ARCADIA-PIERPORT WATERSHED PLAN

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CHAPTER ONE:

THE ARCADIA-PIERPORT WATERSHED

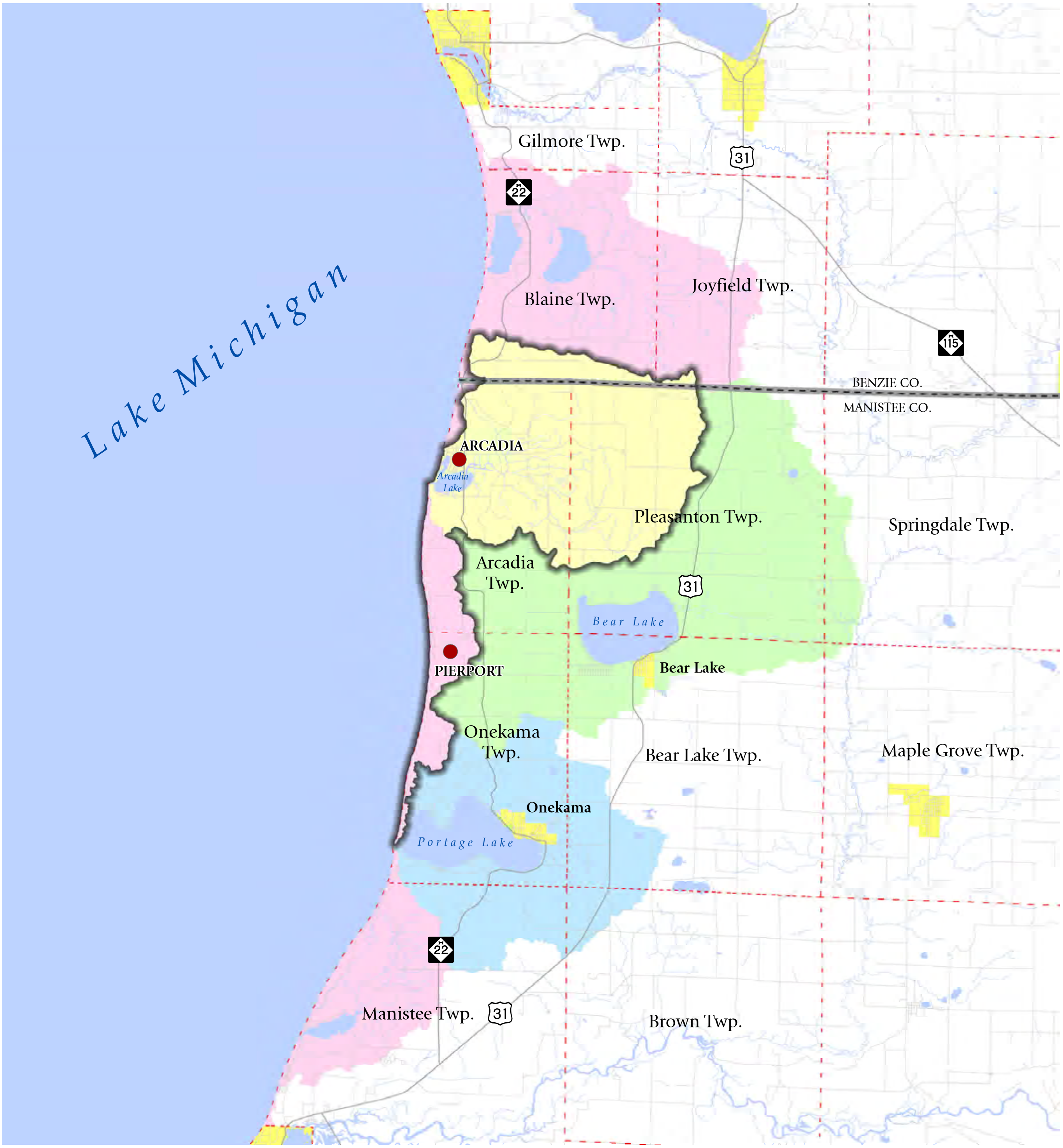
Introduction

The Arcadia-Pierport Watershed is within a region of premier tourist and outdoor recreation attractions in the State of Michigan.

The Arcadia-Pierport Watershed is within a region of premier tourist and outdoor recreation attractions in the State of Michigan. Its landscape and beauty contribute significantly to the quality of life enjoyed by year-round residents and attract numerous and repeat visitors to the area, directly impacting local business prosperity. However, the economic benefits that accrue due to the area's beauty and natural resources often put considerable pressure on the environment. Thus, it becomes imperative to factor in environmental restoration and protection with continued development to ensure environmental and community resiliency in the face of increasing climate variability.

How does the quality of water in our area affect us individually, and why should we care? These are questions with which environmental agencies have been dealing for years. How can we get people who live in and use the Arcadia-Pierport Watershed to care and learn about their water quality and consider how their individual actions may affect it? The answer is simple; our lives are tied to water by many different threads. The primary thread is that humans need clean, drinkable water to live. The drinking water that we rely upon may become contaminated by a number of chemicals and pollutants (like fertilizers, pesticides, and gasoline) that we and others use everyday and don't think about. Additionally, new and emerging issues involving pharmaceuticals and other medical wastes in our water supply are just beginning to be researched. What about the water and watershed in which we recreate? Healthy ecosystems are why people love to live here. Many people live in the Arcadia-Pierport Watershed because of the numerous forms of recreation it provides, as well as the beauty of the landscape. But if pollution is unchecked and degradation of our natural resources continues, many of the activities we like to do will be in jeopardy. Contamination of our streams, lakes, and marsh from numerous sources may lead to unsafe swimming and blooms of aquatic plants, which are an annoyance to swimmers and boaters. Recreational fishing is also impacted by water pollution; many inland lakes already have fish consumption advisories due to heavy metal contamination. Other forms of recreation that many of us enjoy on a daily basis are at stake as well, including

Map 1: Subwatershed Boundaries



ARCADIA-PIERPORT WATERSHED

Subwatershed Boundaries

Data Sources: State of Michigan Geographic Data Library

- City or Village
- County Boundary
- Township Boundary
- Roads
- Water Features
- Unincorporated Villages

Subwatershed Name:

- Arcadia Lake
- Lower Herring Lake-Frontal Lake Michigan
- Portage Lake
- Little Bear Creek
- Arcadia-Pierport Watershed

Beckett&Raeder

swimming, kayaking, canoeing, and even hiking.

It is imperative that we educate our residents and visitors about our watershed, let them know what is impacting our resource, and educate them on what they can do to help make the Arcadia-Pierport Watershed a place where they want to live and come back to time and time again. (Adapted from *Grand Traverse Bay Watershed Protection Plan*, 2005)

Watersheds connect settlements to each other in a way that is particularly dissociated from jurisdictional boundaries. First, they are usually larger than any standard municipal unit — several to dozens of municipalities can sometimes fit inside a single watershed. Second, and more importantly, water moves under its own power from jurisdiction to jurisdiction. This means that the impact of land use decisions on water quality are felt far beyond the authoritative reach of the decision-makers. Regional planning is therefore an especially valuable tool in watershed protection, as in the case of the *Portage Lake Watershed Forever Plan* that brought the Village of Onekama and Onekama Township together or the Crystal Lake and Watershed Association that is the most recent incarnation of a citizen-led group focused on that waterbody stretching back over 40 years. For this reason, federal and state monies for water quality management are often disbursed on the basis of an approved watershed plan. Section 319 of the national Clean Water Act provides grants to address nonpoint source pollution (pollution from diffuse sources such as fertilizer, oil, road salt, and animal waste in runoff). The Clean Michigan Initiative is a $675 million bond dedicated to the state's water resources, including a $90 million clean water fund and $70 million in pollution and remediation monies. (*Arcadia Township Master Plan*, 2014)

Watershed management is a common and effective approach to managing water resources. The United States Environmental Protection Agency (U.S. EPA), the federal agency responsible for meeting the requirements set forth in the federal Clean Water Act (1973), describes the "watershed approach" as "a flexible framework for managing water resource quality and quantity within specified drainage areas, or watersheds. 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, actions, participants, and resources related to developing and implementing the plan." (*Handbook for Developing Watershed Plans to Restore and Protect Our Waters*, 2008)

The Arcadia-Pierport Watershed is located in northwestern Manistee County within the Township of Arcadia, Michigan, but portions of the watershed also lie in several other jurisdictions, including Onekama and Pleasanton Townships in Manistee County and Joyfield and Blaine Townships in Benzie County.

For planning purposes, the watershed encompasses two distinct water drainage areas. The Arcadia Lake portion of the watershed drains into Lake Michigan via the connecting channel from Arcadia Lake. The Pierport drainage area is an isolated watershed extending about 8.5 miles south of Arcadia along the coast of Lake Michigan and drains directly into Lake Michigan via runoff down sand dune slopes and via groundwater seeps and intermittent streams. This southern leg of the Arcadia-Pierport Watershed passes through the unincorporated community of Pierport and is nestled between the Arcadia Lake Watershed, the Little Bear Creek Watershed, and the Portage Lake Watershed, as shown in Map 1. (*Lake Michigan Lakewide Management Plan (LaMP) 2008: Watershed Fact Sheets*, 2008; State of Michigan, 2013)

The Arcadia-Pierport Watershed is bounded by the Lower Herring Lake-Frontal Lake Michigan Watershed to the north and south, the Little Bear Creek Watershed to the east, and the Portage Lake Watershed to the south. The Arcadia-Pierport Watershed encompasses about 29.65 square miles, or roughly 18,973 acres. The Arcadia Lake drainage area, before entering the marshlands, covers 25.07 square miles, or about 16,046.57 acres. Arcadia Lake covers 243 acres and Arcadia Marsh about 270 acres, according to Chris Sullivan, Grand Traverse Regional Land Conservancy Land Protection Specialist. Arcadia Lake provides direct access to Lake Michigan by way of a channel that requires periodic dredging. (*Lake Michigan Lakewide*

Figure 1: Scenic Beauty in Watershed

Management Plan (LaMP) 2008: Watershed Fact Sheets, 2008; State of Michigan, 2013; Sullivan, personal communication, 2015, July 22)

The Pierport portion of the watershed extends south to the north edge of the channel between Portage Lake and Lake Michigan. This portion consists of a coastal strip of land about 8.5 miles long and includes the unincorporated community of Pierport. The Pierport Coastal Zone has several small, unnamed creeks that originate on the dune ridge or as groundwater seeps. The creek near Burnham Road is about 3/4 miles long and flows beneath Lakeview Road directly into Lake Michigan.

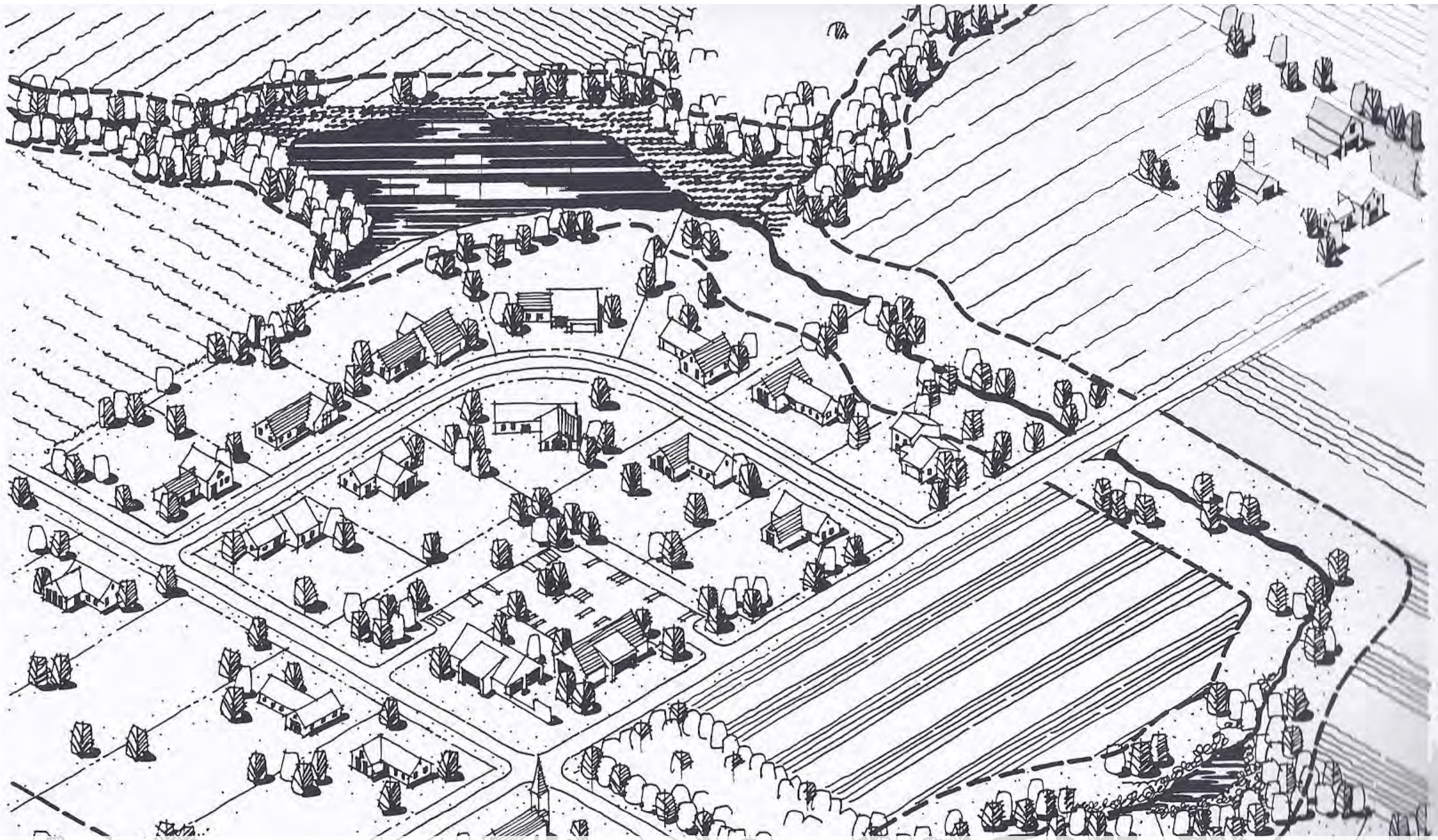
In December 2013, The Alliance for Economic Success received a watershed management planning grant for the Arcadia-Pierport Watershed from the Michigan Department of Environmental Quality's Coastal Zone Management program. The grant was used to develop this protection plan for the Arcadia-Pierport Watershed. The plan provides a description of the watershed, including such topics as bodies of water, population, land use, municipalities, and recreational activities; summarizes each of the two drainage areas in the watershed; and outlines current water quality conditions in the watershed, as well as identifying the need for additional information to be gathered.

The Arcadia-Pierport Watershed Management Plan (Plan) applies the "watershed approach" to analyzing the watershed's current conditions and creating a game plan to protect the integrity of its waters to ensure a quality water resource for the community into the future. After adequate funding allows for allocation and review of needed data, the Plan will identify the known sources and causes of the priority nonpoint source pollutants and their locations within the watershed and recommend a variety of measures necessary to protect or enhance water quality throughout the watershed based on community desires and economic capacity. Why are these efforts so critical to water quality protection, especially in a watershed with relatively healthy lakes, streams, and wetlands? Nonpoint source pollution, according to the EPA, is considered the greatest threat to water quality and is the most significant source of water quality impairment in the United States. 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." (***Handbook for Developing Watershed Plans to Restore and Protect Our Waters***, 2008)

For watersheds with minimal nonpoint source pollution, the development and implementation of watershed plans is crucial to ensure they remain unimpaired. The final Arcadia-Pierport Watershed Plan will contain the actions and steps needed to protect the water resources and address the water quality concerns of the community; implementation of these steps, however, must follow. Then, at some point in the future, the Plan will need to be updated to reflect current water quality and resource conditions and address any land use changes, as well as document accomplishments of goals toward water quality protection. Watershed management is an ongoing effort, essential for ensuring high quality water resources that will support the growth of the community into the future.

This Plan is intended for use by area watershed groups, lake associations, local governments, volunteer groups, and many others. It provides recommendations on how to reduce water quality degradation and protect our most critical watershed resource. The plans, reports, and other documents, materials, and resources referenced in this Plan are for the purpose of context and/or because they provide valuable information of relevance to this Plan.

Figure 2: Old Faceful Artesian Well in Pierport, Michigan



Definitions and Concepts

So what is a watershed, exactly, and why is it important? A watershed is an area of land that drains to a common body of water. The boundaries of the watershed are established by the slopes and land contours that direct water to a common point.

Watersheds do not follow city, township, or village boundaries, and as a result, cooperation between two or more jurisdictions is often needed to help protect and restore the watershed. Map 1 shows the boundaries of the Arcadia-Pierport Watershed and the watersheds adjacent to it.

It is important to know your watershed because the land use activities within it have the potential to impact the community that lives within it in unexpected ways. And that community not only includes people — it also includes the animals, birds, plants, and insects that call the watershed home.

The watershed consists of water that can be readily seen in streams, rivers, and lakes, but it also includes groundwater, which is out of sight and, often, out of mind — that is, until a residential drinking water well becomes contaminated or runs dry. You see, it really is all connected. Seepage of groundwater into streams and rivers is often what helps to maintain flow during the driest periods of summer.

Groundwater

Groundwater generally is subsurface water beneath the water table in soils and geologic formations that are fully saturated. (Freeze and Cherry, 1979)

The geologic formations which contain groundwater are known as aquifers. Some aquifers are confined between two impermeable underground geological formations, creating pressurized water, which is released when a well is placed, causing water to flow out the well without pumping; sometimes, this is called an artesian well. Old Faceful in Pierport is an example of a well that tapped a confined aquifer. Water from wells in unconfined aquifers needs to be pumped in order for it to reach the surface.

“Garbage in-Garbage out” is a phrase used when it comes to running computer programs, but it can apply also to watersheds. Any chemical or nutrient that goes into water, whether it be into a surface waterbody or groundwater, and overwhelms the ability of living organisms to degrade it, has the potential to cause problems eventually. The predominately sandy soils in the watershed mean that chemicals and nutrients entering groundwater can travel relatively quickly and sometimes unpredictably when the layers of soils above bedrock are not well defined or understood. The cumulative impacts of chemicals, nutrients, and land use activities over time can degrade the watershed to the point where it affects public health, economic development, and quality of life.

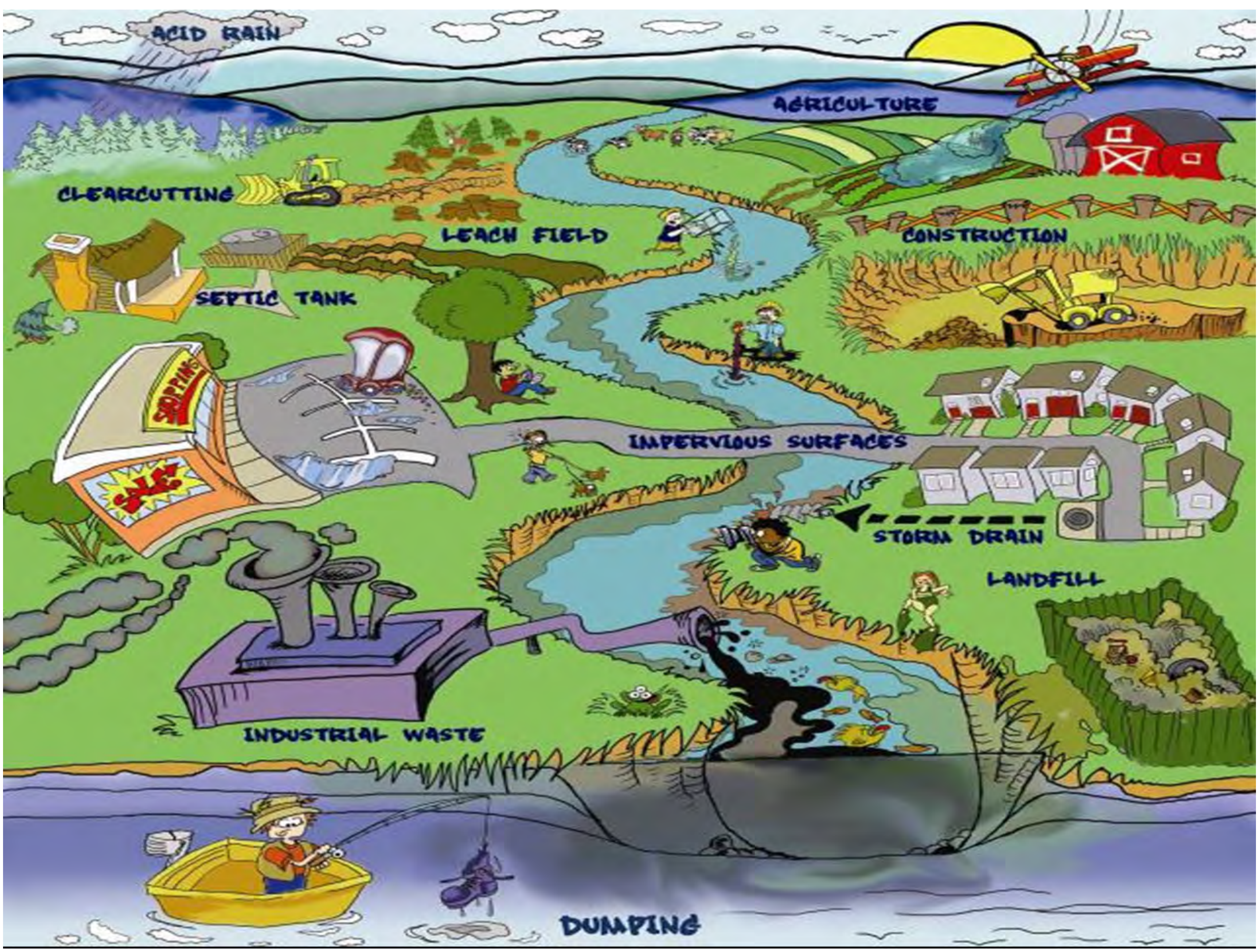
Nonpoint Source Pollution

The other thing about watersheds is that there are often areas within them that are more sensitive to certain land use practices. For instance, groundwater recharge and groundwater discharge areas need protection to ensure that water quality and quantity are not degraded. Land activities that occur on sloping land and loosen soil without taking proper precautions to prevent the soil from eroding into streams and rivers can degrade fish habitat, impact property along streams and lakes, and even make waterways impassable by boat. Roadways that cross rivers and streams, if not properly constructed and designed to prevent erosion, can significantly contribute to soil runoff into the waterbodies. Agricultural practices, particularly those activities that cultivate land or pasture animals close to or along the banks of streams, rivers, and lakes (without a vegetative buffer), can result in surface soil movement into waterways from rain, wind, or snowmelt. Those soils can also carry chemicals and nutrients that adhere to the soil particles, further impacting water quality. The overland movement of surface soils into surface waters is called Nonpoint Source Pollution. Watershed Goals I, II, and III in Table 44 in CHAPTER SIX address pollution and monitoring, while Watershed Goal V addresses green infrastructure. Completion of Implementation Task IA in Table 46 in CHAPTER NINE could help to identify nonpoint source pollution in the Arcadia-Pierport Watershed.

Point Source Pollution

The opposite of Nonpoint Source Pollution is Point Source Pollution, which occurs when pollutants, chemicals, nutrients, and high or low temperature wastewater (relative to the receiving waterbody) are discharged from a household, commercial business, or

Figure 3: Nonpoint Sources of Pollution



manufacturer through a pipe or via a ditch. If these unintended consequences from various land use activities are something the watershed community finds undesirable, then it is very important to develop a watershed plan and to implement it.

In the rest of this chapter, we will examine the dimensions, jurisdictions, climate and natural features of the watershed. Some of the terms used are familiar. According to Oxford Dictionaries, "geography" is "The study of the physical features of the earth and its atmosphere, and of human activity as it affects and is affected by these, including the distribution of populations and resources, land use, and industries." (Oxford University Press, 2015).

Hydrography, on the other hand, may be a less familiar term. It focuses on a description of the waterbodies in an area. Size, order, discharge flow rate, and mapping are some characteristics studied. The Order of streams within a river system is sometimes used to give a sense of how running waters converge and feed into larger streams. The headwater streams are generally classified as First-Order streams, and depending on how they join with other streams, are classified as Second-Order, Third-Order, and so on. Figure 5 illustrates the concept.

Riparian Buffers

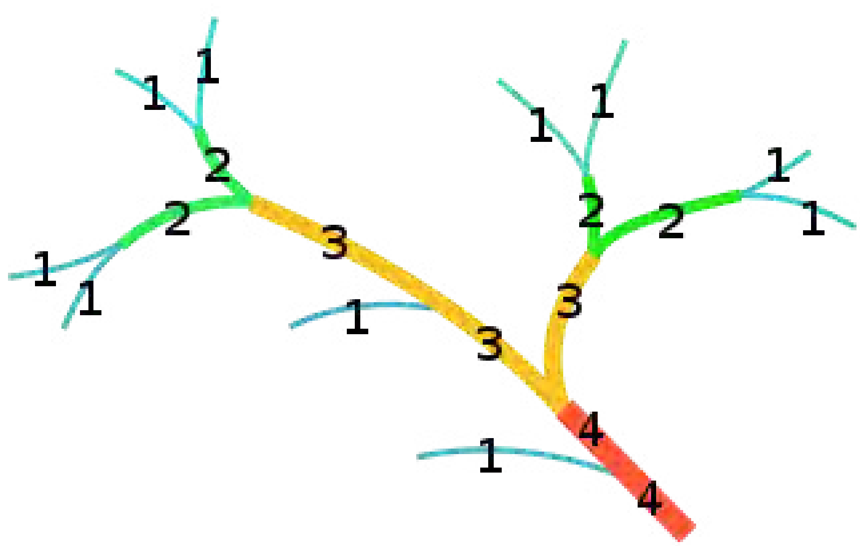
One simple, yet extremely effective tool for protecting the health and integrity of waterways is the use of vegetated buffers along its riparian (streamside) corridors. These riparian buffers are areas of vegetation located immediately adjacent to a waterbody or stream system. According to the EPA, these simple strips of vegetated land can offer an enormous number of environmental benefits, including:

- Restoring and maintaining the physical and biological integrity of the water resources
- Removing pollutants from urban stormwater
- Stabilizing stream banks, resulting in reduced erosion and sedimentation
- Providing infiltration of stormwater runoff

The Arcadia-Pierport Watershed is impacted more by nonpoint than point sources of pollution.

Figure 4: Example of Point Source Pollution

Figure 5: Stream Order



A riparian buffer is a vegetated, usually forested, area (a "buffer strip") near a stream, which helps shade and partially protect a stream from the impact of adjacent land uses.

- Maintaining base flow of streams
- Contributing organic matter that serves as a source of food and energy for the aquatic ecosystem
- Providing tree canopy to shade streams and regulate temperature (Mayer, Reynolds, Jr., and Canfield, 2005)

To help establish guidelines for permitted and restricted uses, the EPA and the Michigan Department of Environmental Quality (MDEQ) recommend using a multi-zone approach to differentiate appropriate levels of activity within different areas of the riparian corridor.

For the Lakes to Land region, a buffer of 50 feet in total width is recommended for both sides of the stream system. Within this 50 feet, the buffer is divided into two distinct zones, a Streamside Zone and an Outer Zone. Implementation Task IIIA in Table 46 addresses riparian buffers.

Stream Characteristics

A stream is a body of water that flows naturally in a channel. (Langbein and Iseri, 1995) Depending on its geographic location or certain characteristics, a stream may be referred to as a branch, brook, beck, burn, creek, "crick," gill (occasionally ghyll), kill, lick, mill race, rill, river, syke, bayou, rivulet, streamage, wash, run, or runnel.

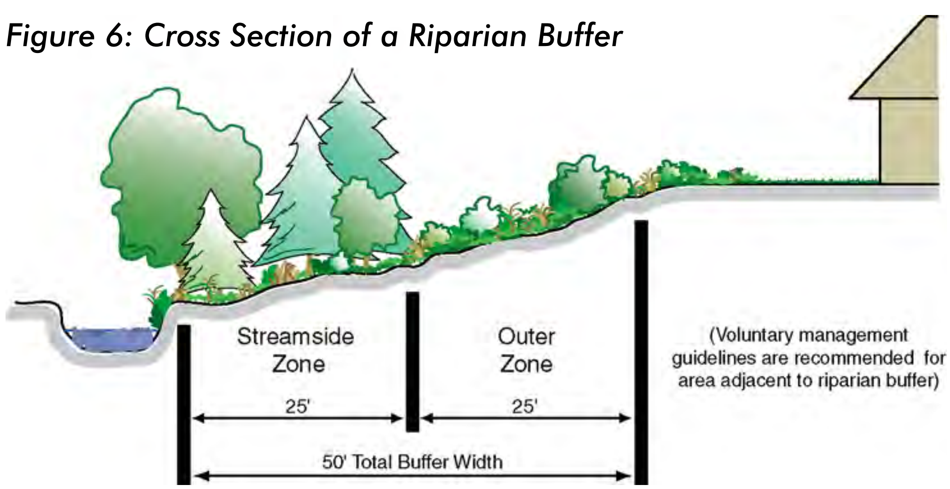
Streams are important for many reasons. According to the EPA, "They protect against floods, filter pollutants, recycle potentially-harmful nutrients, and provide food and habitat for many types of fish. These streams also play a critical role in maintaining the quality and supply of our drinking water, ensure a continual flow of water to surface waters, and help recharge underground aquifers." (United States Environmental Protection Agency, 2013)

Following is a selection of definitions related to hydrology.

Common Terms:

Bar
A shoal that develops in a stream as sediment is deposited as the current slows or is impeded by wave action at the confluence.

Figure 6: Cross Section of a Riparian Buffer



Bifurcation
A fork into two or more streams.

Bank
"The margins of a channel. Banks are called right or left as viewed facing in the direction of the flow." (Langbein and Iseri, 1995)

Channel
"An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. River, creek, run, branch, anabranch, and tributary are some of the terms used to describe natural channels." (Langbein and Iseri, 1995)

Confluence
The point at which the two streams merge. If the two tributaries are of approximately equal size, the confluence may be called a fork.

Direct runoff
"The runoff entering stream channels promptly after rainfall or snowmelt. Superposed on base runoff, it forms the bulk of the hydrograph of a flood." (Langbein and Iseri, 1995)

Drainage basin
"A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water." (Langbein and Iseri, 1995)

Floodplain
Lands adjacent to the stream that are subject to flooding when a stream overflows its banks.

Headwaters
The part of a stream or river proximate to its source. The word is most commonly used in the plural where there is no single point source.

Knickpoint
The point on a stream's profile where a sudden change in stream gradient occurs.

Meander
"The winding of a stream channel." (Langbein and Iseri, 1995)

Mouth
The point at which the stream discharges, possibly via an estuary or delta, into a static body of water such as a lake or ocean.

Pool
"A deep reach of a stream. The reach of a stream between two riffles. Natural streams often consist of a succession of two riffles." (Langbein and Iseri, 1995)

Reach
"The length of channel uniform with respect to discharge, depth, area, and slope...More generally, any length of a river." (Langbein and Iseri, 1995)

Reservoir
"A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water." (Langbein and Iseri, 1995)

Riffle
"A rapid in a stream." (Langbein and Iseri, 1995)

Riparian
"Pertaining to the banks of a stream." (Langbein and Iseri, 1995)

River
A large natural stream, which may be a waterway.

