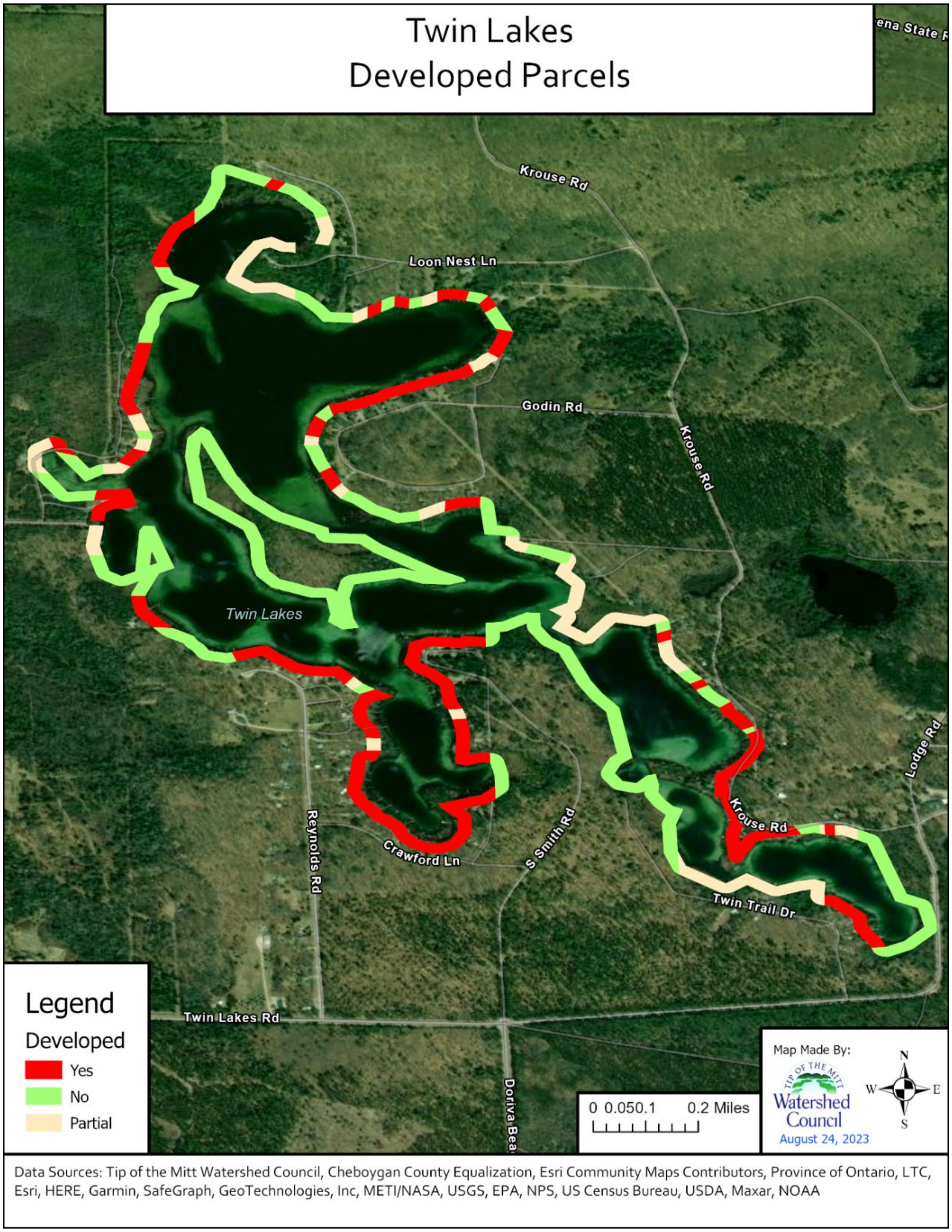


Figure 73. Twin Lakes developed parcels

Erosion and Greenbelts

Heavy erosion was found at one property and moderate erosion was found at one property (Figure 75). The rest of the 78 properties had no erosion. Poorer greenbelt score are scattered along the shoreline, but tend to be found in the more developed areas (Figure 74). Nearly all shoreline properties had a greenbelt that was greater than 25% of the parcel. Overall, Twin Lakes has a very healthy shoreline that should be preserved.

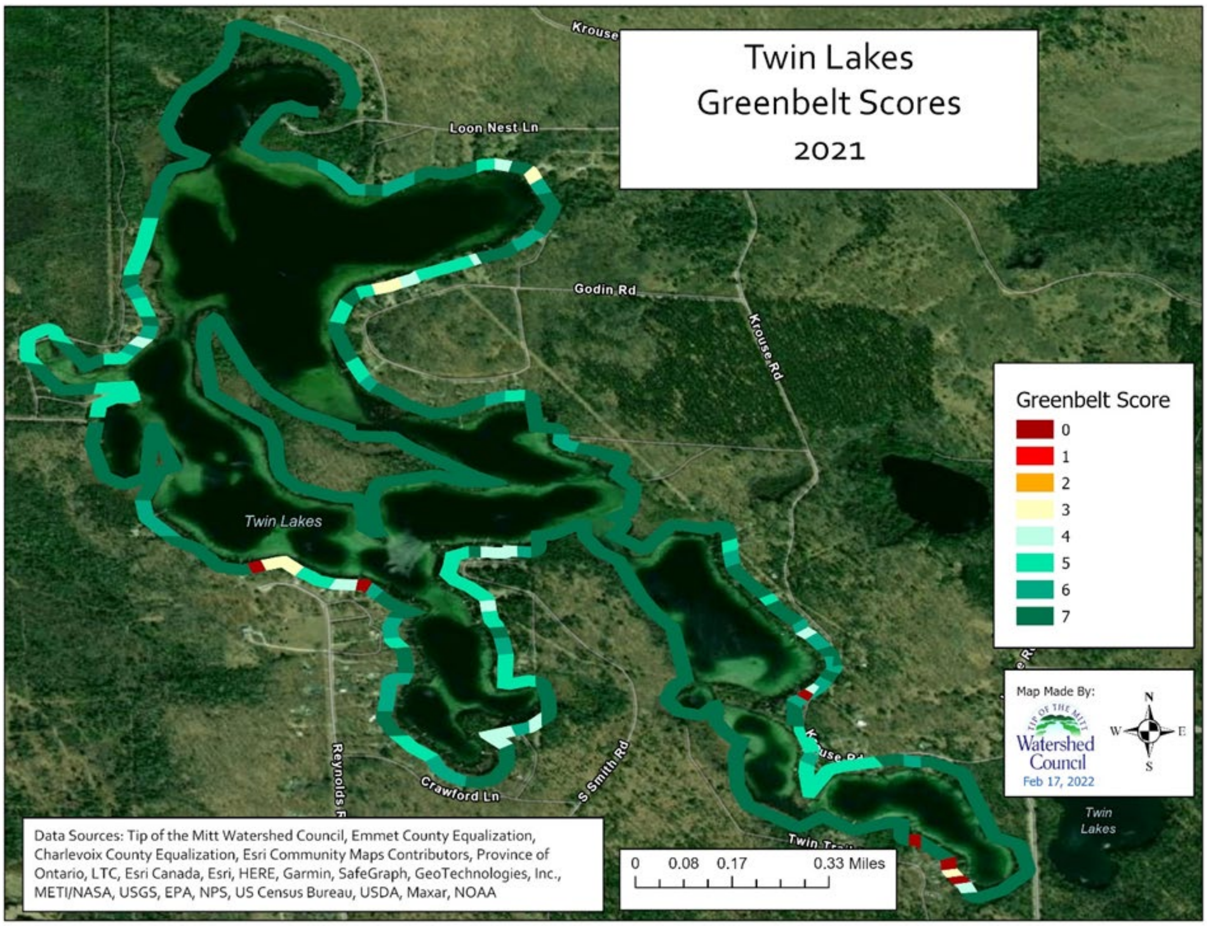


Figure 74. Twin Lakes greenbelt score

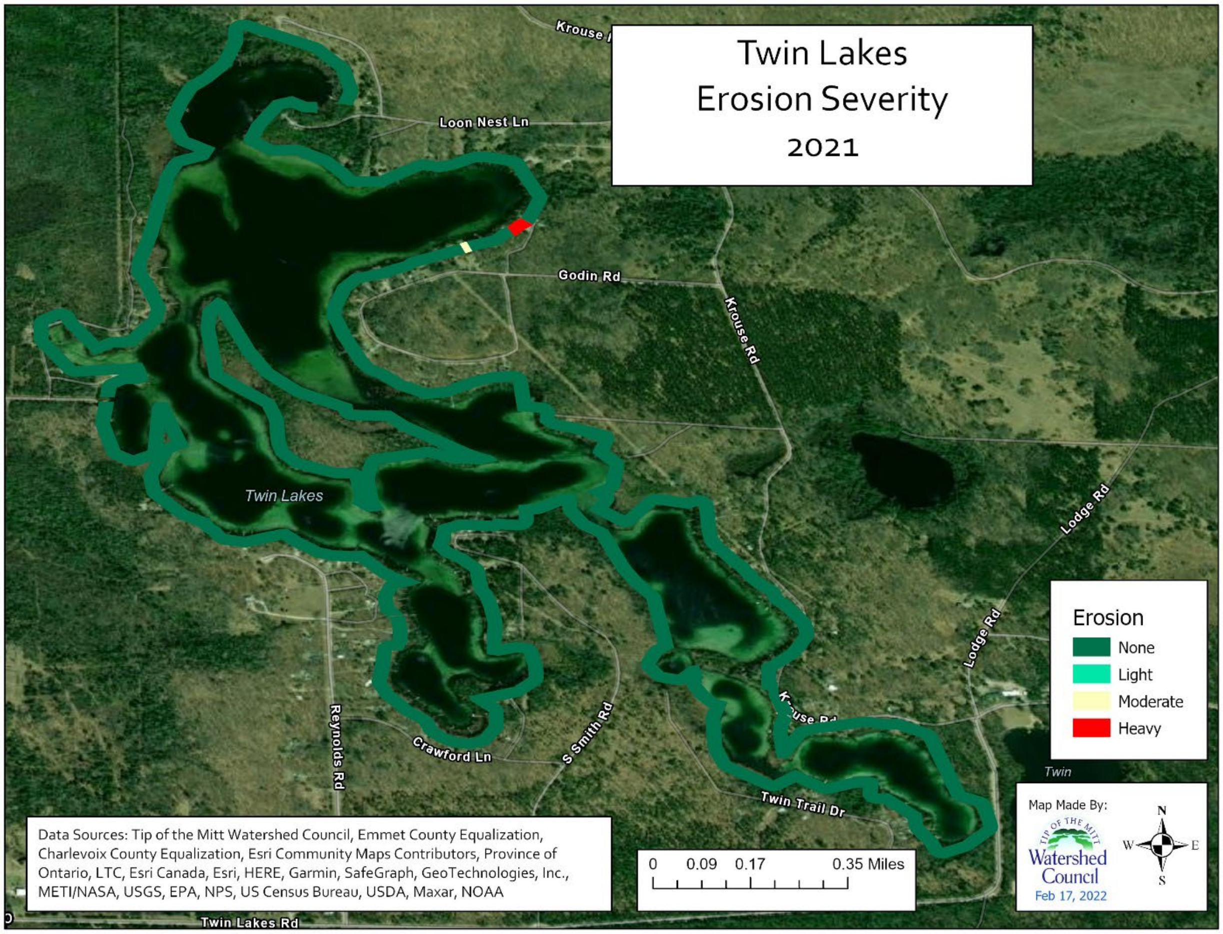


Figure 75. Twin Lakes erosion severity

4.7 Streambank Erosion Surveys

The Watershed's major tributaries were inventoried and evaluated for streambank erosion and alterations. Streambanks were surveyed along navigable sections of streams or rivers. The main Rivers surveyed in their entirety were the Lower Black River, Cheboygan River, and Indian River. The Little Sturgeon River was surveyed from I-75 to Indian River; Pigeon River was surveyed from Afton Road to Riverwoods Trail; the Little Sturgeon River was surveyed from I-75 to Indian River, and Mullett Creek was surveyed from M-27 to I-75 (Table 26). Kimberly Creek was surveyed using a spot-check system, looking at streambank conditions at West Ostrander Road and Quarry Road.

Table 26. Streambank reaches assesed

River	Survey Start Point	Survey End Point	Miles Surveyed	% of River Surveyed
Cheboygan River	Mullett Lake	Lake Huron	7	100%
Lower Black River	Black Lake	Cheboygan River	10.5	100%
Indian River	Burt Lake	Mullett Lake	3.9	100%
Little Sturgeon River	I-75	Indian River	0.7	7%
Mullett Creek	M-27	I-75	1.1	12%
Pigeon River	M-68	Riverwoods Trail	4.3	3%*
Little Pigeon River	Silery Road	East Mullett Lake Road	0.4	1%
Kimberly Creek**	W. Ostrander Road	Quarry Road	NA	NA

**% surveyed includes tributaries*

***Kimberly Creek was surveyed using spot-checks*

The most dominant streambank alterations along the rivers are rip rap and seawalls. Cheboygan River had the largest percentage of alterations, followed by Indian River (Table 27).

Table 27. Streambank alterations

	Rip Rap		Seawall	
	Miles	%	Miles	%
Cheboygan River	2.58	18%	3.61	26%
Indian River	0	0	1.68	22%
Lower Black River	0.74	4%	0.42	2%
Little Sturgeon River	0	0	0.13	9%

**Percentage of total survey distance on each water body*

Greenbelt scores ranged from 0 to 7, representing the greenbelt status or health. Scores of 0 were considered very poor, 1-2: poor, 3-4: moderate, 5-6: good, and 7: excellent. Greenbelt were assessed on the most developed rivers in the Watershed. The Little Sturgeon River and Lower Black River had the best greenbelt scores, while Cheboygan and Indian Rivers had the worst scores (Table 28).

Table 28. Greenbelt scores

Greenbelt Score	Indian River		Lower Black River		Cheboygan River		Little Sturgeon River	
	# Parcels	%	# Parcels	%	# Parcels	%	# Parcels	
0	138	61%	65	13%	184	42%	5	10%
1	2	1%	0	0%	0	0%	0	0%
2	5	2%	51	10%	42	10%	0	0%
3	17	7%	38	7%	16	4%	4	8%
4	26	11%	39	8%	63	14%	13	26%
5	17	7%	96	19%	50	11%	4	8%
6	6	3%	67	13%	48	11%	12	24%
7	16	7%	158	31%	38	9%	12	24%
TOTAL	227		514		441		50	

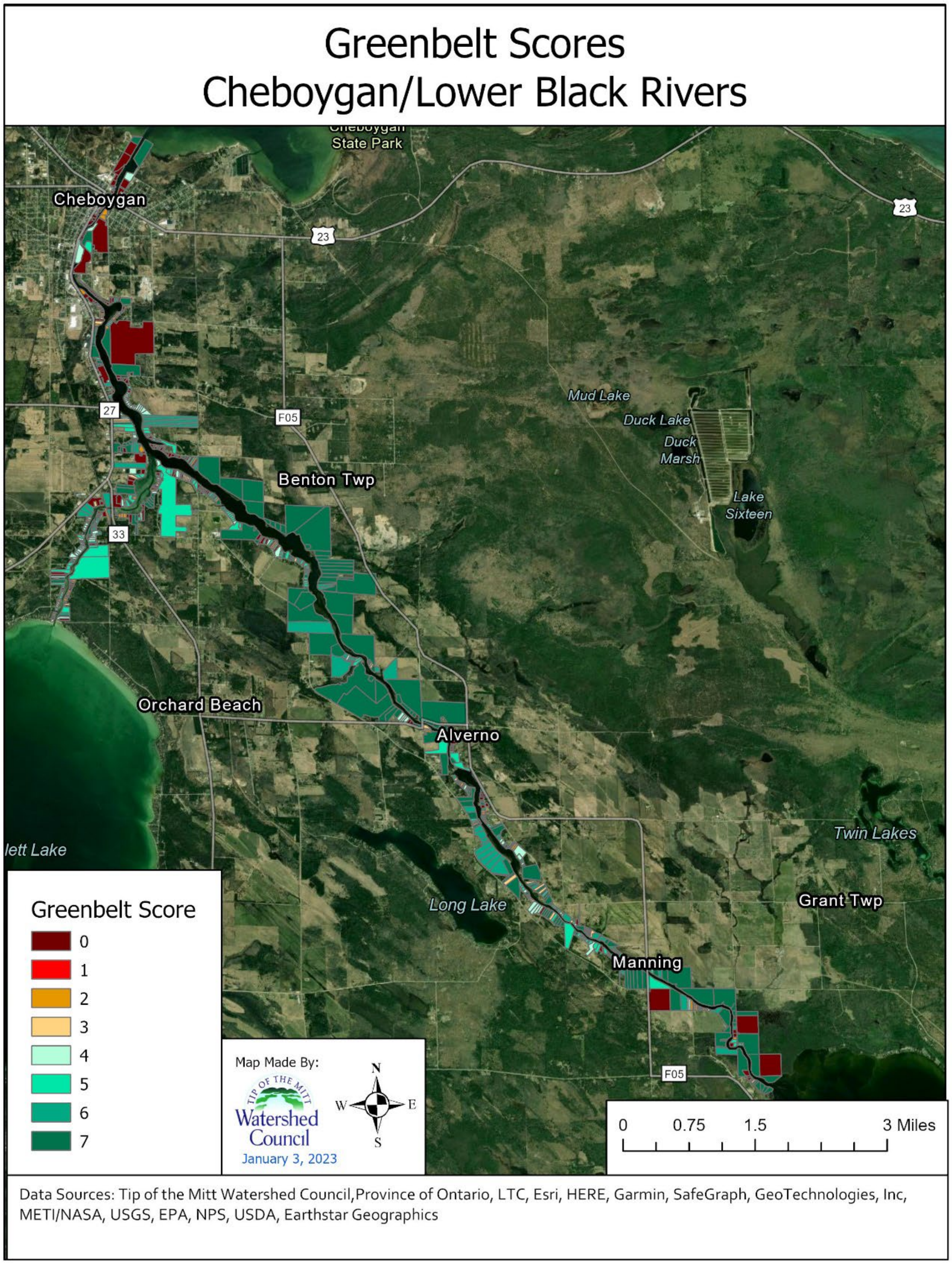


Figure 76. Greenbelt scores of Lower Black/Cheboygan Rivers

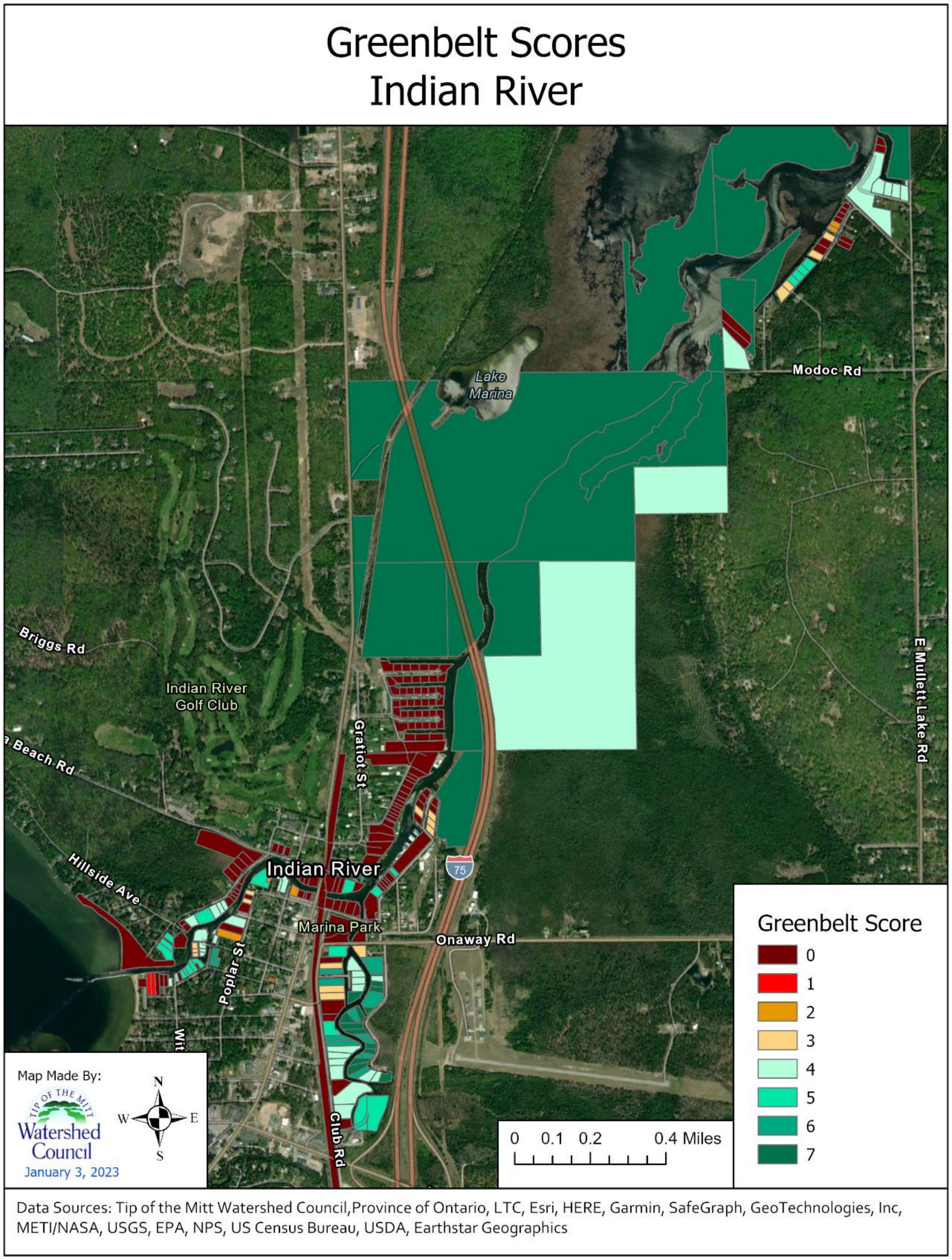


Figure 77. Greenbelt scores on Indian and Little Sturgeon Rivers

Pigeon River had several severe erosions sites in the surveyed reach. This is due in part to the steep banks and natural processes that cause erosion on the outer bend. There were few moderate and minor erosion sites on all other rivers. No erosion was found on the surveyed reach of Mullett Creek (Table 29).