Run
A somewhat smoothly flowing segment of the stream.

Runoff
"That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage, or other works of man in or on the stream channels." (Langbein and Iseri, 1995)

Segment
A part of a stream extending between tributary junctions.

Source
The spring from which the stream originates or other point of origin of a stream.

Spring
The point at which a stream emerges from an underground course through unconsolidated sediments or through caves.

Stream (Types)
Gaining. "A stream or reach of a stream that receives water from the zone of saturation." (Langbein and Iseri, 1995)
Losing. "A stream or reach of a stream that contributes water to the zone of saturation." (Langbein and Iseri, 1995)
Insulated. "A stream or reach of a stream that neither contributes water to the zone of saturation nor receives water from it. It is separated from the zones of saturation by an impermeable bed." (Langbein and Iseri, 1995)
Perched. "A perched stream is either a losing stream or an insulated stream that is separated from the underlying ground water by a zone of aeration." (Langbein and Iseri, 1995)

Stream bed
The bottom of a stream.

Stream corridor
Streams, its floodplains, and the transitional upland fringe.

Streamflow
"The discharge that ocucrs in a natural channel. Although the term discharge can be applied to the flow of a canal, the word streamflow uniquely describes the discharge in a surface stream course. The term 'streamflow' is more general than runoff, as streamflow may be applied to discharge whether or not it is affected by diversion or regulation." (Langbein and Iseri, 1995)

Surface runoff
"That part of the runoff which travels over the soil surface to the nearest stream channel. It is also defined as that part of the runoff of a drainage basin that has not passed beneath the surface since precipitation." (Langbein and Iseri, 1995)

Surface water
"Water on the surface of the earth." (Langbein and Iseri, 1995)

Thalweg
The river's longitudinal section, or the line joining the deepest point in the channel at each stage from source to mouth.

Watershed
"The divide separating one drainage basin from another..." (Langbein and Iseri, 1995)

(Langbein and Iseri, 1995; Wikipedia, 2015)

Figure 7: Hierarchical Organization of Stream Systems
Source: Frissell et al., 1986

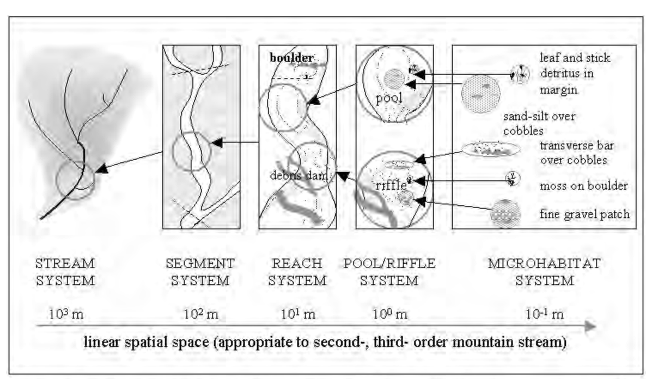


Fig. 6.1. Hierarchical organisation of stream systems and their habitat subsystems, as a framework fo analysing processes at various scales (adapted from Frissell *et al.* 1986)

Wetlands

Wetlands are often associated with river and stream systems but can also occur where groundwater reaches the surface, creating fens. Fens are groundwater-fed, peat-forming wetlands covered by grass, sedges, reeds, and wildflowers, and sometimes birch and willow. Fens typically occur in the northern United States as a result of glaciation. Bogs are a type of wetland whose source water is from precipitation.

According to the EPA (U.S. EPA Regulations listed at 40CFR230.3(t)), "wetlands" are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support...a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." (United States Environmental Protection Agency, 1993)

Wetlands have many important functions in the watershed, including filtering, controlling floods, processing nutrients, and serving as nurseries for young game fish, among other things.

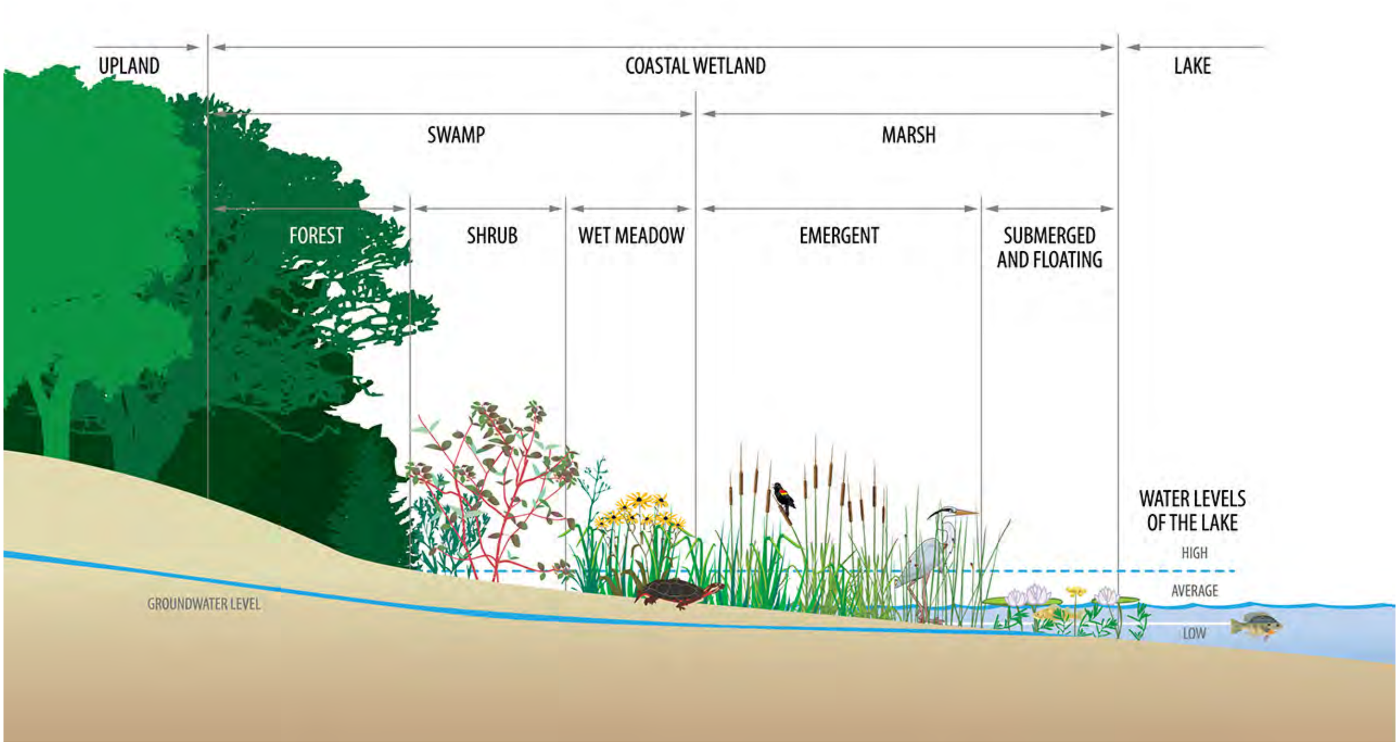
Arcadia Marsh is a special type of wetland known as a Great Lakes Coastal Marsh. Wetlands that are located adjacent to the Great Lakes are directly influenced by the waters of the Great Lakes. Such influences include the Great Lakes water levels, along-shore currents and storm-driven wave action.

Wetlands, along with rivers, streams, and lakes, often have robust insect communities that live on or within bottom sediments (benthic macroinvertebrates), within the water column, or on top of the water (aquatic macroinvertebrates). A macroinvertebrate is a water bug that can be seen with the naked eye. Many macroinvertebrates make their homes in rocks, leaves, and sediment in stream beds. Some bugs spend their entire lives in water; however, others just spend their immature stages in water and their adult lives out of water. An example is the dragonfly. See Figure 8 below.

Figure 8: Adult Dragonfly

The make-up of macroinvertebrate communities can indicate water quality. Certain species are much more tolerant of polluted and degraded conditions. Depending on the macroinvertebrate species found in a waterbody, predictions about water quality can be made. For example, the presence of caddisflies, mayflies, and stoneflies can often indicate high quality streams because these species do not survive in polluted water.

Figure 9: Great Lakes Coastal Wetland Types
Source: Michigan Sea Grant Program



Other factors, however, affect macroinvertebrate communities, including water temperature and flow rate. So although water quality may be good, if the temperature is too high or the flow rate too slow, the kinds of macroinvertebrates found there will be affected. Table 1 below illustrates the natural and human influences that cause macroinvertebrate populations to change. Fisheries Biologists and Aquatic Biologists often collect data of fish species, macroinvertebrates, and aquatic plants to assess habitat and water quality. These are often called Biosurveys. During the course of these surveys, invasive species may be identified.

The National Invasive Species Council defines an Invasive Species "as a species that is: 1) non-native... and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health." (National Invasive Species Information Center, 2012) MDEQ states that invasive species are a source of biological pollution that have significant economic effects on natural resources, human health, recreational opportunities, and other human values. Invasives often compete with native species for food and habitat. They may adversely impact waterfront property values, tourism, utilities, and other industries. (State of Michigan, 2015) For example, zebra mussels can clog drinking water intake valves operated by utilities and industrial process water or cooling water intakes. Eurasion watermilfoil, an invasive aquatic plant, can foul boat motors, making lakes impassable and unfishable. Watershed Goals I, II, and III in Table 44 address invasive species, and completion of Implementation Task IIIB could help to curtail the spread of invasive species.

Table 1: Influences on Macroinvertebrate Populations

Natural influences that cause macroinvertebrate populations to change:	*Human influences that cause macroinvertebrate populations to change:*
Seasons — life histories of invertebrates are tied to food availability. For example, macroinvertebrates that eat algae are most abundant in the summer when algae production is at its highest.	**Nutrient enrichment** — added nutrients from human sewage, fertilizer or manure can accelerate the growth of algae and other plants. When these plants die, decomposition by microorganisms can use up dissolved oxygen in the water.
Dissolved Oxygen — macroinvertebrates breathe oxygen that is dissolved in the water. In the immature stage, many species require high levels of dissolved oxygen in order to survive.	**pH** — Dumping of industrial pollutants and runoff from mining activities can lower pH (making water more acidic). Low pH can weaken shells and exoskeletons and kill macroinvertebrates.
Substrate — what the bottom of the stream is comprised of will affect the types of macroinvertebrates. For example, macroinvertebrates that eat tiny food particles prefer sandy or muddy substrate.	**Removal of riparian vegetation** — this takes away macroinvertebrates' food source and important breeding grounds.

Figure 10: Stonefly, Caddisfly, and Mayfly

Figure 11: Arcadia Bluffs Golf Club

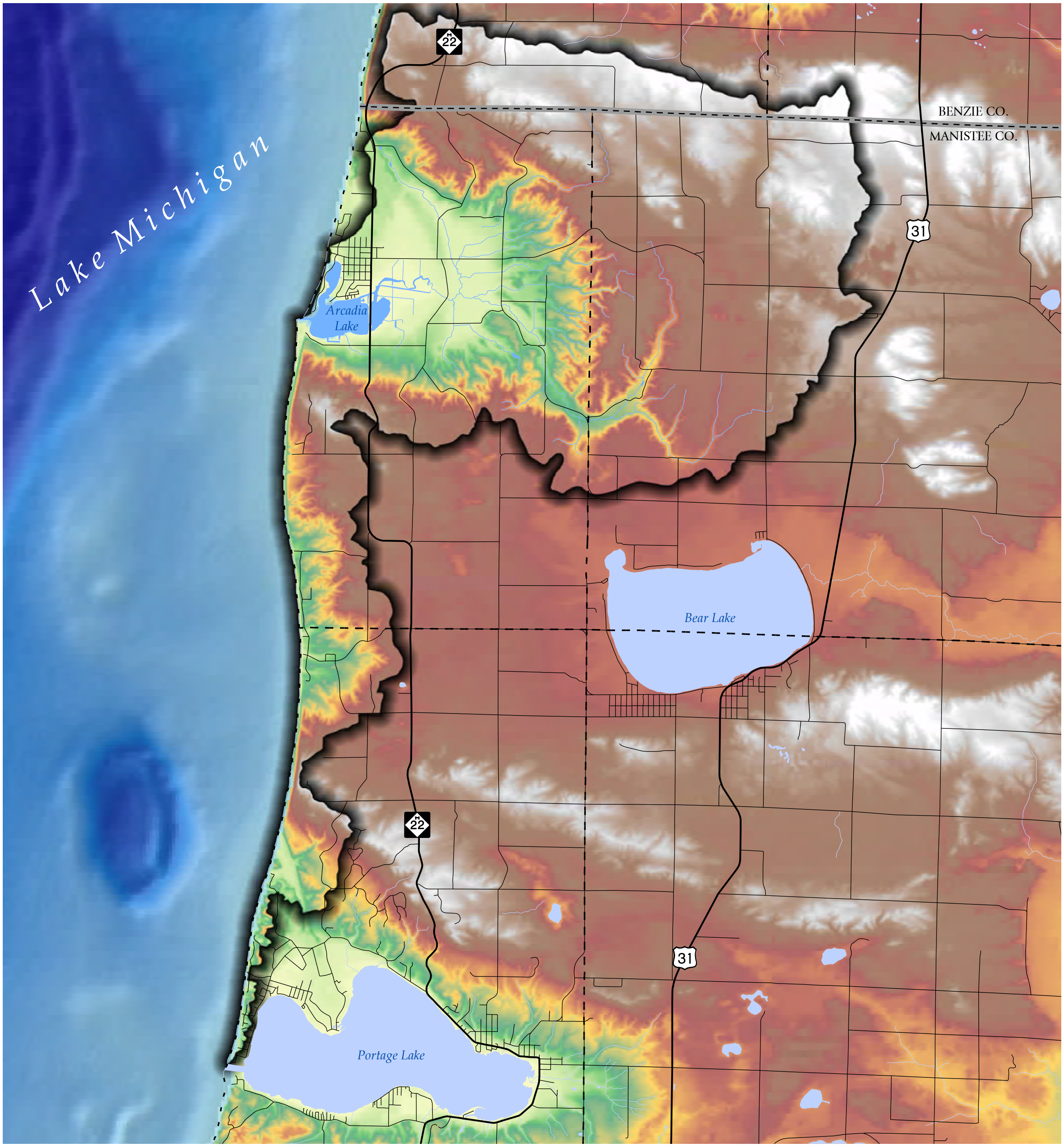
Geography and Hydrography

There are approximately 7,025 acres of critical dunes along the shores of Benzie and Manistee Counties, nearly all (91%) of which are in Benzie County.

Arcadia Lake is fed primarily by Bowens Creek. (Tonello, 2008) Bowens Creek has a relatively small, dendritic watershed consisting of many small spring creeks originating from glacial moraines to the north, east, and south of Arcadia. As these streams flow off the moraines, they are typically very high-gradient. However, in its last several miles before flowing under M-22, Bowens Creek flows through a flat, low-gradient reach that is surrounded by emergent wetland. Bowens Creek and its tributaries are mostly trout streams with populations of brown trout, brook trout, migratory rainbow trout (steelhead), coho salmon, and Chinook salmon. All salmonid populations in the Bowens Creek watershed are self-sustaining, since no stocking takes place. The immediate terrain surrounding Arcadia Lake is relatively flat, with wetlands and agricultural land present. However, glacial moraines are present on all three sides of Arcadia, forming a bowl shape, and these hills are primarily wooded with hardwoods and some pine. (Tonello, 2012)

Michigan hosts the largest collection of freshwater sand dunes in the world, a unique ecosystem sheltering five threatened and endangered species. Protecting the dunes lining the Lake Michigan shoreline along significant portions of Manistee and Benzie Counties is an essential aspect of land use planning in northwest Michigan. Sand mining has been regulated by the State since 1976, and activities related to development, recreation, and forestry have been regulated since 1989. Earthmoving, vegetation removal, and construction activities within a critical dune area are subjected to a permit process. Previously, local governments assumed that permitting authority by passing zoning restrictions that are at least as protective as state regulations, an option that has not been exercised by any Lakes to Land community. There are approximately 7,025 acres of critical dunes along the shores of Benzie and Manistee Counties, nearly all (91%) of which are in Benzie County. Critical Dune Areas have not been designated in Arcadia Township by MDEQ. (*Arcadia Township Master Plan*, 2014; Smar, personal communication, 2015, September 29) Attention to Watershed Goal II, which addresses inventorying and data collection, in Table 44 could help to close this gap.

Map 2: Topography and Bathymetry



ARCADIA-PIERPORT WATERSHED

Topography and Bathymetry

Data Sources: State of Michigan Geographic Data Library

- Watershed Boundary
- County Boundary
- Township Boundary
- Major Road
- Minor Road

Elevation (ft): 575 700 825 950 1075

Lake Depth (ft): 1 75 150 225 300

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The Sand Dune Regulations are found under Part 353, Sand Dune Protection and Management Act, of the Natural Resources and Environmental Protection Act, NREPA, 1994 PA 451 as amended. Critical dune areas represent some of the most spectacular dunes extending along the Lake Michigan shoreline, with two of these areas located just north of the Portage Lake channel. Serving as natural barriers to Great Lake storm surges, these sand dunes are classified as "critical" due to their significant slope, over 35 percent in most cases. Given their highly erosive condition, the State of Michigan previously required certain standards on construction and site design. (*Onekama Community Master Plan*, 2010) As Critical Dune Areas have not been designated by MDEQ in Arcadia Township, the township could control development activities through, for instance, an ordinance or overlay district in these areas without regard to restrictions in Part 353. (Smar, personal communication, 2015, September 29)

Coastal sand dunes are one of Michigan's most treasured resources. The enactment of legislation regulating land use on sand dunes in 1994 was intended by the legislature to balance competing public and private interests over that resource. However, the Sand Dune Protection and Management Act (SDPMA) was extensively amended in August of 2012. As amended, local governments have a significantly diminished role in determining land use on sand dunes within their borders. (Great Lakes Law, 2014)

The 2012 amendment made four key changes to the SPDMA. First, there is a greater level of state preemption of local authority. Second, limitations on who may request a public hearing for a permit proposal further restrict local involvement. Third, permit applications now enjoy an effective presumption in favor of approval. Finally, more state control and less environmental research over what area should be classified as a "critical dune" erodes the public's interest. Many other small changes demonstrate that the new SPDMA favors private property rights over local authority and public interests. (Great Lakes Law, 2014)

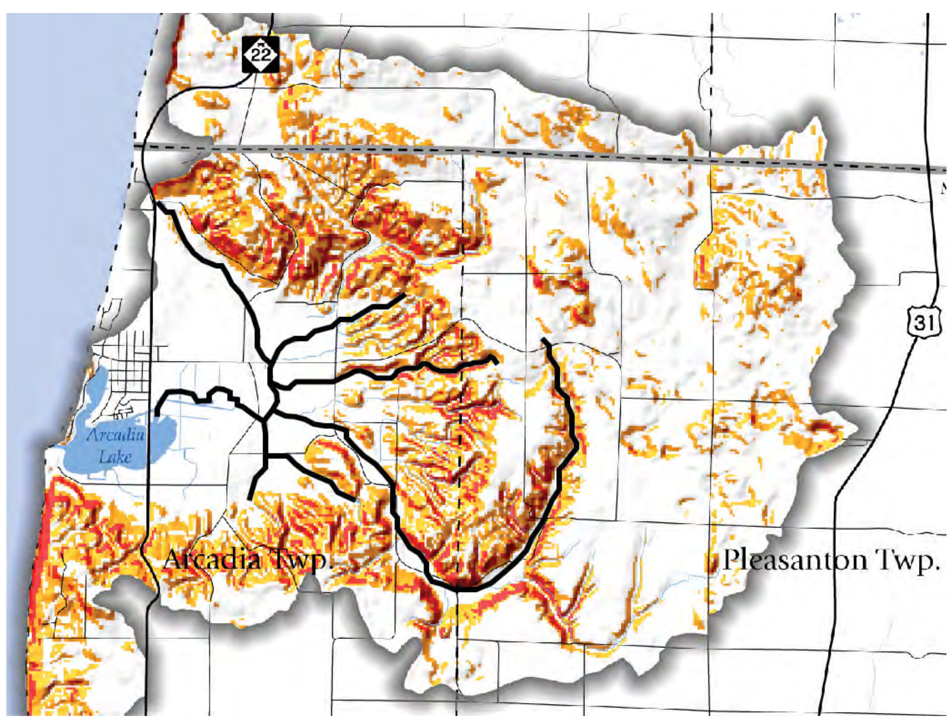
Topography and Elevation

The configuration of a surface, including its relief and the relative positions of its natural and constructed features, defines its topography. Map 2 demonstrates the highly varied terrain of the Lakes to Land region, which ranges from the lowest valleys to the highest ridge that separates Benzie and Manistee Counties. Glaciers gouged the coast intermittently to form low-lying lakes, which have in turn been modified to suit human use over the past few hundred years. In many cases, the lakes remain surrounded by lands of higher elevation to form spectacular bluffs, as in the Arcadia and Frankfort areas. Topography plays an indispensable role in development. Engineering concerns presented by swift grade changes were a strong influence on the location of the region's railroad corridors. (*Arcadia Township Master Plan*, 2014)

Construction in areas of low elevation can be subject to flooding, while a building on a severe slope risks an unstable foundation. Also pictured on this map is the configuration of the Lake Michigan floor — its bathymetry. This helps determine how a waterbody can be used. Shallower waters remain warmer and offer recreational opportunities like swimming and windsurfing, while only deeper waters can accommodate the larger vessels used by industry. (*Arcadia Township Master Plan*, 2014)

Map 3 below follows several of the tributaries as they meander through and around the topographic features within the watershed. Maps 2, 3, and 4 illustrate the "bowl-shaped" pattern of the watershed formed by projecting ridges (fingers) that traverse outward

Map 3: Illustration of How Topography Affects Tributary Location



Map 4: Slopes

ARCADIA-PIERPORT WATERSHED

Strong and Steep Slopes

Data Sources: State of Michigan Geographic Data Library

0 0.5 1 2 Miles

Watershed Boundary
County Boundary
Township Boundary
Major Road
Minor Road

Slope Degree:
9.1 - 16
16.1 - 80

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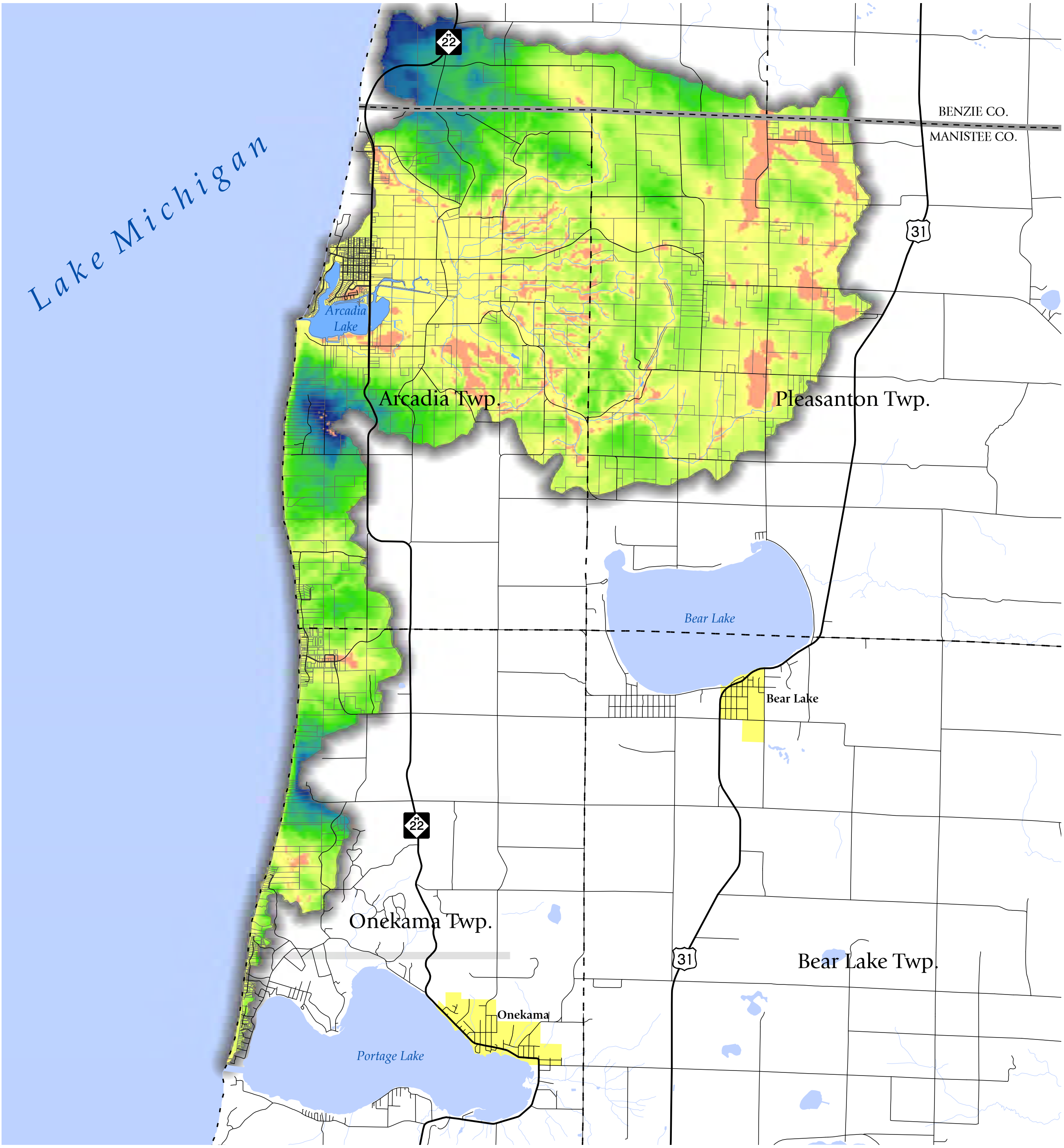
from Arcadia Lake in a radial "finger-like" fashion. In many instances, the tributaries within the watershed move through the valleys caused by these physical features.

Slope

Slope is a calculation of "rise over run," or the change in elevation at two points divided by the distance between them. When calculated this way, slope is expressed as a percentage or gradient. It can also be expressed in degrees, as the angle of the surface as compared to the horizontal. Map 4 shows "strong" slopes, defined by an angle between 9.1 and 16 degrees (15-30% grade, or a 15- to 30-foot rise over 100 feet of distance), and "steep" slopes which have a rise of over 16 degrees (>30% grade). Awareness of the locations and extents of these slopes can impact decisions with respect to land use and transportation planning. The threat of erosion, sedimentation, and landslides all increase with the slope of a developed surface. Transportation requires more energy to cover the same distance, a situation that is drastically exacerbated as winter snow and ice reduce surface friction on the roads. On the other hand, part of northwest Michigan's magnetic appeal is provided by its beautiful vistas and the recreational opportunities offered by its varied terrain. Many areas of steep slopes and undulating grades are concentrated around the inland lakes near Lake Michigan, and the unincorporated village of Arcadia is nestled in a valley surrounded by steep slope hills. M-22 owes its "Scenic Route" designation to the spectacular views offered by steep hills; the popular state lookout, Inspiration Point, just north of Arcadia, is the highest elevation on the eastern shore of Lake Michigan. (*Arcadia Township Master Plan*, 2014)

Figure 12: Variations in Local Topography

Map 5: Water Table Depth



ARCADIA-PIERPORT WATERSHED

Water Table Depth

Data Sources: State of Michigan Geographic Data Library

0 0.5 1 2 Miles

- Parcel Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road

Water Table Depth (ft):

0 100 200 300 400

No Data Available

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Groundwater, Geology, and Soils

"I think we've been on this slippery slope (of excessive groundwater withdrawals) for a long time but people haven't been seeing the threat. It's becoming obvious that we weren't kidding when we said groundwater in Michigan is a finite resource." - David Lusch, 2013

Groundwater

For a variety of reasons, access to groundwater — the primary source of drinking water for 44 percent of Michigan residents and nearly all irrigated farms — is becoming a critical issue in several areas of the state. Statewide, the Michigan Department of Environmental Quality has identified 12 counties where groundwater withdrawals have stressed at least one watershed. "I think we've been on this slippery slope (of excessive groundwater withdrawals) for a long time but people haven't been seeing the threat," Lusch said. "It's becoming obvious that we weren't kidding when we said groundwater in Michigan is a finite resource." (Alexander, 2013)

Since Michigan's new water use regulations went into effect in 2008, 1,789 high-capacity wells capable of pumping more than 100,000 gallons daily have been drilled, according to state data. The vast majority of those wells irrigate farm fields, said Andrew LeBaron, an MDEQ environmental quality analyst. MDEQ has prohibited 12 large water withdrawals since 2008. The growing number of farmers irrigating crops is putting "localized pressure" on groundwater resources in several areas, said James Clift, policy director for the Michigan Environmental Council and a member of the state's Water Use Advisory Council. (Alexander, 2013)

"It's not a statewide water scarcity issue, it's a localized issue," Clift said. "But we have dozens of watersheds that are coming up to this line where we have to be careful" to avoid water withdrawals that could harm fish populations and hurt tourism. (Alexander, 2013)

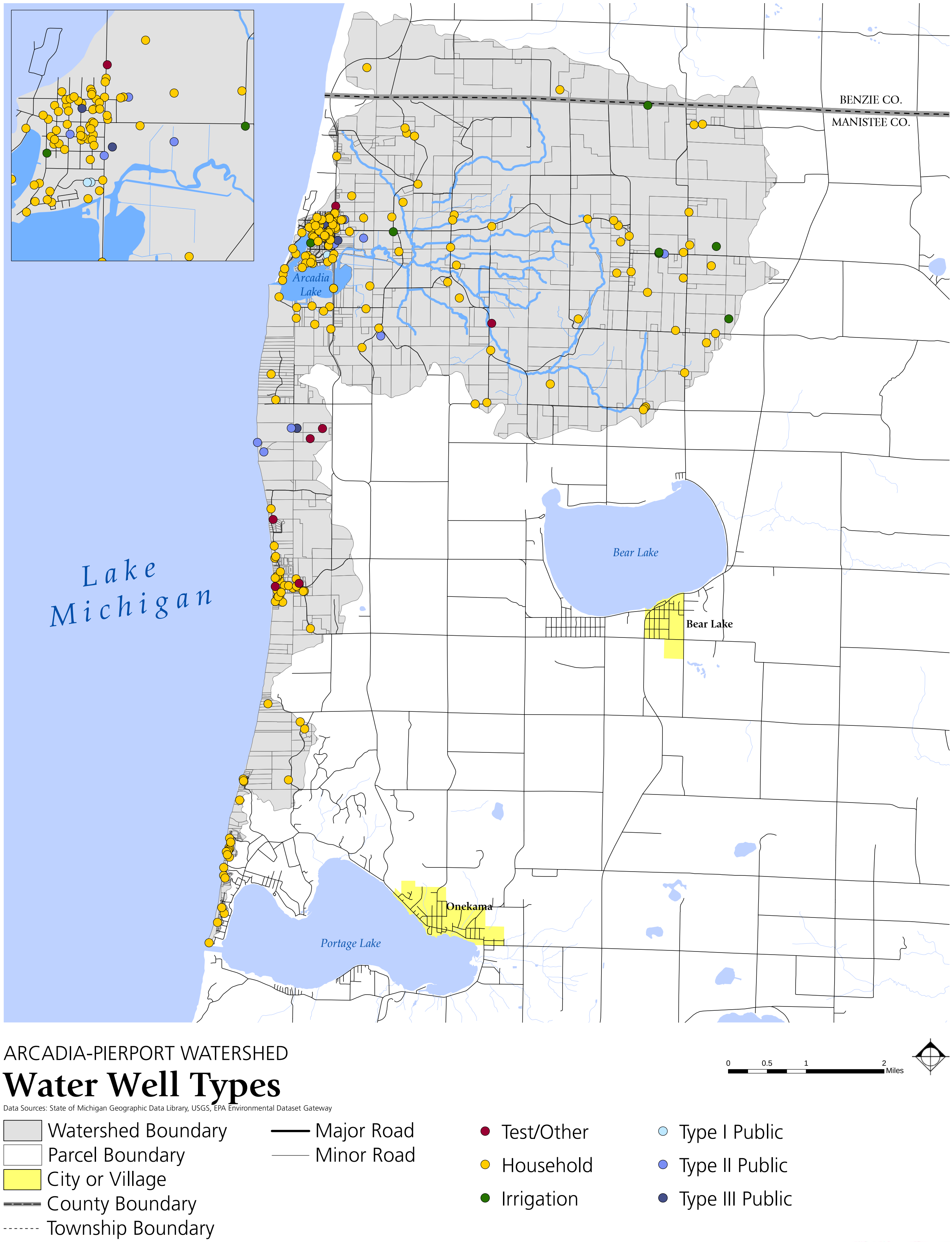
44% of Michigan residents get their primary source of water from groundwater.

All water withdrawals over 100,000 gallons daily must pass a screening by the state's Water Withdrawal Assessment Tool. The tool is a computer program designed to prevent large water withdrawals from draining nearby streams or harming fish populations.

The tool limits the volume of water that can be pumped out of the ground or surface waters in hundreds of watersheds across the state. That restriction establishes the amount of "legally available water," LeBaron said. (Alexander, 2013)

There are no public water systems that serve residents in the Arcadia-Pierport Watershed. Residents and businesses rely on privately maintained wells. Map 5 depicts the water

Map 6: Well Locations and Types



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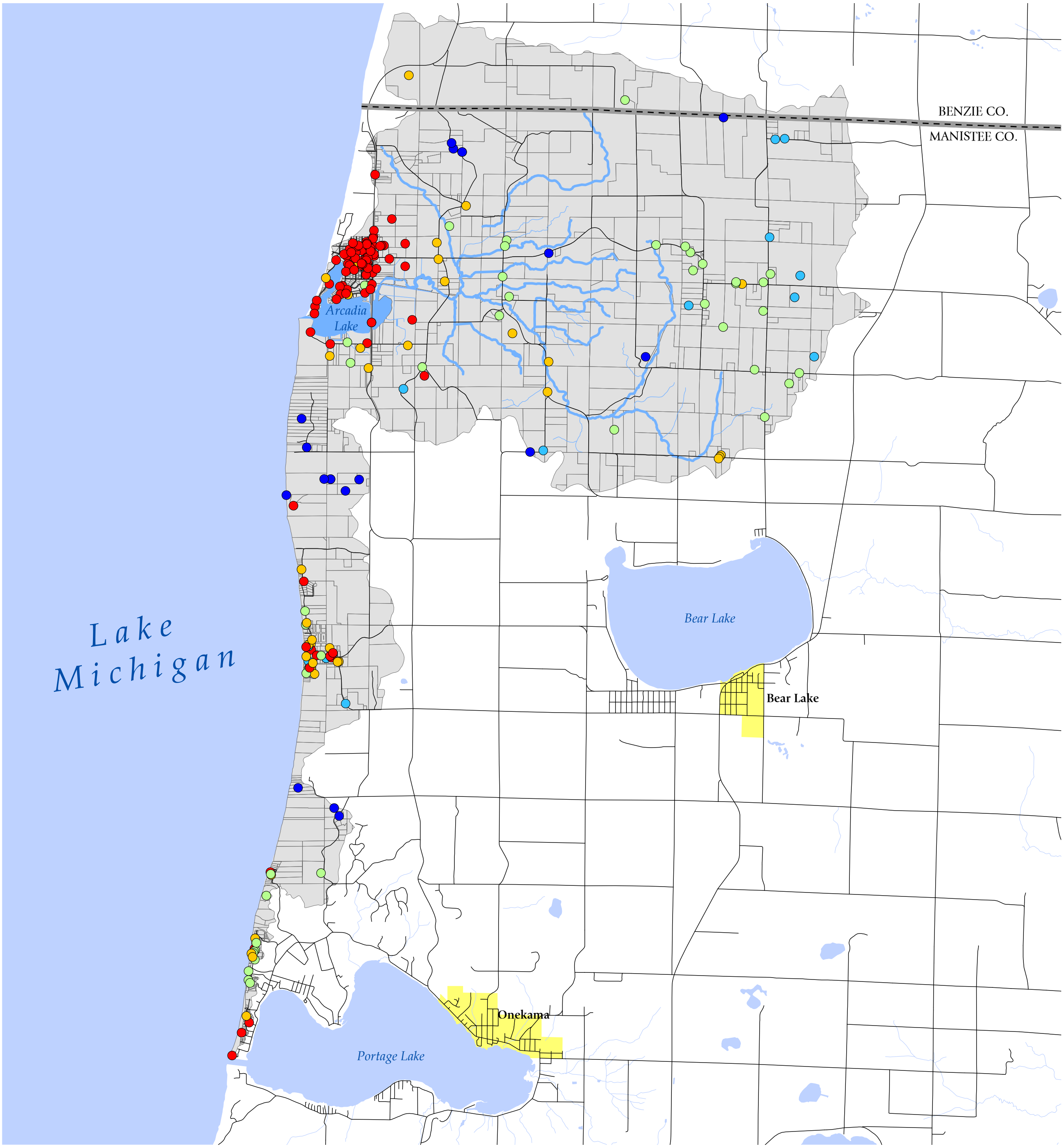
Map 7: Well Depths



ARCADIA-PIERPORT WATERSHED

Water Well Depths

Data Sources: State of Michigan Geographic Data Library, USGS, EPA Environmental Dataset Gateway

Watershed Boundary
Parcel Boundary
City or Village
County Boundary
Township Boundary

Major Road
Minor Road

Well Depth in Feet

0.0 - 62.0
62.1 - 104.0
104.1 - 165.0
165.1 - 252.0
252.1 - 410.0

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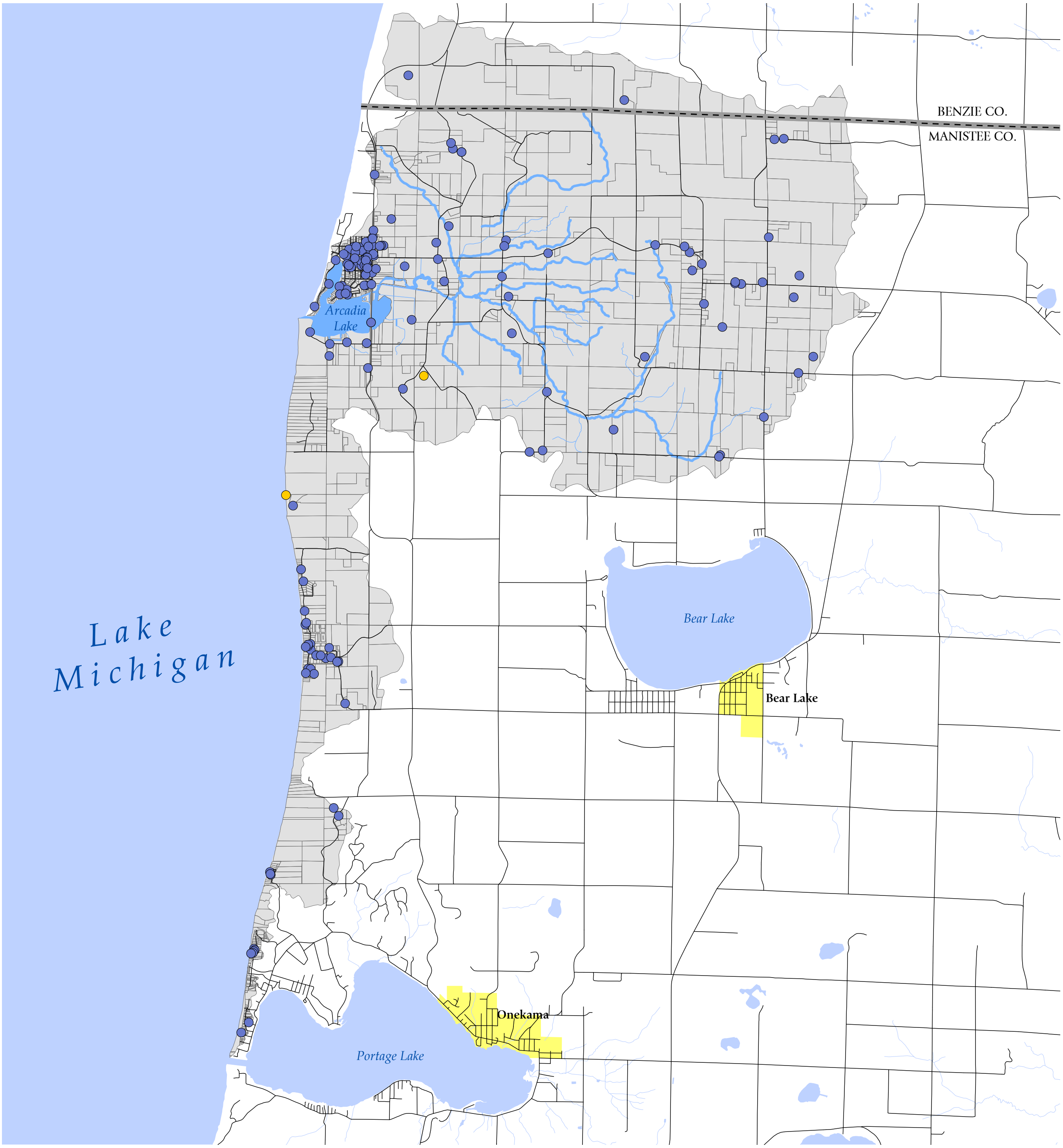
Map 8: Well Aquifer Sources



ARCADIA-PIERPORT WATERSHED

Water Well Aquifer Sources

Data Sources: State of Michigan Geographic Data Library, USGS, EPA Environmental Dataset Gateway

0 0.5 1 2 Miles

- Watershed Boundary
- Parcel Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road
- Glacial Drift
- Bedrock

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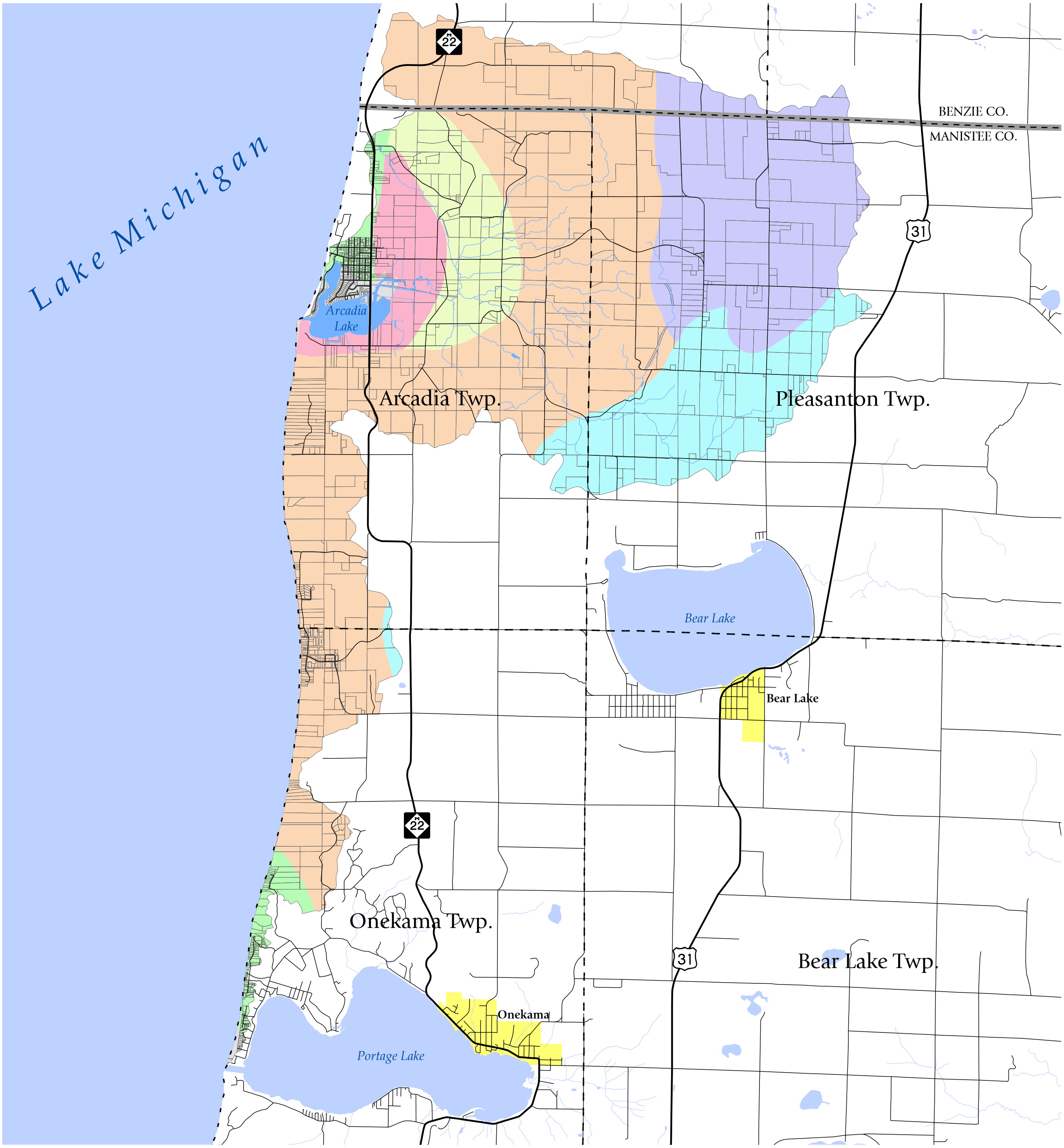
Map 9: Geology



ARCADIA-PIERPORT WATERSHED

Quaternary Geology

Data Sources: State of Michigan Geographic Data Library

Parcel Boundary
City or Village
County Boundary
Township Boundary
Major Road
Minor Road

Type:

Dune Sand
Lacustrine Sand and Gravel
Glacial Outwash Sand, Gravel, and Postglacial Alluvium
Coarse-Textured Glacial Till
Medium-Textured Glacial Till
End Moraines of Medium-Textured Till

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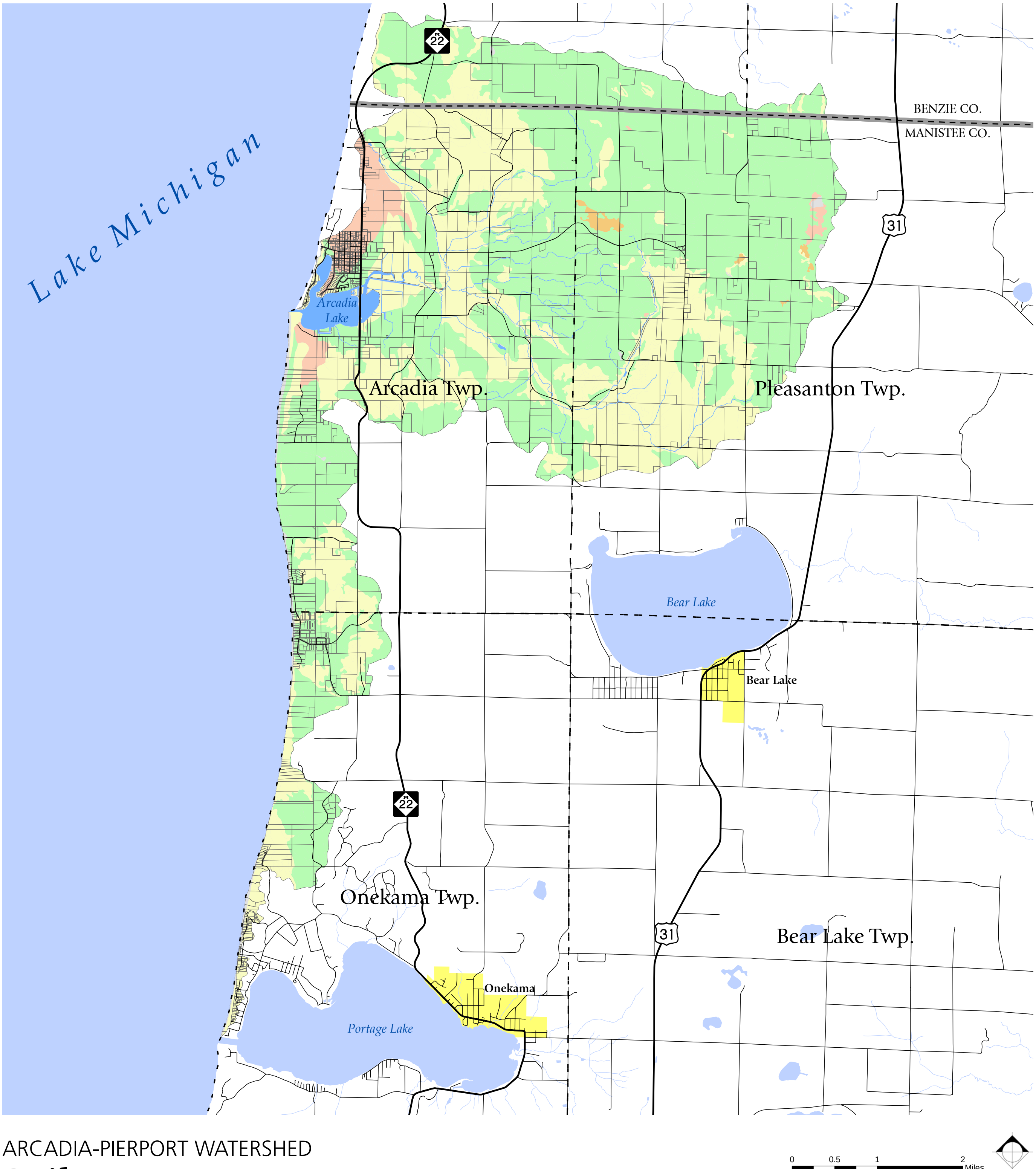
Map 10: Soils



ARCADIA-PIERPORT WATERSHED

Soil Taxonomy

Data Sources: State of Michigan Geographic Data Library, USDA

- Parcel Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road

Type:

- Alfisols
- Entisols
- Histosols
- Spodosols

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table depth, and Maps 6-8 show spatial information about wells. Watershed Goals I, II, and III in Table 44 address water sources and quality.

While existing regulations protect water from permitted waste discharges, leaking underground storage tanks and other nonpoint discharges from land uses involving the storage, disposal, transportation, and use of hazardous waste materials may threaten groundwater resources in the watershed. (*Greater Bear Watershed Management Plan*, 2013)

Abandoned wells and improperly decommissioned wells can pose a pathway for contamination of the groundwater resources in the watershed.

Geology

Some of the thickest and most complex glacial drift in Michigan is located in the Northwestern Lower Peninsula of Michigan. These glacial deposits (the materials left behind as the glaciers advanced and retreated throughout the area) vary from 200 feet to 1,000 feet above the bedrock formations in Manistee County.

The bedrock beneath the glacial deposits in the Arcadia-Pierport Watershed consists of various types of shale. The predominant shale formations are the Antrim and Ellsworth formations. Manistee County itself is at the rim of the large sedimentary rock feature covering most of the Lower Peninsula of Michigan (known as the Michigan Formation). The outer edges of this formation contain significant hydrocarbon deposits. Manistee County ranks second in the state in all time total production of both oil and natural gas dating back to 1925. (*Greater Bear Watershed Management Plan*, 2013) Map 9 depicts the geology of the watershed.

The age and integrity of the oil and natural gas production infrastructure may pose a risk for groundwater contamination, which is of particular concern because of the permeability of the watershed's surficial geology (mostly sand and gravel substrates). The porous substrates may allow a faster and farther spread of contaminants from oil and natural gas production activities if there are spills or infrastructural failures.

Soils

The surface soils of the watershed reflect the glacial origins of this area along the Lake Michigan shoreline. In general, the soils are well-drained (permeable), sandy soils. Generally, surface runoff is minimized by the permeability of the soils in the watershed.

Substrates in the hilly upper portions of the Bowens Creek portion of the watershed consist mostly of sand, while further downstream in the lowlands, the soils consist of sand, muck, and some clay. Sand, however, is the predominant substrate in the watershed. There are a few areas that have significant amounts of gravel, but these gravel patches are restricted mostly to high gradient areas. The lower portion of Bowens Creek in the Arcadia Marsh has been impacted to a greater extent by human activities. (Tonello, 2008)

The Coastal Dune zone of the Arcadia-Pierport Watershed consists primarily of soils described as the Nordhouse Association. These soils are level to very steep, excessively drained, sandy soils on lake plains and dunes. Slopes range from 0 to 70 percent. (*Onekama Community Master Plan*, 2010)

As illustrated on Map 10, a significant portion of the watershed is composed of the Alfisol soil type. Alfisols typically form under a hardwood cover and are clay-enriched with a high native fertility. The "alf" refers to aluminium (Al) and iron (Fe). This is an important soil type for food and fiber production.

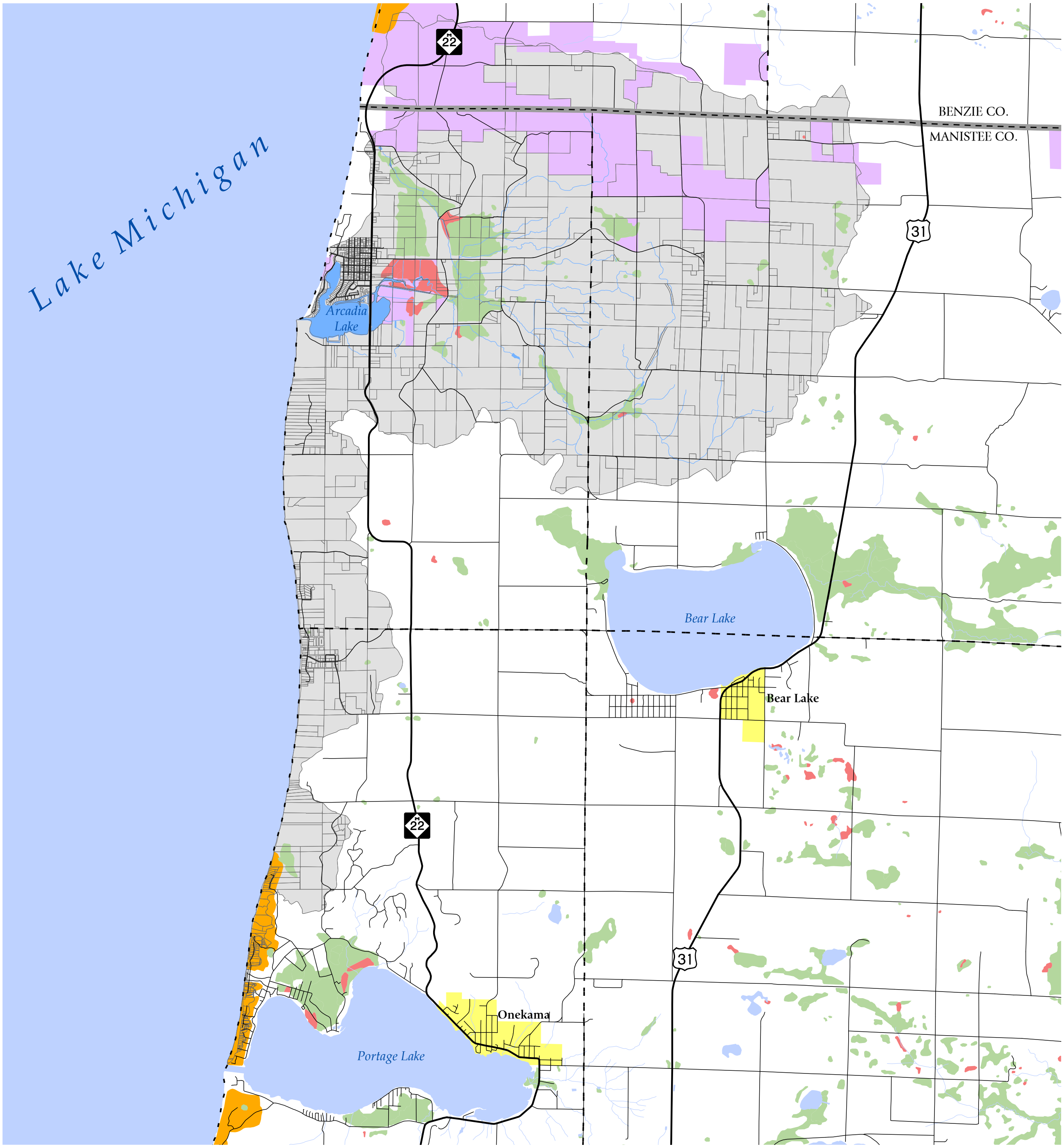
The next most prominent soil taxonomy is the Entisol, which is basically unaltered from their parent material. A common characteristic is its "A horizon," which is typically called topsoil. It contains partially decomposed organic material which makes it darker in appearance than other soil types.

Spodosols are acidic soils in forest environments, while Histosols are organic-type soils. There are a total of 12 soil orders; the others include Gelisols, Andisols, Aridisols, Vertisols, Oxisols, Ultisols, Mollisols, and Inceptisols. (McDaniel, n.d.) Spodosols are relevant to the Arcadia-Pierport Watershed because the residential area of Arcadia, with its septic tanks, is built upon Spodosol soils. (Sullivan, personal communication, 2015, August 17)

Figure 13: Two Soil Profiles

Alfisol Profile *Entisol Profile*

Map 11: Natural and Sensitive Areas



ARCADIA-PIERPORT WATERSHED

Natural and Sensitive Areas

0 0.5 1 2 Miles

Data Sources: State of Michigan Geographic Data Library, GTRLC

- Watershed Boundary
- Parcel Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road

Wetland Type:
- Emergent
- Forested/Shrub

- GTRLC Nature Preserve
- Critical Dunes

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Wetlands and Biological Rarity Index

For many of us, water simply flows from a faucet, and we think little about it beyond this point of contact. We have lost a sense of respect for the wild river, for the complex workings of a wetland, for the intricate web of life that water supports. - Sandra Postel, 2003

What is a Wetland?

Simply stated, wetlands are a part of our landscape that are defined by the presence of water. More specifically, wetlands are areas where the presence of water determines or influences most, if not all, of an area's biogeochemistry — that is, the biological, physical, and chemical characteristics of a particular site.

Wetlands typically represent transitional zones between upland and aquatic ecosystems, although not always. Some wetlands may be scattered across the landscape in depressions that collect water or zones where groundwater surfaces.

Different types of wetlands can be characterized by how much water is found and when it occurs on a site and the chemical nature of the water, soils, and/or underlying bedrock of the wetland ecosystem. Distinct plant communities may be found in different types of wetlands, with each member species adapted to the local hydrology, including the spatial and temporal distribution of water and its underlying chemistry. Many animal, fungal, and microbial species are completely dependent upon wetlands for critical stages in their lifecycles, while still other species choose to make use of wetlands for many of their life activities. (The Wetlands Initiative, n.d.) Map 11 depicts the locations of wetlands, as well as other natural and sensitive areas, in the Arcadia-Pierport Watershed and surrounding area, while Table 2 shows the acreage of these areas.

Defining Wetlands

Although we can readily describe wetland characteristics and what they do, in practice, there has been a great deal of difficulty in defining specifically what constitutes a wetland. A workable definition became critical in classifying habitat for legal purposes, especially in regard to determining what lands are protected by state and federal legislation. The U.S. Fish and Wildlife Service defined wetlands as follows in Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al., 1979):

"Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water... Wetlands must have one or more of the following three

Table 2: Acreage of Wetlands and Natural Features within Watershed

Type of Natural Feature	*Acreage in Watershed (acres)*	*Percentage of Watershed (%)*
Emergent Wetland	166.99 acres	0.88%
Forested/Shrub Wetland	878.09 acres	4.63%
Critical Dunes	189.22 acres	1.00%
GTRLC Nature Preserve	2,880.53 acres	15.18%
Total	*4,114.83 acres*	*21.69%*

attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is saturated with water or covered by shallow water at some time during the growing season of each year." (The Wetlands Initiative, n.d.)

The U.S. Army Corps of Engineers, the federal agency responsible for enforcing federal laws protecting wetlands, has more recently determined that in order for an area to be considered a wetland, it must have all three of the attributes referenced above, i.e., the area must be predominantly characterized by wetland vegetation, soils, and hydrology. (The Wetlands Initiative, n.d.)

Types of Wetlands

There are many different types of wetland, each determined by its hydrology, water chemistry, soils, and the predominant plant species found therein. Some wetlands are permanently flooded, while others are only seasonally flooded, but retain saturated soils throughout the unflooded periods. Still other wetlands may or may not ever be flooded, but maintain saturated soil conditions long enough for hydric soil characteristics to develop, i.e., chemical changes in the soil resulting from the low oxygen conditions associated with prolonged saturation. Wetlands may be characterized as dominated by trees, shrubs, or herbaceous vegetation. They may be fed by precipitation, runoff, or groundwater, with water chemistry ranging from very acidic to alkaline.

Marshes are wetlands that are permanently flooded or flooded during high water periods at the edges of rivers, streams, lakes, or ponds. Marshes may be dominated by submersed, floating-leaved, or emergent vegetation, including cattails, pondweeds, water lilies, and various sedges, rushes, spike rushes, grasses, and other forbs. Marshes can be subcategorized into emergent marsh and hemi-marsh. An example of a Marsh is Arcadia Marsh, located east of Lake Arcadia and M-22.

Emergent marsh is the marsh found around shorelines out to relatively shallow water, and is generally characterized by up to 100% cover with emergent plant species. In the Midwest, these may consist of various graminoids such as river bulrush and rice cut grass, and characteristic forbs such as purple false foxglove, nodding bur marigold, pickerel-weed, and duck potato. These marshes are ideal habitat for a wide range of animals, including raccoons, Great Blue Herons, and a multitude of dragonflies, butterflies, and other insects. Emergent marshes also provide critical habitat for rare amphibians and reptiles, such as the plains leopard frog and Blanding's turtle.

Hemi-marsh is found in deeper water, and is characterized by an open mix of emergent and/or floating-leaved vegetation interspersed with a submersed plant community. The submersed community may consist of species like sago pondweed, coontail, and wild celery, while the emergent or floating-leaved group may include deeper water species like broad-leaved cattail, American lotus, mosquito fern, white water lily, and common bur reed. The combination of emergents and floating-leaved species with open water creates an ideal combination of food and cover for many aquatic-dependent birds and amphibians. American Bitterns and Great Egrets comb these areas in hunting, while Common Moorhens and Pied-billed Grebes use them as areas to nest and rear their young. The rich vegetation also provides exceptional habitat for fish and is a great production area for the zooplankton and insects that are a critical part of the site's intricate food web.