Table 29. Erosion sites

River	Severe	Moderate	Minor
Lower Black River	0	1	19
Cheboygan River	0	9	13
Indian River	0	0	10
Little Sturgeon River	0	0	11
Little Pigeon River	0	0	1
Pigeon River	6	9	23

Figure 78. Severe erosion site on Pigeon River (PR-18)

Sediment loads for major streambank erosion were determined by using a Direct Volume Method for each erosion site. Lateral recession rates (LRR) ranged from .03 to .4, depending on severity, and an average soil weight density for loamy sand/sandy loam of 100. The eroding area is in square feet, the lateral recession rate is in feet/year, and density is in pounds/cubic feet (pcf). Pigeon River has the highest nutrient loading estimates in the Watershed (Table 30).

Direct Volume Method	***(eroding area) x (lateral recession rate) x (density) = erosion in tons/year***
	2000 lbs/ton
Phosphorus Loading	Sediment (T/year) x .0005 lbP/lb x 2000 lb/T x soil correction factor (.85)
Nitrogen Loading	Sediment (T/year) x .001 lbN/lb x 2000 lb/T x soil correction factor (.85)

Table 30. Pollutant loading estimates by river

River	Sediment loading tons/year	Phosphorus loading lbs/year	Nitrogen loading lbs/year
Lower Black River	25	21	50,400
Cheboygan River	324	275	647,485
Indian River	2	2	4,430
Little Sturgeon River	2	2	4,414
Pigeon River	625	532	1,250,711

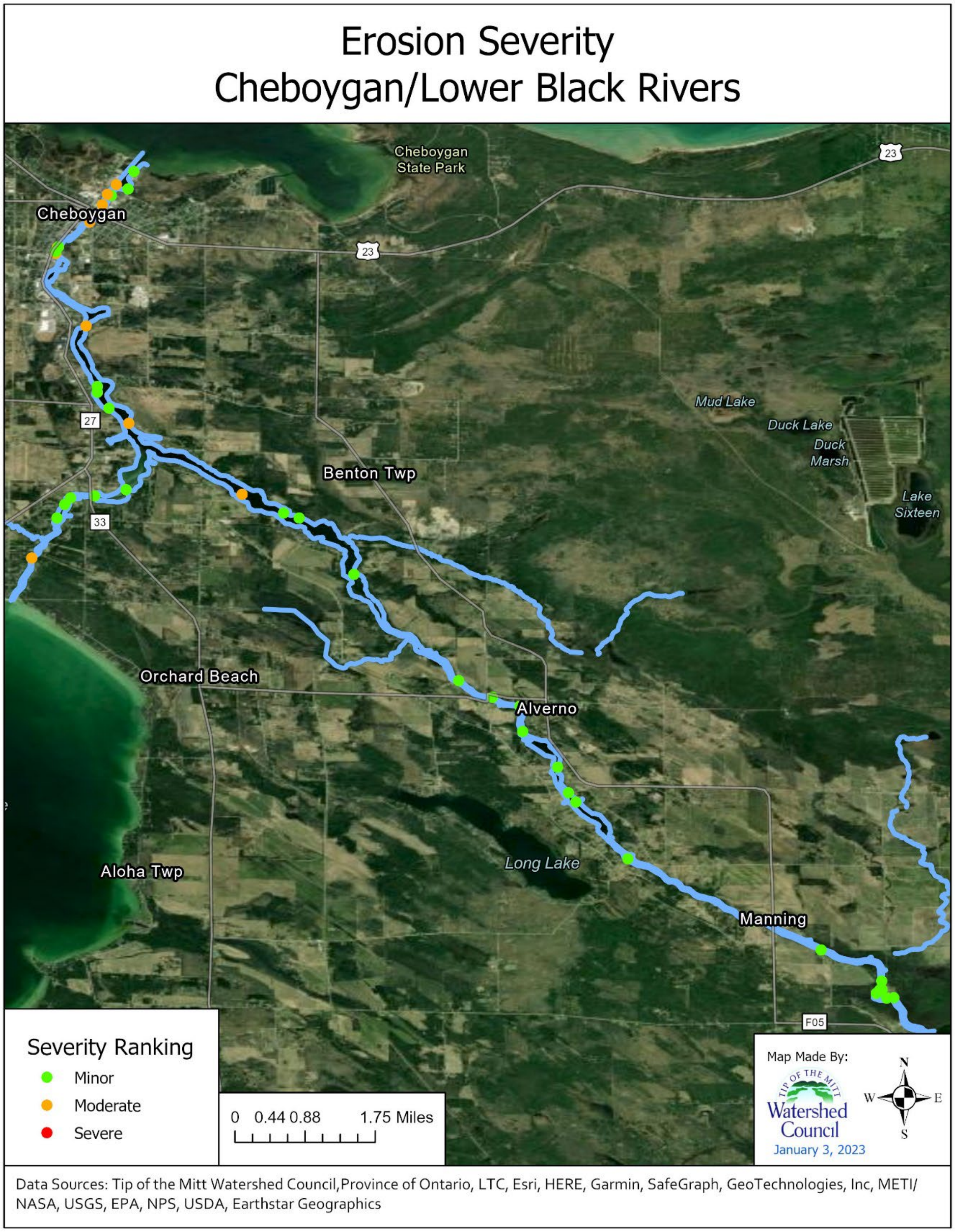


Figure 79: Streambank Erosion on Lower Black and Cheboygan River

Figure 80: Streambank Erosion on Indian River and Little Sturgeon River

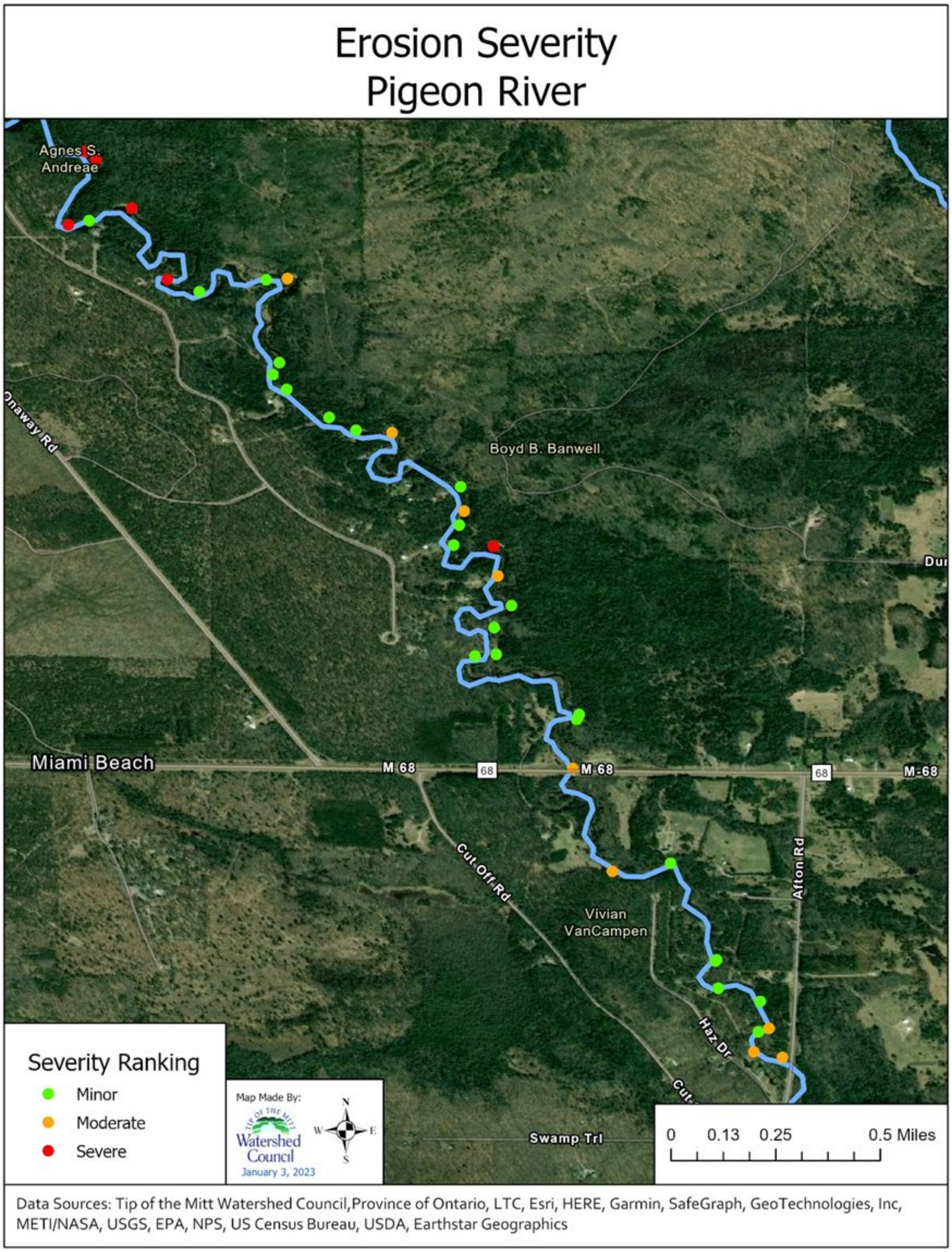


Figure 81: Streambank Erosion on Pigeon River (Afton Road to River to Riverwoods Trail)

4.8 Stormwater

Stormwater runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not infiltrate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates pollutants that can adversely affect water quality if the runoff is discharged untreated. Nutrients used in fertilizers applied to lawns and gardens, pet waste, and sediments from soil particles that are washed away from bare spots in lawns and gardens, roadways, and other areas of exposed soils are just a few examples of nonpoint source pollutants.

Stormwater runoff occurs naturally, but increases as a result of landscape development and urbanization. As forests, grasslands, wetlands, and pastures are replaced by impervious surfaces such as streets, roofs, sidewalks, and parking lots, the amount of stormwater runoff generated by a storm event increases dramatically. The negative effects of stormwater runoff on aquatic ecosystems have been well documented. Increased stormwater runoff alters the natural flow regime of streams by scouring stream banks and streambeds, increasing sedimentation, and reducing water quality and aquatic habitat for fish, aquatic insects, and other aquatic organisms. In addition, stormwater carries many harmful substances found in urban areas, such as bacteria from pet and animal wastes, fertilizers, oil, grease, deicing road salts, sediments, heavy metals, and pesticides, which wash into receiving water bodies.

The Watershed contains four urban areas where stormwater runoff potentially degrades the water quality and aquatic habitat of receiving water bodies. Developed areas of Indian River, Topinabee, Aloha, and Cheboygan lie within the Watershed. Many of these urban areas possess paved streets with curbs, gutters, and subsurface drainage pipes called storm sewers. These storm sewers prevent flooding and water damage within the urban areas, but also have the potential to negatively impact local surface water resources. Numerous artesian wells flow forth from waterfront parcels, and provide a steady source of clean and cold water. Along any given section of riverfront or lake front, wells can be seen as steadily flowing pipes, usually 2" to 4" in diameter, constantly discharging clean water. In some situations, these may have the appearance of a stormwater outfall. At times, groundwater may flow into stormwater infrastructure, allowing for continuous flow despite dry conditions.

TOMWC conducted a stormwater inventory in 2016 of Indian River as part of the Burt Lake watershed plan which abuts this watershed. In 2021, the City of Cheboygan contracted with an engineer, as a part of a larger grant funded project to update some of their water infrastructure, who shared that data with TOMWC for this plan. Topinabee and Aloha were inventoried in 2022 by TOMWC staff. The inventories involved review of storm sewer maps provided by local and state governments, delineating different drainage catchment areas, and identifying locations of stormwater inlets and outlets. This approach essentially delineates "urban watersheds," each contributing flow to an outlet at the lowest elevation point in the system, often near lakes, streams, or wetlands. Occasionally, a stormwater basin will not contribute stormwater to surface waters – rainfall simply soaks into the ground. For this reason, low-density development in pervious soils often have no stormwater management as there is no need. In runoff-producing systems, retention basins, bio-swales, and rain gardens are human designed depressions that collect stormwater and encourage infiltration. Basins that outlet to such structures are considered "internal infiltration" and do not contribute pollutants to surface waters. Wetlands also have the ability to filter pollutants from runoff, and stormwater systems that outlet to wetlands are generally considered less impactful than those that outlet to lakes, rivers, or streams.

Inventory data for each basin consisted of basin area, percentage impervious surface, average yearly rainfall, and retention status of effluent. This data was entered into an empirical model to predict pollutant loadings in each urban area for four major pollutants: sediment, nutrients, metals, and bacteria. These predicted loadings can be used to prioritize basins for stormwater BMP installation.

Indian River

The community of Indian River is situated on the shoreline of Burt Lake and the Indian River. 12 basins deliver runoff to the Indian River which flows into Mullett Lake. Basin 6, a residential area, and 15 contribute the most pollutants. Basin 15 is largely a commercial area that drains straight east and into a channel that eventually outlets to the Little Sturgeon River. Within the village development, over 230 developed acres lie within the Mullett Lake Watershed, whereas roughly 120 developed acres are within the Burt Lake Watershed.

Indian River is known for abundant water, both in surface water and groundwater. While meeting with local officials, it was made clear that flooding had been a problem in the past, and the best means to mitigate the risk of future flooding is to channel groundwater, along with stormwater, into infrastructure that leads to surface water. Such a situation poses challenges to conventional stormwater BMPs that focus on infiltration of excess water. Much of Indian River sits on muck soils that do not allow for efficient infiltration of runoff.

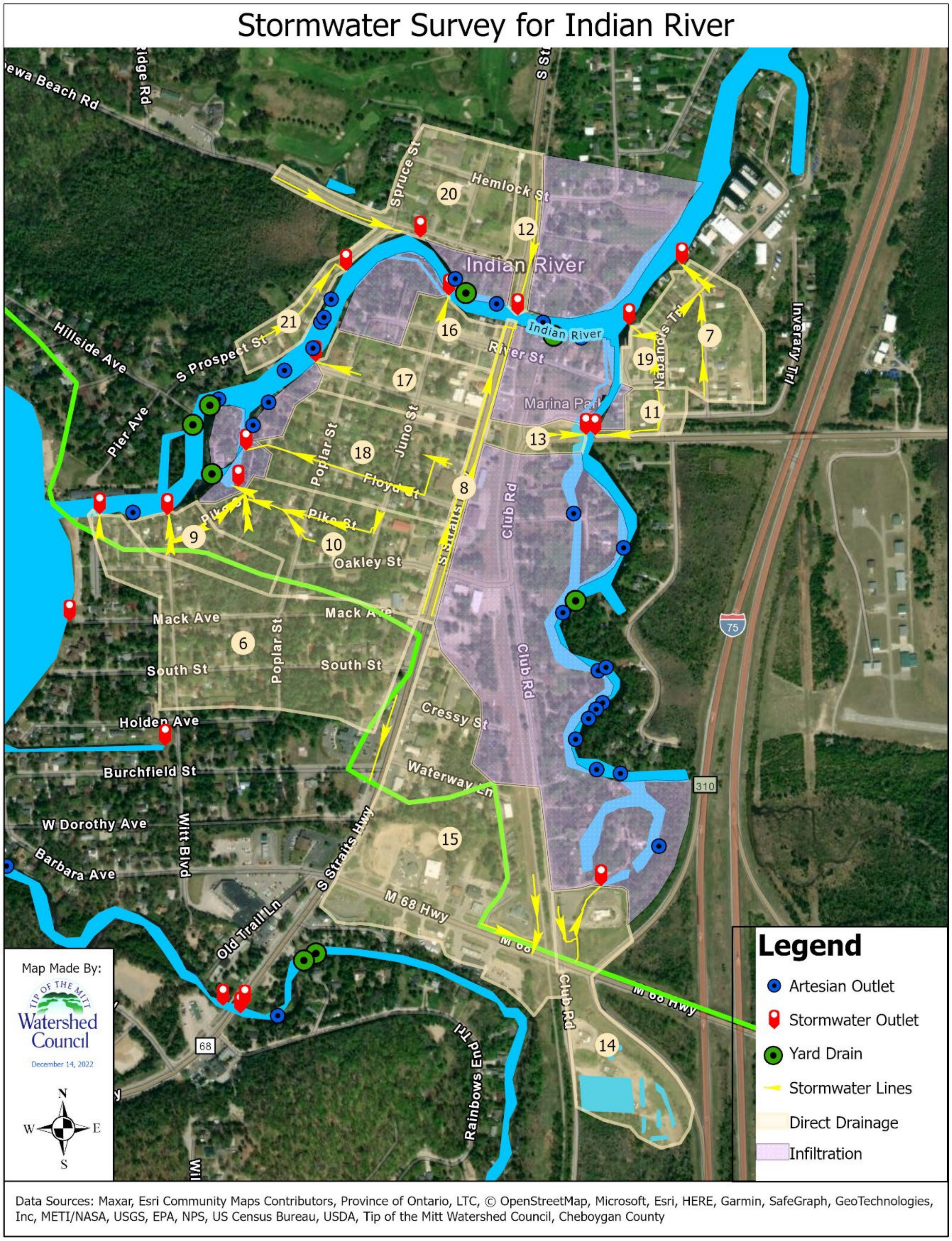


Figure 82: Stormwater survey Indian River

Cheboygan

The City of Cheboygan lies on the shores of Lake Huron. The Cheboygan River Watershed boundary runs narrowly through the City. There were a few gaps in the data from the engineering firm, so we were not able to define some basin areas. 24 basins were identified as having direct drainage into the Cheboygan River (Figure 83). The largest 3 basins are 2, 9, and 20 which contribute the highest pollutant loadings. Basin 2 covers a large urban area that is approximately half businesses, including a gas station and car dealership, and half residential area. Basin 9 is largely residential but also includes the industrial site of the Great Lakes Tissue Plant. Basin 20 is all residential. There is a large industrial area (approximately 23 acres) at the outlet of the Cheboygan River, and a Coast Guard refueling station. The north side of the River has a narrows strip of sandy soils from the dam down to the mouth, whereas the rest of Cheboygan has poorly drained soils.

TOMWC sampled stormwater and tributaries as part of three different projects in the City of Cheboygan in 2013, 2020, and 2021. Results showed that all 10 outfalls that were monitored had total phosphorus and total nitrogen values above EPA reference conditions. Over half of those outfalls had high total suspended solids. Multiple urban streams and drains within City limits are more polluted with nutrients and heavy metals compared to natural streams in the watershed. When compared to other cities in Northern Michigan monitored by TOMWC, Cheboygan stormwater is the most polluted.

Of the basins monitored within the Watershed in 2020, basin 19 (Mill Street), basin 13 (Lincoln Street), and basin 9, (Court Street) had the highest levels of conductivity and were thus targeted for further monitoring (TN, TP, TSS, E. coli). That monitoring, in conjunction with a series of workshops and communications with City staff helped develop a map the City that identified areas of concern, areas slated for future development, and areas that need to be preserved. Monitoring results can be found in Appendix F.