Sedge meadows (or wet meadows) are wetlands with permanently or near-permanently saturated soils. They may form a transitional zone between marshes and other wetlands with less saturated soils, or occur in wet depressions and swales, or around groundwater discharge zones. The meadows are wet grasslands often dominated by sedges and grasses with relatively few forbs. They may be low in species diversity (with as few as a single dominant species), but relatively rich in some of the rarer species adapted to saturated soil conditions. There are many sedge species, with characteristic dominants including the lake sedge, tussock sedge, or brown fox sedge. Birds frequenting this habitat include the King Rail, Sandhill Crane, Northern Harrier, and Sedge Wren. Reptiles such as the northern water snake and amphibians like the pickerel frog and cricket frog are also common.

Wet prairie is an ecosystem sometimes found between sedge meadows and mesic prairies. Wet prairies are herbaceous wetlands dominated by a mixture of graminoids (grasses and sedges) and forbs, such as little bluestem, northern dropseed, prairie indian plantain, marsh phlox, and foxglove beardtongue. Wetland areas that are intermediate between wet prairie and mesic (dry) prairie can be characterized as wet-mesic prairie, the driest type of wetland in the Midwest.

Animals that may be found in wet prairies include Henslow's Sparrows, Short-eared Owls, eastern hog-nosed snakes, and coyotes.

Fens and seeps are wetlands that are fed by surfacing groundwater. The type of vegetation found within these wetlands is dependent upon the water chemistry and pH. Fens are typically alkaline from groundwater emerging from calcareous or dolomitic soils or bedrock zones, and many of the species found there can only grow under those conditions. Fens are dominated by herbaceous vegetation such as grass of Parnassus, bog lobelia, or beaked spikerush, but may also include trees or shrubs, such as various shrubby cinquefoils and/or willows.

Seeps are typically found along the base of slopes or glacial moraines where water emerges from saturated soils or a spring. Seeps are found throughout the Arcadia-Pierport Watershed. These usually small areas consist of plants such as clearweed, jewelweed, low nutrush, and marsh marigold.

Bogs are basin wetlands for which precipitation is the only source of water, i.e., they are typically not fed by surfacing groundwater or streams. Bogs are generally dominated by sphagnum mosses, which may form a floating mat over deeper water that supports a rich assortment of other species adapted to acidic water conditions. Sphagnum mosses acidify the water down to pH levels as low as 3.0, comparable to that of acid rain. Some of the unique plants adapted to these acidic conditions include some of the carnivorous plants such as the sundews and pitcher plants, as well as such economically important species as blueberry and cranberry. Because of the predominance of sandy, gravelly substrates, bogs are not a feature of the Arcadia-Pierport Watershed. (The Wetlands Initiative, n.d.)

Finally, forested/shrub wetlands are described by the U.S. Fish and Wildlife Service's National Wetlands Inventory as, "Forested swamp or wetland shrub bog or wetland." (United States Fish and Wildlife Service, 2015)

"Wetland" is the collective term for marshes, swamps, bogs, and similar areas often found between open water and upland areas. Part 303 of the Michigan Natural Resources and Environmental Protection Act (NREPA) defines a wetland as: "Land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation or aquatic life and is commonly referred to as a bog, swamp, or marsh." Wetland areas subject to regulation by the MDEQ include:

- Wetlands, regardless of size, which are contiguous to, or are within 500 feet of the ordinary high water mark of any lake, stream, or pond
- Wetlands which are larger than five acres and not contiguous to any lake, stream, or pond.
- Wetlands which are not contiguous to any lake, stream or pond, but are essential to the preservation of natural resources.

(*Onekama Community Master Plan*, 2010)

Wetland Benefits

Wetlands are valuable natural resources providing many important benefits to residents and the natural environment. Wetlands help improve water quality, manage storm water runoff, provide important fish and wildlife habitat, and support hunting and fishing activities. Wetlands contribute to the quality of other natural resources too, such as inland lakes, ground water, fisheries, and wildlife habitat. Wetlands store excess water and nutrients, control floods, and slow the filling of rivers, lakes and streams with sediment. In addition, acre for acre, wetlands produce more wildlife and plants than any other Michigan habitat. More specifically, benefits of wetlands include:

- Reduce flooding by absorbing runoff from rain and melting snow and slowly releasing excess water into rivers and lakes. (One acre, flooded to a depth of one foot, contains 325,851 gallons of water.)
- Filter pollutants from surface runoff, trapping fertilizers, pesticides, sediments, and other potential contaminants and breaking them down into less harmful substances. This improves water clarity and quality.
- Recharge groundwater supplies when connected to underground aquifers.
- Contribute to natural nutrient and water cycles, produce vital atmospheric gases, including oxygen, and serve as nutrient traps when next to inland lakes or streams.
- Provide commercial and recreational values to the economy by producing plants, game birds (ducks, geese), and fur-bearing mammals.

Survival of certain varieties of fish directly depends on wetlands, requiring shallow water areas for breeding, feeding and escape from predators.
(*Onekama Community Master Plan*, 2010)

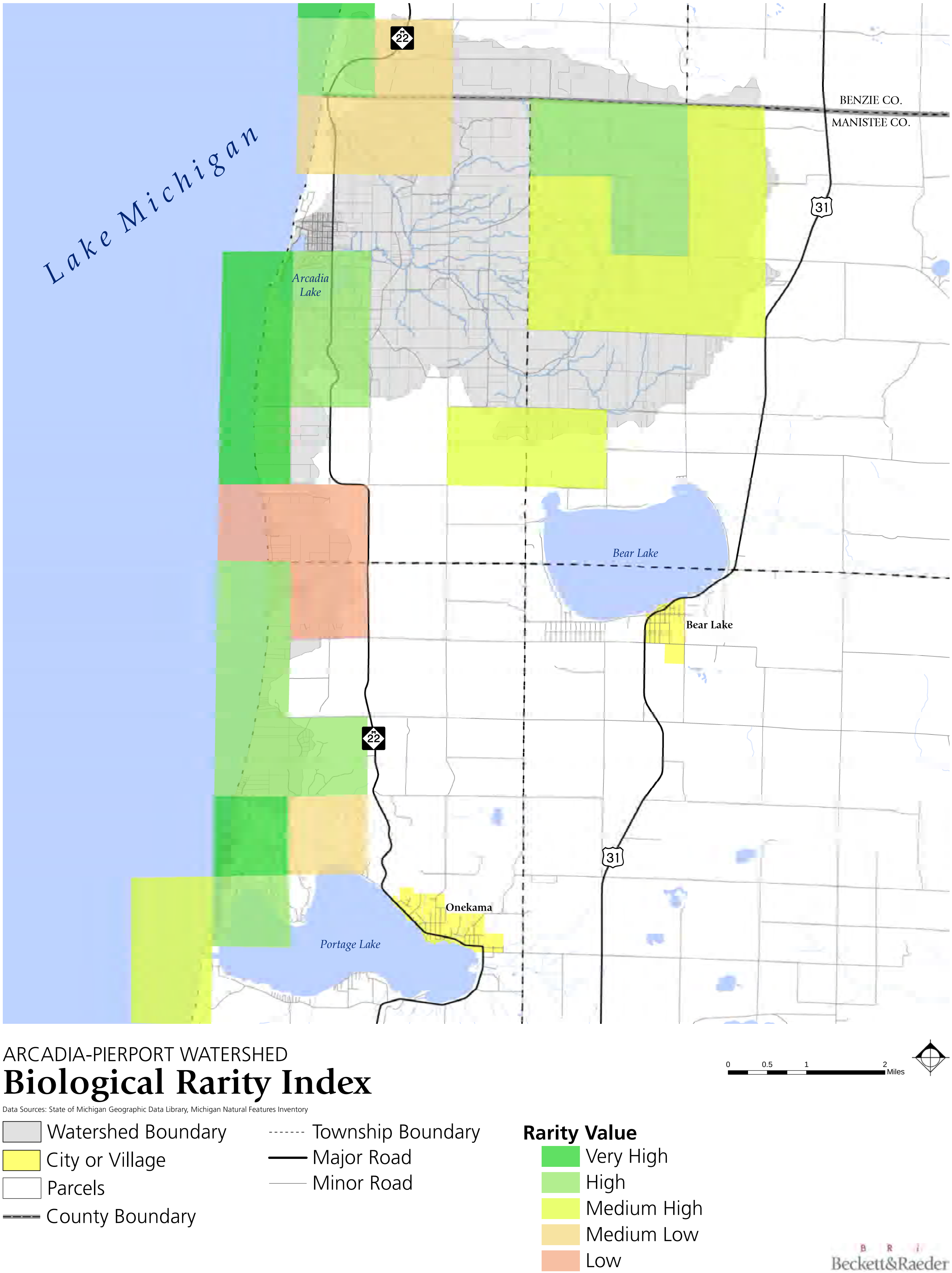
Biological Rarity Index

The Biological Rarity (Biorarity) Index model is based on the Michigan Natural Features Inventory database of known sightings of threatened, endangered, or special concern species and high quality natural communities. Each record is spatially subset to its habitat using landcover data, stream lines, and rail corridors. The record is then assigned three values based on the species' global status, State status, and occurrence quality rank. These values are multiplied by a likelihood of continued occurrence factor based on the age of the database record. Finally, the scores of all the records in a geographic unit are summed to determine the Biorarity Index for that unit. (Michigan Natural Features Inventory, n.d.)

Within the Arcadia-Pierport Watershed, the majority of the properties south of Arcadia Lake and west of M-22 are denoted as "High" value, except for Section 33 and 34 just south of Schaef Road.

In the eastern portion of the watershed south of Taylor Road and east of Zilch Road, these areas are noted as having "High" and "Medium High" biological rarity.

Map 12: Biological Rarity Index

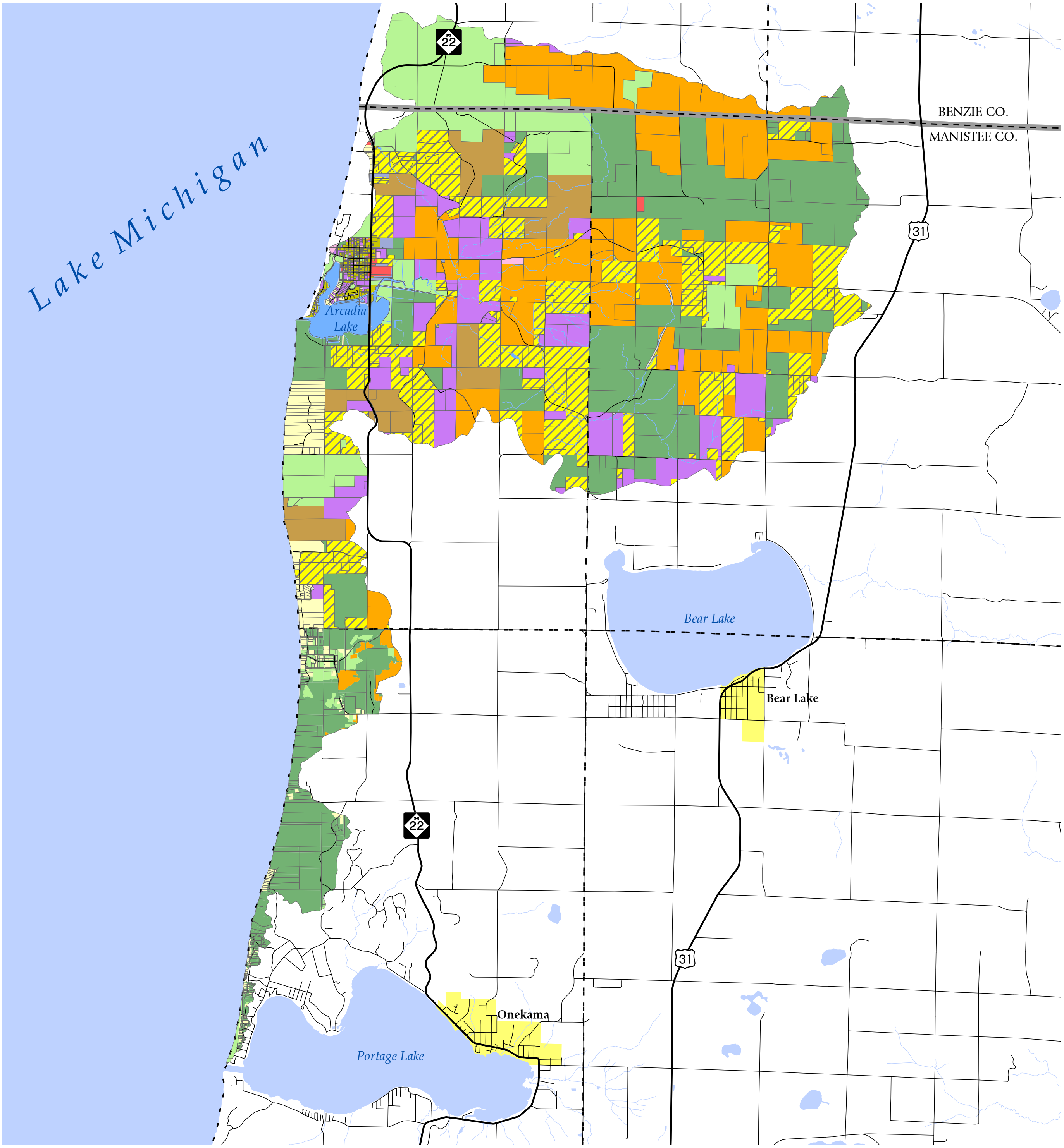


Map 12 illustrates the Biological Rarity Index for the Arcadia-Pierport Watershed, while Table 3 identifies rare species in the watershed and adjacent Manistee County properties. There are gaps in the map due to limitations in the dataset. The information is accurate as of the most recent publishing (2013) of Biorarity Index findings by the Michigan Natural Features Inventory. (Michigan Natural Features Inventory, n.d.) Attention to Watershed Goal II, which addresses inventorying and data collection, in Table 44 could help to close this gap.

Table 3: Rare Species in Watershed and Adjacent Manistee County Properties

Scientific Name	Common Name	Taxonomic Group
Accipiter gentilis	Northern goshawk	Birds
Ammodramus savannarum	Grasshopper sparrow	Birds
Botaurus lentiginosus	American bittern	Birds
Buteo lineatus	Red-shouldered hawk	Birds
Charadrius melodus	Piping plover	Birds
Circus cyaneus	Northern harrier	Birds
Cistothorus palustris	Marsh wren	Birds
Cygnus buccinator	Trumpeter swan	Birds
Dendroica cerulea	Cerulean warbler	Birds
Gavia immer	Common loon	Birds
Haliaeetus leucocephalus	Bald eagle	Birds
Ixobrychus exilis	Least bittern	Birds
Lanius ludovicianus migrans	Migrant loggerhead shrike	Birds
Pandion haliaetus	Osprey	Birds
Seiurus motacilla	Louisiana waterthrush	Birds
Acipenser fulvescens	Lake sturgeon	Fish
Coregonus artedi	Lake herring or Cisco	Fish
Coregonus kiyi	Kiyi	Fish
Coregonus zenithicus	Shortjaw cisco	Fish
Notropis anogenus	Pugnose shiner	Fish
Notropis dorsalis	Bigmouth shiner	Fish
Cirsium hillii	Hill's thistle	Flowering Plants
Cirsium pitcheri	Pitcher's thistle	Flowering Plants
Hemicarpha micrantha	Dwarf-bulrush	Flowering Plants
Orobanche fasciculata	Broomrape	Flowering Plants
Panax quinquefolius	Ginseng	Flowering Plants
Prunus alleghaniensis var. davisii	Alleghany or Sloe plum	Flowering Plants
Zizania aquatica var. aquatica	Wild rice	Flowering Plants
Trimerotropis huroniana	Lake Huron locust	Insects
Microtus pinetorum	Woodland vole	Mammals
Myotis sodalis	Indiana bat	Mammals
Perimyotis subflavus	Eastern pipistrelle	Mammals
Pleurobema sintoxia	Round pigtoe	Mussels
Clemmys guttata	Spotted turtle	Reptiles
Emydoidea blandingii	Blanding's turtle	Reptiles
Glyptemys insculpta	Wood turtle	Reptiles
Sistrurus catenatus catenatus	Eastern massasauga	Reptiles
Terrapene carolina carolina	Eastern box turtle	Reptiles
Pomatiopsis cincinnatiensis	Brown walker	Snails

Map 13: Existing Land Use



ARCADIA-PIERPORT WATERSHED

Existing Land Use

Data Sources: State of Michigan Geographic Data Library, USDA

Parcel Boundary
City or Village
County Boundary
Township Boundary
Major Road
Minor Road

Type:

Agriculture
Forest
Industrial
Leisure Activities
Mass Assembly
Natural Resources
Residential, Cottage/Resort
Residential, Rural
Residential, Settlement
Shopping, Business, or Trade
Social/Institutional
Unclassified/Vacant

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Land Use

"The 37 million acres that are Michigan is all the Michigan we will ever have." - Former Governor William Milliken, 2003

Land Use and Land Cover

"Land cover" refers to the physical material at the surface of the Earth: vegetation, water, pavement, ice, bare rock, wetlands, etc. The vast majority of land within both Benzie and Manistee Counties is designated as Forest, with significant pockets designated Agriculture. Map 13 shows the distribution of the various land use types in the Arcadia-Pierport Watershed, while Table 4 shows the quantity of the types. This information was gleaned from the recently adopted ***Arcadia Township Master Plan***, which was part of the Lakes to Land Regional Initiative. (***Arcadia Township Master Plan***, 2014) The existing land use maps were the results of local planning commissioners performing field inventories of properties within their jurisdictions. Unlike a Land Cover map, which is based on remote sensing parameters, the local existing land use map is field verified and a very current representation on how the land is being used.

Shopping, business and trade, and residential settlement categories are often referred to as "Urban land cover." Urban land cover refers to the impermeable surfaces with which we line our developments such as streets, sidewalks, buildings, and parking lots. Additionally, nearly every lake

Agricultural and forest land comprise the largest land use catagories.

in the region is accompanied by an area of denser urban-type development reflected by the number of dwellings per acre. The proximity of development to waterbodies presents particular challenges to water quality. Precipitation runoff carries pollutants such as vehicle fluids, salts, and animal waste across impermeable surfaces and directly into the water, without any of the filtration that would be provided by a permeable surface such as soil. Improperly constructed or failing septic fields can leach human waste into the water and increase the nitrates in the groundwater. Chemical fertilizer, even when properly applied and at the residential scale, can have serious consequences for water quality due to its concentration of phosphorous and, in some applications, pesticides. Phosphorous, which is an essential element for plant life, can reduce the dissolved oxygen (DO) in a waterbody and thus its ability to support macroinvertebrates and fish and animal habitats. (*Arcadia Township Master Plan*, 2014) Watershed Goals I, II, and III in Table 44 address water quality, while Watershed Goal IV addresses septic tanks, and Watershed Goal V addresses green infrastructure. Completion of Implementation Tasks IIA, IIIC, IIID, IIIE, IVA, and VA in Table 46 could help with water quality and to address problems from runoff and septic systems.

Historical and Current Land Use/Cover Type Inventory

Arcadia Township: The Arcadia & Betsie River Railroad, terminating in Arcadia, had extended over 17 miles to connect with the Chicago and West Michigan Railway by 1895. The line maintained an influx of goods to the area and allowed crop transportation from the fertile fields of the township to the markets of Chicago. There was also a good market for ice, which was cut from Bear Lake and hauled by wagon to A&BRR's Sorenson Station just east of Pleasanton Township from about 1890 until 1937. The Arcadia Furniture Factory on the north end of Bar Lake manufactured both furniture and fine veneers to be sold in Macy's in New York City. The Village of Arcadia, originally named Starkeville after lumberman Henry Starke, changed its moniker to match the township in 1870. Anne M. Dempster opened the post office in 1870. Just north of town was a notable "fancy house," which soared in popularity when proprietors struck upon the novel idea of sending a wagon to Arcadia's pier to greet incoming sailors.

As the nineteenth century drew to a close, the lumber barons had just about clear-cut the entire state of Michigan. Though agriculture was expected to take the place of logging in the local economy, as it had done elsewhere, soils better suited to the slow, woody growth of trees ensured that it did not. Collapsing farm prices and tax delinquency following the end of World War I placed hundreds of thousands of acres of land under government control.

Faced with a population hemorrhage out of northern Michigan, the state's Conservation Department embarked on a program of rehabilitating the land for recreational purposes. The Manistee National Forest was created in 1938. The Sleeping Bear Dunes National Lakeshore began as an unsuccessful 1941 recommendation to establish a state park on the Leelanau Peninsula. Finally authorized by the National Parks Service in 1970, it extends across approximately 35 miles of Lake Michigan Shoreline from Benzie to Leelanau Counties. In the 1990s, Rotary Charities commissioned a study showing a breakneck pace of development in northern Michigan and responded by incubating the Grand Traverse Regional Land Conservancy. The Conservancy has since partnered with individuals, foundations, and all levels of government to protect over 34,000 acres of land and 100 miles of shoreline. (*Arcadia Township Master Plan*, 2014)

Pierport is located on Lake Michigan, south of Arcadia. The Turnersport Pier Company constructed a pier in Pierport for the shipment of wood in 1866. Pierport was known as Turnersport at first, and a post office opened in 1868. C. W. Perry took over the Turnersport Pier Company in 1870 and was instrumental in developing the settlement, which was renamed Pierport. Pierport grew, and in its prime in the 1870s and 1880s, it was home to a post office, a school, stores, and two piers and a stop on the railroad. It began to decline in the late 1880s and 1890s, and the post office

Table 4: Existing Land Use in Watershed

Type of Land Use	*Acreage in Watershed (acres)*	*Percentage of Watershed (%)*
Agricultural	4,980.81 acres	28.95%
Forest	3,479.50 acres	20.22%
Industrial	28.59 acres	0.17%
Leisure Activities	2,141.69 acres	12.45%
Mass Assembly	19.39 acres	0.11%
Natural Resources	1,031.03 acres	5.99%
Residential, Cottage/Resort	376.01 acres	2.19%
Residential, Rural	3,370.79 acres	19.59%
Residential, Settlement	98.28 acres	0.57%
Shopping, Business, Trade	33.87 acres	0.20%
Social/Institutional	0.77 acres	0.01%
Unclassified/Vacant	1,646.94 acres	9.57%
Total	*17,207.67 acres*	*100%*

closed in 1933. (Historic Arcadia, Michigan, n.d.)

Conserved and Public Lands

For two decades the Grand Traverse Regional Land Conservancy (GTRLC) has protected and cared for the northwest Michigan's natural, scenic, farm and forest lands. The GTRLC "thinks" about the landscape in terms of watersheds, rivers, scenic transportation corridors and the vital clusters of the region's working farms and forests. Thus, GTRLC is able to evaluate how certain land uses and protection and stewardship efforts impact the things our community members value the most — access to our region's majestic shorelines; opportunities for hiking, biking, hunting, canoeing, birding, fishing and other outdoor activities; safe, clean water; a sense of rural character; respect for private property rights; and a healthy economy. GTRLC's mission is to protect significant natural, scenic, and farm lands, and advance stewardship, now and for future generations. Its service area includes Antrim, Benzie, Grand Traverse, Kalkaska and Manistee Counties. With the support of individual donors and foundations, volunteers, and the partnership and leadership of local, state, and federal agencies, GTRLC has protected over 38,000 acres of land and more than 114 miles of shoreline along the region's exceptional rivers, lakes and streams. For more information, visit www.gtrlc.org. (Grand Traverse Regional Land Conservancy, n.d.a)

The largest landholder in the Arcadia-Pierport Watershed is GTRLC. GTRLC owns approximately 2,891.41 acres in the Arcadia-Pierport Watershed. Of that total, approximately 270 acres are in Arcadia Marsh, while approximately 2,614.41 acres are in the Arcadia Dunes Nature Preserve, and approximately seven acres are in the northwestern corner of the watershed. GTRLC also has conservation easements on 1,490.26 agricultural acres in the watershed. The total would be approximately 4,381.67 acres. (Sullivan, personal communication, 2015, June 11; Sullivan, personal communication, 2015, July 22) In partnership with organizations like Ducks Unlimited, Conservation Resource Alliance, the Little River Band of Ottawa Indians, and others, GTRLC has established the Arcadia Marsh Nature Preserve. The channel that connects Arcadia Lake to Lake Michigan is under federal jurisdiction.

Arcadia Township, located in Manistee County, is bordered on the west by Lake Michigan and nestled in a spectacular natural valley surrounded by soaring sand bluffs. The Township contains two interconnected lakes, one of which is a Harbor of Refuge, and a significant freshwater Great Lakes coastal marsh. Arcadia Marsh, one of the Conservancy's nature preserves, is one of only 15 or so remaining coastal marshes along Lake Michigan's Lower Peninsula shoreline, and hosts over 150 species of birds, including

Figure 14: Camp Arcadia

Figure 15: Arcadia Dunes

17 State-designated Endangered, Threatened, or Species of Special Concern species.

The Grand Traverse Regional Land Conservancy's long-term vision for its Arcadia Marsh property includes maintaining ecosystem integrity; creating and maintaining access for restoration of the approximtaely 270-acre Marsh; honoring donor and grant commitments, which include accessibility; and maintaining and building relationships with users and stewards of the property. (Sullivan, personal communication, 2015, July 22) This current phase of the Arcadia Marsh project includes additional land acquisition, restoration work, and the development of Universally Accessible infrastructure, including parking, signage, picnic areas, trails and boardwalks, and fishing piers.

There are 17.7 miles of hiking and mountain biking trails at Arcadia Dunes, but none of them are accessible to those with physical limitations. (Grand Traverse Regional Land Conservancy, n.d.a) Wooded Universally Accessible trails are rare in northern Michigan outside of Hartwick Pines (Grayling area). The goal of this project is to create a 1/2 mile paved Universally Accessible trail overlooking the Lake Michigan coast. The project supports the goals of the Michigan DNR-approved management plan for the property and public access and users' needs. The development of the trail may also alleviate use pressure and erosion on the existing trail to the Old Baldy dune.

Arcadia Township has also planned three investment phases for improvements at Arcadia Beach along Lake Michigan. The improvements include new parking and Universally Accessible restroom facilities, a viewing platform, and beach access, as well as a playground area. GTRLC is collaborating with the Township to manage a joint fundraising campaign for the Arcadia Dunes, Arcadia Marsh, and Arcadia Beach projects. This collaborative project reinforces the power of community-based partnerships that aim to protect natural resources and stimulate the economy, provide an example of rural placemaking, demonstrate a role that conservancies can play in community building and economic development, and illustrate a landscape level approach to conservation planning and implementation.

Recreation

The majority of the land surrounding Arcadia Lake is privately owned. The only boat launch on Arcadia Lake is in the Village of Arcadia at Veteran's Memorial Park. The park includes a launch, marina facility, and a universally accessible fishing pier and is operated by Arcadia Township.

Arcadia Lake is unique in that it has not been previously surveyed by the Michigan Department of Natural Resources (MDNR) Fisheries Division. Most inland lakes in Michigan have had fisheries surveys conducted on them numerous times, often starting in the 1930s or 1940s. Despite this, Arcadia Lake has long had a good reputation as a fishing lake. In addition to its spring brown trout fishery, it is known for its good fishing for yellow perch, northern pike (both summer and through the ice) and bass, both largemouth and smallmouth. It is known as a very good bowfishing lake for common carp, particularly during the June spawning period. Migratory salmonids like Chinook salmon (fall) and steelhead (late fall, winter, and early spring) can also be caught from Arcadia Lake at times.

There have been six entries into the MDNR Master-Angler program from Arcadia Lake in recent years. Species entered include three common carp, one smallmouth bass, one walleye, and one channel catfish. Arcadia Lake is a popular destination for bowfishing for carp, so the presence of Master Angler-sized carp is not surprising. The walleye and smallmouth bass were both particularly impressive. The walleye was 34 inches long and caught in 2002. The smallmouth bass was 25 inches long and caught in 2003. Both fish were catch and release entries. At one time, Arcadia Lake was home to the State Record brown trout. The record fish was caught in 1984 and weighed 34 lbs 6 oz. It was caught by Robert Henderson of

Figure 16: Brown Trout
Source: MDNR

Vestaburg, Michigan, while trolling with an Eppinger Copy Cat spoon. The Henderson brown trout stood as the Michigan state record until 1998 when a larger brown trout was caught from Lake Michigan. Mr. Henderson's brown trout was also considered the world record for several years. (Tonello, 2012)

The Explore the Shores network of barrier-free sites that provide access to water in Manistee County is the result of a dynamic partnership led by the Alliance for Economic Success, a regional economic development organization with a wide variety of public and private partners, including the Grand Traverse Regional Land Conservancy. Two of the conservancy's protected nature preserves — Arcadia Marsh Nature Preserve and Arcadia Dunes: The C.S. Mott Nature Preserve — are part of a collaborative network of publicly accessible and jointly marketed sites designed to provide barrier-free accessibility, educational opportunities, and a connection to recreation and fishing in Manistee County.

With a climate tempered by the cool waters of Lake Michigan, has made Arcadia has been a refuge for visitors from southern Michigan and neighboring states since the 1900s. People are drawn to the natural beauty and relative remoteness of the area — many of the visitors are connected with the nationally renowned Arcadia Bluffs Golf Club, built in 1999 in the south part of the township, and Camp Arcadia, a Lutheran family retreat center founded in 1922, which draws thousands of visitors each year.