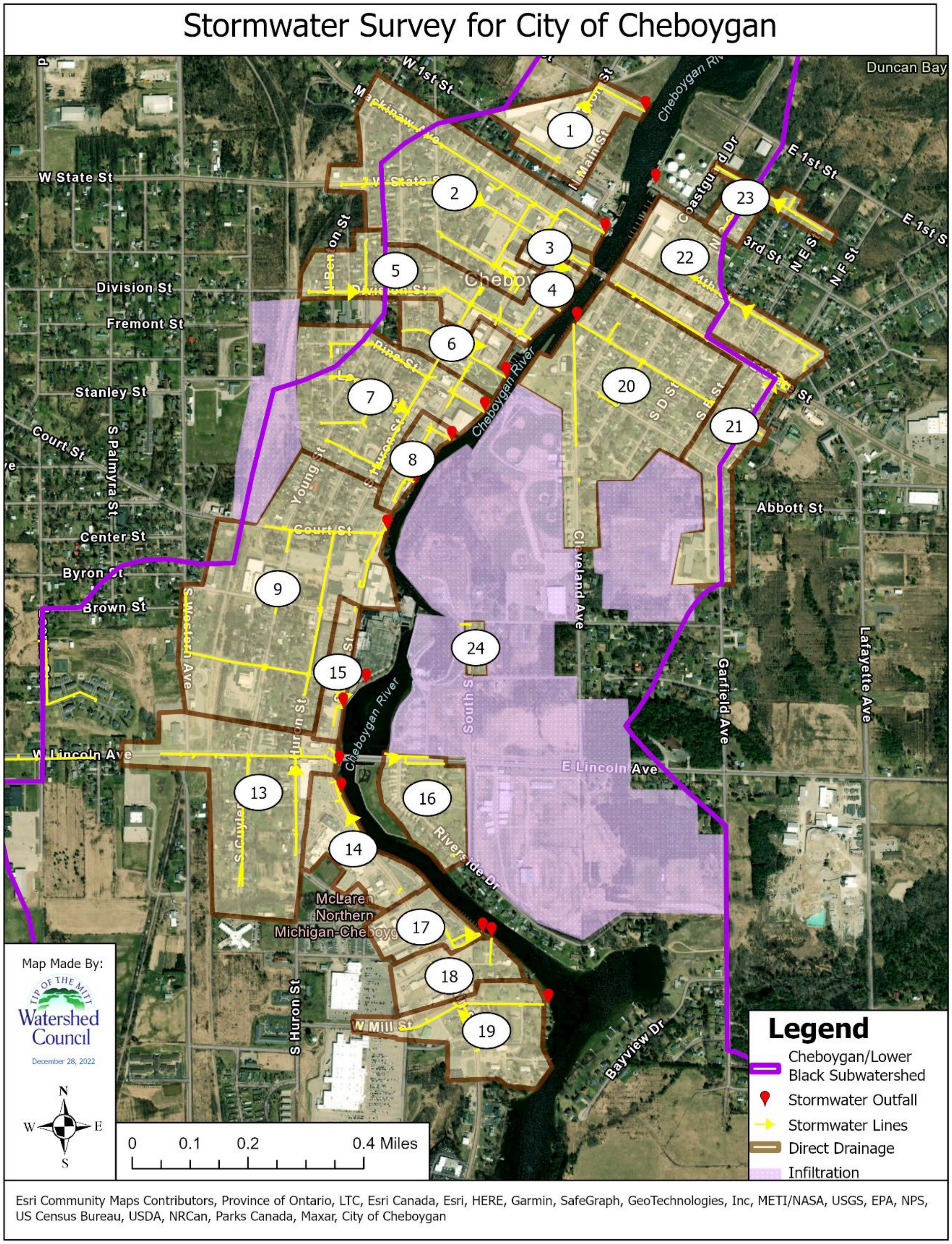


Figure 83. Stormwater survey for Cheboygan

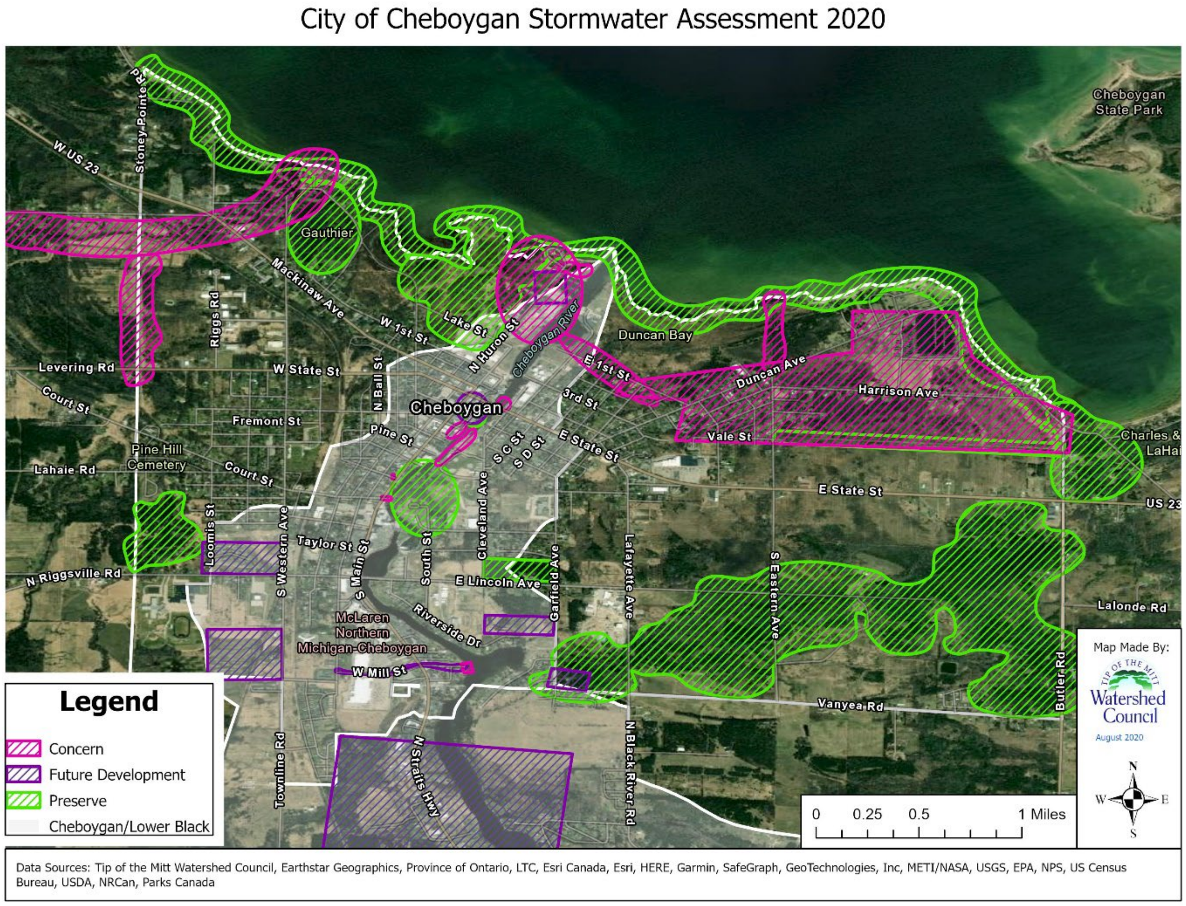


Figure 84. Stormwater Assessment Cheboygan (2020)

Aloha

The unincorporated community of Aloha is located on the northeast shore of Mullett Lake, approximately 8 miles south of Cheboygan. Stormwater runoff is contributed directly by Waikiki, Center, Main Street and Vacationland Drive (Figure 85).

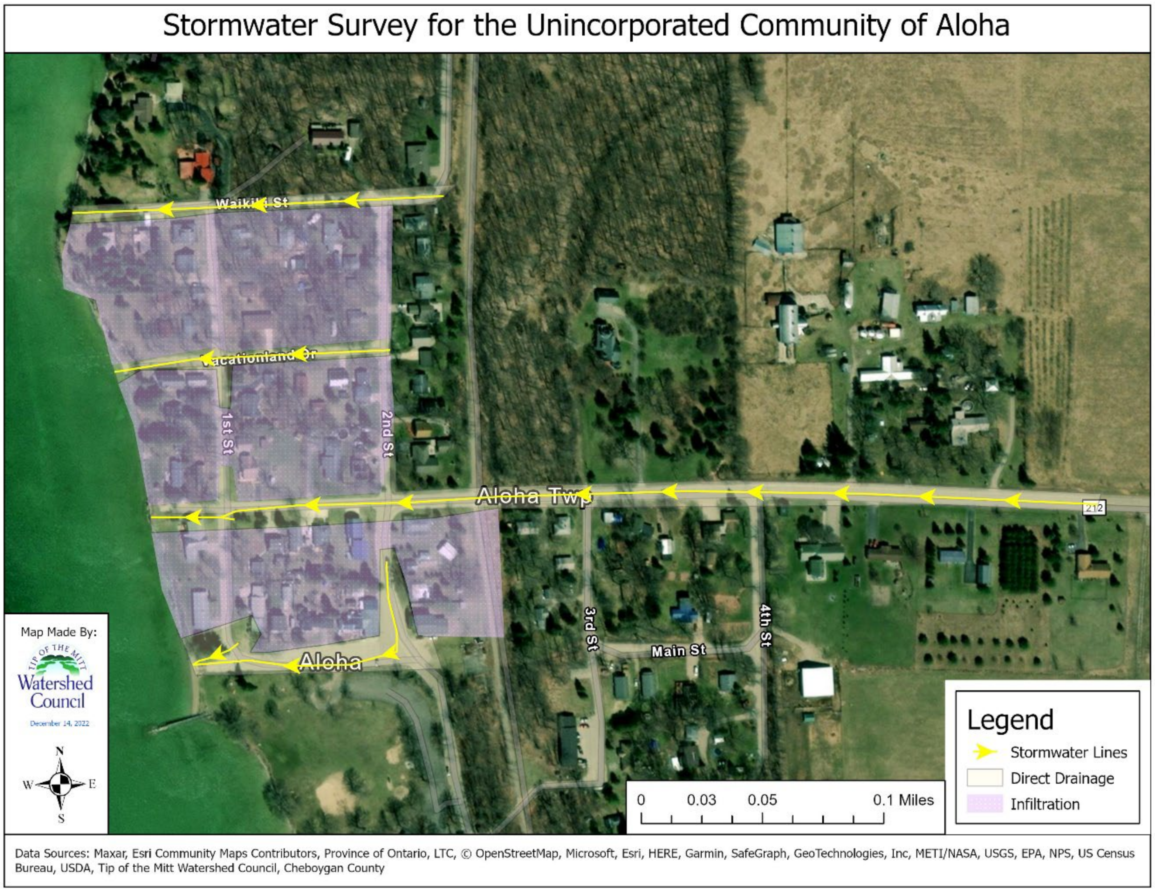


Figure 85. Stormwater survey for Aloha

Topinabee

The Village of Topinabee is located on the southwest shore of Mullett Lake, approximately 5 miles north of Indian River. There are a total of five basins which drain to Mullett Lake. Stormwater is conveyed through storm drains, but there are no outfalls that go directly into the lake. Stormwater enters the lake directly from South Street or the stormwater is conveyed into small streams that outlet into the lake (Figure 86). Some parcels have pipes that discharge water directly to the lake.

Figure 86. Stormwater survey for Topinabee

Pollutant loads were estimated using average annual precipitation. Estimates show that Cheboygan contributes the most pollutants, followed by Indian River, Topinabee and Aloha (Table 31). It should be noted that while not all the outfalls in Cheboygan were monitored, basin 9 had higher levels that some of the surrounding outfalls which corresponds to the estimated pollutant loadings that suggested basin 9 would contribute the most.

Table 31. Pollutant loading estimates by urban area

Urban Area	Phosphorus Load (lbs/yr)	Nitrogen Load (lbs/yr)	Sediment Load (lbs/yr)
Topinabee	10	78	2114
Aloha	3	24	660
Indian River	149	1145	31,200
Cheboygan	448	3,447	91,119

CHAPTER 5. WATER QUALITY THREATS

As detailed in previous chapters, different land uses (sources) and activities (causes) have the potential to impact water quality, and subsequently, threaten the designated uses of a water body. It is critical to identify and understand the link between the source of nonpoint source pollutants and the potential cause. It is this understanding that forms the framework for developing the goals, objectives, and implementation tasks of the Watershed Management Plan.

5.1 Sediment Sources and Causes

Sediment pollution comes from a variety of sources and causes.

Sources of sediment can include lakeshores and streambanks, road/stream crossings, agricultural practices, construction, logging, and others.

Causes of sediment pollution range as well and oftentimes include:

- Lakeshore and streambank erosion- a result of the removal or loss of shoreline vegetation.
- Improperly sized culvert and lack of runoff diversions- main reason for erosion and sedimentation associated with road/stream crossings.
- New construction in the shoreline area can also contribute sediment, particularly if inadequate erosion controls are used.
- Motorboats travelling at excessive speeds in no-wake areas causes erosion and sedimentation.
- Not maintaining buffer strips during logging can also contribute to erosion and sedimentation.
- Livestock access to streams for a watering source can destroy the bank and cause erosion and sedimentation.

5.2 Nutrient Sources and Causes

Nutrient pollution may also be derived from a variety of sources, and oftentimes is linked with sediment pollution because nutrients attach to sediment particles.

Sources of nutrient pollution include shoreline and streambank erosion, road crossings, turf management, failing septic systems, agricultural practices, stormwater discharges in urban areas, manure application and management, golf course management, and new construction.

Consequently, shoreline, streambank, and road/stream crossing erosion contribute sediment and nutrient pollution.

Causes of nutrient pollution oftentimes mirror that of sediment pollution. They may include:

- Lakeshore and streambank erosion is often a result of the removal of shoreline vegetation.
- Improperly sized culverts and lack of runoff diversions are the main reason for erosion and sedimentation associated with road/stream crossings.
- Livestock access to streams for a watering source can destroy the bank and cause erosion and sedimentation. In addition, manure may be directly entering stream.
- Outdated, poorly maintained, and improperly designed septic systems discharge nutrients.
- Improper (overuse, wrong formulation, etc.) application of fertilizers on agricultural fields, golf courses, and residential lawns.
- Urban stormwater carries pet waste and other nutrient sources and is discharged to a lake or stream without treatment.

5.3 Sources and Causes of Other Pollutants

Sources of oils, grease, and heavy metals include stormwater discharges in urban areas and road/stream crossings.

Sources of pesticides include agricultural fields and residential, commercial, and municipal turf management.

Sources of bacteria include stormwater discharges in urban areas, manure application and storage, septic systems, and livestock access to streams.

Causes may include:

- Outdated, poorly maintained, and improperly designed septic systems discharge bacteria and other pathogens.
- Urban stormwater carries bacteria, oils, grease, and heavy metals and is then discharged to a lake or stream without treatment.
- Unrestricted livestock access to a stream allows waste to enter the stream directly.
- Over application of pesticides on residential, commercial, and municipal properties, as well as agricultural fields.

- Reducing and preventing nonpoint source pollutants relies upon addressing the priority pollutants' sources and causes, which have been identified and ranked for the Watershed (Table 32). The pollutants are ranked according to their potential impact on water quality. Sources are ranked for each pollutant according to their prevalence. Causes are ranked according to their priority by source.

5.4 Other Environmental Stressors

Habitat Degradation

The disruption of a water body's hydrology can cause systemic problems that affect water quality and habitat. The most common sources of these disruptions are road/stream crossings and dams. Road/stream crossings, if designed or installed improperly, can restrict flow and create upstream flooding and downstream erosion. Downstream reaches can become sediment starved due to the interference of sediment transport. Water temperatures can increase from upstream impounding. Excess sediments and nutrients can enter a stream more readily due to localized erosion. Road/stream crossing can also create physical barriers to upstream passage of aquatic organisms due to perched culverts or accelerated velocity of water through the structure. Dams can result in many of the same conditions stated above, including disturbance of sediment transport, increased water temperatures, downstream erosion, and as barriers to aquatic organism passage.

Invasive Species

Invasive species can have a profound impact of water resources. Whether fully aquatic species, such as Eurasian watermilfoil (*Myriophyllum spicatum*), or semi-aquatic species, such as common reed (*Phragmites australis),* once a noxious invasive species becomes established within or around a waterbody, the impacts are far-reaching. Native plant communities can become outcompeted by more aggressive invasive species thereby limiting the availability of food and shelter to local wildlife. Local hydrology can change and lead to flooding and erosion. Recreation can become impaired from excess growth of plants that limit swimming, boating, etc. Decomposition of dead and decaying plant matter can deplete dissolved oxygen, which then affects fish and other aquatic organisms.

Thermal Pollution

Thermal pollution is caused when surface waters are unnaturally warmed from either a warm water discharge, such is the case when stormwater flows directly into a lake or stream, or when sunlight is allowed to penetrate deeper into the water column due to increased water clarity or impounding of water. Increased water temperatures can affect aquatic life as some species have limited tolerance for even very small increases in water temperature due to less dissolved oxygen and other factors.

Climate Change

Although climate change is not a nonpoint source pollutant, cause, or source of nonpoint source pollution, it does factor into watershed protection. Climate change predictions indicate that the Earth's average temperature will increase, which will subsequently influence the patterns and amounts of global precipitation. Sea levels will rise, ice and snow cover will be reduced, and there will be more frequent and extreme weather events. Given these predictions, it is critical that high-quality water resources are protected to maintain their resilience in the face of climate change. As described earlier, the Burt Lake Watershed includes some of the most pristine lakes, streams, and wetlands within Michigan. Protecting them now will help to mitigate not only the local effects of climate change, but also on a regional scale.

Summary

Table 32 (below) summarizes pollutant sources, causes, and environmental stressors. Known causes are not ranked any higher than suspected sources because not all sources were able to be investigated. Suspected sources have been widely researched and are known sources, but we have not confirmed with data in this watershed.

Table 32. Pollutant causes and sources

Rank	Pollutant/ Stressors	Source (k: known; s: suspected)	Rank	Cause (listed in priority order by source)
1	Nutrients: Phosphorus and Nitrogen	Stormwater (k)	1	Inadequate treatment of stormwater (k)
		Shoreline/streambank development & property management (k)	1	Fertilizers (s)
				Removal of native shoreline vegetation (k)
		Septic systems (s)	2	Outdated, poorly maintained, and improperly designed systems (s)
		Road/stream crossings (k)	3	Inadequate infrastructure (k)
				Lack of runoff diversions (k)
				Lack of vegetation (k)
		Agriculture and Forestry (s)	4	Limited use of BMPs (s)
1	Sediment	Road/stream crossings (k)	1	Inadequate infrastructure (k)
				Lack of runoff diversions (k)
				Inadequate fill on road surface (k)
				Lack of vegetation (k)
		Shoreline/streambank development & property management (k)	2	Removal of native shoreline vegetation (k)
		Stormwater (k)	3	Inadequate treatment of stormwater (s)
		Agriculture and Forestry (s)	3	Limited use of BMPs (s)

Rank	Pollutant/ Stressors	Source (k: known; s: suspected)	Rank	Cause (listed in priority order by source)
		New development and construction (s)	4	Lack of proper erosion control and stormwater management measures (s)
				Removal of native shoreline vegetation (k)
3	Habitat Degradation	Shoreline/streambank development & property management (k)	1	Removal of native shoreline and nearshore habitat (k)
				Shoreline alterations (beach sanding, seawall construction, etc.) (k)
		Road/stream crossings (k)	2	Hydrologic disruption, barrier for aquatic organisms (k)
		Small dams (k)	3	Hydrologic disruption, barrier for aquatic organisms (k)
4	Invasive Species	Recreation (k)	1	Lack of clean boating practices and other BMPs
		New development and construction (s)	2	Lack of BMPs
5	Thermal Pollution	Stormwater (k)	1	Warmer stormwater discharged to lakes and streams (s)
		Small dams and RSXs (k)	2	Warmed water from impounded streams
5	Oils, grease, heavy metals	Urban stormwater (k)	1	Inadequate treatment of stormwater that may contain oils, grease, heavy metals (s)

Rank	Pollutant/ Stressors	Source (k: known; s: suspected)	Rank	Cause (listed in priority order by source)
5	Pesticides	Shoreline/streambank development & property management (k)	1	Misuse and over use of pesticides (s)
5	Pathogens	Urban stormwater (k)	1	Pet waste, wildlife (k)
		Septic systems (s)	2	Outdated, poorly maintained, and improperly designed systems (s)

CHAPTER 6. CRITICAL AND PRIORITY AREAS

6.1 Critical Areas

Critical areas have been identified to help prioritize and target management efforts within the Watershed (Figure 87. These areas were determined based on the results of resource inventories and monitoring- they contribute the most pollutants to surface waters. Table 33 is not an all-inclusive list of impaired areas, but concentrated areas of impairment.

Table 33. Critical areas

Source	Critical Area Subwatershed	Critical Area Location
Stormwater	Mullett Lake Direct	Indian River
	Lower Black/Cheboygan Rivers	City of Cheboygan, Tannery Gully
	Pigeon River	None
Shoreline Degradation	Mullett Lake Direct	Mullett Lake-northwest and southern shoreline
	Lower Black/Cheboygan Rivers	Long Lake-north and south end
	Pigeon River	None
Streambank Alterations	Mullett Lake Direct	Indian River
	Lower Black/Cheboygan Rivers	Cheboygan and Lower Black Rivers (entire)
	Pigeon River	None
RSX/Hydrologic Disruption	Mullett Lake Direct	Little Sturgeon River
	Lower Black/Cheboygan Rivers	Laperell Creek
	Pigeon River	Little Pigeon River, Kimberley Creek
Agriculture	Mullett Lake Direct	Mullett Creek

Source	Critical Area Subwatershed	Critical Area Location
	Lower Black/Cheboygan Rivers	Lower Black River
	Pigeon River	None
Wetland Functional Loss	Mullett Lake Direct	Indian River
	Lower Black/Cheboygan Rivers	Cheboygan; upper reaches of Lower Black River
	Pigeon River	Lower reach of Pigeon River

Subsequently, implementation tasks have been developed in response to these critical areas. Implementation tasks allow stakeholders to address where management steps are needed most for watershed protection. There were no critical areas in the upper reaches of the Pigeon River.