Transportation

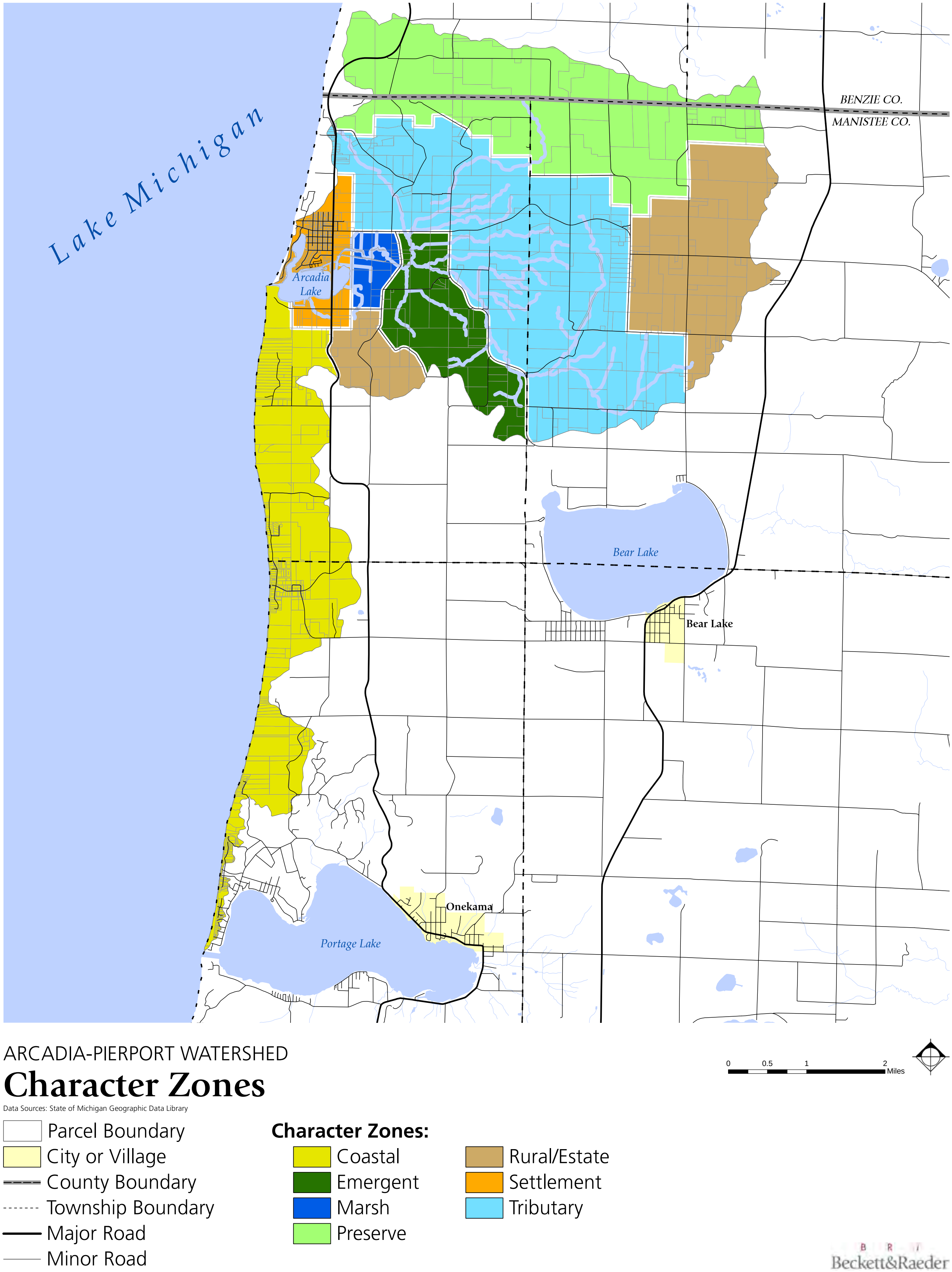
Transportation corridors — state and federal highways, paved county roads and dirt roads, and snowmobile and ATV trails and bike trails — can each have adverse impacts on the watershed, depending on the roadway or trail design, construction practices, and maintenance. Culverts and bridges that afford safe passage to vehicles over streams and rivers can contribute to erosion of stream banks and runoff contaminated with salt or road oils, as well as block fish passage to upper reaches in the creeks, limiting habitat use. Roads cross over creeks 57 times in the Arcadia-Pierport Watershed and the area between Arcadia Lake and Arcadia Marsh one time. (Grand Traverse Regional Land Conservancy, n.d.b; State of Michigan, 2013)

Populated Areas

With over 6 miles of shoreline, Lake Michigan forms the western boundary of Onekama Township. Residential development has concentrated in two core areas, Pierport and the Portage Lake channel. Portions of the shoreline between these two concentrations of development have maintained their natural land cover. Much of the existing development along Lake Michigan north of the channel is located in designated Critical Dune territory, while lakeshore development near Pierport is located in High Risk Erosion areas. Like many communities along Lake Michigan, the shoreline in Onekama Township is exposed to high winds and water erosion caused by frequent storms and fluctuating lake levels producing consequent wave action. These natural processes can have detrimental effects on the stability of the dunes and the lakefront residential homes that reside within the dune system. (*Onekama Community Master Plan*, 2010)

Figure 17: Explore the Shores
Source: Michigan.gov

Map 14: Character Zones



Character Zones

Character zones merge the natural and man-made environments together, helping us understand their relationships and connectivity.

Character Zones

The Arcadia-Pierport Watershed has seven distinct Character Zones:

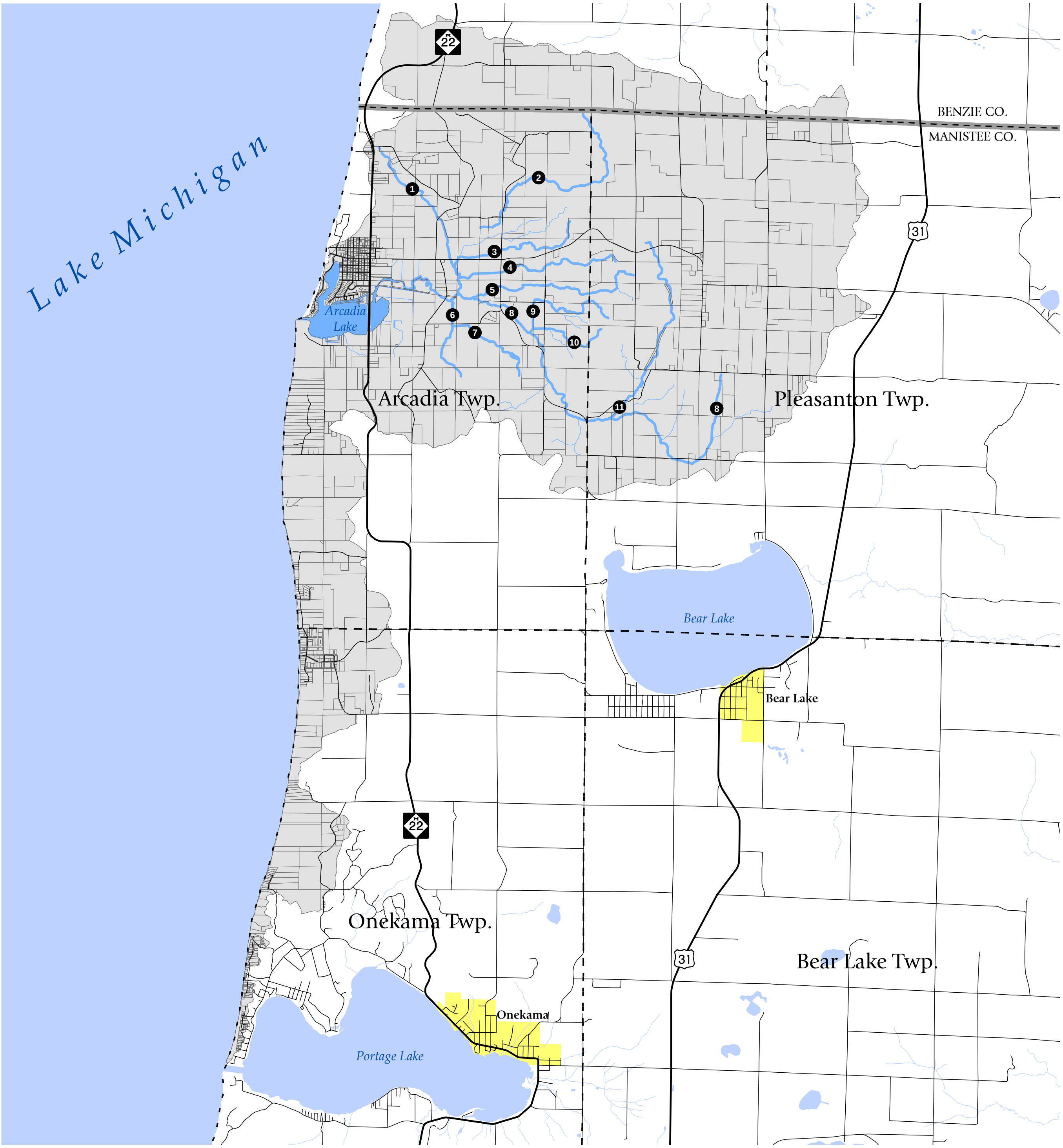
- The Coastal Dunes area
- Bowens Creek and its tributaries upstream of Arcadia Marsh
- The Preserve, which is the headlands that feeds a number of the Bowens Creek tributaries and is owned and managed by the Grand Traverse Regional Land Conservancy
- Arcadia Lake and the associated settlement area
- Arcadia Marsh
- The Emergent wetland area adjacent to Arcadia Marsh (United States Fish & Wildlife Service, n.d.)
- Rural/Estate areas that are larger, privately-owned tracts of land with relatively low population density

Map 14 and Table 6 present information about the Character Zones.

Coastal Dunes Zone

The Coastal Dunes Zone stretches for about 8.5 miles along the Lake Michigan coastline from the Portage Lake Channel to the Arcadia Lake Channel, crossing the two Townships of Arcadia and Onekama. (State of Michigan, 2013) The southernmost stretch of Coastal Dunes is identified as Barrier Dunes, and the MDEQ has designated this area as a Critical Dune Area. The northern section has not been evaluated to determine if it merits a critical dune designation. The Coastal Dunes cover approximately 3,271 acres (5.11 square miles), or 17% of the watershed. (State of Michigan, 2013) Land use in this area includes residential homes on large lots/tracts of land, the Arcadia Bluffs Golf Club, and some small scale agriculture.

Map 15: Watershed Tributaries



ARCADIA-PIERPORT WATERSHED

Tributaries

Data Sources: State of Michigan Geographic Data Library, USGS

0 0.5 1 2 Miles

- Watershed Boundary
- Parcel Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road

1. Lucker Creek
2. Toohey Creek
3. Van Bushkirk Creek
4. Tondu Creek
5. Richley Creek
6. Chamberlain Creek
7. Schimke Creek
8. Bowens Creek
9. Hull Creek
10. Ware Creek
11. Lumley Creek

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Figure 18: Bowens Creek Meandering toward Arcadia Lake

Tributary Zone

Bowens Creek is supplied by a number of spring-fed creek tributaries that converge to form the mainstem of Bowens Creek. There appears to be some disagreement about the names of various creeks within the Bowens Creek watershed, as well as their convergence points. A number of maps were reviewed, including the Land Atlas and Plat Book for Manistee County (years 2005, 2007, and 2013), the Michigan Department of Natural Resources Spatial Data Library (specifically, the applicable USGS Topo maps), and the Michigan Center for Geographic Information online resources for Benzie and Manistee Counties. There were differences among and between these three mapping sources, including creek names and creek lengths. Please note that the watershed studies conducted by the DNR and the Little River Band of Ottawa Indians (LRBOI) used different map sources to identify the creeks under study. Names are not official, and some have been modified to reference more easily which creek is being referred. Assumptions were also made regarding the length of some tributaries. For example, where two small creeks converged at the Bowens Creek headwater area (by Alkire Road in Pleasanton Township), we picked one to represent the uppermost reach of Bowens Creek and considered the other a separate unnamed tributary.

The primary tributaries in the Arcadia-Pierport Watershed are Lucker Creek, Toohey Creek, Van Bushkirk Creek, Richley Creek, and Chamberlain Creek. The tributaries in the watershed are shown on Maps 15 and 16, and information about them is presented in Table 5. The mainstem of Bowens Creek flows for about 6.79 miles before it enters Arcadia Lake as a third-order stream. (State of Michigan, 2013) Arcadia Lake is a "drowned rivermouth" lake with a direct connection to Lake Michigan. Virtually the entire Bowens Creek watershed is accessible to migratory fish from Lake Michigan, except where a number of perched culverts prevent fish passage. (Tonello, 2008)

The upper Tributary Character Zone represents the higher elevations of the Bowens Creek drainage area and covers 9.19 square miles, or 5,878.43 acres.

Bowens Creek and all of its tributaries are Designated Trout Streams by the MDNR, and all are classified as Type 1 streams. Type 1 streams are open to fishing only during the "regular" trout season, which runs from the last Saturday in April through September 30. The minimum size limit for brook trout and brown trout is 8 inches, and 10 inches for rainbow trout, coho salmon, and Chinook salmon.

The daily possession limit for trout or salmon is five fish, with no more than three fish 15 inches or larger. (Tonello, 2008) Land use in this zone includes residential housing on large lots/tracts, agricultural activities, and recreational activities, such as fishing.

Lucker Creek

Lucker Creek is a first-order stream that is 2.27 miles long, originates near St. Pierre Road and M-22, and flows south to join Bowens Creek just south of Glovers Lake Road.

Toohey Creek

Toohey Creek was used as the control site in studies conducted by the LRBOI. (*Final Technical Report - Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013) Toohey Creek is a spring-fed, first-order stream. It is about 2.88 miles long. Toohey Creek originates near Gilbert Road and ends north at the Benzie-Manistee County border near Taylor Road.

Van Bushkirk Creek

Van Bushkirk Creek's headwaters are near the eastern edge of Arcadia Township, and the Creek flows westward along the north side of Glovers Lake Road for about 1.80 miles. This first-order stream enters Bowens Creek just south of Glovers Lake Road.

Tondu Creek

Tondu Creek's headwaters originate in Pleasanton Township just east of Arcadia Township's boundary and flow westward for about 2.10 miles south of Glovers Lake Road, entering Bowens Creek just below VanBushkirk Creek.

Richley Creek

Richley Creek begins in Pleasanton Township just west of Leitau Road and flows westward for about 2.27 miles, more or less paralleling Tondu Creek and entering Bowens Creek north of Frederick Road.

Chamberlain Creek

Chamberlain Creek is a second-order stream whose headwaters are north of Erdman Road, and the Creek flows north for about 1.11 miles before joining Bowens Creek just east of St. Pierre Road.

Schimke Creek

Schimke Creek is a first-order stream that is about 1.28 miles long. It begins near Lumley and Ware Roads, flowing into a small pond and exiting on the opposite side, flowing northwest through the Emergent Zone until it reaches Frederick Road. Then it turns west and runs parallel to Frederick Road for almost one quarter mile before entering Chamberlain Creek.

Bowens Creek

Bowens Creek is a third-order stream. The catchment area for Bowens Creek (including all the tributaries) is about 24 square miles. The land cover is dominated by forest (48.7%), cultivated crops (19.0%), and grasslands (15.4%). (*Final Technical Report - Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013) Bowens Creek is the longest creek in the watershed, flowing about 6.79 miles from its headwaters just east of Butwell Road in Pleasanton Township to Lake Arcadia.

Hull Creek

Hull Creek is a spring-fed, first-order stream meandering through a few small agricultural parcels for about 1.61 miles. The stream is somewhat flashy due to clay in the watershed and the numerous gullies draining nearby agricultural land. Hull Creek's watershed is dominated by forest (48.6%), pasture/hay (25.0%), and cultivated crops (20.7%). (*Final Technical Report - Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

Ware Creek

Ware Creek is a spring-fed, first-order stream located about 2 miles straight east of Arcadia Lake, that winds its way for about 1 mile through a few small agricultural parcels before entering Hull Creek just west of Ware Road. The land cover here is dominated by forest (82.6%) and, to a lesser extent, pasture/hay (10.1%). (*Final Technical Report - Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

Lumley Creek

Lumley Creek begins just north of Glovers Lake Road and west of Leitau. It flows in a southerly direction for about 2.66 miles, joining Bowens Creek east of Lumley Road.

The Tributary zone has the greatest interface with the land utilization practices.

Map 16: Tributary Network

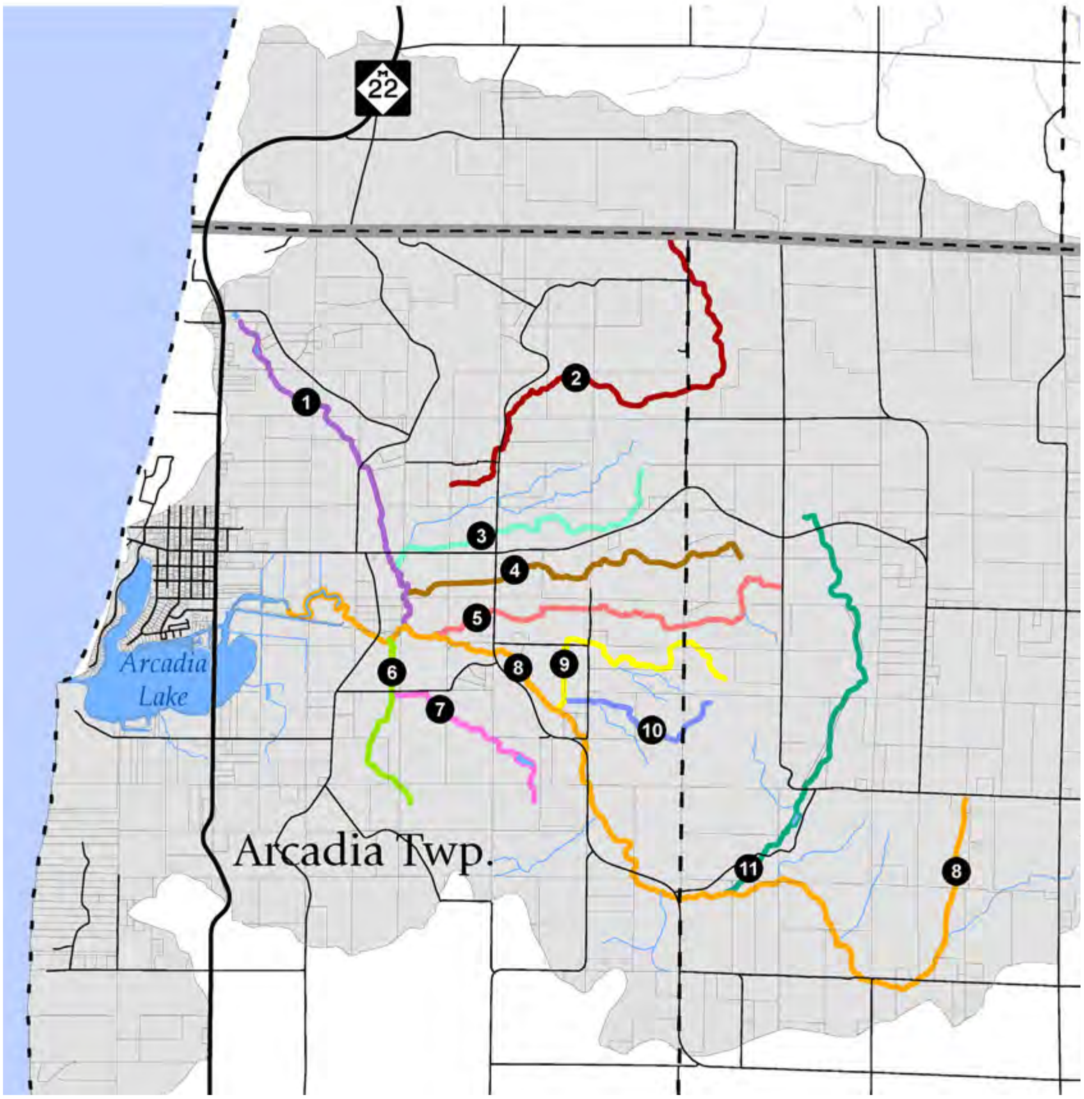

Table 5: Watershed Stream/Tributary Segments

Identifying Number on Maps 15 and 16	*Tributary Name*	*Number of Segments*	*Length (miles)*
1	Lucker Creek	6	2.27 miles
2	Toohey Creek	2	2.88 miles
3	Van Bushkirk Creek	2	1.80 miles
4	Tondu Creek	1	2.10 miles
5	Richley Creek	3	2.27 miles
6	Chamberlain Creek	2	1.11 miles
7	Schimke Creek	4	1.28 miles
8	Bowens Creek	15	6.79 miles
9	Hull Creek	3	1.61 miles
10	Ware Creek	2	1.00 miles
11	Lumley Creek	6	2.66 miles
--	*Total*	--	*25.77 miles*

The Preserve

The total preserve lands measure about 6.7 square miles in the Arcadia-Pierport Watershed. (Grand Traverse Regional Land Conservancy, n.d.a; State of Michigan, 2013) The Arcadia Dunes Nature Preserve consists of approximately 2,614.41 acres that are owned by the Grand Traverse Regional Land Conservancy in the Arcadia-Pierport Watershed. (Sullivan, personal communication, 2015, June 11; Sullivan, personal communication, 2015, July 22) The majority of the acreage covers the northern tier of the Arcadia-Pierport Watershed and includes the headwaters of Toohey Creek.

Arcadia Lake and Associated Settlement Area

Arcadia Lake is an inland lake with a direct connection to Lake Michigan in northwestern Manistee County. Known as a "drowned rivermouth lake," Arcadia Lake is connected to Lake Michigan via a dredged channel that is approximately 250 yards in length, with rock rip-rap breakwalls that extend out into Lake Michigan. Arcadia Lake is 243 acres in size, with a maximum depth of approximately 28 feet. The main basin of Arcadia Lake is relatively shallow, with an average depth of less than 20 feet. The north arm of the lake was historically dredged to allow larger boat traffic (possibly even ships at one time). Therefore, it is characterized by steep drop offs and an average depth greater than 20 feet. (Tonello, 2012) The majority of the land surrounding Arcadia Lake is privately-owned. All residences have residential wells and septic systems; there is no public water or wastewater system in place. The Settlement Zone is about 1.31 square miles, or 843 acres. This area also includes a small commercial district with motels, bed and breakfasts, a gas station and convenience store, small food/beverage establishments, small shops, a boat storage facility, and a community center and professional offices, as well as recreational facilities (boat ramp, lakeside parks, and the town beach and campground).

Arcadia Marsh

The lower section of the Bowens Creek watershed is part of a unique and diverse ecosystem defined as Great Lakes coastal wetland. Below St. Pierre Road, Bowens Creek flows approximately 1.25 miles through Arcadia Marsh into Arcadia Lake and eventually into Lake Michigan. (*Final Technical Report - Arcadia Marsh/ Bowens Creek Restoration and Fish Passage*, 2013)

The dimensions of the Marsh are open to interpretation; however, for management purposes, it is considered to be the area within the polygon created by M-22, Glovers Lake Road, St. Pierre Road, and Chamberlain Road and totals about 330 acres.

Bowens Creek was channelized along a railroad grade running through Arcadia Marsh, and, as a result of a host of additional anthropogenic disturbances, the stream was nearly completely diverted. The channelized segment ran from just downstream of St. Pierre Road approximately 1/2 mile to near its confluence with Arcadia Lake. The riparian vegetation along this stretch was predominately grasses and sedges with very little in-stream habitat or riparian cover. (*Final Technical Report - Arcadia Marsh/ Bowens Creek Restoration and Fish Passage*, 2013)

According to Chris Sullivan, "In 2011 Ducks Unlimited secured a $783,000 Sustain Our Great Lakes grant for restoration in Arcadia Marsh (GTRLC was one of the partners), including the restoration of the channelized section of Bowens Creek, re-establishment of shallow open water habitat, and the replacement of road-stream crossings in the watershed. With leftover funds from that grant, GTRLC was able to purchase a 38-acre addition to the Arcadia Marsh Preserve. Land acquisition was not part of the original grant." (Sullivan, personal communication, 2015, June 11) The Conservancy now owns approximately 270 acres of Arcadia Marsh. (State of Michigan, 2013; Sullivan, personal communication, 2015, June 11; Sullivan, personal communication, 2015, July 22) With its marsh landholdings, the GTRLC has established the Arcadia Marsh Preserve, creating public access structures to view and enjoy the marsh ecosystem. A 2013 grant of about $66,000 provided through the North American Wetland Conservation Act (NAWCA) helped the Conservancy purchase a 66.5 acre addition to the marsh. In the spring of 2014, Great Lakes Fish and Wildlife Restoration Act (GLFWRA) grant funding received by the Grand Traverse Band of Ottawa and Chippewa Indians (GTB) provided $74,247 to the Conservancy to continue invasive species management through 2017 and to engage GTB to complete a watershed assessment and conduct Arcadia Marsh restoration planning. (Sullivan, personal communication, August 17)

Emergent Wetland Zone

The Emergent Wetland zone is an area of nearly 100% upright perennial plants, primarily grasses, sedges, and bulrushes, but may also include shrubs and trees that can live in water-saturated conditions. This zone is bounded by Glovers Lake Road to the north, St. Pierre and Erdman Roads to the west, Norconk Roads to the south, and Gilbert, Ware, and Lumley Roads to the east. The Emergent Wetland zone covers approximately 1,452 acres (2.26 square miles). Lower reaches of a number of creeks pass

Table 6: Area of the Character Zones in Watershed

Character Zone	Square Miles in Watershed (square miles)	Acreage in Watershed (acres)	Percentage of Watershed (%)
Coastal	5.11 square miles	3,271.01 acres	17.2%
Emergent	2.26 square miles	1,451.78 acres	7.7%
Marsh	0.52 square miles	331.25 acres	1.7%
Preserve	6.68 square miles	4,279.37 acres	22.6%
Rural/Estate	4.55 square miles	2,918.11 acres	15.4%
Settlement	1.31 square miles	842.97 acres	4.4%
Tributary	9.19 square miles	5,878.43 acres	31.0%
Total	*29.62 square miles*	*18,972.92 acres*	*100.0%*

through the Emergent Wetland zone, including Bowens Creek, Lucker Creek, Richey Creek, Tondu Creek, and Van Bushkirk Creek. Schimke Creek and Chamberlain Creek are entirely in this zone. Land use in this area include residential homes on larger acreages, with some agricultural activities that include animal management.

Rural/Estate Area

The two Rural/Estate areas are low population density areas of farmlands, orchards, pasture and fallow land, and forest. The headwaters of Bowens Creek reach into the eastern Rural/Estate area, however, the western Rural/Estate area does not contain any USGS-named waterbodies. There are smaller water features in both the east and west Rural/Estate areas that are unnamed, which are likely groundwater recharge and discharge areas. The combined acreage of the Rural/Estate areas totals 2,918 acres (about 4.55 square miles).

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CHAPTER TWO:

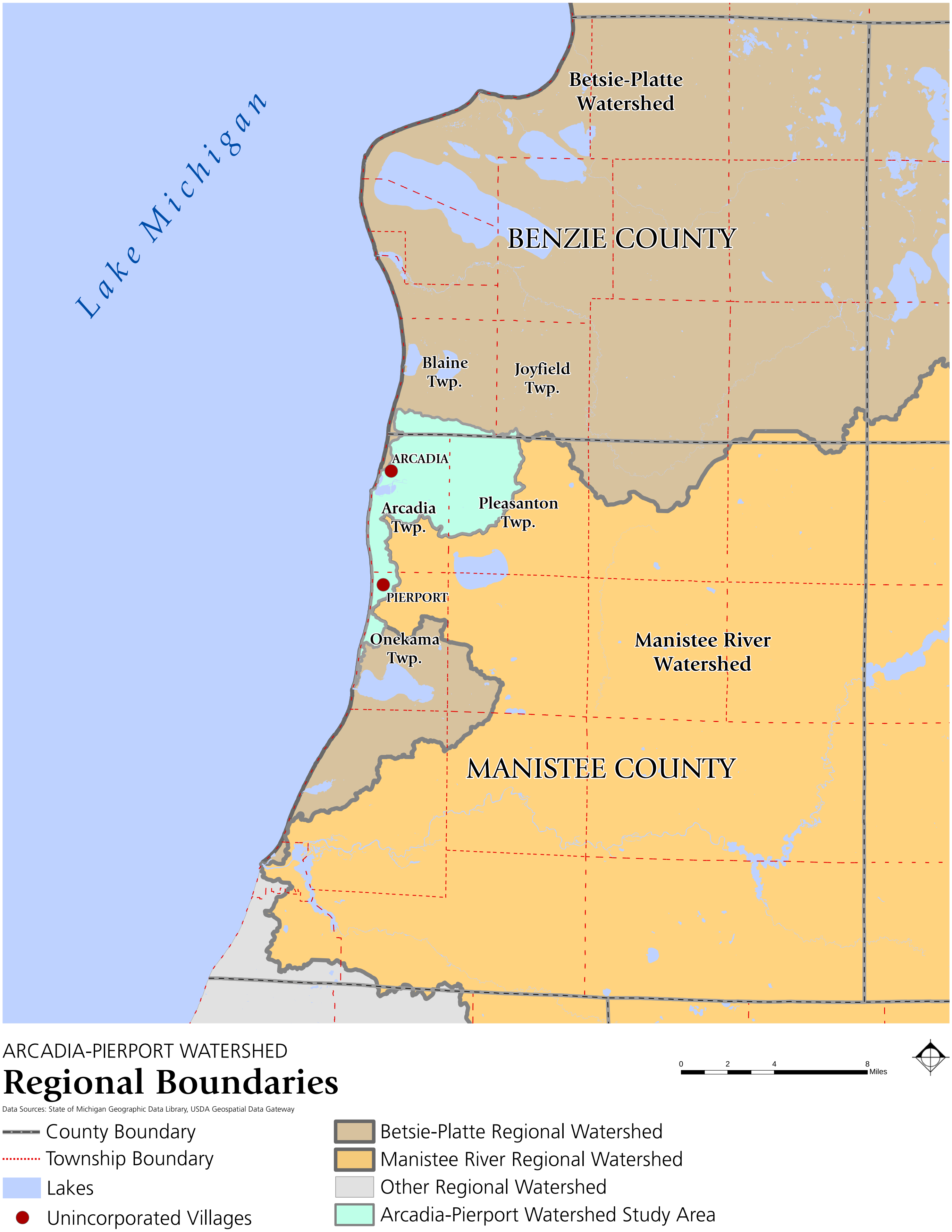
WATER QUALITY OF THE ARCADIA-PIERPORT WATERSHED

First, it is important to recognize that there is a larger watershed that encompasses the Arcadia-Pierport Watershed and that there are subwatersheds of the Arcadia-Pierport Watershed, as shown in Map 17. The Arcadia-Pierport Watershed is a smaller watershed within the regional Betsie-Platte Watershed, which borders the Manistee River Watershed, as shown in Map 18. There are nested watersheds in this area – smaller ones within larger ones – and watersheds flow to different locations, some to Lake Michigan, and some to creeks or the Betsie River. (***Lake Michigan Lakewide Management Plan (LaMP) 2008: Watershed Fact Sheets***, 2008; State of Michigan, 2013; United States Department of Agriculture, Natural Resources Conservation Service, 2013)

In the ***Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage***, the Little River Band of Ottawa Indians divided Bowens Creek and tributaries into two subwatersheds, which they called "UPPER WATERSHED – ROAD STREAM CROSSINGS" and "LOWER WATERSHED – ARCADIA MARSH." In the upper watershed, LRBOI sampling locations were on Alkire (part of Bowens Creek), Hull, Ware, and Toohey Creeks. In the lower watershed, LRBOI sampling locations were on different portions of Bowens Creek. (***Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage***, 2013) As shown in Map 19, the Arcadia-Pierport Watershed is actually made up of the Arcadia Lake Watershed (upper portion, and herein referred to as the Arcadia portion of the watershed) and the so-called Pierport Watershed (tail portion, and herein referred to as the Pierport portion of the watershed because it contains the community of Pierport), which is also considered a part of the Lower Herring Lake-Frontal Lake Michigan Watershed. For the purposes of this watershed plan, the watershed area is referred to as the Arcadia-Pierport Watershed. The Arcadia-Pierport Watershed is bordered by other subwatersheds of the Betsie-Platte Watershed, including the Lower Herring Lake-Frontal Lake Michigan Watershed, and the Portage Lake Watershed. The multiplicity of watersheds is illustrated in Map 20. (***Lake Michigan Lakewide Management Plan (LaMP) 2008: Watershed Fact Sheets***, 2008; State of Michigan, 2013)