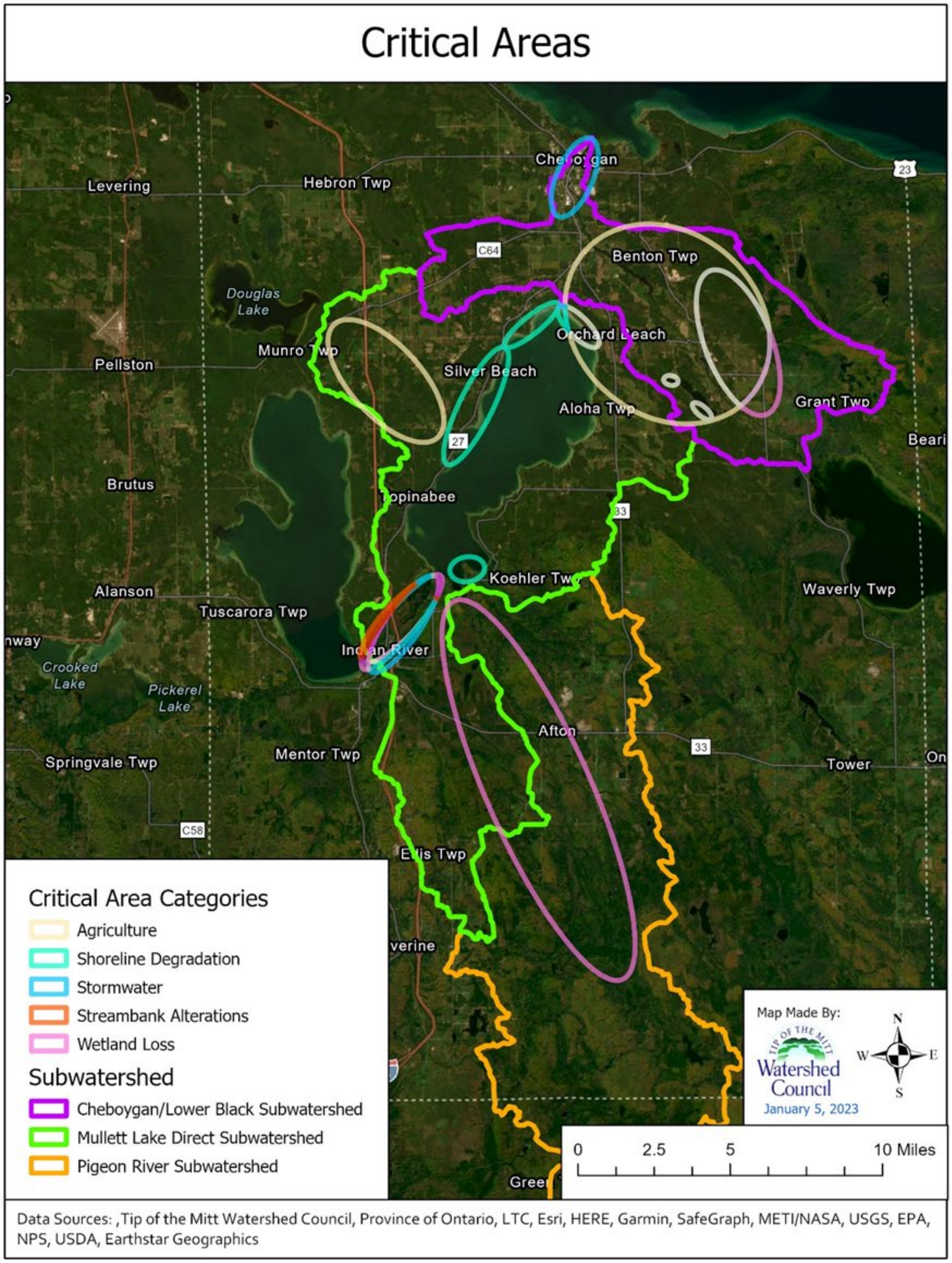


Figure 87. Critical areas

6.2 Priority Areas

Priority areas are considered the areas within the Watershed with features that are most vulnerable to development and other land uses (Figure 88). Protecting these features will provide long-term protection of water quality within the Watershed. Table 34 illustrates the priority areas by type, which are described below.

Table 34. Priority areas

Source	Priority Area Subwatershed	Priority Area Location
Groundwater Recharge	Mullett Lake Direct	Mullett Creek
	Pigeon River	Headwaters and middle reach
	Lower Black/Cheboygan Rivers	Meyers & Spring Creek
Natural Shorelines and Biodiversity	Mullett Lake Direct	Parrot Point; Indian River Spreads
	Pigeon River	Pigeon River Spreads
	Lower Black/Cheboygan Rivers	Twin Lakes; NE side of Long Lake
Wetlands	Mullett Lake Direct	Mullett Creek, Indian River Spreads
	Pigeon River	Headwaters
	Lower Black/Cheboygan Rivers	Upper reaches of Lower Black River on the north side; headwaters of Laperell Creek

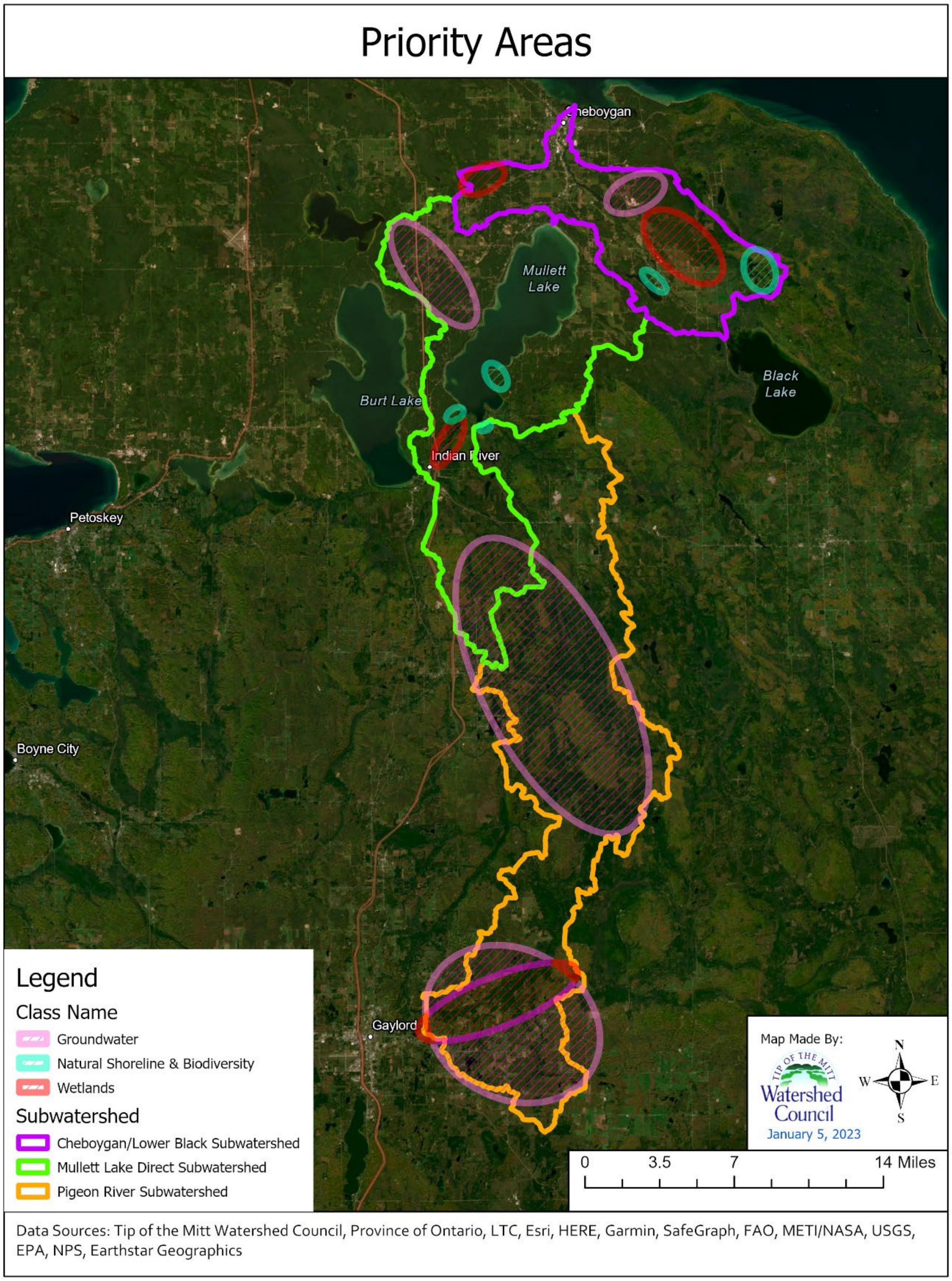


Figure 88. Priority areas

6.3 Priority Parcel Analysis

In addition to identifying priority areas, TOMWC's Priority Parcel Analysis comprehensively ranks individual land parcels using a quantitative scoring system that reflects each parcel's ecological value. While the process is a holistic approach to ecological evaluation, special emphasis is placed on the protection of water resources. Anthropogenic variables pertaining to development are also used in the criteria to frame the rankings from a land acquisition and preservation standpoint. The Analysis is done entirely in a Geographic Information System (GIS), using commonly available spatial data. Many of the data layers used in the analysis were obtained from the Michigan Geographic Data Library. A portion of the data is supplied by partner organizations and government agencies, including parcel datasets from county GIS or equalization departments, and protected lands from local conservancies.

Properly managing high-quality water resources requires addressing known sources of pollution and reducing future sources. Although effective regulation and strong stewardship ethics reduce the adverse impacts of development and land management to our surface waters, the permanent protection of sensitive lands is potentially the most effective tool for long-term water quality and aquatic ecosystem protection. Permanent protection of sensitive areas helps maintain the ecological integrity of our lakes, streams, and wetlands, and arguably provides the most positive impact per conservation effort. Permanent protection is best achieved through purchase, donation, or conservation easement.

Parcels within the Watershed were analyzed and ranked based on variables considered important for protecting and improving the quality and ecology integrity of the Watershed's aquatic ecosystems. Descriptions of scoring criteria and the point system used to assign priority rankings to parcels are described below. The scores for each criterion were summed to produce a total score for each land parcel.

Parcel Size: Larger blocks of contiguous land typically have higher ecological value due to their potential to harbor a greater diversity of species and habitat types. Permanent protection of large parcels is also more time and cost effective than protecting small parcels. The selection threshold for parcel size criteria during this process was 10 acres. The larger the parcel, the more points it received.

Groundwater Recharge Potential: Groundwater discharge is essential for the maintenance of the cold-water fisheries that prevail in watersheds of the Northern Lower Peninsula. Land with highly permeable soils allows precipitation to percolate through the soils and recharge groundwater supplies. Predominant soil type and associated permeability were determined for each parcel using the physical properties found in county soil surveys (Natural Resource Conservation Service, Cheboygan and Otsego Counties). Parcels were scored based on the extent (acreage) of soils conducive to groundwater recharge.

Wetlands: Wetlands provide a variety of important functions that contribute to the health of the Watershed, including fish and wildlife habitat, water quality protection, flood and erosion control, and recreational opportunities. National Wetlands Inventory data were utilized to determine the acreage of wetlands on individual properties and assign scores.

Lake and Stream Riparian Ecosystems: Activities on land immediately adjacent to a waterbody are critically important to maintaining water quality and ecological health. Properties with lake or stream shorelines were given scores based on total shoreline distance contained within the parcel.

Steep Slopes: Steep, highly erodible slopes are particularly vulnerable to improper use. Large amounts of erosion can degrade terrestrial habitat and impact water quality through sedimentation. Parcels with slopes greater than 20% scored points in this category.

Protected Land Adjacency: Properties adjacent to protected lands, such as state forests or conservancy preserves, have a high ecological value because they provide a buffer to preexisting protected lands. They also increase the contiguous protected area, which essentially expands the biological corridor for species migration and interaction. Parcels bordering local or state government land and conservancy properties were identified and scored based upon the number of sides on the parcel adjacent to protected lands. Properties that linked two separate protected land parcels, or doubled the size of an existing parcel, received additional points.

Threatened or Endangered Species (state or federally listed): The protection of threatened and endangered species is important because many species are indicators of environmental quality and other dependent species could be affected. The Biological Rarity (Bio rarity) Index model, developed by the Michigan Natural Features Inventory, provides an estimate of occurrence based on known sightings of threatened, endangered, or special concern species and high-quality natural communities. Priority scores were based on model predictions for occurrence of threatened and endangered species or habitat types on the parcel.

Proximity to Development: Properties near urban areas have a high conservation value due to the imminent threat of development. Because these properties are near population centers, they have the greatest potential for public use and provide the most gain in terms of ecosystem preservation. NOAA CCAP (Coastal Change Analysis

Program) land cover data and MGDL municipal boundary data were used to identify urban areas and growth corridors. Parcels were scored based on proximity to these areas.

Natural Land Cover Types: Land in its natural state is more ecologically valuable than altered land because natural land cover tends to contain a greater diversity of habitat and species, and is more resilient to invasion by non-native species. NOAA's CCAP land-cover dataset was used to determine a percent coverage of natural land cover types for each parcel. Parcels with greater than 50% natural land cover received points.

Drinking Water Protection Areas: Wellhead protection areas are critical recharge zones that maintain aquifer water supplies and sustain local municipal drinking water systems. Development within these areas can jeopardize water sources by contaminating water supplies or inhibiting the infiltration of rainwater. Points were assigned to parcels that lie within wellhead protection areas and based on the percentage of the parcel within the area.

Exceptional Resources: This criterion provides a fixed, two-point score increase to any parcel adjacent to an exceptional resource. Exceptional resources are locally occurring conditions that are rare, vulnerable to degradation, and have high intrinsic value. The following were identified as critical resources for this analysis: critical dunes, blue-ribbon trout streams, and undeveloped lakes.

The Watershed was found to contain 14,385 individual parcels within the Watershed's boundary. Parcels scored between 0 and 38, with a maximum possible score of 50. These parcels were divided into categories to simplify analysis. The ranking with the most parcels (42%) was "very low" (Table 35). These parcels had an average size of 1.74 acres, compared to the Watershed-wide average of 12.9 acres. The smallest category, ranking "very high," contained 0.1% of all parcels within the Watershed. The average parcel size within the category is 215.5 acres. Thus, land protection is often most efficient when large parcels are protected, maximizing the benefits of protecting continuous riparian corridors, significant amounts of aquatic habitat, or large areas of hydrologically sensitive lands (i.e. wetlands, headwaters, or groundwater recharge areas).

Table 35. Priority parcel ranking

Priority for Protection	Number of Parcels	%
Very Low (0-6)	6048	42.0%
Low (7-11)	5688	39.5%
Moderate (12-22)	2474	17.2%
High (23-29)	162	1.1%
Very High (30+)	13	0.1%
Total	14385	

*Percent of parcels within the Watershed

A total of 577 parcels are currently protected within the Watershed (Table 36). These protected lands are made up of a combination of state land (forests and parks), conservancy preserves, conservation easements, and local government parcels.

Table 36. Priority parcels by subwatershed

Subwatershed	Number of Parcels	%
Pigeon River	224	5.4%
Mullett Direct	219	3.9%
LBlack/Cheboygan	134	2.6%
Total	577	

Percent of parcels within the subwatershed

Table 37. Priority parcel ranking by subwatershed

Priority for Protection	Pigeon River	%	Mullett Direct	%	LB/Cheb	%
Very Low (1-6)	1372	35.1%	2451	44.8%	2225	44.4%
Low (7-11)	1346	34.4%	2186	40.0%	2156	43.0%
Moderate (12-22)	1076	27.5%	777	14.2%	621	12.4%
High (23-29)	104	2.7%	51	0.9%	7	0.1%
Very High (30+)	10	0.3%	3	0.1%	0	0.0%
Total	3908		5468		5009	

Table 37 illustrates the number of parcels in each ranking category by subwatershed. The analysis highlighted certain areas throughout the Watershed where land protection efforts would achieve the most gains for water resource protection.

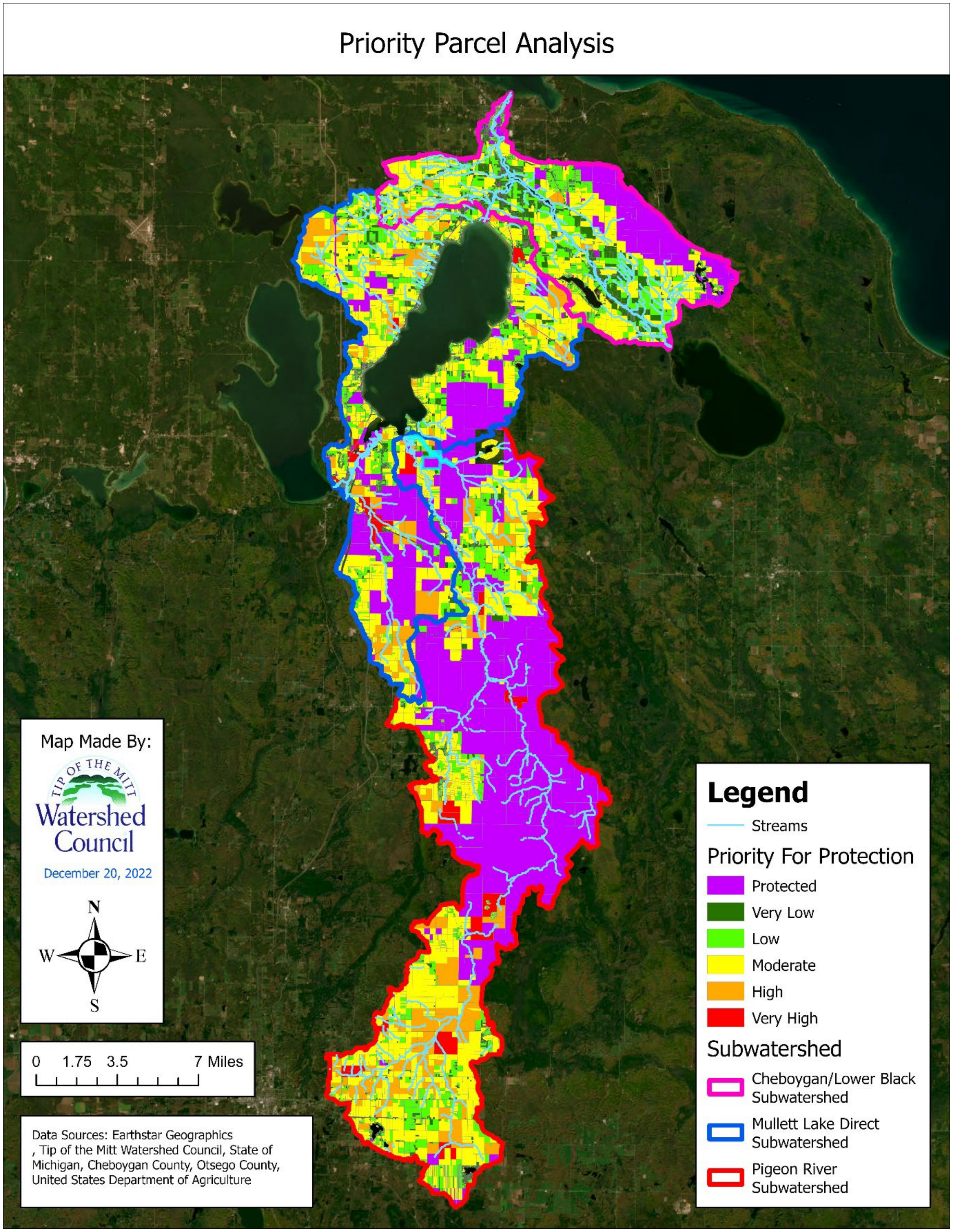


Figure 89. Priority parcels for permanent land protection in the watershed

CHAPTER 7. GOALS AND OBJECTIVES

Goals and objectives have been identified as part of the Mullett Lake, Lower Black and Cheboygan Rivers Watershed Management Plan. Goals and objectives are based upon both the Watershed's natural resources needs, including protection and restoration, as well as the health, livelihoods, recreational needs, and industries of the people that live and visit the Watershed. Goals are listed in no particular order.

7.1 Goals and Objectives

Goal 1: Protect water quality of the Watershed's lakes and streams.	
1.1	Reduce nutrient and sediment inputs through restoration of natural shorelines and streambanks where shore surveys and erosion inventories indicate greenbelts are "poor," erosion is moderate or severe, hardened shoreline structures are present, as well as where road/stream crossings are contributing sediment.
1.2	Reduce nutrient inputs through maintenance or replacement of nonfunctioning septic systems.
1.3	Reduce agricultural and forestry impacts to water quality through increased implementation of best management practices.
1.4	Manage stormwater in developed areas.
1.5	Conduct resource inventories and monitor water quality on a regular basis to assess conditions that may be affecting water quality.
1.6	Identify potential water quality threats through expanded monitoring and research.
1.7	Adopt and enforce water quality protection zoning ordinances.

Goal 2: Protect and restore aquatic and riparian habitats.	
2.1	Protect natural and restore degraded shorelines and streambanks along with riparian, instream habitat improvements, and wetlands.
2.2	Manage priority invasive species throughout the Watershed.
2.3	Protect water resources from future development by incorporating green infrastructure.
2.4	Implement permanent land protection strategies in priority areas and on priority parcels.
2.5	Support efforts to protect or restore critical habitat for native species.