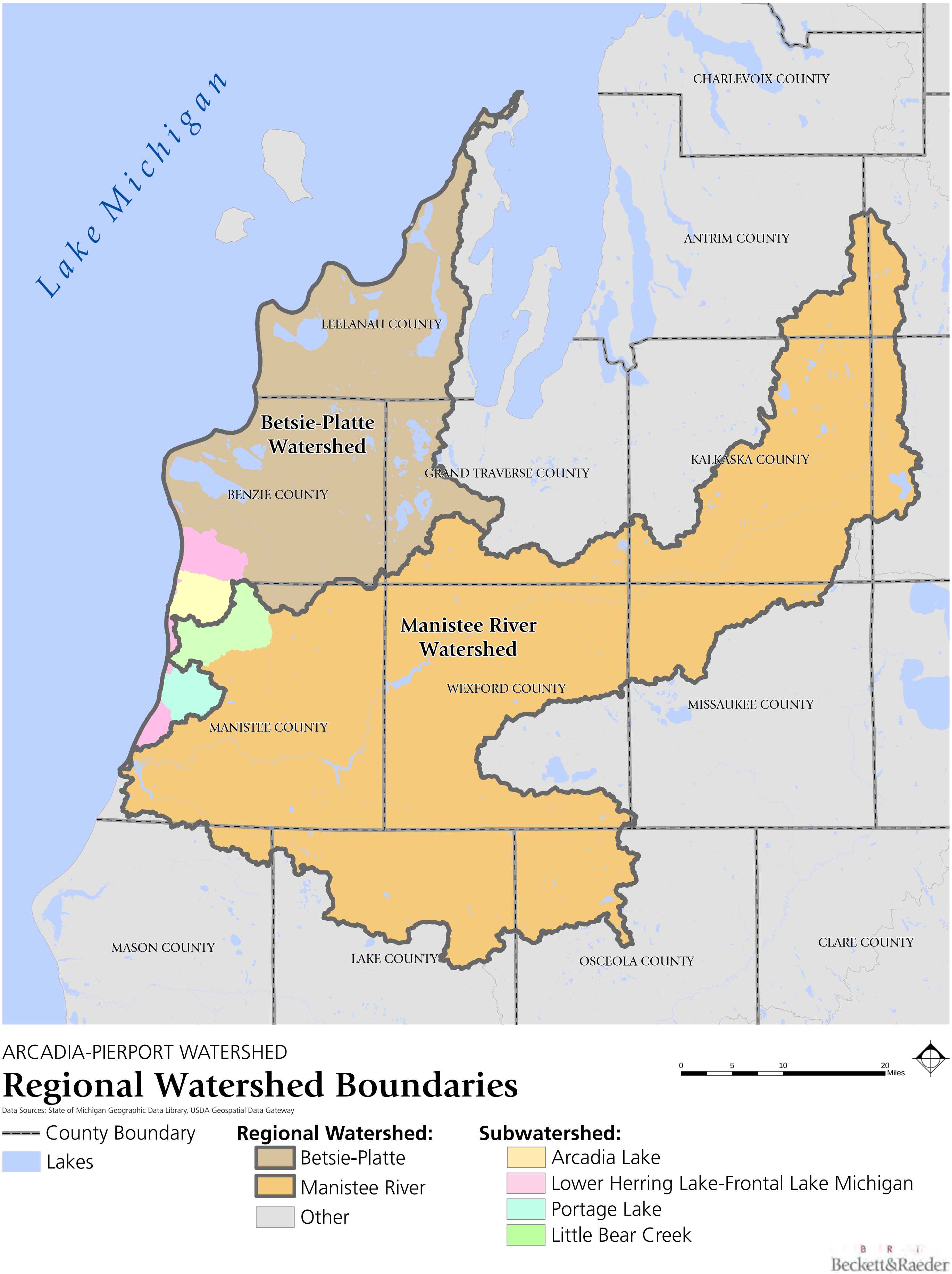
Water quality data on the Arcadia-Pierport Watershed are difficult to find and not extensive. Despite gaps in available data and information, the watershed planning process is ongoing. Watershed Goals I, II, and III in Table 44 address water quality, and completion of Implementation Tasks IIA, IIB, IIID, and IIIE in Table 46 could help in this regard. The main sources used to describe water quality in this chapter are information provided by governmental agencies, the ***Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage***, a 2013 report by the Little

Map 17: Regional Boundaries

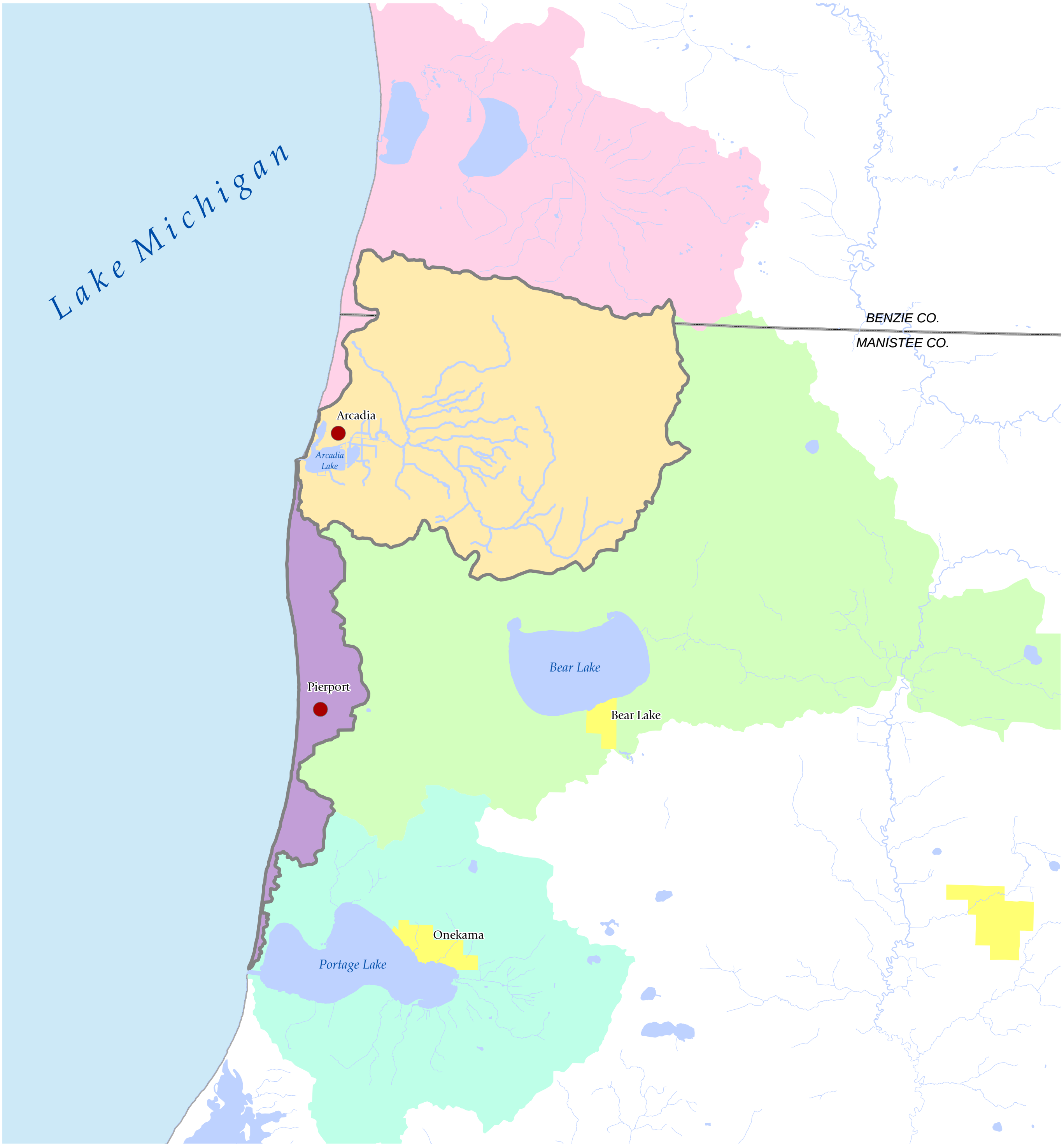


Beckett&Raeder

Map 18: Regional Watershed Boundaries



Map 19: Watershed Area



ARCADIA-PIERPORT WATERSHED

Arcadia-Pierport Watershed General Area

Data Sources: State of Michigan Geographic Data Library

0 0.5 1 2 Miles

- Arcadia-Pierport Watershed Boundary
- City or Village
- County Boundary
- Rivers
- Lakes
- Unincorporated Villages
- Arcadia Lake Watershed
- Pierport Watershed
- Lower Herring Lake - Frontal Lake Michigan
- Little Bear Creek Watershed
- Portage Lake Watershed

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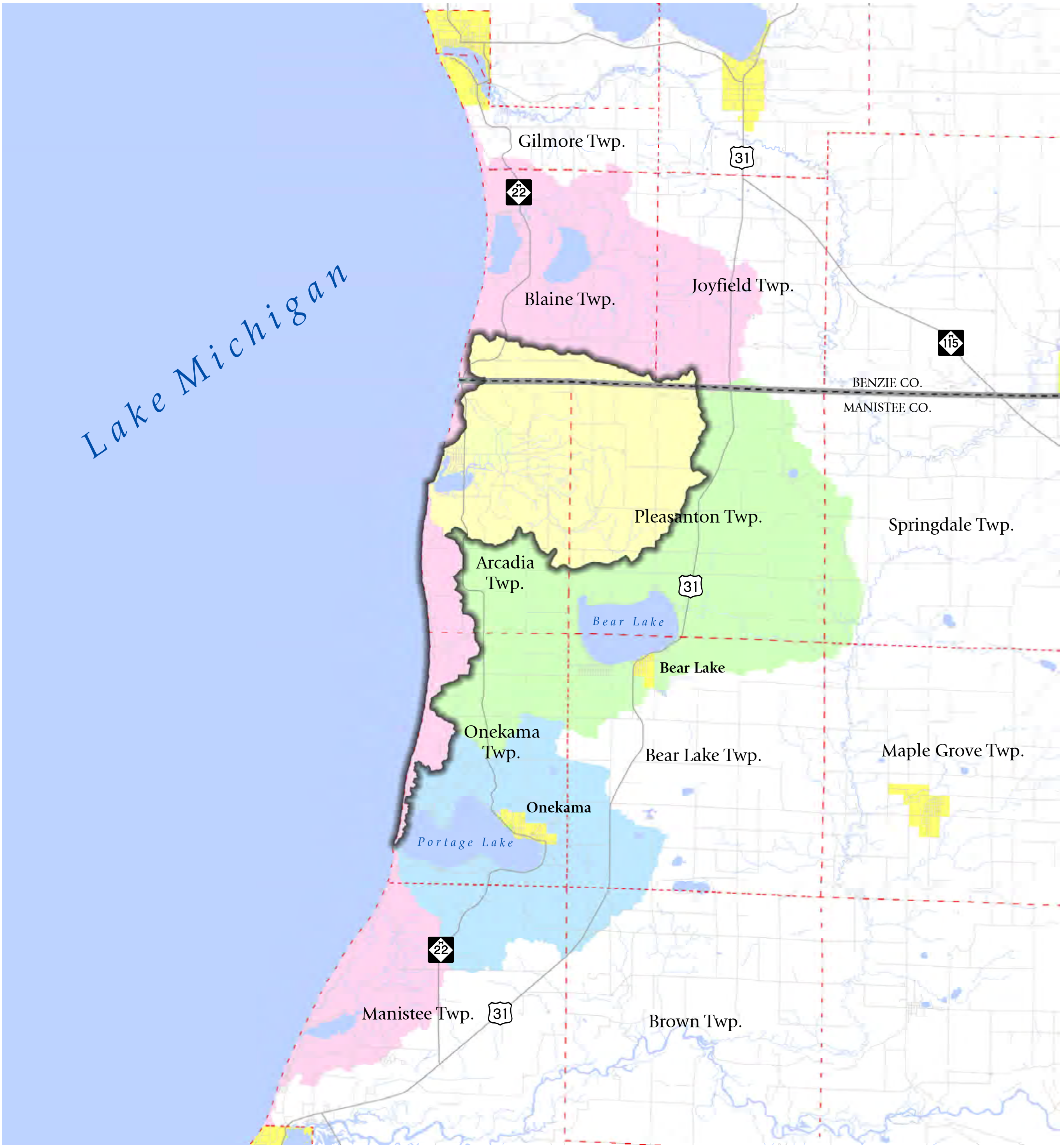
Map 20: Subwatershed Boundaries



ARCADIA-PIERPORT WATERSHED

Subwatershed Boundaries

Data Sources: State of Michigan Geographic Data Library

- City or Village
- County Boundary
- Township Boundary
- Roads
- Lakes
- Rivers and Streams

Subwatershed Name (Regional Watershed in Parenthesis)

- Arcadia Lake (Betsie-Platte)
- Lower Herring Lake-Frontal Lake Michigan (Betsie-Platte)
- Portage Lake (Betsie-Platte)
- Little Bear Creek (Manistee River)
- Arcadia-Pierport Watershed (Betsie-Platte)

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Figure 19: Waterbodies in Watershed
Source: State of Michigan, 2013

River Band of Ottawa Indians (LRBOI), and two Michigan Department of Natural Resources Status of the Fishery Resource Report documents written by fisheries biologist Mark Tonello. The LRBOI Natural Resources Department participated in the Arcadia Marsh Restoration Project by doing stream monitoring; the LRBOI report presents data on temperature, dissolved oxygen concentration, pH, conductivity, and turbidity, as well as biological data, for the watershed tributaries from 2010-13, covering time both prior to and following stream restoration activities. Restoration was done on road/stream crossings in the tributaries and on Arcadia Marsh, and Bowens Creek was redirected to its historical channel. Tonello's 2008 and 2012 reports are more focused on fish species than water chemistry. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013; Tonello, 2008; Tonello, 2012)

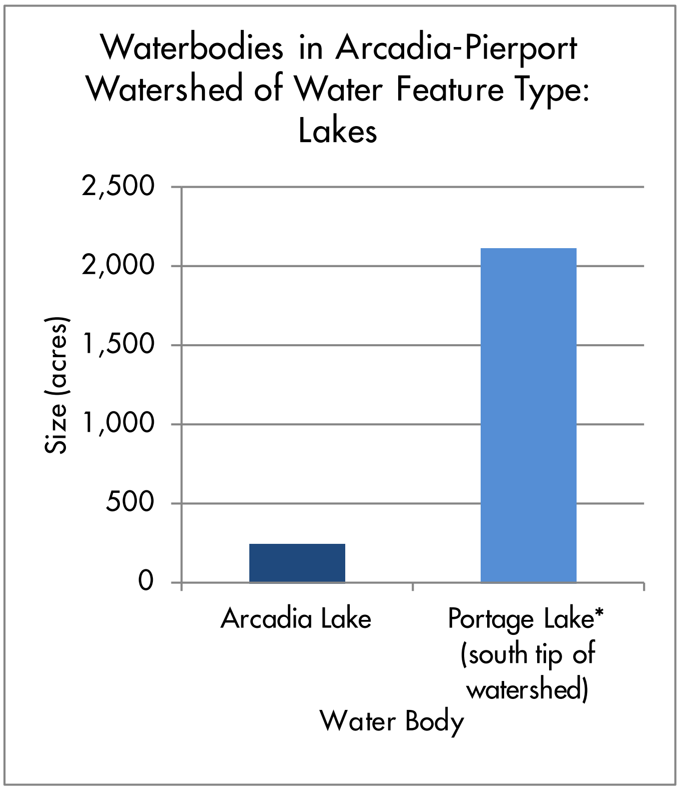
Figure 19 identifies the waterbodies in the Arcadia-Pierport Watershed (including Portage Lake, which borders the watershed). The shades of blue differentiate between the lake within the watershed versus the lake not within the watershed and lakes versus creeks.

Graphs 1 and 2 (by water feature type) show the relative sizes of these waterbodies. The same color scheme as in Figure 19 is used. Refer to Table 5 in CHAPTER ONE for exact stream lengths. Arcadia Lake is 242.82 acres, while Portage Lake is 2,114.64 acres – 8.71 times bigger than Arcadia Lake. (State of Michigan, 2013)

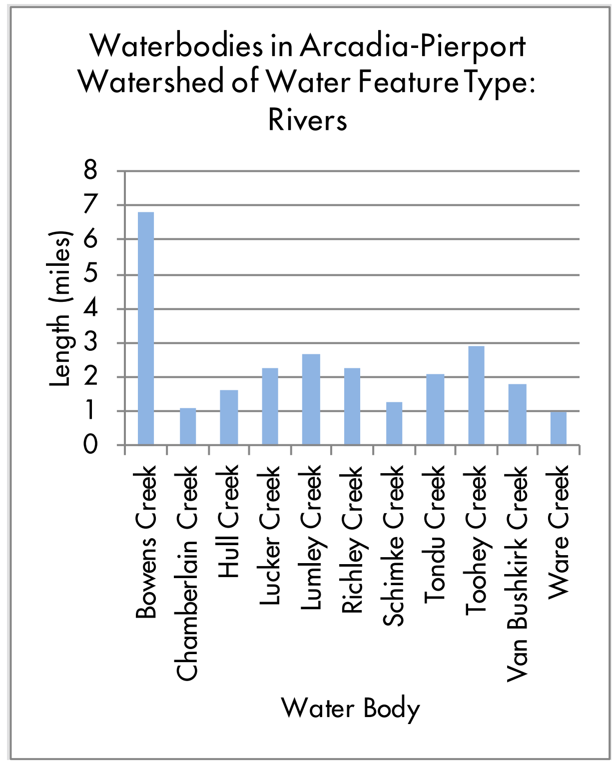
According to the *Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, "In 2009, Ducks Unlimited was awarded a National Fish and Wildlife Foundation – Sustain Our Great Lakes Stewardship Grant. Through this funding and the collaboration of many partners seven perched, undersized or misaligned culverts within Bowens Creek and its tributaries were replaced. The culverts were preventing access to upstream areas for many migratory and resident species of fish. Additionally, water quality was being negatively impacted due to streambank scouring occurring as a result of misaligned and perched culverts. The restoration of the upper watershed of Bowens Creek was designed to improve passage for fish and other aquatic organism[s] re-connecting approximately ten miles of stream. The LRBOI Natural Resources department partnered in the project to monitor fish, macroinvertebrates and habitat throughout the restoration project." (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

"Through this funding as well as the effort of numerous partners a one-mile section of channelized Bowens Creek that flows through Arcadia Marsh was redirected into its original watercourse by plugging five diversion ditches… This process will divert the entire creek flow back into its original meandering

Graph 1: Waterbodies in Watershed of Water Feature Type: Lakes
Source: State of Michigan, 2013



Graph 2: Waterbodies in Watershed of Water Feature Type: Rivers
Source: State of Michigan, 2013



channel and allow natural hydrologic processes to return to the original Bowens Creek within Arcadia Marsh. The LRBOI Natural Resources department partnered in the project to specifically address pre- and post-monitoring of fish, macroinvertebrates and habitat throughout the restoration project." (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

Over $783,000 of Sustain Our Great Lakes grant money was provided to Ducks Unlimited, Inc. for work in the Arcadia Marsh and Bowens Creek areas. According to Sustain Our Great Lakes, "Ducks Unlimited, Grand Traverse Regional Land Conservancy, Conservation Resource Alliance and other partners restored and protected the ecology of lower Bowens Creek and Arcadia Marsh within 0.7 miles of the Lake Michigan shoreline. The project goals include: restoration of fish passage to 11 miles of Bowens Creek by replacing 10 culverts; restoration of one mile of channelized stream by redirecting it to its natural watercourse; restoration of 307 acres of coastal marsh through sediment removal and invasive species control. These actions will improve and protect habitat and connectivity for several native fish and migratory bird species." (Sustain Our Great Lakes, 2014) Seven culverts have been replaced. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

Numerous parameters can be used to assess water quality. The state of Michigan's water quality standards are described in depth in CHAPTER FOUR. (Part 4. Water Quality Standards, n.d.) More briefly, and for the purposes of this chapter, the Tip of the Mitt Watershed Council, based in Petoskey, provides an insightful overview of many of them. Temperature is commonly tested and can change based on depth and time of year and whether mixing occurs in a waterbody. Water near the surface may be hotter in summer and colder in winter than deeper water. Dissolved oxygen is also measured because organisms require it to survive. There are higher concentrations of dissolved oxygen in cold water than in warm water, but dissolved oxygen levels can also change based on depth and time of year. "Generally, warm water fish need at least 5 mg/l of D.O., and cold water fish need at least 7 mg/l for good growth and survival." (Tip of the Mitt Watershed Council, 2015b) Developing fish require more dissolved oxygen than adults, and fish often cannot survive for long in water with less than 2 mg/l of dissolved oxygen. If there are too many nutrients or too many pollutants, dissolved oxygen may decline. (Tip of the Mitt Watershed Council, 2015b)

pH conveys the degree of acidity or basicity of water. pH is based on a scale of 0-14; a pH of 7 indicates that a waterbody is neutral, while a waterbody is considered basic, or alkaline, if pH is above 7 and acidic if below. According to the Tip of the Mitt Watershed Council, "When pH is outside the range of 5.5 to 8.5, most aquatic organisms become stressed and populations of some species can become depressed or disappear entirely. Rapid pH fluctuations can also stress aquatic organisms. Acidity can aggravate toxic contamination problems." (Tip of the Mitt Watershed Council, 2015b)

Conductivity describes whether water can carry electricity, which it can do if dissolved ions like calcium and chloride are present. Therefore, it can indicate the amount of total dissolved solids. "Rain water has very low conductivity (near 0 microsiemens/cm) while sea water has very high conductivity (~50,000 µS/cm)." (Tip of the Mitt Watershed Council, 2015b) Conductivity levels can be elevated if pH is high and water is mineral-rich. If water is polluted, it is likely that conductivity will increase. Chloride, related to conductivity, is an element of salt and is often found in freshwater, but if levels increase, it may indicate anthropogenic influence. "Surface waters seem to have a normal level of 4 mg/l. Even slight increases in chloride concentration can have a subtle impact on aquatic ecosystems, but most fish and other large aquatic organisms are not directly affected until concentrations reach 1,000 mg/l or more." (Tip of the Mitt Watershed Council, 2015b)

Turbidity relates to water clarity. "Algae, sediments, and other suspended or dissolved materials in the water can impart color as well as turbidity," writes the Tip of the Mitt Watershed Council, and "The more algae or sediment in water, the less clear it is." (Tip of the Mitt Watershed Council, 2015b) Clear water indicates high quality and productivity and is associated with less nutrient concentration. Cloudy water, on the other hand, can prevent sunlight from infiltrating the water and can impact fish and habitats. The amount of clarity can change in a waterbody based on depth and time of year but is generally highest when temperatures are cold. "Clarity varies greatly, from several feet in small inland lakes, to about 50 feet in large inland lakes and bays of the Great Lakes." (Tip of the Mitt Watershed Council, 2015b)

Chlorophyll a is a green pigment and indicates phytoplankton concentration. Nitrogen and phosphorus are nutrients; nutrients must be present for plants to grow. Various forms of nitrogen and phosphorus may be present in a body of water, and levels can vary greatly. "Nitrogen is a major component of all plant and animal matter…," while "Phosphorus is the most important nutrient for productivity in surface waters because it is usually in shortest supply relative to nitrogen and carbon. A water body is considered phosphorous limited if the ratio of nitrogen to phosphorous is greater than 15:1. Phosphorus is normally found at concentrations less than 10 micrograms per liter (ug/l = parts per billion) in high quality surface waters." (Tip of the Mitt Watershed Council, 2015b) These two elements often indicate the impact of humans. "Septic tank effluent contains 15,000 and 50,000 ug/l of phosphorus and nitrogen respectively. Nutrient pollution is the most serious threat to the water quality of northern Michigan's lakes and streams." (Tip of the Mitt Watershed Council, 2015b)

Researchers studying the West River Watershed in Connecticut sampled fish species in order to draw conclusions about water quality and wrote about the value of fish as indicators of water quality and environmental health. The species of fish that live in a body of water can reveal other aspects of water quality, like habitat and aquatic chemistry. Furthermore, some species are particularly intolerant of changing conditions and, thus, can serve as signals. (Moore et al., 1997) The presence of trout species, for instance, indicates good water quality, as trout need cold water, clean environments, sufficient dissolved oxygen, and diverse macroinvertebrate food sources to thrive. Macroinvertebrates are associated with high water quality as well, for they consume detritus and bacteria. (*Arcadia Township Master Plan*, 2014)

Another paper also addresses the value of fish as gauges of the quality of the water, using the Middle Thames Estuary in England as the case study. Researchers looked at the fish population, as this can change in response to alteration of habitats. They found that dissolved oxygen and temperature, in particular, were associated with number of fish. Analysis of the estuary over time led the researchers to conclude that more fish and a higher diversity of fish were correlated with higher quality water and that a shift in species, particularly to more tolerant species, and decrease in diversity corresponded with a decline in water quality. (Araújo, Williams, and Bailey, 2000)

Figure 20: Waters of Lake Michigan

According to the EPA, there are numerous types of indicators of ecological health or, conversely, stress. Appropriate indicators differ depending on type of waterbody. Indicators "can provide an estimate of the condition of an ecological resource with respect to some environmental value, such as biotic integrity." (United States Environmental Protection Agency, 2011) The type of fish and the health of those fish (such as whether their tissues are contaminated) are important gauges of the condition of a lake, stream, or river. (United States Environmental Protection Agency, 2011)

Fish are especially valuable indicators for several reasons. According to the EPA, "Extensive life history information is available for many species, and because many are high order consumers, they often reflect the responses of the entire trophic structure to environmental stress. Also, fish provide a more publicly understandable indicator of environmental degradation. Fish generally have long life histories and integrate pollution effects over longer time periods and large spatial scales." (United States Environmental Protection Agency, 2011)

Thus, not only are fish valuable barometers in and of themselves, but because they are at higher trophic levels, they can indicate if there are stressors impacting multiple trophic levels. Fish also can demonstrate changes over time and space and may garner more public interest and concern. Contamination of fish tissues can demonstrate the presence of toxins in a waterbody. Microorganisms like zooplankton are also indicative of ecological well-being because species may exhibit biological and physical changes in response to a stressor. Phytoplankton, invertebrates, and bottom-dwelling species are other indicators, as are habitat characteristics. (United States Environmental Protection Agency, 2011)

The EPA's ***Handbook for Developing Watershed Plans to Restore and Protect Our Waters*** also includes information on gauging water quality and health through the use of biological indicators. The EPA calls fish and other species, as well as the biological and habitat characteristics of these species, "'biocriteria'" and notes in the publication, "Monitoring of these biological indicators provides a simple and often inexpensive way to screen waters that are supporting their uses without a lot of expensive chemical and other testing. In addition, biological assessments can capture the impacts of intense, short-term pollution that might go undetected…" (***Handbook for Developing Watershed Plans to Restore and Protect Our Waters***, 2008) Based on this justification, this chapter reflects an interest in fish species as indicators of water quality. Watershed Goals I, II, and III in Table 44 address water quality.