Goal 3: Sustain tourism, recreational opportunities, and industry in a manner consistent with water quality protection.	
3.1	Support and expand low-impact recreational opportunities.
3.2	Incorporate watershed protection into recreational planning efforts.
3.3	Limit impacts from recreational activities.
3.4	Support measures that minimize the risk of exposure to pathogens, bacteria, heavy metals, and other contaminants.

Goal 4: Protect regional and local hydrology.	
4.1	Limit impacts to wetlands and groundwater recharge areas.
4.2	Manage stormwater throughout the Watershed.
4.3	Restore hydrology where impacted.
4.4	Protect drinking water sources.

Goal 5: Protect the Mullett Lake, Lower Black and Cheboygan Rivers Watershed from future threats/emerging issues.	
5.1	Advocate for measures that will minimize or eliminate risks of an oil leak from the Line 5 pipeline.
5.2	Mitigate climate change impacts, including more severe coastal storms in our area.
5.3	Remain aware and responsive to PFAS contamination and impacts within the Watershed.
5.4	Be aware and responsive to any new threats or emerging issues that may impact the Watershed on a broad scale.

7.2 Information and Education Goals and Objectives

Goal 6: Develop and implement effective outreach and education efforts that address nonpoint source pollution within the Watershed, engage all Watershed constituents, and convey constituents' respective roles in watershed protection.	
6.1	Utilize the Internet, email, social media, podcasts, video, news media, surveys, print materials, advertising, workshops, presentations, and other innovative forms of communication.
6.2	Apply concepts from the United States Environmental Protection Agency's Getting in Step: A Guide for Conducting Watershed Outreach Campaigns (3rd edition, November 2010) to improve communication efforts.

Goal 7: Enhance watershed protection capacity among Watershed stakeholders.	
7.1	Capitalize on the strengths and capacity of the Watershed stakeholders along with their respective programs and skill sets to implement the Watershed Management Plan.
7.2	Provide resources, data, technical assistance to local governments, residents, businesses, organizations, and other entities.
7.3	Provide watershed protection incentives.
7.4	Provide watershed protection volunteer opportunities.
7.5	Sustain and broaden the Mullett Lake, Lower Black and Cheboygan Rivers Watershed Advisory Committee.
7.6	Implement school age educational programs that foster water resource awareness and stewardship.

CHAPTER 8.
IMPLEMENTATION TASKS

8.1 Overview of Implementation Tasks and Actions

The Mullett Lake, Lower Black Cheboygan Rivers Watershed Management Plan Advisory Committee seeks an integrative approach to reduce existing sources of nonpoint source pollution and prevent future contributions. Effective watershed management must rely upon an integrative approach that includes:

1) Best management practices (BMPs)

2) Partnerships, community consensus building, and work with local governments,

3) Information and education components

The recommended implementation tasks and actions represent the best management practices and initiatives identified by the Advisory Committee as being the most critical for water quality protection within the Watershed.

8.2 Proposed Best Management Practices (BMPs)

BMPs are techniques, measures, or structural controls designed to minimize or eliminate runoff and pollutants from entering surface and ground waters. Non-structural BMPs are preventative actions that involve management and source controls. These include policies and ordinances that provide requirements and standards to direct growth of identified areas, protection of sensitive areas such as wetlands and riparian areas, and maintaining and/or increasing open space. Other examples include providing buffers along sensitive water bodies, limiting impervious surfaces, and minimizing disturbance of soils and vegetation. Additional non-structural BMPs can be education programs for homeowners, students, businesses, developers, and local officials about everyday actions that protect water quality. Educational efforts are expounded upon in the Information and Education Strategy.

Structural BMPs are physical systems that are constructed to reduce the impact of development and stormwater on water quality. They can include stormwater facilities such as stormwater wetlands; filtration practices such as grassed swales and filter strips; and infiltration practices such as bioretention areas and infiltration trenches.

Structural and non-structural BMPs will be used in combination in the Watershed to obtain the maximum reduction or elimination of NPS pollutants. BMPs should be selected according to their potential to reduce the targeted NPS pollutant, as well as budget, maintenance requirements, available space, and other factors. Some examples of possible BMPs for the most common sources of nonpoint source pollutants are listed in Table 38. Specific BMP recommendations for the Watershed are located in the Implementation Tasks (Table 42).

Table 38: Structural and nonstructural best management practices (BMPs) (EPA 2008)

	Structural Practices	Nonstructural Practices
Agriculture	Contour buffer strips Grassed waterway Herbaceous wind barriers Mulching Live fascines Live staking Livestock exclusion fence Revetments Riprap Sediment basins Terraces Waste treatment lagoons	• Brush management • Conservation coverage • Conservation tillage • Educational materials • Erosion and sediment control plan • Nutrient management plan • Pesticide management • Prescribed grazing • Residue management • Requirement for minimum riparian buffer • Rotational grazing • Workshops/training for developing nutrient management plans
Forestry	Broad-based dips Culverts Establishment of riparian buffer Mulching Revegetation of fire lines with adapted herbaceous species Temporary cover crops Windrows	• Education campaign on forestry-related NPS control • Erosion and sediment control plans • Forest chemical management • Fire management • Operation of planting machines along the contour to avoid ditch formation • Planning and proper road layout and design • Preharvest planning • Training loggers and landowners about forest management practices, forest ecology, etc.
Urban	Bioretention cells Breakwaters Brush layering Infiltration basins Green roofs Live fascines Marsh creation/restoration Establishment of riparian buffers Riprap Stormwater ponds Sand filters Sediment basins Tree revetments Vegetated gabions Water quality swales	• Planning for disconnection of impervious surface (e.g., eliminating or reducing curb and gutter) • Educational materials • Erosion and sediment control plan • Fertilizer management • Ordinances • Pet waste programs • Pollution prevention plans • No-wake zones • Setbacks • Workshops on proper installation of structural BMPs • Zoning overlay districts

Note: Practices listed under one land use category can be applied in other land use settings.

8.3 BMP Effectiveness

The actual effectiveness or efficiency of a BMP is determined by the size of the BMP implemented (e.g., feet of vegetated buffer or acres of stormwater detention ponds), and how much pollution was initially coming from the source. Table 39 (Huron River TOMWC, 2003) lists estimates of pollutant removal efficiencies for stormwater BMPs that may be used in the Watershed.

Information regarding pollutant removal efficiency, designs of BMPs, and costs are continually evolving and improving. As a result, it is critical to research the latest technologies, design, and methodologies before implementing BMPs within the Watershed.

Table 39: Pollutant Removal Efficiencies of Stormwater BMPs

Pollutant Removal Efficiencies						
Management Practice	Total Phosphorus (%)	Total Nitrogen (%)	TSS (%)	Metals (%)	Bacteria (%)	Oil & Grease (%)
High-powered street sweeping	30-90		45-90			
Riparian buffers: Forested: 20-40 m width, Grass: 4-9 m width	Forested: 23-42; Grass: 39-78	Forested: 85; Grass: 17-99	Grass : 63-89			
Vegetated roofs	70-100 runoff reduction, 40-50 of snow/rainfall. 60 temperature reduction. Structural addition of plants over a traditional roof system.					
Vegetated filter strips: 7.5m length, 45m length	40-80	20-80	40-90			
Bioretention	65-98	49	81	51-71	90	
Wet extended detention pond	48-90	31-90	50-99	29-73	38-100	66
Constructed wetland	39-83	56	69	(-80)-63	76	
Infiltration trench	50-100	42-100	50-100			
Infiltration basin	60-100	50-100	50-100	85-90	90	
Grassed swales	15-77	15-45	65-95	14-71	(-50) -(-25)	
Catch basin inlet devices		30-40 sand filter	30-90			
Sand and organic filter	41-84	22-54	63-109	26-100	(-23)-98	

Soil stabilization on construction sites			80-90			
Sediment basins or traps at construction sites			65			
Porous pavement	65	80-85	82-95	98-99		

8.4 Information and Education Strategy

Effective watershed protection is most successful when I/E efforts are incorporated into watershed management planning. The I/E Strategy reflects the various watershed audiences and the potential means of informing and educating. The following groups have been identified as the key audiences in which the I/E Strategy is based.

Component 1: General Watershed Community

General watershed protection and resource information should continue to be developed and disseminated through print and social media, websites, and educational events. Information should be general in nature with the following topic areas of focus:

- Water resources and water quality of the Watershed
- Stormwater: what is it, how it affects water quality, and how to manage it
- Cultivating the next generation of watershed stewards
- Boater education: clean boating practices

Component 2: Riparian Education

Riparians play an enormous role in watershed protection. Many riparians, however, remain unaware of the connection between water quality and riparian management. Focus areas should include what role riparians play in resource protection. The Michigan Shoreland Stewards program, an education and outreach component of the Michigan Natural Shoreline Partnership, is a valuable resource that applies to all lakes within the state. Promotion of this program, along with other local initiatives, is key in order to increase awareness of stewardship opportunities. In addition to shoreline management, efforts to increase awareness of aquatic invasive species should be emphasized among riparians. Riparians should have adequate access to current invasive species information, including identification, current range/distribution, modes of spread, best management practices, and reporting tools such as the Midwest Invasive Species Information Network (MISIN).

Component 3: Targeted Engagement

Efforts to identify, address, and engage with targeted groups should be at the forefront. Examples of these types of targeted groups include private property owners or homeowner associations known to have:

- A small dam
- A particularly threatening invasive species
- Suspected septic system issues

Other groups may include agricultural producers/farmers, local government officials, septic haulers, engineers, road commissions, and others to encourage best management practices where they are lacking.

Component 4: Mullett Lake, Lower Black and Cheboygan Rivers Watershed Advisory Committee

There are many watershed stakeholders given the area of the Watershed. They include local governments, resource agencies, nonprofits, lake associations, and others. Although not unique to this watershed, many of the groups and agencies have overlapping service areas and services. As more watershed protection projects are implemented, it is critical that information is shared among stakeholders to prevent duplication, assist with prioritization of watershed needs, pool resources, and leverage future opportunities. In order to maintain this important connectivity, the Mullett Lake, Lower Black and Cheboygan Rivers Lake Watershed Advisory Committee will continue to meet quarterly. New committee members should be recruited, particularly from groups that have yet to be represented.

8.5 Implementation Tasks

The following implementation task table includes a comprehensive list of proposed tasks and actions that, if implemented, will result in water quality protection or improvements. Tasks and actions are organized by category to facilitate easy reference. The recommendations are based on a 10-year timeline (2023-2032), a standard duration of time for a watershed management plan (Table 42). Each task and action identifies the following:

Priority Level: Each task and action has been assigned a priority level based on one or more of the following factors:

- Urgency to correct or reduce an existing problem
- Need to enact a specific task or action before a problem develops

- Availability of funds, partner(s), or program(s) ready to implement
- Overall need to balance low, medium, and high priorities over the course of ten years

Unit Cost/Total Cost estimate: An estimated unit cost is provided when applicable. An estimated total cost is provided when applicable and calculable (Table 41).

Milestones: Milestone(s) are identified, when possible, to establish an interim, measurable benchmark for determining progress of a specific task or action.

Timeline: Based on the ten-year span of the Watershed Management Plan, tasks fall into short-term (1-2 years), mid-term (3-5 years), and long-term (5-10 years). When a task or action is ongoing, it is noted as spanning the ten years.

Potential Partners: The potential partners specified are those who have the interest or capacity to implement the task or action (Table 40). They are not obligated to fulfill the task or action. It is expected that they will consider pursuing funds to implement the task or action, work with other identified potential partners, and communicate any progress with the Mullett Lake, Lower Black and Cheboygan Rivers Watershed Advisory Committee.

Table 40. Watershed partners

Watershed Partners	Abbreviation
Tip of the Mitt Watershed Council	TOMWC
Burt Township	Local Government
Cheboygan County Planning & Zoning	Local Government
Cheboygan County Planning Commission	Local Government
Cheboygan County Road Commission	Road Commissions
Huron Pines	HP
Little Traverse Bay Bands of Odawa Indians	LTBB
Little Traverse Conservancy	LTC
Michigan Department of Environment, Great Lakes, and Energy	EGLE
Michigan Department of Natural Resources	MDNR
Lake Associations and Friends Groups	LA

Potential Funding Sources: Potential funding sources for each task or action include, but are not limited to:

- Private foundation (PF)

- State grant (SG)
- Federal grant (FG)
- Local government (LG)
- Partner organization (PO)
- Revenue generated (RG)
- Private cost-share (CS)
- Local businesses (LB)

Objectives & Information and Education Objectives Addressed: Each task and action support one or more of the objectives in Chapter 7.

Tasks shown in **bold** are actions that should be prioritized.

Italicized Potential Project Partners indicates the anticipated project lead.

Table 41. Cost estimate by category

Water Quality Monitoring	$328,000
Wetlands	$355,000
Shoreline and Streambank Protection	$458,500
Stormwater Management	$765,000
Planning and Zoning	$250,500
Land Use	$75,500
Road/stream crossings	$5,018,000
Land Protection	$1,207,500
Ecosystem Health	$1,140,000
Recreation, Safety, and Human Health	$576,000
Hydrology and Groundwater	$63,500
Threatened and Endangered Species	$180,000
Aquatic Invasive Species	$1,363,000
Septic Systems	$560,000
Emerging Issues	$402,000
Total	$12,742,500

**Includes I/E Strategy cost*

Table 42. Implementation tasks

Priority	Water Quality Monitoring		Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	WQ.1	**Continue surface water quality monitoring conducted by various agencies, governments, and academic institutions according to their respective programs.**	$200,000	Monitor			*EGLE, TOMWC, MDNR, LTBB, LA*	PF, SG, FG, LG, PO	1.5	7.1, 7.2, 7.4
		Notes: Various groups monitor according to their individual protocols and monitoring strategy. Data should be made available to the Advisory Committee.								
	WQ.2	**Continue implementing Comprehensive Water Quality Monitoring (CWQM) program every 3 years on Mullett Lake, Long Lake, and Twin Lakes.**	$10,000	Monitor			*TOMWC*, LA	SG, FG, PO	1.5	7.1, 7.2, 7.4
		Notes: TOMWC conducts monitoring, along with entities. Data should be made available to the Advisory Committee.								
	WQ.3	**Continue implementing TOMWC's Volunteer Stream Monitoring (VSM) program and expand to include the two additional tributaries.**	$15,000	Recruit and Monitor	Monitor		*TOMWC*, LA	SG, FG, PO	1.5	7.1, 7.2, 7.4
		Notes: Recruit and maintain new VSM team for two new creeks by year 2; monitor new streams and all currently monitored streams annually.								
	WQ.4	**Continue implementing TOMWC Volunteer Lake Monitoring (VLM) program on Mullett Lake, Long Lake, and Twin Lakes.**	$10,000	Recruit and Monitor	Monitor		*TOMWC*, LA	SG, FG, PO	1.5	7.1, 7.2, 7.4
		Notes: Recruit and maintain new VLM; monitor annually for 10 years.								
Medium	WQ.5	Expand monitoring parameters (e.g. PAHs, pharmaceuticals) to address newly emerging water quality threats.	$15,000	Identify, Plan, Funding	Monitor new parameter		*TOMWC*, LTBB	SG, FG, PO	1.6, 5.4	7.1
		Notes: Identify priority parameters, develop monitoring plan, and secure funding; begin monitoring new parameter in 2024; retain parameter (new in 2019) through 2025 monitoring.								
	WQ.6	Conduct water quality and discharge monitoring of all major and minor tributaries to assess the impacts of individual tributaries to Mullett Lake.	$15,000		Monitor and Report		*TOMWC*	SG, FG, PO	1.5	2.2
		Notes: Review recommendations in Mullett Lake tributary study (2007)								
	WQ.7	Conduct septic evaluations on lakefront properties using newest monitoring protocols.	$25,000	Develop campaign	Evaluations		*TOMWC*	PF, SG, FG, PO, CS	1.2	2.2
		Notes: Promote septic evaluation services to LA in conjunction with septic outreach/campaign, develop cost/share program for lakefront property owners								

Low	WQ.8	Expand as necessary the study of algae in lakes. Provide shoreline property information on the algae and its management.	$25,000		Study and Outreach		*TOMWC*, LA	PF, SG, FG, PO	1.5	1.1, 2.2
		Notes: Identify project partners and study locations, secure funding, determine and implement outreach efforts as needed								
	WQ.9	**Continue the Fish Contaminant Monitoring program in lakes previously monitored and not monitored to date. Continue to report results via the program's online database.**	$8,000		Monitor		*EGLE*, MDNR	SG, PO	1.5	7.1, 7.2
		Notes: Follow protocol established by the EGLE/MDNR.								
	WQ.10	Investigate low dissolved oxygen in Mullett Creek	$1,000		Monitor		*TOMWC*, EGLE	PO, SG, FG, PF	1.5	
		Notes: Conduct seasonal monitoring								
	WQ.11	Determine the effectiveness of water quality protection efforts achieved through watershed management plan implementation by using the criteria set forth in the Evaluation Strategy.	$4,000	Track Progress		Evaluate	*TOMWC*	SG, PO	1.5	2.1, 2.2, 2.5
		Notes: Compare 10 years of monitoring data with Evaluation Strategy criteria.								

Priority	Wetlands		Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	WL.1	**Continue to review EGLE Part 303 Wetland Permit Applications to evaluate proposed wetland impacts. Submit comments to EGLE regarding anticipated wetland impacts when appropriate and work with applicants to minimize impacts.**	$25,000		Ongoing		*TOMWC*, HP, LA	PF, PO	4.1	7.2
		Notes: Respond to all permit applications when potential wetland impacts are high.								
Medium	WL.2	Restore wetlands in critical areas.	$300,000		Identify and Funding	Restore	*TOMWC*, HP	PF, SG, FG, LG, PO	2.1	
		Notes: Identify wetland restoration site, secure funding, develop plans; Complete one wetland restoration (>5 acres)								
Low	WL.3	Ground truth wetlands identified through Landscape Level Wetlands Functional Analysis to confirm high-value wetland status.	$30,000			Ground truth	*TOMWC*, EGLE, HP	PF, SG, FG, LG, PO	4.1	7.2
		Notes: Identify priority areas for ground truthing and project partners								

Priority		Shoreline and Streambank Protection	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	SP.1	Implement shoreline best management practices (BMPs) on moderate and severe shoreline erosion sites on Mullett Lake in conjunction with property owner outreach.	$100,000		Funding and begin Installation	Continue Installation	*TOMWC*, LA, local governments	PF, SG, FG, LG, PO, CS	1.1, 2.1	6.1, 7.2
		Notes: Secure funding to implement outreach program; Implement 5 erosion control projects.								
	SP.2	Implement best management practices (BMPs) on moderate and severe shoreline erosion sites on smaller inland lakes in conjunction with property owner outreach	$40,000		Funding and Installation	Continue Installation	*TOMWC*, CCD, HP, LA	PF, SG, FG, LG, PO, CS	1.1, 2.1	6.1, 7.2
		Notes: Secure funding to implement outreach program; Implement 5 erosion control projects								
	SP.3	Restore severe streambank erosion sites	$75,000		Identify	Restore	*TOMWC*, HP	PF, SG, FG, PO, CS	1.1, 2.1	
		Notes: If all severe sites are restored it would reduce sediment loading by an estimated 550 tons/yr.								
	SP.4	**Engage property owners and assist them with site assessments as well as coordination on greenbelt development and improvement projects promoting the use of native plants.**	$20,000	Ongoing			*TOMWC*, LA	PF, SG, FG, PO, CS		6.1, 7.2
		Notes: Provide guidance to 50 property owners via workshops, consultations, and other methods.								
	SP.5	**Provide riparian property owners with assistance and resources (publications, websites, workshops, and on-site assessments) as they relate to shoreline and streambank management.**	$30,000	Ongoing			*TOMWC*, LA, local governments, CCD, HP	PF, SG, FG, PO		6.1, 7.1, 7.2, 7.3
		Notes: Conduct at least 10 site assessments/year and 3 workshops (total); 100 site assessments and 3 workshops.								
	SP.6	**Continue to review all relevant EGLE and ACOE Permit Applications to evaluate proposed impacts. Submit comments to agencies regarding anticipated impacts when appropriate and work with applicants to minimize impacts.**	$25,000	Ongoing			*TOMWC*, LA, local governments, CCD, HP	PF, PO	4.1	7.2
		Notes: Respond to all permit applications when potential impacts are high.								
Medium	SP.7	**Promote the Michigan Shoreland Stewards (Michigan Natural Shoreline Partnership program).**	$35,000	Ongoing			*TOMWC*, LA, local governments, CCD, HP	SG, FG, PO		6.1, 7.1, 7.2
		Notes: Conduct trainings, site assessments, presentations to LA; Increase overall program enrollment by 30% on lakes within Watershed.								

Priority										
	SP.8	**Promote the use of Certified Natural Shoreline Professionals (Michigan Natural Shoreline Partnership program) to riparians for bioengineering projects.**	$5,000	Ongoing			*TOMWC*, HP, LA	SG, FG, PO		6.1, 7.1, 7.2
		Notes: Conducted through personal communication or mailing								
	SP.9	Repeat streambank inventories on Indian River, Lower Black and Cheboygan Rivers.	$6,000			Funding and Inventory	*TOMWC*, HP	PF, SG, FG, PO	1.5	
		Notes: Secure funding to conduct survey; Completion of inventory and results summary.								
	SP.10	Repeat shoreline surveys on Mullett Lake, Twin Lakes, Long Lake and conduct post-shoreline survey outreach with riparians	$30,000		Survey and Distribute		*TOMWC*, LA	PF, SG, FG, LG, PO	1.5	6.1, 7.2
		Notes: Secure funding to conduct surveys.								
	SP.11	Repeat streambank inventory on the Pigeon River and smaller watershed tributaries.	$6,000			Funding and Inventory	*TOMWC*, HP	PF, SG, FG, PO	1.5	
		Notes: Secure funding to conduct survey; Completion of inventory and results summary								
	SP.12	Develop outreach materials and presentations on river and stream best management practices for riparian owners	$40,000	Funding and Identify	Publication		*TOMWC*, HP	PF, SG, FG, PO, CS		6.1, 7.2
		Notes: Develop and distribute publication specifically for streambank riparians								
	SP.13	Develop and implement cost/share greenbelt program(s) on lakes with supportive LA, including demonstration sites.	$50,000	Adoption	Implementation		*TOMWC*, LA	PF, SG, FG, PO, CS	1.1, 2.1	6.1, 7.2, 7.3
		Notes: Adoption of program by at least one lake association; Approximately 20% increase in greenbelts rated good or excellent overall								
Low	SP.14	**Establish no-mow zones and native vegetation in public spaces**	$2,000	Implement			*local governments*	PF, SG, FG, PO, CS	1.1	
		Notes: install signage and create maps as needed.								

Priority		Stormwater Management	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	SW.1	Develop stormwater management plan for the City of Cheboygan	$40,000		Funding & Develop		*local governments*	PF, SG, FG, LG, PO	1.4, 3.4	7.2
		Notes: Secure funding.								

	SW.2	Implement the City of Cheboygan's stormwater management plan	$200,000			Implement	*local governments*, TOMWC, HP	PF, SG, FG, LG, PO	1.4, 3.4	
		Notes: Implement in priority areas once plan is developed.								
	SW.3	Install stormwater best management practices, including rain gardens, oil/grit separators, and other structures in Topinabee, Indian River, and Cheboygan.	$150,000		Identify and Funding	Installation	*TOMWC*, local governments, and businesses	PF, SG, FG, LG, PO, CS, LB	1.4, 2.3, 4.2	
		Notes: Identify locations and secure funding; Install at least three BMPs								
	SW.4	Monitor stormwater discharge at outfalls in Cheboygan and Indian River	$15,000		Funding	Monitor	*TOMWC*, HP	PF, SG, FG, LG	1.5, 1.6	7.2
		Notes: Identify outfalls and monitoring parameters; secure funding; monitor; Distribution of monitoring report.								
	SW.5	Incorporate green infrastructure into new or re-developments where the potential to impact water resources is present.	$100,000		Identify and Funding	Installation	*TOMWC*, local governments and businesses	PF, SG, FG, PO, CS, LB	1.5, 2.3, 4.2	
		Notes: Identify potential project(s), secure funding, implement and promote; One or more local examples of green infrastructure, project publicity, public awareness.								
	SW.6	**Develop model stormwater ordinance language for the Watershed and support the adoption and enforcement of stormwater ordinances for municipalities and townships in Cheboygan County.**	$10,000	Develop	Adopt		*TOMWC*, local governments	PF, SG, PO	3.4	7.2
		Notes: Assess the effectiveness; identify shortcomings, and work to improve stormwater ordinances in Cheboygan County.								
	SW.7	**Conduct green stormwater infrastructure visioning for Cheboygan**	$30,000	Funding	Visioning		*TOMWC*, local governments	PF, SG, PO	1.4	6.1
		Notes: Includes education and outreach								
	SW.8	Develop and implement education programs that highlight impacts of stormwater runoff on surface waters. Offer tours, workshops, print and electronic resources to local officials, business owners, and citizens to learn more about stormwater and how to minimize impacts.	$30,000		Outreach		*TOMWC*, local governments	PF, SG, LG, PO		6.1, 6.2, 7.2
		Notes: Conduct three workshops, prepare regular press releases, and other outreach (e.g. rain barrel workshop, demonstration sites)								
Medium	SW.9	Provide technical and financial resources to watershed residents to increase stormwater awareness and implementation of green infrastructure.	$50,000	Funding	Develop and Distribute		*TOMWC*, HP, local governments	PF, SG, PO, LB		7.2
		Notes: Secure funding, develop/distribute green infrastructure publication and other resources to a minimum of 1,000 watershed residents; Distribute printed and electronic versions.								

	SW.10	Provide technical and financial resources to local governments to implement green infrastructure, including rain gardens, oil/grit separators, and other structures.	$100,000		Identify and Funding	Installation	*TOMWC*, HP, local governments, and businesses	PF, SG, FG, LG, PO, CS, LB		7.2
		Notes: Identify locations and secure funding; Install at least three BMPs.								
	SW.11	Provide technical and financial resources to businesses to reduce stormwater runoff from their sites.	$100,000		Identify and Funding		*TOMWC*, HP, local governments, and businesses	PF, SG, FG, LG, PO, CS, LB		7.2
		Notes: Identify priority businesses and sites, seek funding and partnerships to help with implementation of large-scale projects.								
	SW.12	Identify areas for placing plowed snow away from storm drains or surface water.	$2,000				TOMWC, local governments, businesses	PF, LG, local businesses		
		Notes:								
	SW.13	Conduct a workshop for the road commission to reduce the use of road salt	$2,000		Workshop		*TOMWC*	PF, LG		
		Notes:								
Low	SW.14	Provide opportunities to learn about and implement green infrastructure techniques to developers, builders, architects, and landscape architects.	$5,000		Workshop		*TOMWC*, HP	PF, SG, LG, PO, RG, LB		7.2
		Notes: Secure funding, develop workshop(s), promote; Conduct at least one workshop with a minimum of 25 attendees.								
	SW.15	Provide programs and resources to Cheboygan County contractors about soil erosion and stormwater management techniques.	$5,000		Workshop		*TOMWC*, local governments	PF, SG, LG, PO, RG, LB		6.2, 7.2
		Notes: Conduct at least 2 workshops.								
	SW.16	Update impervious surface studies of Indian River, Topinabee, Aloha, Cheboygan	$6,000			Update	*TOMWC*, local governments	PF, LG, PO	1.5	
		Notes: Use existing impervious surface maps and update.								

Priority		Planning and Zoning	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	PZ.1	**Utilize the recommendations of the Cheboygan County Gaps Analysis (2014) to encourage adoption of model standards in zoning ordinances to protect water quality.**	$80,000		Implement		LA, local governments	PF, LG, PO	1.7, 3.4	
		Notes: 2 model standards adopted by year 10								

	PZ.2	Create an educational campaign about natural shorelines for Cheboygan County to gain public support for zoning ordinances.	$50,000		Funding	Implement	TOMWC, local governments	PF, LG, PO, SG, FG		6.1, 6.2, 7.2
		Notes: Could be combined with other outreach efforts								
	PZ.3	Work with Cheboygan County to require a Natural Vegetation Strip in the Lake and Stream Protection District	$10,000		Support	Implement	TOMWC, LA, local governments	PF, LG, PO	1.7, 3.4, 4.2	
		Notes: Majority support established from citizens and local officials by year 3; Vegetation Strip required by year 6 to protect surface waters								
	PZ.4	Work with Cheboygan County to adopt a wetland setback of at least 25', similar to shoreline setbacks	$3,000			Support and Implement	TOMWC, LA, local governments	PF, LG, PO	1.7, 3.4	
		Notes: Majority support established from citizens and local officials by year 6; Setback established to protect wetlands by year 8								
	PZ.5	Utilize local expertise and site plan checklists to evaluate site plans for water quality protections.	$2,000		Ongoing		TOMWC, local, governments	LG	4.2	
		Notes: Work with local planners and landowners on site plan review								
Medium	PZ.6	Establish lot coverage limits in all Cheboygan County zoning districts to limit impervious surfaces to 15% in exchange for incentives	$8,000			Support and Implement	TOMWC, LA, local governments	PF, LG, PO	1.7, 3.4	7.3
		Notes: Stakeholders in agreement and supporting change by year 7; Incentive-based lot coverage limits by year 9 to protect surface waters from NPS								
	PZ.7	Work with Cheboygan County to adopt short term rental ordinances to prevent septic system failure.	$10,000			Support and Implement	*Local governments,* TOMWC		1.7, 3.4	
		Notes: Stakeholders supporting change by year 10								
	PZ.8	Establish a drain commission for Cheboygan County	$10,000			Support and Implement	*Local governments,* TOMWC		1.7, 3.4	
		Notes: Gain support and establish by year 10								
	PZ.9	Set up drainage assessment districts to fund maintenance and best management practices in drainage areas.	$20,000			Support and Implement	Local governments, TOMWC		1.7, 3.4	6.1, 7.1, 7.2
		Notes: Conduct outreach to gain public support.								
	PZ.10	**Building on the Septic Question reports, work with local governments in Cheboygan County to pass local septic regulations (time-of-transfer; mandatory pumping/inspection, and/or; short-term rentals)**	$50,000	Ongoing	Support	Adopt	TOMWC, *local governments*	PF, LG, PO	1.1, 1.7, 3.4	
		Notes: 3 townships and/or municipalities adopt septic regulations by year 5.								

Low	PZ.11	Incorporate the EGLE/EPA-approved Watershed Plan into both the Cheboygan County Master Plan, and township and municipal plans.	$2,500		Incorporate		*Local governments*	PO, LG		7.2
		Notes: Incorporate into both by year 10.								
	PZ.12	Establish requirement that state permits must be issued for regulated wetlands before a Zoning permit is issued in Cheboygan	$3,000			Implement	TOMWC, LA, local governments	PF, LG, PO	1.7, 3.4	
		Notes: Majority support established from citizens and local officials by year 5; State permit approval required by year 7 to protect local wetlands								
	PZ.13	Require groundwater protection tasks to be specified for mining operations in Cheboygan County.	$2,000			Support and Implement	TOMWC, *local governments*	PF, SG	1.7, 3.4	
		Notes: Stakeholders in agreement and supporting change by year 10; Mining BMPs in place to protect groundwater resources								

Priority		Land Use	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	LU.1	Implement agricultural BMPs in designated critical areas.	$50,000		Identify	Implement	*CCD*, NRCS, local governments	PF, SG, FG, CS	1.3	
		Notes: Identify and prioritize BMPs, engage with land owners; Implement a minimum of 2 BMPs.								
	LU.2	**Promote MAEAP and other BMP programs to agricultural producers.**	$10,000	Ongoing			*CCD*	SG, PO	1.3	7.1
		Notes: Conduct site assessments to potential enrollees; Increase enrollment by 20% by year 10.								
	LU.3	Promote forestry best management practices to practitioners.	$5,000		Workshop		*MDNR*, TOMWC	SG, PO, LG	1.3	7.1
		Notes: Conduct Better Back Roads workshops for timber harvesters.								
Medium	LU.4	Enroll private property owners in Forest Management programs, such as State of Michigan's Forest Stewardship Program or Natural Resource Conservation Service's Environmental Quality Incentives Program.	$2,000	Identify	Enroll		MDNR, NRCS, CCD	SG, PO	1.3	7.1
		Notes: Identify private forested lands with high potential to yield water quality benefits; engage with property owners; Increase enrollment in either program by 15%.								
	LU.5	Provide comments that protect and/or increase designation of MDNR Forestry Riparian Management Zones to ensure greater water quality protection.	$1,000	Ongoing			*MDNR*, TOMWC, HP, local governments	PO	1.3	7.1
		Notes: Review current and identify potential RMZs; relay to MDNR; 50% increase in designated RMZs.								
Lo	LU.6	Conduct an agriculture inventory of the watershed	$5,000			Survey	*TOMWC*	SG, PO	1.5	

		Notes: Determine if there are new survey methods								
	LU.7	Conduct a forestry inventory of the watershed	$5,000			Survey	*TOMWC*	SG, PO	1.5	
		Notes: Determine if there are new survey methods								
	LU.8	Address recreational abuse on MDNR forest lands where affecting water quality	$2,500	Ongoing			*MDNR*	PO	3.1	
		Notes: Report to DNR Forestry Division as sites are discovered.								
	LU.9	Address illegal dumping on MDNR forest lands	$5,000	Ongoing			*MDNR*	SG	3.3	
		Notes: Identify recurring dump sites near surface waters; Develop and implement strategies to monitor and control.								

Priority		Road/Stream Crossing	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	RX.1	**Implement priority RSX projects for improved hydrology, erosion control, and fish passage in the Pigeon River Watershed**	$1,500,000	Identify and Funding	Implement		*HP*, TOMWC Road Commissions	PF, SG, FG, PO, LG	1.1, 2.1, 2.5	
		Notes: Identify five priority sites and secure funding; Completion of three priority RSX projects by year 10; if all severe sites replaced, sediment loading reduced by 100 tons/yr								
	RX.2	**Implement priority RSX projects for improved hydrology, erosion control, climate adaptation, road safety, and fish passage in the Lower Black and Cheboygan River Watershed**	$1,500,000	Identify and Funding	Implement		*HP*, TOMWC, Road Commissions	PF, SG, FG, PO, LG	1.1, 2.1, 2.5	
		Notes: Identify three priority sites and secure funding; Completion of three priority RSX projects by year 10; if all severe sites replaced, sediment loading reduced by 17 tons/yr								
	RX.3	**Implement priority RSX projects for improved hydrology, erosion control, and fish passage in the Mullett Lake Direct**	$1,500,000	Identify and Funding	Implement		*HP*, TOMWC, Road Commissions	PF, SG, FG, PO, LG	1.1, 2.1, 2.5	
		Notes: Identify two priority sites and secure funding; Completion of two priority RSX projects; if all severe sites replaced, sediment loading reduced by 50 tons/yr								
Medium	RX.4	Address moderate severity RSX throughout the Watershed as resources become available.	$300,000			Identify and Implement	*HP*, TOMWC, road commissions	PF, SG, FG, PO, LG	1.1, 2.1, 2.5	
		Notes: Identify groupings of RSX on a subwatershed basis that if implemented, in aggregate, would be competitive for funding; if all moderate sites replaced, sediment loading reduced by 200 tons/yr								
	RX.5	Repeat road stream crossing inventory every 5-10 years to determine if priorities are the same, and to document newly installed BMPs or improvements.	$12,000		Funding and Survey		*HP*, TOMWC	PF, SG, PO	1.5	
		Notes: Secure funding to conduct survey; Completion of inventory and results summary; Completion of inventory and upload data to the DNR Stream Crossing Database and/or www.northernmichiganstreams.org								

Priority	ID	Action	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
	RX.6	Educate road commissions on BMP's for aquatic organism passage	$6,000		Workshop		*TOMWC, HP*, road commissions	PF, SG, LG		6.1, 6.2, 7.1, 7.2
		Notes: Conduct workshops								
Low	RX.7	Address minor severity RSX throughout the Watershed as resources become available.	$200,000			Identify and Implement	HP, TOMWC, road commissions	PF, SG, FG, PO, LG	1.1, 2.1, 2.5	
		Notes: Identify groupings of RSX on a subwatershed basis that if implemented, in aggregate, would be competitive for funding; if all severe sites replaced, sediment loading reduced by 90 tons/yr								
Priority		Land Protection and Management	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	LP.1	**Permanently protect 1500 acres or more of high and very high priority parcels throughout the Watershed**	$1,200,000	Ongoing			*LTC*, HP, HC, local governments	PF, SG, FG, LG, PO	2.4	7.1
		Notes: Conduct outreach via workshop, newsletters, direct contact or other means to engage with land owners; 1500 ac. permanently protected (700 acres land acquisition, 800 ac. conservation easements)								
	LP.2	**Educate landowners on land protection options**	$2,500	Ongoing			*LTC*, HP, HC	PF, PO		6.1, 7.1, 7.2
		Notes:								
Medium	LP.3	**Continue to work with Michigan Department of Natural Resources on potential assist and transfer projects on priority sensitive lands in the Watershed.**	$ 20,000	Ongoing			*LTC*, HP, HC, local governments	SG, FG, PO	2.4	7.1
		Notes: Use results from priority parcel analysis as target								
Low	LP.4	Repeat priority parcel process (PPP) for the entire Watershed to identify additional priority parcels.	$5,000			Analysis	*TOMWC*, LTC	PF, LG, PO	2.4	
		Notes: Evaluate process used for PPP and incorporate new criteria that address climate change adaptation, Landscape Level Wetlands Functional Assessment, and others as they are identified; obtain updated GIS data; complete by year 6.								
Priority		Ecosystem Health	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed

High	EH.1	Protect and restore critical habitat within the Watershed's priority areas that currently support, or have the potential to support, robust populations of native fish species (e.g. brook trout).	$800,000	Identify	Implement		*MDNR*, TOMWC, HP	PF, SG, FG, PO, CS	2.1, 2.5, 4.3	
		Notes: Identify priority projects for fish habitat projects based on fish and habitat surveys; Secure funding and implement at least one project by year 10.								
Medium	EH.2	Compile known information about small dams within the Watershed. Remotely gather additional information to fill in gaps. Prioritize field assessments and work to meet with property owners to discuss options.	$5,000	Convene	Report		*TOMWC*, EGLE, MDNR, HP	SG, FG, PO	2.1, 2.5, 4.3	6.1, 7.1
		Notes: Convene small dam projects working group to begin implementation; Report of small dam findings with priority projects and property owners identified.								
Medium	EH.3	Develop and implement outreach and education strategy targeting owners of priority small dams. Focus on ecosystem impacts, dam removal options, and available assistance.	$5,000		Engage		*TOMWC*, EGLE, MDNR, HP	PF, SG, FG, PO		6.1, 6.2, 7.2
		Notes: Develop materials packet for distribution; Engage with at least 3 priority small dam owners.								
Medium	EH.4	Remove priority small dams throughout the Watershed where ecosystem benefits outweigh dam utility.	$300,000		Funding	Removal	*HP*, TOMWC, EGLE, MDNR	SG, FG, PO, CS	2.1, 2.5, 4.3	
		Notes: Secure funding for dam removal; Remove at least two priority small dams.								
Low	EH.5	Conduct a cost-benefit analysis of large dams in the watershed.	$25,000			Analysis and Outreach	*TOMWC*, HP	PF, SG, FG, PO		7.2
		Notes: Secure funding and conduct outreach on results								
Low	EH.6	Conduct habitat mapping on priority streams.	$5,000		Funding	Monitor	*MDNR*, TOMWC, USGS	SG, FG, PO	2.1, 2.5	
		Notes: Secure funding to conduct surveys; Baseline data collected for three streams.								

Priority		Recreation, Safety and Human Health	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	RH.1	**Monitor public beaches annually for potential health hazards, report advisories and beach closings via Beachguard.**	$440,000	Ongoing			*DHD4*, EGLE, HP, local governments	SG, FG, LG, PO	1.5	
		Notes: Secure funding to implement program annually.								

	RH.2	Develop Inland Waterway campaign that includes social media, advertisements, printed materials, and signage that highlights exceptional natural resources, boating safety, clean boating, invasive species, water quality, and the Inland Waterway-Water Trail, etc. to educate recreationers.	$50,000		Convene	Launch	*TOMWC*, LA, local governments, local business	PO, SG, FG, PF		6.1, 7.1, 7.2
		Notes: Convene working group to identify needs, develop communications plan, seek funding and additional partners; Launch campaign								
	RH.3	Partner with liveries and outfitters to promote low-impact recreation and watershed protection.	$8,000	Identify	Implement		*TOMWC*, local businesses	PF, PO, LB	3.3	6.1, 6.2, 7.2
		Notes: Identify partner businesses, identify needs and methods to convey message; Partner with at least two businesses to reduce recreational impacts.								
	RH.4	Implement stormwater and erosion control BMPs at boat launches and other access points where water quality impacts are noted.	$60,000		Report and Implement		*MDNR*, TOMWC, local governments,	PF, LG, SG, FG, PO	1.4, 2.3, 3.3, 4.2	
		Notes: Identify sites and partners, compile report, prioritize project(s), improve 3-4 launches.								
Medium	RH.5	Promote clean boating practices and state boating regulations at marinas, boat launches, fishing tournaments, events and other public venues.	$5,000	Implement	Partner		*TOMWC*, LA, local businesses, MDNR	PF, PO, LB	3.3	6.1, 6.2
		Notes: Identify partner businesses, identify needs and methods to convey message; Could be done in conjunction with other events.								
	RH.6	**Increase number of certified Michigan Clean Marinas within the Watershed**	$2,000		Ongoing		*MI Sea Grant*	PF, LG, PO	3.3	6.1, 7.1
		Notes: Promote program and conduct consultations; At least four new marinas certified by year 10								
Low	RH.7	**Provide information and feedback to local and state governments regarding their recreational planning efforts that may impact the Watershed**	$6,000		Ongoing		*TOMWC*, HP, LA	SG, LG, PO	3.3	7.2
		Notes: Respond to planning efforts as projects are proposed								
	RH.8	Provide comments to MDNR on trails where potential to impact water resources is high.	$5,000		Identify	Implement	*MDNR*, local governments	SG, FG, PO	2.5	
		Notes: Identify areas where restrictions are needed; Implement measures to restrict access.								