Figure 21: Arcadia Lake

Water Quality of Arcadia Lake

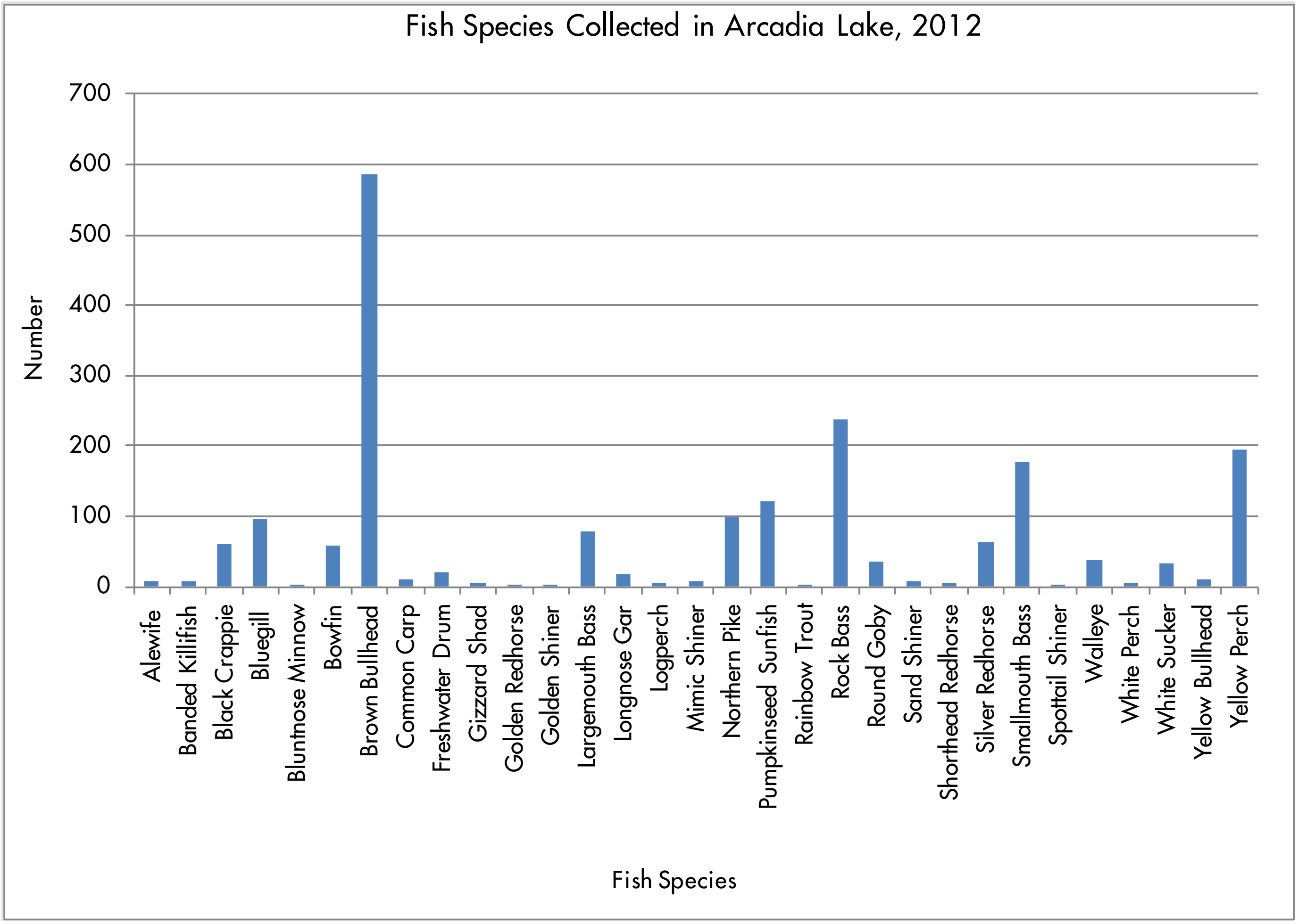
Water quality data were collected at Arcadia Lake by MDEQ on two dates in 2004 (April 19 and August 4) from a sampling station "approximately 1200 feet south of the northern most point on the lake shore." (State of Michigan, 2001-2015) Table 7 presents a selection of these data. The data shown were chosen to provide a sampling of the types of parameters and range of values that were measured at various depths in the lake. (State of Michigan, 2001-2015)

Based on available data for Arcadia Lake, the values for the selected parameters displayed in Table 7 can be compared to those described by the Tip of the Mitt Watershed Council and in Part 4. Water Quality Standards. Temperature and dissolved oxygen levels in the lake are acceptable. The pH value of 8.3 is satisfactory; however, the pH value of 8.6 falls above the Tip of the Mitt Watershed Council's suggested range but within the range specified in Part 4. Water Quality Standards. The units given for the specific conductance values differ from the conductivity standards reported by the state and the Tip of the Mitt Watershed Council. The units given for the nitrogen and phosphorus values also differ from the standard used by the state for phosphorus (monthly average) and from the numbers reported by the Tip of the Mitt Watershed Council (ug/l). However, upon converting mg/l to ug/l, it can be determined that Arcadia Lake's reported nitrogen (various forms) and phosphorus values are far below the levels of nitrogen and phosphorus in effluent from septic tanks. The lake's chloride level exceeds what the Tip of the Mitt Watershed Council indicates is the typical level in surface waterbodies, but is considerably below a problematic level. (Part 4. Water Quality Standards, n.d.; State of Michigan, 2001-2015; Tip of the Mitt Watershed Council, 2015b)

Table 7: Select Water Quality Data for Arcadia Lake, 2004
Source: State of Michigan, 2001-2015

Select Parameter	*Depth (feet)*	*Value*	*Sample Date*
Temperature	3 ft	22.5°C	8/4/2004
Temperature	28 ft	12°C	4/19/2004
Chlorophyll a	12 ft	2.3 ug/l	4/19/2004
Chlorophyll a	19 ft	4 ug/l	8/4/2004
Dissolved Oxygen	15 ft	10.9 mg/l	8/4/2004
Dissolved Oxygen	28 ft	9.3 mg/l	4/19/2004
Nitrogen, ammonia (NH3)+ organic	3 ft	0.428 mg/l	8/4/2004
Nitrogen, ammonia (NH3)+ organic	22 ft	0.275 mg/l	8/4/2004
Nitrogen, ammonia as N	3 ft	0.01 mg/l	8/4/2004
Nitrogen, ammonia as N	14.5 ft	0.027 mg/l	4/19/2004
Nitrogen, mixed forms (NH3)+(NH4)+organic+(NO2)+(NO3)	3 ft	3.95 mg/l	4/19/2004
Nitrogen, mixed forms (NH3)+(NH4)+organic+(NO2)+(NO3)	22 ft	0.46 mg/l	8/4/2004
Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	3 ft	0.518 mg/l	4/19/2004
Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N	12 ft	0.096 mg/l	8/4/2004
Nitrogen, organic	3 ft	0.35 mg/l	4/19/2004
Nitrogen, organic	26 ft	0.27 mg/l	4/19/2004
Nitrogen, ammonia (NH3) as NH3	3 ft	0.03 mg/l	4/19/2004
Nitrogen, ammonia (NH3) as NH3	26 ft	0.03 mg/l	4/19/2004
pH	3 ft	8.6	8/4/2004
pH	28 ft	8.3	4/19/2004
Phosphorus	3 ft	0.023 mg/l	4/19/2004
Phosphorus	22 ft	0.004 mg/l	8/4/2004
Specific Conductance	3 ft	289 umho/cm	8/4/2004
Specific Conductance	28 ft	316 umho/cm	4/19/2004
Calcium	14.5 ft	41.1 mg/l	4/19/2004
Chloride	14.5 ft	6 mg/l	4/19/2004
Magnesium	14.5 ft	14.2 mg/l	4/19/2004
Potassium	14.5 ft	1.1 mg/l	4/19/2004
Sodium	14.5 ft	3.8 mg/l	4/19/2004
Sulfur, sulfate (SO4) as SO4	14.5 ft	7 mg/l	4/19/2004

Graph 3: Fish Species Collected in Arcadia Lake, 2012
Source: Tonello, 2012

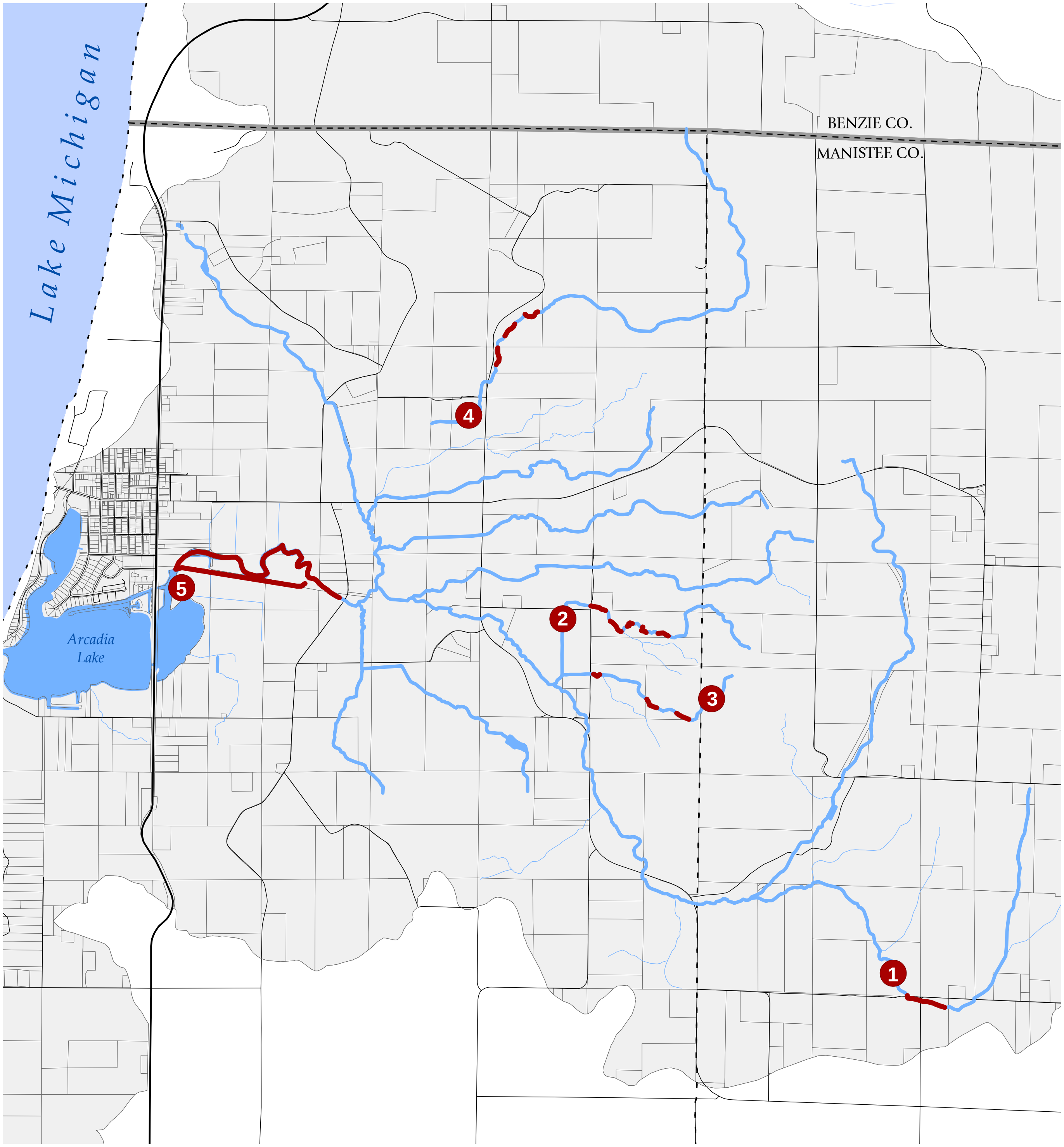


Mark Tonello's 2012 report notes that Arcadia Lake was dredged in the past, and, since it is connected to Lake Michigan, water levels in Arcadia Lake are impacted by those in that Great Lake. Habitats in Arcadia Lake are made up of sand, slabwood, organic matter, and gravel. Fish species sampled in the lake included a diverse, robust population of smallmouth, largemouth and rock bass, northern pike, yellow perch, walleye, and brown bullhead, and the lake is good for fishing. However, the ecosystem and water quality of the lake are impacted by the dominating presence of Eurasian watermilfoil, which affects fishing and other recreational pursuits. (Tonello, 2012)

Eurasian watermilfoil is an invasive species that colonizes waterbodies. It originated in Europe and Asia and was found in North America in the 1940s. Now, over 40 U.S. states, including Michigan, contain Eurasian watermilfoil. Where it has invaded, it greatly impacts the ecosystem. Not only does Eurasian watermilfoil inhibit the ability of native species to live and thrive, but it also produces tangled masses of weeds on the surfaces of waterbodies that make it difficult for boating, swimming, and other recreational pursuits. Water quality suffers when the Eurasian watermilfoil dies, as dissolved oxygen levels decrease. Eurasian watermilfoil is successful because it can live in low water temperatures and spread easily through fragmenting. It can also spread by attaching to boats. Thus, it is difficult to control. (Tip of the Mitt Watershed Council, 2015a)

Graph 3 is based on data from Tonello's 2012 report and represents the cumulative numbers of fish species collected by MDNR in Arcadia Lake using various sampling methods on June 4-8 and July 16, 2012. The graph shows that of the species collected, there was a particularly high number of brown bullhead fish. (Tonello, 2012)

Map 21: Little River Band of Ottawa Indians Monitoring Stations



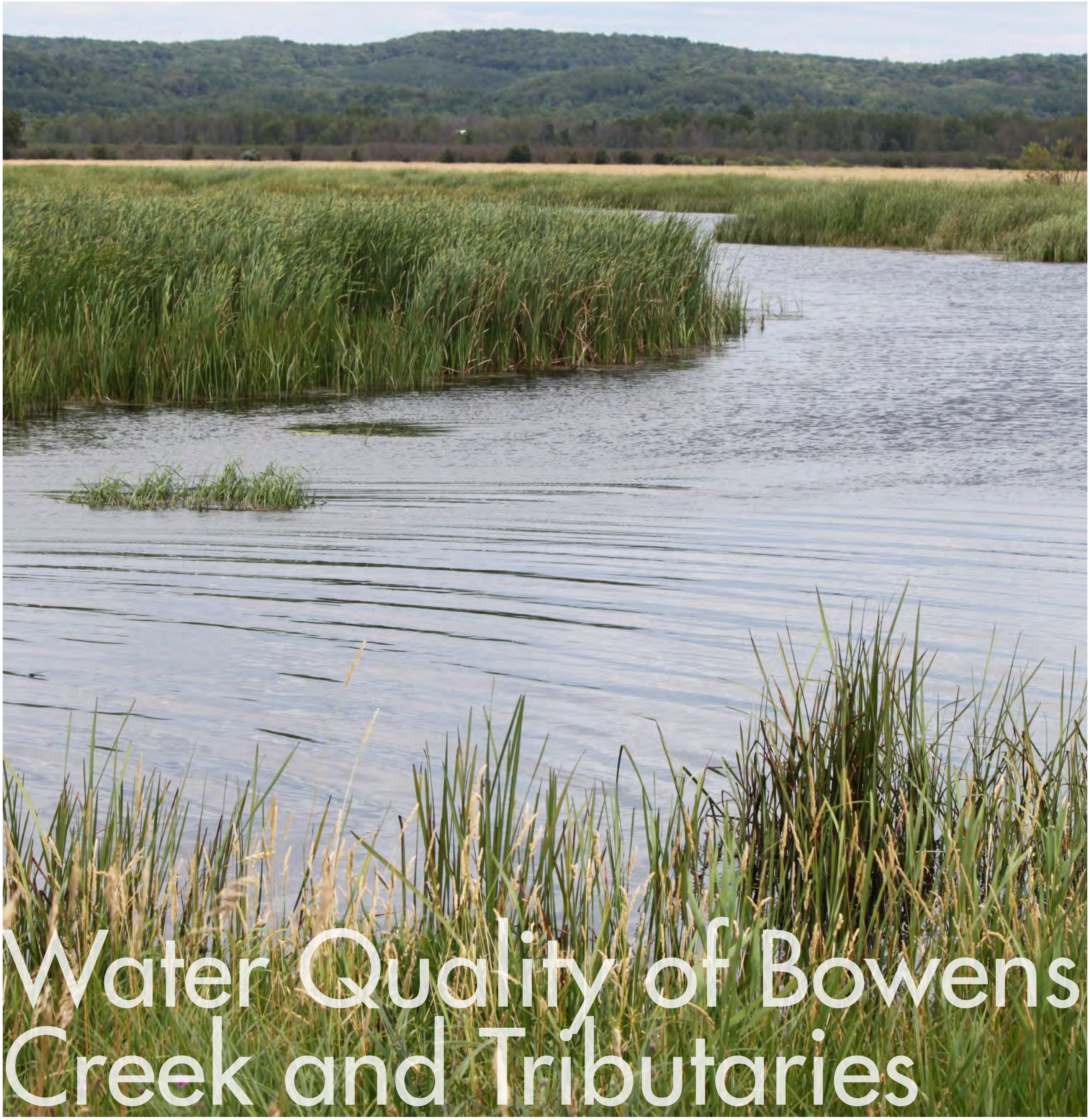
ARCADIA-PIERPORT WATERSHED

Little River Band of Ottawa Indians Monitoring Stations

Data Sources: State of Michigan Geographic Data Library, USGS, Little River Band of Ottawa Indians

- Watershed Boundary
- Parcel Boundary
- County Boundary
- Township Boundary
- Major Road
- Minor Road
- 1 Alkire Creek
- 2 Hull Creek
- 3 Ware Creek
- 4 Toohey Creek
- 5 Bowens Creek

Beckett&Raeder



Water Quality of Bowens Creek and Tributaries

According to the LRBOI *Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, water quality of the upper watershed tributaries was determined to be good for species that thrive in cold, oxygenated environments. LRBOI sampling locations on the upper watershed creek sites, which the LRBOI sampled from 2010-2013, are shown on Map 21. Sampling locations in the upper watershed were on Alkire, Hull, Ware, and Toohey Creeks. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

According to the LRBOI, in the upper watershed tributaries sampled, average temperature ranged from 10.3-14.5 ˚C, average dissolved oxygen concentration ranged from 8.4-11.3 ppm, average pH ranged from 7.7-7.9, average conductivity ranged from 0.2205-0.3689 mS/cm, and

Table 8: Select Water Quality Data for Alkire Creek
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013

Select Parameter	Average Value
Width	1.0 m
Depth	0.11 m
Temperature	14.5˚C
Dissolved Oxygen	8.4 ppm
pH	7.7
Conductivity	0.2205 mS/cm
Turbidity	2.9 NTU

Table 9: Select Water Quality Data for Hull Creek
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013

Select Parameter	Average Value
Width	1.4 m
Depth	0.10 m
Temperature	11.1˚C
Dissolved Oxygen	10.5 ppm
pH	7.9
Conductivity	0.3297 mS/cm
Turbidity	3.1 NTU

Table 10: Select Water Quality Data for Ware Creek
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013

Select Parameter	Average Value
Width	2.1 m
Depth	0.10 m
Temperature	10.3˚C
Dissolved Oxygen	11.3 ppm
pH	7.9
Conductivity	0.3317 mS/cm
Turbidity	9.0 NTU

Table 11: Select Water Quality Data for Toohey Creek
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013

Select Parameter	Average Value
Width	3.1 m
Depth	0.06 m
Temperature	11.1˚C
Dissolved Oxygen	10.6 ppm
pH	7.8
Conductivity	0.3689 mS/cm
Turbidity	2.6 NTU

average turbidity ranged from 2.6-9.0 NTU. Habitats consist of pools, riffles, and runs and differ in their substrate compositions (sand, pebbles, cobbles, woody debris, silt, gravel, and clay). (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

In the upper watershed tributaries sampled by the LRBOI, habitats were considered good, though they were not found to have improved significantly in tests following the replacement of seven culverts in 2011; changes in habitat scores for the upper watershed creek sample sites ranged from 0-10 points. Diversity of macroinvertebrate communities was found to be good and to have increased in richness post-restoration. Fish species present in the upper watershed tributaries include coho salmon, sculpin, and rainbow, brook, and brown trout, though compositions differed between the four upper watershed sites and over three years. Where culverts were replaced, studies found an increase in diversity and in concentrations of salmon and trout. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

The LRBOI Natural Resources Department sampled tributaries at various sites from 2010-2013. Tables 8-11 are based on data from the *Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*. The tables provide a selection of the LRBOI data from the various sampling stations on the creeks in the upper watershed. The values from the LRBOI are averages from 2010-2013. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

Bowens Creek has been impacted by human activities and was channelized through Arcadia Marsh in the past but was directed back to its original form in 2012-2013. In the lower watershed sites of Bowens Creek (see Map 21) that were sampled by the LRBOI both before and after restoration, temperature ranged from an average of 13.4-19.8˚C before restoration and 11.6-13.7˚C following restoration, dissolved oxygen concentration ranged from an average of 7.8-11.5 ppm pre-restoration and 5.9-10.8 ppm post-restoration, pH ranged from an average of 7.8-8.3 pre-restoration and 7.3-7.9 post-restoration, conductivity ranged from an average of 0.2752-0.3324 mS/cm pre-restoration and 0.3477-0.3556 mS/cm post-restoration, and turbidity ranged from an average of 2.9-26.6 NTU pre-restoration and 2.5-3.2 NTU post-restoration. Habitats consisted mostly of runs, with some pools; they, too, differed in substrate compositions. Macroinvertebrate communities were not considered to be good in the lower watershed sites that were sampled. Fish species present in the lower watershed tributaries were found to have changed significantly from a diverse array of species before restoration to mostly trout (rainbow and brown trout) after restoration; following restoration, diversity of species decreased, and fewer cool-water species were present in the lower watershed tributaries. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

Tables 12-16 are based on data from the *Final Technical Report – Arcadia Marsh/Bowens* Creek Restoration and Fish Passage. The tables provide a selection of the LRBOI data from the sampling stations in the lower watershed. For this portion of the watershed, except for the Bowens Creek channelized segment sampling site, the water chemistry values from the LRBOI are divided into the pre-restoration and post-restoration periods; for the channelized segment site, values are only available pre-restoration. The width and depth values pre-restoration are averages from 2010-2011, while the temperature, dissolved oxygen, pH, conductivity, and turbidity values pre-restoration are averages from 2010-2012; the values post-restoration are from 2013. As the tables show, the values differ prior to restoration compared to post-restoration, and some consistent patterns can be seen: Depth increased, temperature decreased, dissolved oxygen decreased, pH decreased, and conductivity increased. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

In regards to the channelized segment of Bowens Creek, there are now two segments. According to Chris Sullivan, "the upper segment between the two channel plugs is permanently ponded, without a surface input or output. The lower segment is part of the drowned-rivermouth area of the Marsh and has converted from stream channel to hemi-marsh." (Sullivan, personal communication, 2015, August 17)

Based on available data, the values for the selected parameters displayed in Tables 8-16 can be compared to those described by the Tip of the Mitt Watershed Council and in Part 4. Water Quality Standards. It should be noted that the LRBOI report displays most water quality data in terms of average values rather than specific values, so only general conclusions can be drawn, as it is unknown whether specific values are within acceptable parameters or not. Temperature cannot be analyzed because it is based upon month in Part 4. Water Quality Standards. The units given for the dissolved oxygen values differ from the standard used by the state and reported by the Tip of the Mitt Watershed Council (mg/l). However, upon converting ppm to mg/l, and based on the fact that Bowens Creek and the tributaries of the Arcadia-Pierport Watershed seem to support coldwater fish, as reported in the LRBOI report, the reported values of dissolved oxygen are acceptable everywhere except for in the Historical Lower Bowens Creek Channel post-restoration, the value for which is below the level of dissolved oxygen needed for coldwater fish. pH values

Table 12: Select Water Quality Data for Bowens Creek Channelized Segment
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013; Mays, personal communication, 2015, August 17

Select Parameter	Average Value Pre-Restoration
Width	12.5 m
Depth	0.49 m
Temperature	14.7°C
Dissolved Oxygen	11.5 ppm
pH	8.3
Conductivity	0.3324 mS/cm
Turbidity	9.8 NTU

Table 13: Select Water Quality Data for Historical Lower Bowens Creek Channel
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013; Mays, personal communication, 2015, August 17

Select Parameter	Average Value Pre-Restoration	Value Post-Restoration
Width	14.2 m	6.4 m
Depth	0.32 m	0.49 m
Temperature	19.8°C	13.7°C
Dissolved Oxygen	7.8 ppm	5.9 ppm
pH	7.8	7.3
Conductivity	0.2752 mS/cm	0.3556 mS/cm
Turbidity	2.9 NTU	3.1 NTU

Table 14: Select Water Quality Data for Historical Middle Bowens Creek Channel
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013; Mays, personal communication, 2015, August 17

Select Parameter	Average Value Pre-Restoration	Value Post-Restoration
Width	4.4 m	5.1 m
Depth	0.25 m	0.55 m
Temperature	18.7°C	13.4°C
Dissolved Oxygen	8.1 ppm	7.0 ppm
pH	8.1	7.4
Conductivity	0.2892 mS/cm	0.3518 mS/cm
Turbidity	26.6 NTU	3.2 NTU

Table 15: Select Water Quality Data for Historical Upper Bowens Creek Channel
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013; Mays, personal communication, 2015, August 17

Select Parameter	Average Value Pre-Restoration	Value Post-Restoration
Width	4.7 m	4.1 m
Depth	0.31 m	0.85 m
Temperature	13.7°C	11.6°C
Dissolved Oxygen	11.0 ppm	9.1 ppm
pH	8.1	7.8
Conductivity	0.3250 mS/cm	0.3484 mS/cm
Turbidity	6.7 NTU	3.0 NTU

Table 16: Select Water Quality Data for Bowens Creek Below Saint Pierre Road
Source: Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage, 2013; Mays, personal communication, 2015, August 17

Select Parameter	*Average Value Pre-Restoration*	*Value Post-Restoration*
Width	5.7 m	5.8 m
Depth	0.45 m	0.74 m
Temperature	13.4˚C	12.4˚C
Dissolved Oxygen	11.1 ppm	10.8 ppm
pH	8.1	7.9
Conductivity	0.3216 mS/cm	0.3477 mS/cm
Turbidity	7.4 NTU	2.5 NTU

are acceptable. The units given for the conductivity values also differ from those reported by the Tip of the Mitt Watershed Council, but upon converting μS/cm to mS/cm, the conductivity of Bowens Creek and the tributaries is much closer to that for rainwater than that for seawater. (*Final Technical Report – Arcadia Marsh/ Bowens Creek Restoration and Fish Passage*, 2013; Part 4. Water Quality Standards, n.d.; Tip of the Mitt Watershed Council, 2015b)

Mark Tonello's 2008 report describes how Bowens Creek and its tributaries are cold and are Michigan Department of Natural Resources (MDNR) Designated Trout Streams. Surveys found habitats to be mostly sand and gravel and the presence of poorly-located or -constructed culverts, which impact the watershed habitat and ecosystem. (Tonello, 2008)

Graph 4 is based on data from Tonello's 2008 report and represents the fish species collected and the number of sites from which these species were collected at 18 sites in Bowens Creek and tributaries on May 7 and July 1, 2008. The graph indicates that rainbow trout, brown trout, coho salmon, and sculpin were collected in more sampling sites than were other species. (Tonello, 2008)

Graph 4: Fish Species Collected in Bowens Creek and Tributaries
Source: Tonello, 2008

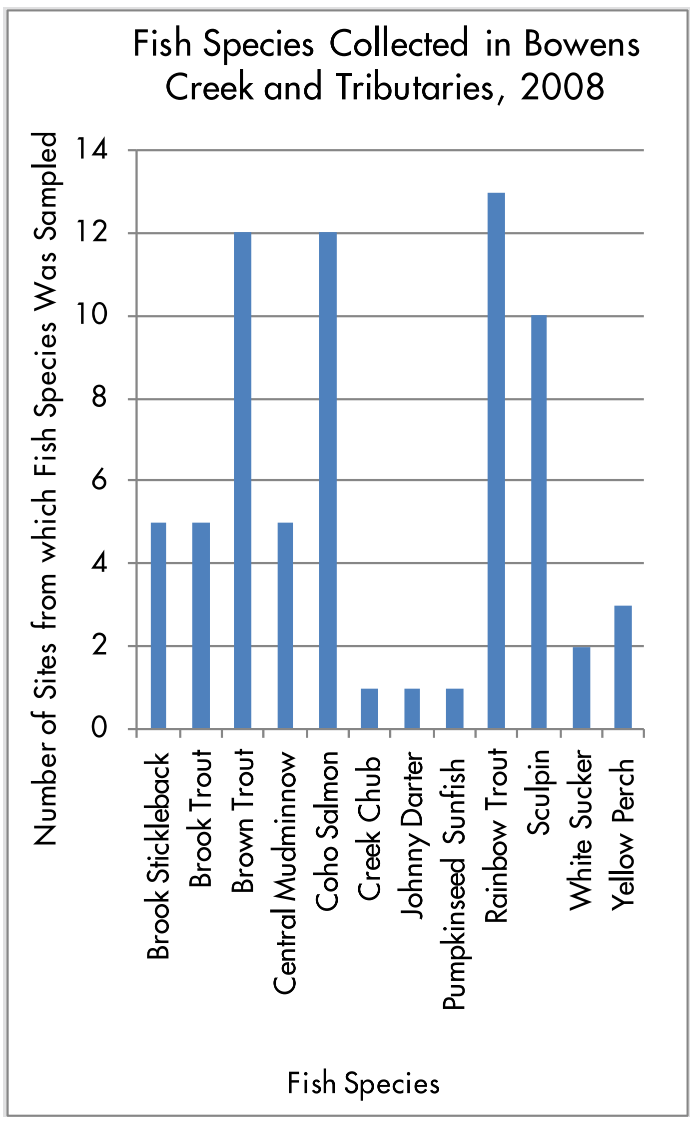
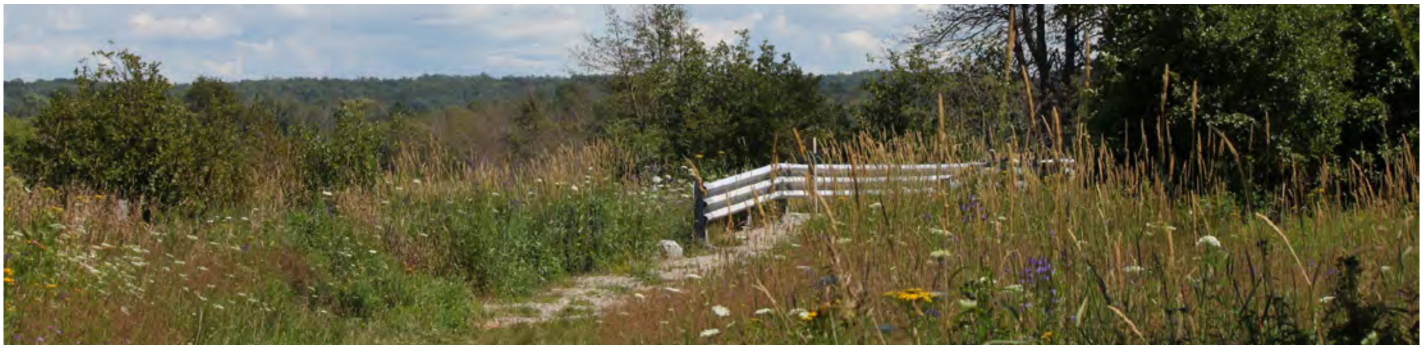


Figure 22: Grand Traverse Regional Land Conservancy's Arcadia Marsh Preserve Signage



Arcadia Marsh

In regards to Arcadia Marsh, there are gaps in available data and information such that it is difficult to characterize the water quality of the marsh. Due to the lack of data, the water quality of Arcadia Marsh cannot be analyzed or compared to available standards. Watershed Goals I, II, and III in Table 44 address water quality, and completion of Implementation Tasks IIA, IIB, IIID, and IIIE in Table 46 could help in this regard.

According to Mark Tonello's 2008 report, Arcadia Marsh is regarded as a swamp. It was home to a railroad grade in the late nineteenth century, drained in the mid-twentieth century, and farmed; thus, the marsh ecosystem has been greatly impacted by anthropogenic disturbances. Habitat in Arcadia Marsh was considered quite poor. Substrates were made up of sand, gravel, and silt. Fish species observed included brown, brook, and rainbow trout, coho salmon, and sculpin. (Tonello, 2008)

Arcadia Marsh is a unique ecosystem; it is considered a Great Lakes Coastal Marsh and is home to a diversity of species, including state-designated Endangered and Threatened species, birds, and fish. Per GTRLC's website, "Coastal marshes are some of the most productive ecosystems in the world, and Arcadia is one of only 15 or so remaining coastal marshes along Lake Michigan's Lower Peninsula shoreline." (Grand Traverse Regional Land Conservancy, n.d.) However, water quality and the ecosystem of Arcadia Marsh have been affected by anthropogenic activities, to great consequence. It says on the GTRLC website, "In the late 1800's, a railroad grade was constructed resulting in an east/west berm through the marsh. The water table was lowered to create conditions more suitable for agriculture and in the 1950s[,] Bowens [C]reek, which feeds the marsh, was diverted for a stock pond which eventually 'blew out'. This caused 40-50% of the water from Bowens Creek to be diverted from its natural course to a straight wide channel along the northern side of the railroad grade. A second diversion of Bowens Creek was constructed in the 1960s in an attempt to improve duck hunting opportunities which diverted nearly all the remaining water from the creek. Bowens Creek is now very shallow and heavily sedimented. Finally, the hydrology and ecological connection between the marsh and Arcadia Lake were permanently impacted when M-22 was constructed in its current location by means of a quarter mile filled causeway perforated only by a narrow bridge." (Grand Traverse Regional Land Conservancy, n.d.) The presence of invasive species like reed canary grass and phragmites in the marsh threatens native species and the marsh ecosystem. GTRLC and other partners are working on restoring the marsh habitat, species, and ecosystem through such actions as acquisition of land, redirection of Bowens Creek, and management of invasive species. According to the GTRLC website, "Restoration began with GTRLC's acquisition of 155 acres within the marsh. Funding was then received in the form of grants…Working in partnership with Ducks Unlimited, Little River Band of Ottawa Indians, Conservation Resource Alliance, and the Manistee County Road Commission, the restoration activities focus on restoring flows within the natural channel of Bowens Creek by constructing plugs at the site of previous diversions, treating invasive species infestations…and re-creating roughly 6 acres of shallow, open water areas within the Marsh by removing built up sod within the areas of the Marsh that are inundated during periods of high water." (Grand Traverse Regional Land Conservancy, n.d.)

According to the LRBOI report, with the redirection of Bowens Creek to its historical meandering channel through Arcadia Marsh, the fish species have been observed to have changed. Rather than hosting fish species that live in cool water, the Marsh now seems to provide a better environment for coldwater species like rainbow trout. (***Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage***, 2013)

Reed canary grass is a grass species that is invasive in Michigan, among other states, and colonizes wetlands, forests, and floodplains. It prevents other plants from growing and is hard to remove because of its ability to recolonize. (United States Department of Agriculture, Forest Service, Forest Health, Staff, 2005) There is a native phragmites grass in Michigan, but invasive phragmites is spreading and imperils the Great Lakes and wetlands. Phragmites grows into a thick body and can displace native species and impact recreational activities. (State of Michigan, 2015)

Figure 23: View from Pierport Road End

Pierport

There is very little information about Pierport and its water quality, so this data gap makes it difficult to assess Pierport's water quality. Due to the lack of data, the water quality of Pierport cannot be analyzed or compared to available standards. Watershed Goals I, II, and III in Table 44 address water quality, and completion of Implementation Tasks IIA, IIB, IIID, and IIIE in Table 46 could help in this regard.