Priority		Hydrology and Groundwater	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	HG.1	Compile all existing groundwater information, identify potential problems, determine data gaps, and develop a strategy for long-term monitoring.	$5,000			Strategy	*EGLE*, TOMWC, USGS, local governments	SG, FG, PO	1.6, 1.5	
		Notes: Complete compilation and assessment of existing data.								

Priority	ID	Action	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
	HG.2	Monitor groundwater based on strategy (HG.1).	$15,000			Monitor	*DHD4*, EGLE, TOMWC, USGS, local governments	SG, FG, LG	1.6	
		Notes: Secure funding, identify project partners and implement.								
Medium	HG.3	Implement Wellhead Protection Programs (WHPP) in communities where greater protection of groundwater is critical to safeguard against drinking water contamination.	$40,000		Identify and Funding	Develop	*DHD4*, EGLE, TOMWC, local governments	SG, PO, local governments	4.1	
		Notes: Identify communities that are at greatest risk for drinking water contamination; secure funding through WHPP grant program; Develop WHPP for at least one community within Watershed								
Low	HG.4	Assess changes (net gain or loss) in permanently protected lands in areas with high groundwater recharge rates	$2,500			Compile and Distribute	*TOMWC*, DHD4, EGLE, USGS	SG, PO	1.5, 4.1	
		Notes: Complete assessment concurrent with watershed management plan update; Compile and distribute results								
	HG.5	Encourage proper maintenance, monitoring, and removal of underground fuel storage tanks. Promote the Michigan Underground Storage Tank Authority (MUSTA) program locally to assist in meeting owners' financial responsibility requirements to remediate contamination caused by releases from petroleum underground storage tanks.	$1,000	Issue	Identify	Removal	*TOMWC*, local governments	PO, local governments	4.1, 4.4	
		Notes: Issue at least one press release and one newsletter article to bring attention to the program.								
Priority	**Threatened, Endangered, and Species of Concern**		**Est. Total Cost**	**Milestone 2024-2025**	**Milestone 2026-2028**	**Milestone 2029-2033**	**Potential Project Partners**	**Potential Funding Sources**	**Objectives Addressed**	**Information & Education Objectives Addressed**
High	TE.1	**Protect and restore wild rice habitat through education and research methods**	$80,000	Research & Restore			*LTBB*, LA	SG, FG	2.5	6.1, 7.1
		Notes: Work with LA on education efforts on the lakes								
	TE.2	Protect and restore habitat for federally endangered Hungerford's Crawling Water Beetle	$100,000	Survey	Restore		*TOMWC*, LTBB, LA	SG, FG	2.5	6.1, 7.1
		Notes: more researched could be conducted								
Priority	**Aquatic Invasive Species**		**Est. Total Cost**	**Milestone 2024-2025**	**Milestone 2026-2028**	**Milestone 2029-2033**	**Potential Project Partners**	**Potential Funding Sources**	**Objectives Addressed**	**Information & Education Objectives Addressed**

High	AIS.1	**Implement on-the-ground management projects to stop the introduction, spread, and distribution of priority invasive species within the Watershed.**	$300,000		Ongoing		*HCISN, HHISN,* TOMWC, CCD,	SG, FG, LG, PO	2.2	
		Notes: Implement at least 20 private or public property projects by year 5								
	AIS.2	Utilize maps identifying critical habitat to target areas for protection and restoration.	$5,000	Implement	Support & Implement		*HCISN, HHISN,* TOMWC	PF, SG, PO, FG	2.2, 2.6	
		Notes: Update maps as necessary								
	AIS.3	**Evaluate effectiveness of past AIS marketing campaigns and test new campaign based on results.**	$100,000	Evaluate			*TOMWC,* CCD, HCISN, HHISN, LA, LTC	PF, SG, FG		6.1
		Notes: Use digital and traditional advertising; secure funding								
	AIS.4	**Monitor the Watershed and implement Early Detection and Rapid Response (EDRR) for aquatic species that pose an imminent threat.**	$20,000		Ongoing		*TOMWC,* CCD, HCISN, HHISN	PF, SG, FG, PO	1.5	
		Notes: E.g.-giant hogweed, European frogbit, and flowering rush. Overlap with ISN lists.								
	AIS.5	Report introductions and spread of invasive species to MISIN (Midwest Invasive Species Network) website.	$20,000	Report	Report	Report	*TOMWC,* CCD, HCISN, HHISN	PF, SG, FG, LG, PO	2.2	
		Notes: Report introductions annually beginning year 1								
	AIS.6	Install permanent or access mobile boat cleaning stations for use at public boat launches.	$100,000	Location, Funding, Strategy	Install or Purchase		*TOMWC,* CCD, HCISN, HHISN, LA, local governments	PF, SG, FG, LG, PO	2.2	
		Notes: Identify locations, secure funding, and develop user and operator strategy								
	AIS.7	**Monitor and manage aquatic and riparian invasive species throughout the Watershed with biological control agent.**	$25,000		Ongoing		TOMWC, CCD, HCISN, HHISN, LA, LTC	PF, LG, PO	1.5	
		Notes: Determine if the best treatment.								
Medium	AIS.8	**Continue integrating aquatic invasive species training into Volunteer Stream and Lake Monitoring programs.**	$10,000		Ongoing		*TOMWC*	PF, SG, FG, LG, PO	1.5	7.4
		Notes: Develop program and begin implementation by year 5; Continue program through year 10.								
	AIS.9	**Provide property owners with assistance and resources with invasive species management through site assessments, distribution of resources, and other outreach.**	$50,000		Ongoing		*TOMWC,* CCD, HCISN, HHISN, LA, LTC	PF, SG, FG, PO, CS		6.1, 7.1, 7.2
		Notes: Perform 50 site assessments and publish 10 widely-distributed AIS articles via newsletters or other media								
	AIS.10	Recruit and coordinate multiple lake association-based volunteer teams to operate boat cleaning stations	$30,000	Develop	Operate		*TOMWC,* LA	PF, PO		7.1, 7.4

		Notes: Develop and promote program, recruit volunteers, trainings and coordination								
	AIS.11	Develop volunteer-based aquatic invasive species monitoring program	$15,000		Implement		*TOMWC*	PF, SG, FG, LG, PO	1.5	7.4
		Notes: Develop program and begin implementation by year 5; Continue program through year 10								
	AIS.12	Conduct sterile male release technique (SMRT) and/or modifying the Cheboygan lock system, to treat existing and potential populations of sea lamprey.	$300,000		SMRT and Research		*USGS*, USFWS	SG, FG	2.2	
		Notes: Continue research to determine most effective lamprey control measures for the Inland Waterway								
	AIS.13	Conduct lampricide treatment in Pigeon River, Meyers and Laperell on as needed basis.	$250,000		Treatment		*USFWS*, USGS	SG, FG	2.2	
		Notes: Lampricide is still a necessary treatment								
	AIS.14	**Conduct annual population estimates of sea lamprey at the Cheboygan dam**	$30,000		Survey		*USFWS*, USGS	SG, FG	2.2	
		Notes: Annual population estimates are critical for sea lamprey research.								
Low	AIS.15	Conduct volunteer-based boater education program through Clean Boats, Clean Waters program.	$15,000		Recruit and Train		*MSUE*, TOMWC, LA	SG, FG, LG, PO		7.1, 7.4
		Notes: Recruit volunteers, host training; Conduct boater outreach.								
	AIS.16	Install signage at water access locations that highlight Clean Boats, Clean Waters program and message.	$3,000	Locations and Funding	Install		*TOMWC*, CCD, HCISN, HHISN, LA	PF, SG, PO, LB		6.1
		Notes: Identify locations on lakes and rivers; target boaters, paddlers, anglers.								
	AIS.17	**Monitor forestry invasive species that could impact riparian areas and water quality**	$100,000		Ongoing		*HCISN, HHISN*, TOMWC, CCD, LTC	SG, FG, PO	2.2	
		Notes: Examples of current threats are Hemlock Woolly Adelgid and Asian Longhorned Beetle.								

Priority		Septic Systems	Est. Total Cost	Milestone 2024-2025	Milestone 2026-2028	Milestone 2029-2033	Potential Project Partners	Potential Funding Sources	Objectives Addressed	Information & Education Objectives Addressed
High	SS.1	Conduct an study on Mullett Lake to determine possible sources of septic failure.	$80,000		Monitor		*TOMWC*, LA	PF, SG, PO	1.2	7.2
		Notes: Results will help identify areas of concern to target for future education outreach								
	SS.2	Conduct a study on smaller lakes to determine possible sources of septic failure.	$40,000			Monitor	*TOWMC*, LA	PF, SG, PO		
		Notes: Results will help identify areas of concern to target for future education outreach								

	SS.3	**Conduct real estate agent workshop and develop outreach materials for real estate agents to encourage septic system review and maintenance.**	$30,000	Funding and Develop	Implement		*TOMWC*, LA	PF, SG, PO		6.2
		Notes: This approach could be applied to other watersheds								
	SS.4	Develop septic system outreach campaign for homeowners, including incentives.	$75,000	Funding and Develop	Implement		*TOMWC*, local governments	PF, SG, FG, LG, PO, CS, LB		6.1
		Notes: Incentives might be free inspections/pumping, discounts, etc.								
Medium	SS.5	Incentivize community pumping and/or inspections	$10,000	Develop incentives	Funding & Implement		*TOMWC*, LA, local governments	PF, PO, LB		6.1, 7.3
		Notes: Could be done through a cost share program or group rates.								
Medium	SS.6	Replace individual septic systems in communities where systems are ineffective or insufficient (for given demand) with community sewer systems.	$300,000		Identify and Fundraise	Convert	*local governments*, TOMWC, LA	SG, FG, LG, CS, LB	1.2	7.3
		Notes: Identify priority community to convert to sewer system, fundraise; Approximately 30 households converted to sewer system.								
Low	SS.7	Determine the economic cost of water pollution due to septic failure	$25,000		Funding and develop		*TOMWC*	PF, PO		7.2
		Notes: contract with a college or university								
Low	SS.8	Digitize septic system records	$10,000		Digitize		TOMWC, DHD4	PF, LG, SG, PO	1.2	
		Notes: In conjunction with a septic study.								
Priority		**Emerging Threats, and Watershed Education**	**Est. Total Cost**	**Milestone 2024-2025**	**Milestone 2026-2028**	**Milestone 2029-2033**	**Potential Project Partners**	**Potential Funding Sources**	**Objectives Addressed**	**Information & Education Objectives Addressed**
High	EW.1	**Advocate for short-term measures that will minimize risks of an oil leak from the Line 5 pipeline. Using information from the state Pipeline Advisory Board, educate partners and local citizens regarding potential long-term solutions, including decommissioning.**	$100,000		Ongoing		*TOMWC*, local governments	PF, PO	2.7, 3.5, 5.1	6.1, 7.1
		Notes: Conduct presentations, workshops, publish articles, press releases, and utilize social media to provide current and accurate information.								
High	EW.2	Mitigate climate change impacts, including more severe coastal storms in our area, by protecting and restoring vulnerable areas and implementing best management practices throughout the Watershed.	$100,000	Develop Strategy	Implement		*TOMWC*, HP, local governments	PF, SG, FG, LG, PO	1.1,1.7, 2.1, 2.4, 4.2, 5.2	

		Notes: Convene working group to identify and prioritize vulnerable areas; develop strategies given climate predictions, disseminate strategies via climate change campaign.								
	EW.3	**Conduct watershed outreach with local schools.**	$30,000		Ongoing		*TOMWC*, HP	PF, SG, FG, PO		6.1, 7.2, 7.6
		Notes: keep current schools with the program and add additional schools. Current programs include Watershed Academy and Water Resources Education Programs								
	EW.4	Host community clean-ups to reduce trash in waterways	$6,000		Ongoing		TOMWC, HP, local governments	PF		
		Notes:								
Medium	EW.5	**Continue to participate in MPART**	$10,000		Ongoing		*EGLE*, TOMWC, local governments	PF, SG, FG, LG	3.4	7.1
		Notes: Stay current on threat of PFAs and provide outreach as necessary								
	EW.6	Conduct environmental outreach at local events	$1,000		Ongoing		TOMWC, EGLE, LA			7.6
		Notes: Earth Week Plus held in Cheboygan, etc.								
	EW.7	Build environmental curriculum that aligns with the Next Generation Science Standards	$35,000			Develop and Implement	TOMWC	PF, SG, FG		7.6
		Notes: Utilize current resources or other partnerships								
Low	EW.8	Monitor microplastics concentrations as new technology becomes available.	$100,000		Monitor		*TOMWC*, EGLE, local governments	PF, SG, FG, LG, PO	1.6, 5.4	
		Notes: Support new research and implement both pilot and permanent technologies where applicable to reduce future microplastics inputs.								
	EW.9	**Develop outreach materials and presentations on the effects of plastic in our waters.**	$20,000	Funding and Publication			*TOMWC*, local governments	PF, SG, FG		6.1, 7.2, 7.6
		Notes: Social media campaign and presentation slides. Seek funding.								

CHAPTER 9. MONITORING STRATEGY

Implementation tasks and actions include many different types of monitoring activities. Monitoring is essential in order to evaluate effectiveness of the collective watershed efforts or individual actions. The following narrative details many of the Recommended Implementation Tasks, however, these monitoring activities are proposed and will only occur if there is funding available.

9.1 Surface Water Quality Monitoring

Surface water quality monitoring will be used to evaluate the overall effectiveness of the nonpoint source watershed management plan and assess changes resulting from specific implementation activities. Water quality data collected by TOMWC, EGLE, USGS, academic institutions, and other sources will be used to assess changes over time in the Watershed where data is available.

TOMWC's Volunteer Lake Monitoring (VLM) program collects baseline data (water transparency, chlorophyll a, temperature) to characterize lake ecosystems, identify specific water quality problems, determine water quality trends, and, most importantly, inform and educate the public regarding water quality issues and aquatic ecology. Mullett Lake, Long Lake and Twin Lakes are monitored as a part of VLM program. During a two-week window in the spring and in the fall, Volunteer Stream Monitoring (VSM) teams collect water temperature, document relative stream conditions, and collect a representative sample of macroinvertebrates. Mullett Creek, Kimberly Creek, and the Pigeon River are monitored annually through the VSM program.

TOMWC's Comprehensive Water Quality Monitoring (CWQM) program collects data for nine parameters (temperature, dissolved oxygen, pH, conductivity, clarity, total phosphorous, total nitrogen, nitrate-nitrogen, and chloride) on 55 lakes and streams on a triennial basis. The data for lakes and rivers in Northern Michigan have been compiled into a single database that can be used by staff to evaluate aquatic ecosystem health, examine trends within or among water bodies, and identify specific problems. Mullett Lake, Long Lake, Twin Lakes, Little Sturgeon River, Cheboygan River, Indian River, and Pigeon River are all monitored as a part of this program.

Physical and chemical parameters to be monitored include, but are not limited to:

- Dissolved oxygen
- pH
- Temperature
- Water clarity
- Turbidity
- Light
- Copper
- Lead
- Cadmium

- Conductivity
- Chemical oxygen demand
- Biological oxygen demand
- Suspended solids
- Dissolved solids
- Carbon
- Phosphorus
- Nitrogen
- Chloride
- Zinc
- Nickel
- Mercury
- Arsenic

Biological monitoring of bacteria, algae, aquatic macrophytes, aquatic macroinvertebrates, fish, and other aquatic organisms will supplement physicochemical data. Discharge will be measured at sites on any lotic systems that are monitored. Additional physical, chemical, or biological parameters will be included in monitoring efforts in response to emerging water quality threats that may include, but is not limited to, the following:

- Pharmaceuticals
- PAH's
- PFAS
- Microplastics

Monitoring water quality does not ensure clean water, but rather provides valuable information to help protect and improve water quality.

Evaluating the effectiveness of improving and maintaining water quality throughout the Watershed will be assessed through the results of monitoring efforts relative to established criteria. In order to accurately assess the state of waters within the Watershed it is necessary to maintain and implement efficient water quality monitoring programs and coordinate efforts. Table 43 outlines current ongoing monitoring efforts in the watershed.

Table 43. Monitoring activities

Ongoing Monitoring				
Organization	**Program**	**Type of Analysis**	**Frequency**	**Water Body**
Tip of the Mitt Watershed Council	Comprehensive Water Quality Monitoring**	Dissolved oxygen, nitrogen, phosphorus, specific conductance, chloride	Triennial: Spring	Cheboygan River, Indian River, Little Sturgeon

				River, Twin Lakes, Long Lake, Mullett Lake, Pigeon River
	Volunteer Lake Monitoring (MiCorp)*	Water clarity, chlorophyll a	Annual	Mullett Lake, Long Lake, Twin Lake
	Volunteer Stream Monitoring (MiCorp)*	Benthic macroinvertebrate community	Biannual: Spring and Fall	Pigeon River, Mullett Creek
Michigan Environment, Great Lakes, and Energy	Biological Sampling and Habitat Assessment	Habitat Assessment, Benthic macroinvertebrate survey	5-year rotation	Pigeon River, Mullett Creek
	Fish Contaminant Monitoring program	Mercury, PCBs, DDT, and others	Annual	Mullett Lake, Twin Lakes
District Health Department #4	Beach Guard	E. coli	Annual: June-August	Mullett Lake
Additional Monitoring needed as Identified in the Implementation Tasks				
To be determined	Not applicable	Baseline WQ data (physical and chemical parameters)	To be determined	Water bodies not currently monitored
		Monitor public beaches		public beaches
		Monitor for septic failure		Mullett Lake, Twin Lakes, Long Lake
		Major and minor tributaries flowing into Mullett Lake		Watershed
		Emerging water quality threats		
		Update Inventories (streambank, stormwater, shoreline, forestry, agriculture)		
		Monitor stormwater outfalls in Cheboygan		

		Conduct habitat monitoring		
		Groundwater monitoring (nutrients)		
		Monitor invasive species		
		PFAs/PFOAs		
		Microplastics		

Program has a quality assurance project plan housed on TOMWC's servers and are available at request/Program has standard operating procedures/*

These monitoring efforts will be reviewed on an annual basis through the Watershed Advisory Committee. One meeting a year will be dedicated to presenting the results of regular water quality monitoring by these groups, or others that is either ongoing or targeted. Any results that are showing degradation or improvements, will be discussed in the 5-year review of this plan and may require the addition of new implementation tasks or monitoring efforts. In the event of water quality degradations, it will be important to engage targeted monitoring efforts to collect data using approved methods that can be compared to state standards.

9.2 Shoreline and Streambank Surveys

Shoreline protection will be achieved by surveying the shorelines of Mullet Lake, Long Lake, and Twin Lakes every five to ten years. These surveys will be conducted by boat and drone (where appropriate). Parameters to be surveyed include indicators of nutrient pollution, erosion, greenbelt health, and shoreline alterations. Streambank surveys will be conducted every five to ten years on the Pigeon River, Indian River, Lower Black and Cheboygan Rivers. Smaller streams, such as Mullett Creek, will be inventoried every ten years, where stream reaches are navigable. The results of surveys will be used to conduct follow-up activities directed toward riparian property owners, which will identify specific problems and encourage corrective actions. Survey results will also be used for trend analyses to determine if riparian areas are improving or deteriorating over time.

Shoreline protection will also be assessed by monitoring the interest in the Michigan Shoreland Stewards program. Monitoring will consist of reviewing statistics of the lake's riparians who take the survey on the Michigan Shoreland Stewards website.

9.3 Stormwater Management

Pollutants associated with cars and roads, including metals, chlorides, and Polycyclic Aromatic Hydrocarbons (PAHs), are also commonly found in urban stormwater and warrant monitoring. The EPA lists metals and salts as pollutants associated with urban runoff that "can harm fish and wildlife populations, kill native vegetation, foul drinking water, and make recreational areas unsafe and unpleasant." PAHs are not water-soluble and persist in the environment for long periods, although they can breakdown from UV light exposure.

A survey of significant stormwater outfalls, generally concentrated in town and villages, is needed to assess the impacts of stormwater runoff on lakes and streams. Cataloging the location of these areas and sampling water quality at the outfall will provide baseline information on the magnitude and character of stormwater issues. Sampling outfalls in the direct aftermath of storm events will provide critical information about the effectiveness of stormwater infrastructure.

Implementation of green stormwater infrastructure (GSI), projects is an important aspect of stormwater management. As more GSI projects are implemented, public interest, awareness, and familiarity with GSI practices will increase. Tracking the number of implemented projects through Information/Education (I/E) efforts, as well as public interest and awareness, will be ongoing.

9.4 Land Use

Land use change and landscape alterations caused by humans will be monitored because of the strong potential to influence nonpoint source pollution. Although primarily done using remotely sensed data in a GIS, field surveys may also be required. Landcover data will be used to assess changes in land use every 10 years. Increases or decreases in landcover associated with development (e.g., agricultural or urban) will be examined in context of changes in water quality and aquatic ecosystem health.

Implementation of both forestry and agriculture BMPs will be monitored through increased enrollment in stewardship-based programs, such as MAEAP and the State of Michigan's Forest Stewardship Program with a focus on enrollment in critical areas.

9.5 Road/Stream Crossing Inventories

Road-stream crossings throughout the Watershed will be re-surveyed, following the same protocols, approximately every 10 years to document current conditions, update prioritization, and to evaluate improvements or BMP installations. Priority will be placed on monitoring known problem sites and areas of high or fluctuating streamflow. Data will be uploaded to www.northernmichiganstreams.org or the Great Lakes Road Stream Crossing Inventory. As is the practice with road/stream crossings, most are not given attention until they fail and create problems. Therefore, monitoring should also include discussion with resource managers and other partners to ascertain whether any road/stream crossings need more immediate attention. The identified top 10 sites will be of priority consideration for structural improvements, but all severe sites must remain in strong consideration.

9.6 Land Protection and Management

The priority parcel process is a tool that reduces nonpoint source pollution impacts to water resources by identifying parcels that are high priority for permanent protection based on ecological value and other criteria. These criteria, listed below, are the most important to consider for long-term water quality protection.

- Parcel Size
- Groundwater Recharge Potential
- Wetland Preservation
- Lake Shoreline/Riparian Protection
- River and Stream Shoreline/Riparian Protection
- Steep Slopes for Erosion Prevention
- Proximity to Protected Lands
- Threatened/Endangered Species
- Proximity to Development
- Natural Landcover Types
- Drinking Water Protection Areas
- Exceptional Resources
- Public Visibility

This prioritization process will be carried out approximately every five years to monitor land protection efforts. Parcels will be reevaluated and assigned updated rankings. Progress in land protection will be evaluated by determining change over time in the number of parcels and the total land area in the Watershed considered to be protected from development. Updated prioritization information will be shared with land conservancies that are active in the Watershed to assist with land protection efforts.

9.7 Ecosystem Health

Habitat diversity is important for maintaining healthy, vibrant aquatic ecosystems, particularly in small streams and the littoral zone of lakes. Nonpoint source pollution can reduce the variety of available habitat in an aquatic ecosystem through excessive sedimentation and cultural eutrophication. Therefore, monitoring habitat conditions throughout the Watershed is an important component for evaluating the effectiveness of nonpoint source pollution management plans.

Habitat mapping on priority streams known to have robust native fish population will establish baseline data. Follow-up mapping will occur approximately ten years afterward. Field surveys will be conducted with a particular emphasis on large woody debris, riffle, pool, run, gravel, cobble, and other important aquatic habitat features.

Ecosystem health will also be monitored by gauging the interest in small dam removal. Stakeholders will identify and work will property owners with small dams in order to ultimately remove dams that are affecting ecosystem health.

9.8 Recreation, Safety, and Human Health

Monitoring of recreation, human health and safety can be achieved by monitoring health alerts issued by the local health agencies. As well as public concerns and inquiries that are received by agencies. Other threats include avian botulism and swimmer's itch.

E. coli, mercury, TCE, and other factors with harmful effects on humans will require additional sampling and it is recommended that further surveys be conducted to assess their impact on the watershed and humans. Although the most significant source of these contaminants in the Watershed is air deposition (which is outside the scope of Watershed Management efforts), monitoring of mercury and PCB's levels in local fish should be a priority for EGLE. Priority will be placed on ensuring the safe recreational use and consumption of water and fish throughout the Watershed, addressing unsafe areas and protecting threatened areas.

9.9 Hydrology and Groundwater

Groundwater is susceptible to contamination by nonpoint source pollution. In addition, landscape development and groundwater withdrawals (e.g., agricultural irrigation and drinking water) have the potential to reduce the amount of available groundwater. Therefore, groundwater monitoring is needed to assess the effectiveness of the nonpoint source management plan.

The first step is to compile all existing groundwater information, identify problems, determine data gaps, and develop a strategy for feasible, effective, and long-term groundwater monitoring. This assessment of existing information and development of a monitoring plan should be completed in 10 years.

High groundwater recharge areas are determined by the presence of permeable soils that allow for relatively rapid recharge of groundwater stores. The same permeability that lends itself to high groundwater recharge rates can also result in nonpoint source pollution passing relatively quickly through the soils and contaminating groundwater stores. It is unlikely that these areas will change significantly moving forward and it is important to collaborate with zoning officials to ensure minimal expansion of impervious surfaces into valuable groundwater recharge areas. Furthermore, increased impervious surface area as a result of landscape development leads to relatively greater decreases in groundwater recharge in areas with highly permeable soils (versus areas with lower soil permeability).

One approach for protecting high groundwater recharge areas is to limit impervious surface coverage. This can be accomplished through various means, such as implementing ordinances that limit the amount of impervious surface area on a parcel or limiting build-out potential through permanent land conservation. Efforts focused on protecting high groundwater recharge areas will be evaluated every ten years by determining changes (net gain or loss) in the extent of permanently protected lands in areas with high groundwater recharge rates.

It is also important to encourage proper maintenance, monitoring, and removal of underground fuel storage tanks, which will be an ongoing process.

9.10 Wetlands

Wetland restoration and protection efforts will be monitored by performing land cover change analyses in a GIS. A watershed-level analysis should be performed every 10 years using remote sensing data to determine increases or decreases in wetland acreage throughout the Watershed (WL.2)

High-value wetlands will be identified and mapped out by assessing wetlands throughout the watershed in terms of ecological and environmental values (e.g., habitat value, water quality benefits, and flood control contributions). Following identification and mapping, the areas containing high value wetlands will be calculated every 10 years to determine any net change. Wetlands are also incorporated into the watershed protection priority parcel analysis in an earlier chapter.

9.11 Aquatic Invasive Species

Many invasive species have become well established within the Watershed, including invasive *Phragmites*, purple loosestrife, Eurasian watermilfoil, zebra and quagga mussels. Although eradication of these species is not feasible, efforts to control their spread within and out of the Watershed is a priority.

Using databases maintained by TOMWC and Michigan Invasive Species Information Network (MISIN), both the *introduction* of additional aquatic invasive species and the *spread* of documented aquatic invasive species within the Watershed will be tracked.

Biological control, where applicable, will be used to control purple loosestrife and Eurasian watermilfoil. Outreach and education, volunteer programs, technical and financial assistance to property owners, and innovative communication and control measures (e.g. mobile boat washing station) will collectively reduce the spread and thwart the introduction of aquatic invasive species.

Education and outreach campaigns will help increase awareness of new and emerging species of concern to help aid in early detection.

9.12 Septic Systems

Continue to explore options for septic system regulations, including a statewide septic code. Develop septic system outreach campaign, including incentives such as a septic giveaway, free septic evaluations. Most local jurisdictions in the watershed who do not have municipal sewer systems will adopt septic ordinances by year 10, as a means to protect water quality.

Enteric bacteria studies on waters can help identify potential sources of septic failure. Results will help target outreach efforts.

9.13 Emerging Threats and Watershed Education

Line 5 Pipeline

Conduct education and outreach to local government officials, lake associations, and other community groups and members about Line 5.

Climate Change

Develop and conduct Information and Education programs to continue to bring awareness among all Watershed residents and stakeholders. Programs will highlight importance of supporting state and federal climate change adaptation initiatives, including the Great Lakes Restoration Initiative and other grant programs that can support local watershed management efforts.

PFAS

Emerging contaminants such as PFAS will be monitored through updates from EGLE and partner agencies. There are currently no PFAS areas of concern in the Watershed.

Microplastic

Develop and conduct Information and Education programs to continue to bring awareness of microplastic among all Watershed residents and stakeholders. As minimal data is currently available, microplastic pollution will be monitored through partner sharing and new research.

Education

Continue to engage with local schools in the watershed, and expand education programming to different age groups and schools.

9.14 Socio-economic Monitoring

Many projects carried out as a result of the watershed management plan will have social and economic impacts. For example, nonpoint source pollution education of watershed residents may affect behavior and result in a reduction of nonpoint source pollution, or nonpoint source pollution reductions in surface waters may increase local tourism revenues and boost the economy. Therefore, monitoring activities should also include social and economic elements.

There are many methods for monitoring social and economic changes as a result of the management plan. Some of the primary tools for conducting this type of monitoring include surveys and demographic/economic change analyses. To establish relationships between socio-economic factors and nonpoint source pollution, data from other monitoring activities (e.g. surface water quality monitoring) will be incorporated into this monitoring effort.

CHAPTER 10. EVALUATION STRATEGY

To ensure that the recommended actions are meeting the goals of the Watershed Plan, an evaluation will be required to determine the progress and effectiveness of the proposed activities. Evaluation is an important part of any watershed planning effort in that it provides feedback on the success of an activity or the project's goals. It also provides communities with important information about how to conduct future efforts, or how to change the approach to a specific problem in order to be more successful the next time. If activities are successful, this will gain more support for future activities amongst decision makers.

10.1 Evaluation Strategy for Plan Implementation

TOMWC will act as the lead organization and will oversee both the coordination of the Advisory Committee and the evaluation strategy for Plan implementation. The evaluation strategy will be used to determine progress in completing the recommended actions and tasks identified in the Plan.

After five years, the Advisory Committee will take stock of the progress that had been made on the actions recommended in the Plan; identify the highest priorities for action today, given developments over the past five years; and to get input from partners on how to improve implementation of the Plan. A series of questions will be used to elicit responses from committee members that will gauge their sense of the effectiveness of the Plan, its strengths and weaknesses, areas in need of change, its usefulness, etc. Responses will be compiled into a report of key findings and suggestions. This will help identify changes in staff and funding sources as well as include emerging issues, and the overall status of projects. Updates will include a summary of water quality improvements related to implemented BMPs where applicable. The report will be presented to the watershed advisory committee and the community. The desired outcome is to meet the goals and objectives of this watershed management plan, by achieving water quality that meets the water quality standards in order to support designated and desired uses.

After ten years, the Watershed Advisory Committee will seek funding to update the plan. The resource inventories will be repeated as necessary and included in the update. Any implementation tasks not completed after the first ten years of Plan implementation will be assessed as to their relevance in the Plan update. New implementation tasks will also be developed based on current conditions of the Watershed and the priorities of the Watershed Advisory Committee.

10.2 Criteria to determine effectiveness of water quality protection efforts

The evaluation strategy for the overall Management Plan in protecting water quality is based on comparing criteria with monitoring results. The Monitoring Strategy in the previous chapter provides the framework in which to collect the appropriate data. A set of criteria (**bold**) were developed based on current data averages (where applicable) (*italicized*) to determine if the proposed pollutant reductions in the Watershed are being achieved and that water quality is being maintained or improved. The water quality criteria for parameters that reflect nutrient and sediment pollution are as follows:

Total phosphorus concentrations in nutrient-poor lakes remain below an average of 9 μg/L.

Total phosphorus concentrations average less than 7 μg/L in Long Lake, and less than 9 μg/L in Twin Lakes.

Total phosphorus concentrations in Mullett Lake remains below an average of 8 μg/L.

Total phosphorus concentrations average less 7.6 μg/L in Mullett Lake.

Total phosphorus concentrations in tributaries remain below an average of 15 μg/L.

For the Watershed, most tributaries have total phosphorus concentrations below 15 μg/L.

Total phosphorus concentrations in the Pigeon River, Indian River, and Cheboygan Rivers remain below and average of 10 μg/L.

Total phosphorus concentrations in the rivers averages less than 8 μg/L.

Total nitrogen concentration in lakes and rivers should remain below 400 μg/L.

Nitrogen concentrations in surface waters are also not regulated by the State of Michigan or the EPA. All lakes and rivers within the Watershed have historical averages of total nitrogen concentrations below 400 μg/L which are in exceedance of this standard.

Total nitrogen concentration in streams should remain below 400 μg/L.

Streams within the Watershed have historical averages of total nitrogen concentrations below 400 μg/L.

Maintain dissolved oxygen levels of 7 ppm or higher in Mullett Lake, Pigeon River, Lower Black and Cheboygan Rivers and the Watershed's coldwater streams.

Dissolved oxygen concentrations in Mullett, Long, Twin Lakes and streams are typically above the 7 ppm standard that is required by the State of Michigan for water bodies that support coldwater fisheries.

Reduce nutrient inputs from stormwater in urban areas.

Depending on numerous factors, such as drainage area, land-cover type, and period between rain events, nutrient loads in stormwater can vary widely. More data is needed to generate a comprehensive baseline data set and accurately assess stormwater impacts. Once baseline data are available, implementation projects that aim to reduce nutrient loads from stormwater in urban areas can be assessed through future stormwater monitoring. It is important to note that implementing stormwater management projects prior to baseline data collection will still achieve pollutant reductions; however, site-specific data will result in more targeted efforts.

Maintain or reduce sediment loads in tributaries and stormwater.

Similar to nutrient inputs in stormwater, additional sediment data is needed to generate a comprehensive baseline data set for stormwater impacts. Once baseline data are generated, comparisons can be made to determine changes in time as related to implementation projects.

Maintain pH levels within range of 6.5 to 9.0 in Mullett Lake, Lower Black and Cheboygan Rivers, and their tributaries as required by the State of Michigan.

Data from TOMWC's Comprehensive Water Quality Monitoring (CWQM) program show that pH levels consistently fall within this range.

Maintain or reduce the level of conductivity in Mullett Lake, Lower Black and Cheboygan Rivers, and their tributaries.

Conductivity levels have been monitored as part of TOMWC's CWQM program and typically ranged from 200 to 300 µS/cm. Groundwater can range from 300 to 500 µS/cm depending on sub-surface conditions. Therefore, conductivity levels in surface waters should consistently be less than 500 µS/cm.

Maintain low water temperatures in water bodies designated for or capable of sustaining coldwater fisheries.

Within these water bodies, maintain low water temperatures to sustain the coldwater fishery. Water temperatures should generally not exceed 20° Celsius throughout summer months.

Prevent beach closings due to bacteriological contamination.

Prevent beach closings throughout the Watershed as a result of E. coli levels that exceed the State of Michigan water quality standard for single day (>300 E. coli per 100 ml of water). Prevent extended beach closings that result from a 30-day geometric mean *measurement that exceeds State standards (>130 E. coli per 100 ml of water in 5 samples over 30 days). This can be evaluated by tracking health alerts issued by the local health agencies. Oftentimes, health alerts are issued when water-related recreation, such as swimming, is prohibited due to a detected pathogen or other health threat.*

Maintain or improve aquatic macroinvertebrate community diversity throughout the watershed.

Aquatic macroinvertebrate diversity in a stream varies depending on many variables, including stream size, stream flow, habitat diversity, water temperature, riparian vegetation, land use, and more. Therefore, aquatic macroinvertebrate diversity at a given location on a stream must be viewed through a lens that accounts for such variables and is best compared with similar stream sites to accurately gauge stream ecosystem health. Reliable baseline data requires monitoring a site for a minimum of three years, after which the site can be compared to others, using diversity indices to determine if the site and stream are normal and healthy. Thereafter, future monitoring can be conducted to assess the benefits of implementation projects to stream ecosystem health.

Reduce *Cladophora* algae growth that is caused by nutrient pollution on Mullett Lake, Long Lake and Twin Lakes where it has been documented.

Cladophora algae occurs naturally in small amounts along the shorelines of Northern Michigan lakes, but grows more extensively and densely as nutrient availability increases. Shoreline surveys conducted on Mullett Lake, Long Lake and Twin Lakes documented the occurrence of Cladophora on the shoreline, as well as the density of growth. Results from these surveys illustrate that Cladophora is present and dense, especially along certain shoreline segments. Thus, the same information generated during future surveys can be used to determine if there were reductions in the number of properties with Cladophora growth or the number with heavy-density growth because of implementation projects.

Maintain low chloride concentrations in surface waters

Data from TOMWC's CWQM program show that chloride concentrations have increased significantly over the last 20 years in most lakes and streams monitored in Northern Michigan. Chloride levels in the Watershed's surface waters average ~12 ppm, with most pristine water bodies reading below 8 ppm. Chloride is monitored because it is a good indicator of human activity in a watershed, i.e., as human population increases and urban and agricultural land use increases, so do chloride levels. In addition, monitoring chloride is valuable because it indicates that more damaging pollutants associated with chloride, such as leaking fluids and metals from automobiles that accumulate on roads along with *deicing salts, are washing into and negatively impacting adjacent surface waters. Although most aquatic life is not affected until chloride reaches very high concentrations (>1000 ppm), some sensitive organisms may be lost at lower levels. Chloride concentrations in the Watershed's surface waters should not surpass 50 ppm and remedial actions should be taken if levels reach 100 ppm.*

Qualitative Criteria

In addition to applying the abovementioned criteria, more qualitative evaluation methods will be used. Field assessments of best management practices (BMPs), such as green infrastructure or streambank or shoreline bioengineering projects, will determine effectiveness by taking photographs, gathering physical, chemical, and/or biological data. Projects will also be documented with photographs to evaluate their effectiveness or need for improvement or modification. For example, shoreline and streambank restoration projects will be photographed before any restoration begins, during project installation, and after project completion. Other project types that may also warrant photographic documentation include road/stream crossings, stormwater and agricultural BMPs, recreational access sites, etc.

Improve Local Knowledge

The most valuable assets in protecting the Watershed are the residents and tourists who live, work and play within its boundaries. In order to achieve commitment to the large-scale vision laid out within this Plan there will need to be a concerted effort to organize, communicate, and educate community members around the shared vision of protecting water resources. Various delivery methods could be employed such as print/social media, paid advertising, and community events/meetings. Tools for implementation and evaluation of this progress are described in Table 44.

Table 44. Implementation and evaluation tools

Audience	Associated Structural / Action Based Threats	Messages	Potential Evaluation
Households	All		
Riparian property owners	Lake shoreline development/use Impervious surface and stormwater runoff	Eliminate the use of fertilizers and pesticides in landscaping Properly dispose of medications	Social Indicators Survey; minimum response rate of 40% with measurable improvements in

	Invasive species Failing septic systems Riverbank development/use Climate change Recreational activity	Properly maintain septic systems Use BMPs to reduce erosion and manage stormwater Reduce carbon footprint Avoid single use plastics Clean, drain, and dry watercrafts, trailers and other boating equipment before entering another waterbody	knowledge as compared to 2017-2019 surveys. Messages delivered through a minimum of 3 different mechanisms.
Business owners	Lake shoreline development/use Impervious surface and stormwater runoff Invasive species Riverbank development/use Climate change Recreational activity	Eliminate the use of fertilizers and pesticides in landscaping Use BMPs to reduce erosion and manage stormwater Reduce carbon footprint Avoid single use plastics Clean, drain, and dry watercrafts, trailers and other boating equipment before entering another waterbody	Social Indicators Survey; minimum response rate of 20%. Messages delivered through a minimum of 3 different mechanisms.
Contractors, realtors, developers	Lake shoreline development/use Impervious surface and stormwater runoff Failing septic systems Riverbank development/use	Use BMPs to reduce erosion and manage stormwater Offer alternatives to shoreline hardening Properly maintain septic systems	Social Indicators Survey; minimum response rate of 20%. Messages delivered through a minimum of 3 different mechanisms.
Agriculture industry	Agricultural runoff Climate change	Eliminate the use of fertilizers and pesticides Effectively treat animal waste Reduce carbon emissions	Social Indicators Survey; minimum response rate of 15%. Messages delivered

			through a minimum of 3 different mechanisms.
Tourists	Recreational activity Climate change	Stay on designated trails Use designated restroom facilities Clean, drain, and dry watercrafts, trailers and other boating equipment before entering another waterbody Reduce carbon footprint Avoid single use plastics	Seasonal Surveys; minimum response rate of 15%. Messages delivered through a minimum of 3 different mechanisms.
Boaters	Invasive species Recreational activity	Use designated restroom facilities Clean, drain, and dry watercrafts, trailers and other boating equipment before entering another waterbody Avoid single use plastics Respect designated no wake areas & Michigan boating laws	Seasonal Surveys; minimum response rate of 25%. Messages delivered through a minimum of 3 different mechanisms.
Anglers	Invasive species Recreational activity	Use designated restroom facilities Clean, drain, and dry watercrafts, trailers and other boating equipment before entering another waterbody Avoid single use plastics Respect designated no wake areas Properly dispose of bait	Seasonal Surveys; minimum response rate of 15%. Messages delivered through a minimum of 3 different mechanisms.

Quiet water Recreation enthusiasts	Invasive species Recreational activity	Clean, drain, and dry watercrafts, trailers and other boating equipment before entering another waterbody	Seasonal Surveys; minimum response rate of 15%. Messages delivered through a minimum of 3 different mechanisms.
Local government officials	All	Enforce current laws Strengthen local greenbelt and septic ordinances Incentivize homeowners who apply BMPs Reduce climate emissions Use BMPs to reduce stormwater runoff	Social Indicators Survey; minimum response rate of 40% with measurable improvements in knowledge as compared to 2017-2019 surveys. Messages delivered through a minimum of 3 different mechanisms.

10.3 SUMMARY

The evaluation strategy presented here provides a framework for assessing the effectiveness of implementation and monitoring efforts through the watershed. As further issues and information emerge, additional tasks and monitoring efforts will certainly be added to those laid out within this Chapter and those previous. Improving monitoring standards and establishing new programs where necessary will help develop robust datasets to inform management actions and educate local citizens, officials, and tourists on their role in watershed health.

Regular meetings of the advisory committee to address current and emerging issues within the Watershed and assess the ongoing effectiveness of this management plan will be critical in extending the lifespan of its usefulness. The tools presented here and throughout the previous chapters are intended to provide baseline data, decision-making tools, and goals to protect the resources in the Watershed for many years to come.

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