Pierport is on the shore of Lake Michigan. This portion of the watershed is home to a small amount of development and the Old Faceful artesian well. Some parts of the area on the shore of Lake Michigan still retain their natural environment, though there has been development in High Risk Erosion Areas and Critical Dune Areas. (*Onekama Community Master Plan*, 2010)

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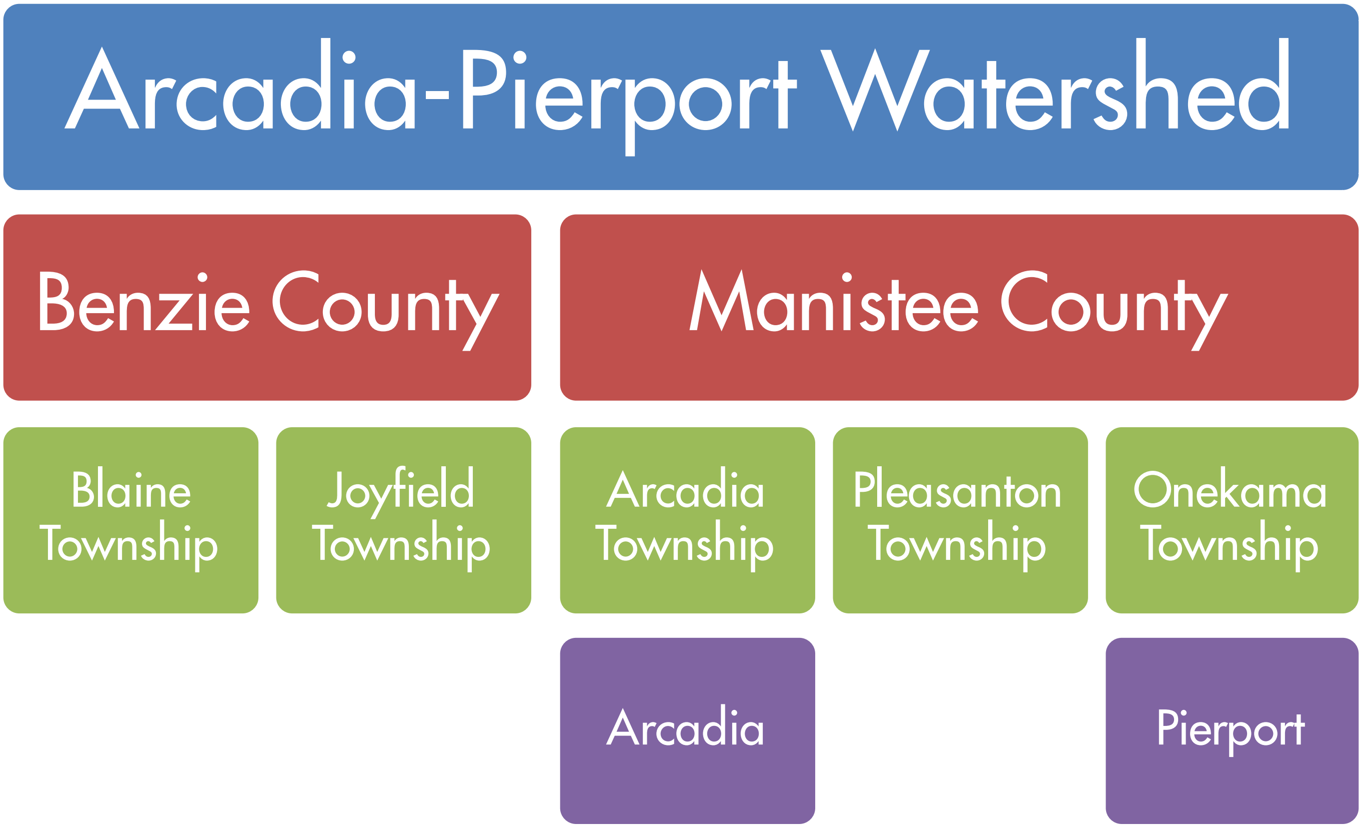
CHAPTER THREE:

COMMUNITY ENGAGEMENT

Figure 24: Jurisdictions in Watershed
Source: State of Michigan, 2013



The Arcadia-Pierport Watershed consists of various jurisdictions. At the larger scale, the watershed is located within two counties – Benzie and Manistee Counties. The watershed also touches parts of five townships – two in Benzie County (Blaine and Joyfield Townships), and three in Manistee County (Arcadia, Pleasanton, and Onekama Townships). The two communities of Arcadia and Pierport are situated in the watershed as well. (State of Michigan, 2013) Figure 24 shows the jurisdictions in the Arcadia-Pierport Watershed and their hierarchy.

Graph 5 shows the amount of the Arcadia-Pierport Watershed occupied by each of the five townships.

The primary elements of community engagement in the planning process for the Arcadia-Pierport Watershed Plan were Watershed Leadership Team (WLT) meetings, public outreach, and a survey that community members were encouraged to complete.

Graph 5: Size of Each Township in Watershed
Source: State of Michigan, 2013

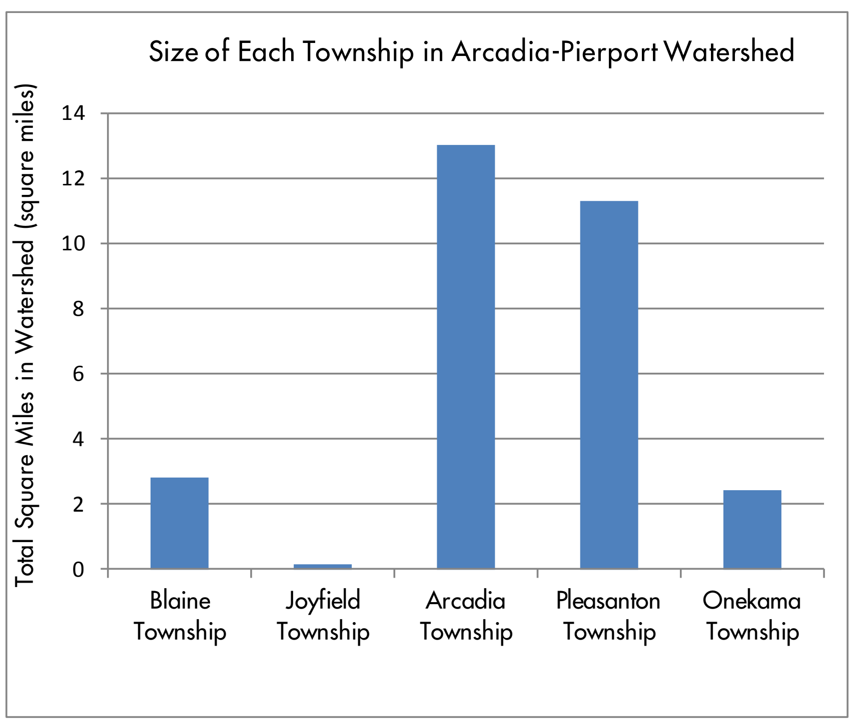


Figure 25: Rural Landscape

Discussion of the Process

Approximately 900 property owners in the watershed were notified about the planning process by mail in July 2014 and invited to fill out a survey. The survey was conducted to engage the community and solicit opinion about the Arcadia-Pierport Watershed. It was posted online for property owners and residents of the watershed to complete.

There are 18 members of the Watershed Leadership Team, which serves to engage and update the community, and 15 WLT meetings were held from July 18, 2013-August 6, 2015. All meetings are open to the public. Presentations were given to Blaine, Joyfield, Arcadia, and Onekama Townships about the planning process and to gain support, which was necessary to obtain funding. Outreach was also conducted at various events.

An important aspect of the community engagement process is the Arcadia-Pierport Watershed Plan webpage (http://www.lakestoland.org/arcadia-pierport-watershed/), created for the project. This webpage is part of the Lakes to Land Regional Initiative website (http://www.lakestoland.org/) and includes information about the meetings, WLT, and Plan. Refer to the webpage for more information.

Figure 26: View of Arcadia from Inspiration Point

Summary of Meetings

The Watershed Leadership Team meetings are generally held at the Pleasant Valley Community Center or the Arcadia Township Hall, and minutes are recorded. Minutes can be found on the Arcadia-Pierport Watershed Plan webpage (http://www.lakestoland.org/arcadia-pierport-watershed/). The WLT, including representatives from the Arcadia-Pierport Watershed community, Beckett & Raeder and other groups, organizations, entities, and agencies, is tasked with obtaining and organizing financing for the Plan, reaching out to community members and getting them involved, and gathering signatures to assure local support for the Watershed Partnership Agreement and Plan. The meetings have addressed the Arcadia-Pierport Watershed Plan process, leadership, partnership, funding, scope, and requirements. The importance of informing and engaging the public through various means has been stressed. Presentations are made and updates given at the meetings. Refer to the webpage for more information.

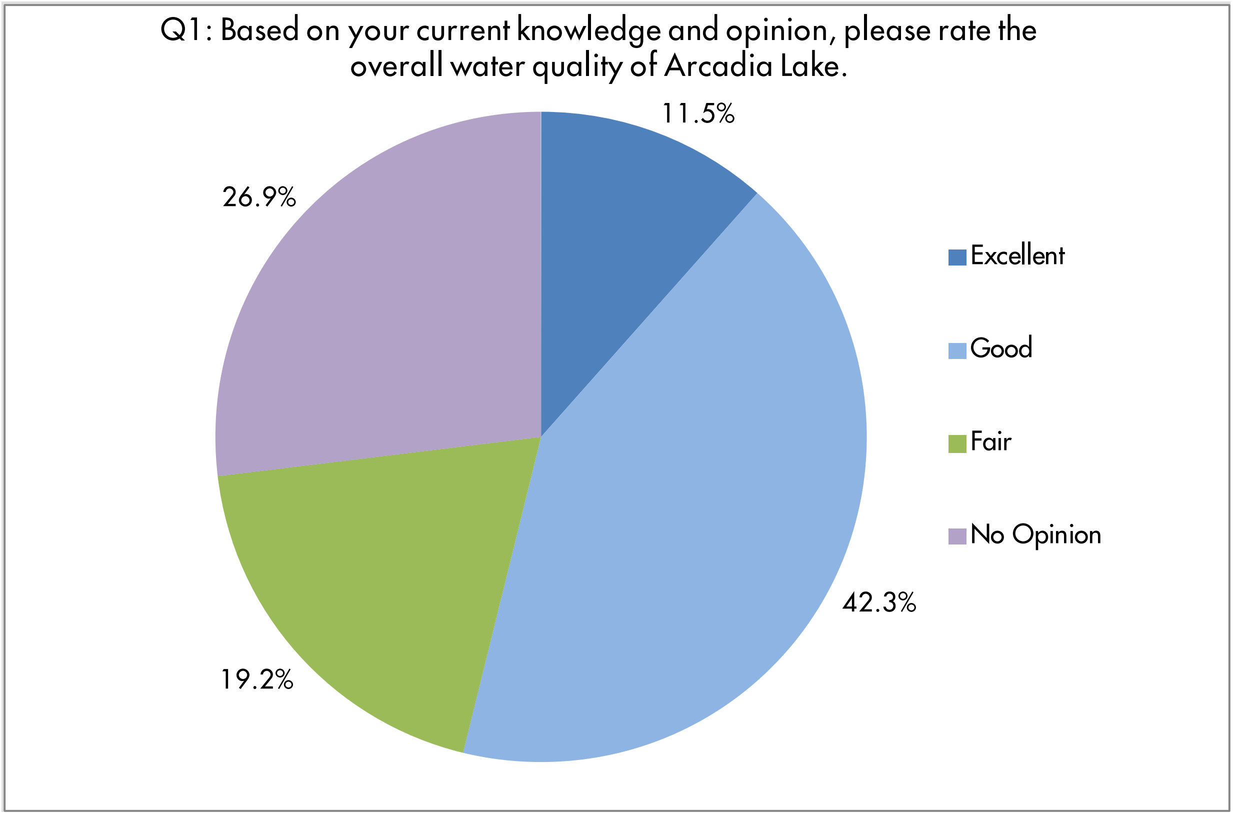
Figure 27: Historic Church in Arcadia

The Arcadia-Pierport Watershed Plan webpage (http://www.lakestoland.org/arcadia-pierport-watershed/) includes questions and answers about watersheds and watershed plans and how people can donate and participate, as well as information on meetings and events, funding, the Watershed Leadership Team and partners, and the project. A link to the survey, Leadership Committee Meeting Minutes, maps, and Plan documents can also be found on the webpage, as can links to the local communities and their plans. A Watershed Kiosk was placed at Manistee County Library's Arcadia Branch Library, outreach was conducted by WLT members, and WLT members manned informational tables at several community festivals and events, where they obtained signatures from locals to express their support for the planning process. Leadership Committee members also visited township board meetings to inform them and obtain letters of support, which Blaine, Joyfield, Arcadia, and Onekama Townships provided. Interested individuals receive information via email as well.

Survey

The Arcadia-Pierport Watershed Property Owner/Resident Survey was created in May 2014 on SurveyMonkey and received 27 responses. 13 individuals filled it out in July 2014, 13 filled it out in August 2014, and 1 filled it out in January 2015. Despite the lower than hoped for response rate, the survey can be considered an important aspect of community engagement. Though analysis of the survey is interesting and informative, percentages are based on the responses of 27 individuals at most, so it is difficult to draw conclusions about local perceptions, knowledge, and beliefs. The survey consisted of 12 questions, the majority of which were multiple choice, about water quality of Arcadia Lake, Arcadia Marsh, and Lake Michigan, recreational activities in the watershed, threats to the watershed, and basic knowledge of how a watershed works. (SurveyMonkey, 2015) A discussion of the survey questions and answers follows.

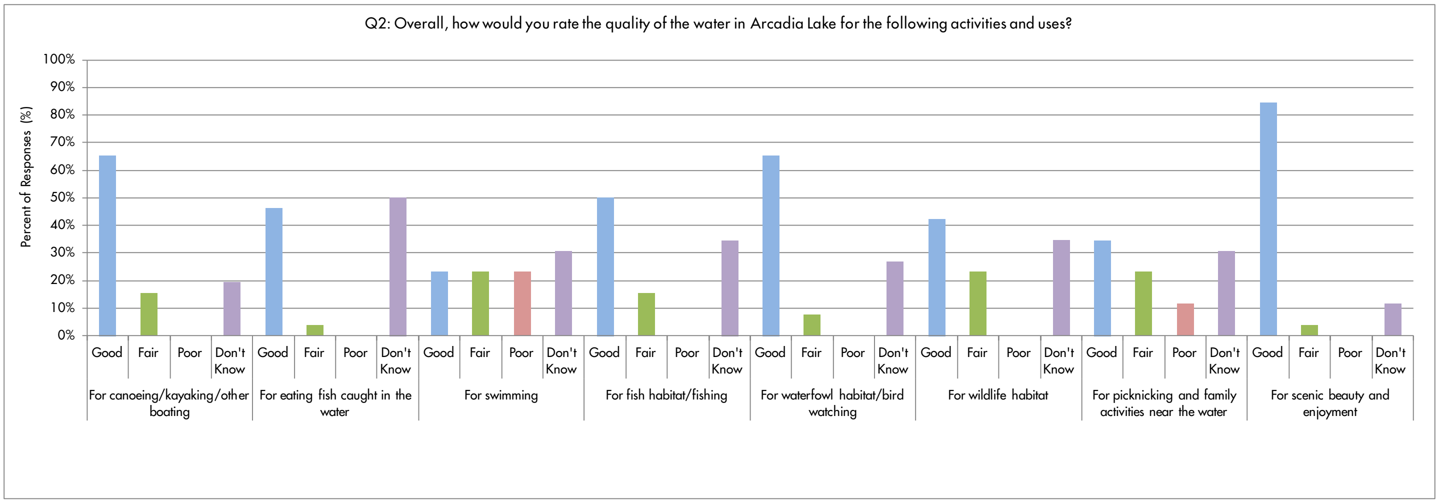
Graph 6: Survey Question One
Source: SurveyMonkey, 2015



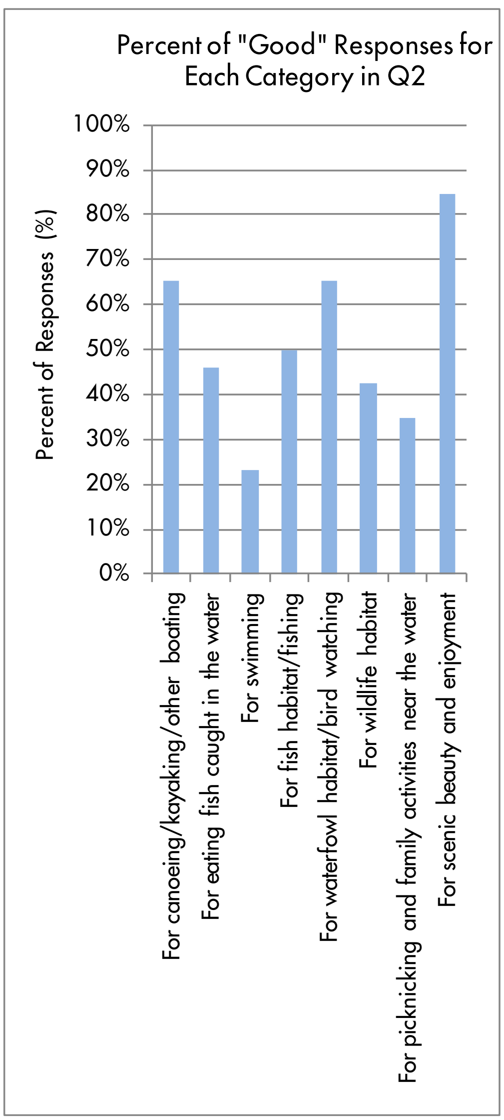
The first question asked respondents to rate the water quality of Arcadia Lake. Possible answer choices were Excellent, Good, Fair, Poor, and No Opinion. 26 individuals answered the question; the percentage of each response is illustrated in Graph 6. The highest percent of responses and the most individuals (42%, 11 individuals) considered the lake's water quality to be Good. The second largest percent of responses was No Opinion – this answer corresponded to 27% of responses (7 individuals). No one chose Poor. (SurveyMonkey, 2015)

The second question asked respondents to rate the water quality of Arcadia Lake for eight categories of activities and uses. Possible answer choices were Good, Fair, Poor, and Don't Know. 26 individuals answered the question; refer to Graph 7 for full results. For all activities and uses except for fish consumption and swimming, the highest percent of responses was that the lake's water quality is Good. For fish consumption and swimming, the highest percent of responses was Don't Know. The only activities and uses for which some respondents considered the lake's water quality to be Poor were swimming and picnicking and other family activities near the lake. Graphs 8 and 9 allow for a juxtaposition of the Good responses with the Poor responses to compare the two extremes; as the graphs show, the percent of Good responses tends to be higher than the percent of Poor responses, and only two activities and uses received any Poor responses at all. Graph 8 zooms in to the Good responses and provides a visual representation of the percent of Good responses received for various activities and uses of the marsh, while Graph 9 zooms in to the Poor responses. Of all the Good responses, the highest percent of responses was that the lake is Good for its scenic beauty; the lowest percent was that the lake is Good for swimming. Of the nine Poor responses, the highest percent of responses was that the lake is Poor for swimming; the lowest percent of responses (0.0%) was that the lake is Poor for canoeing/kayaking/boating, fish consumption, fish habitat/fishing, waterfowl habitat/birdwatching, wildlife habitat, and scenic beauty. (SurveyMonkey, 2015)

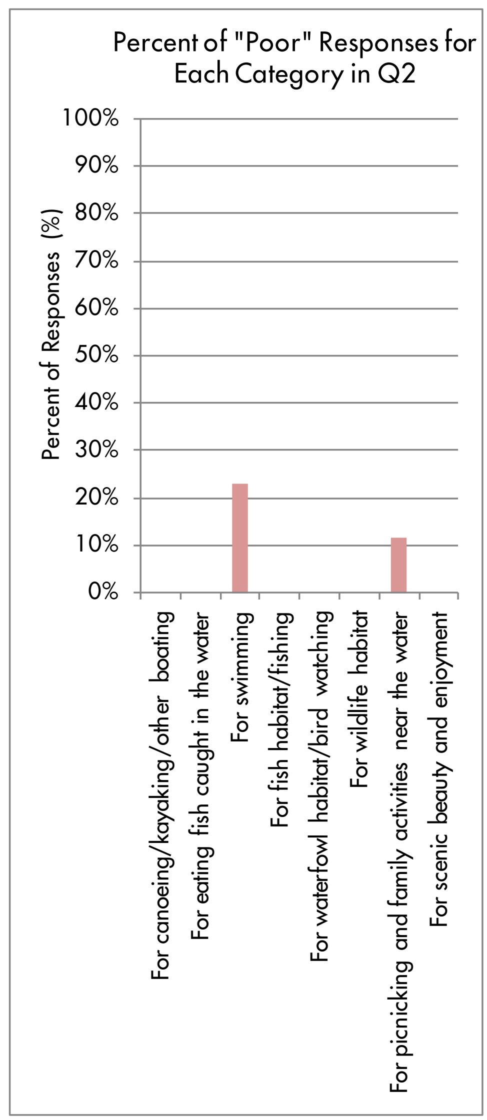
Graph 7: Survey Question Two
Source: SurveyMonkey, 2015



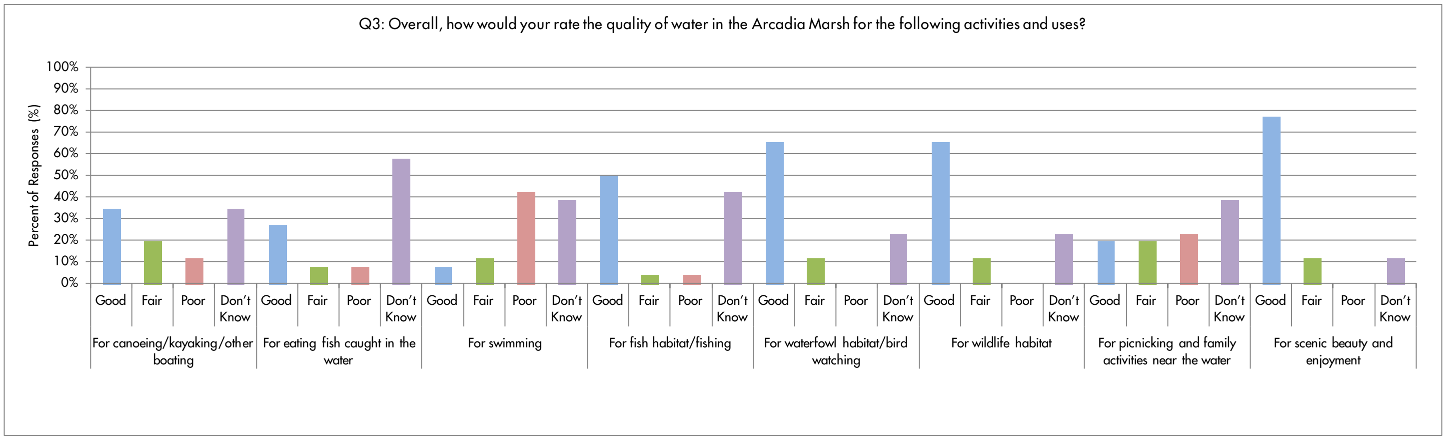
Graph 8: Survey Q2: "Good" Responses
Source: SurveyMonkey, 2015



Graph 9: Survey Q2: "Poor" Responses
Source: SurveyMonkey, 2015

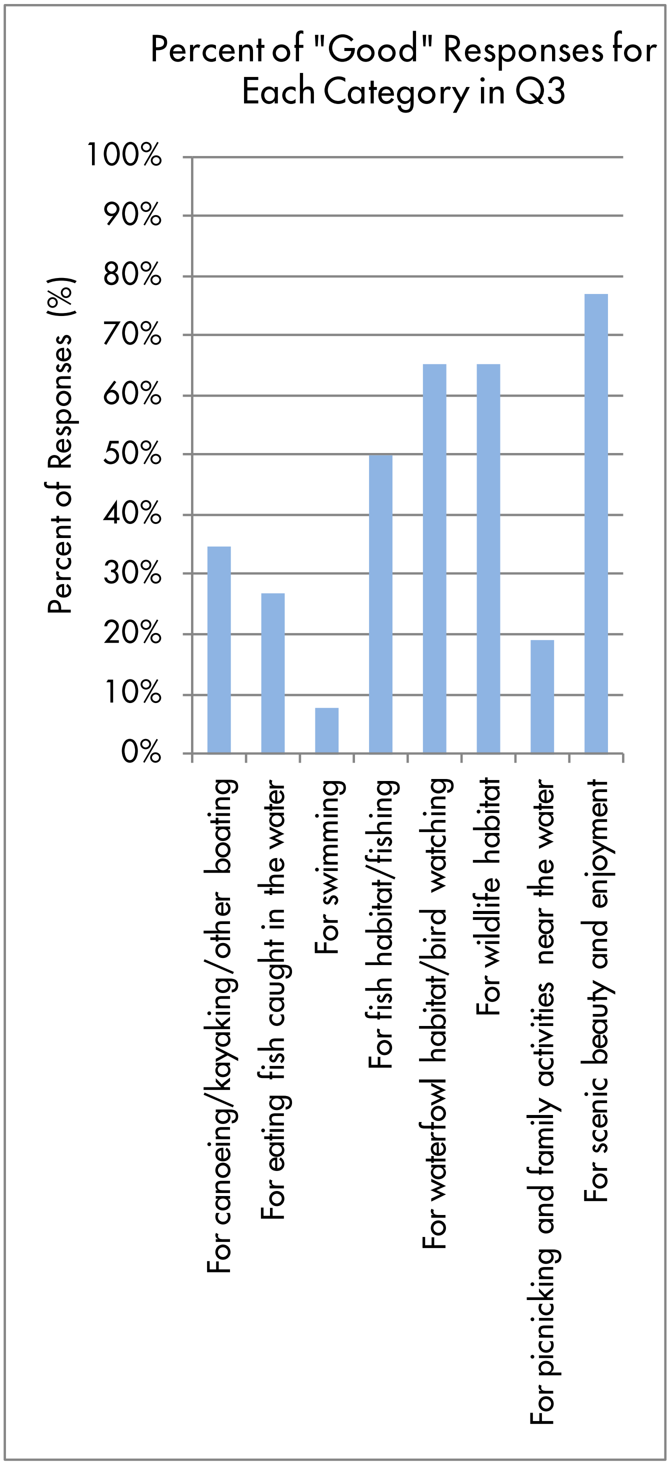


Graph 10: Survey Question Three
Source: SurveyMonkey, 2015

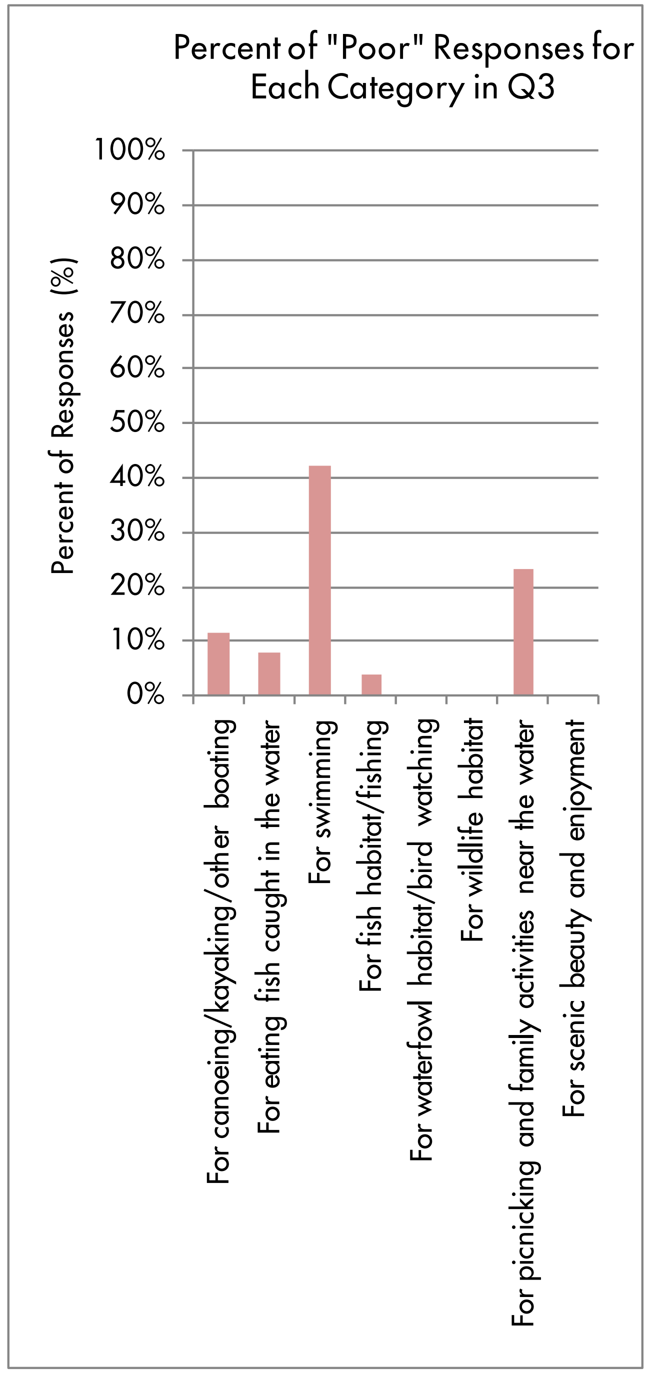


The third question asked respondents to rate the water quality of Arcadia Marsh for eight categories of activities and uses. Possible answer choices were Good, Fair, Poor, and Don't Know. 26 individuals answered the question; refer to Graph 10 for full results. For the other activities and uses besides canoeing/kayaking/boating, fish consumption, swimming, and picnicking and other family activities near the marsh, the highest percent of responses was that the marsh's water quality is Good. For canoeing/kayaking/ boating, the highest percent of responses was tied between Good and Don't Know; for fish consumption and picnicking and other family activities near the marsh, the highest percent of responses was Don't Know; and for swimming, the highest percent of responses was Poor. Graphs 11 and 12 allow for a juxtaposition of the Good responses with the Poor responses to compare the two extremes; as the graphs show, the percent of Good responses tends to be higher than the percent of Poor responses. Graph 11 zooms in to the Good responses and provides a visual representation of the percent of Good responses received for various activities and uses of the marsh, while Graph 12 zooms in to the Poor responses. Of all the Good responses, the highest percent of responses was that the marsh is Good for its scenic beauty; the lowest percent was that the marsh is Good for swimming. Of the 23 Poor responses, the highest percent of responses was that the marsh is Poor for swimming; the lowest percent of responses (0.0%) was that the marsh is Poor for waterfowl habitat/birdwatching, wildlife habitat, and scenic beauty. (SurveyMonkey, 2015)

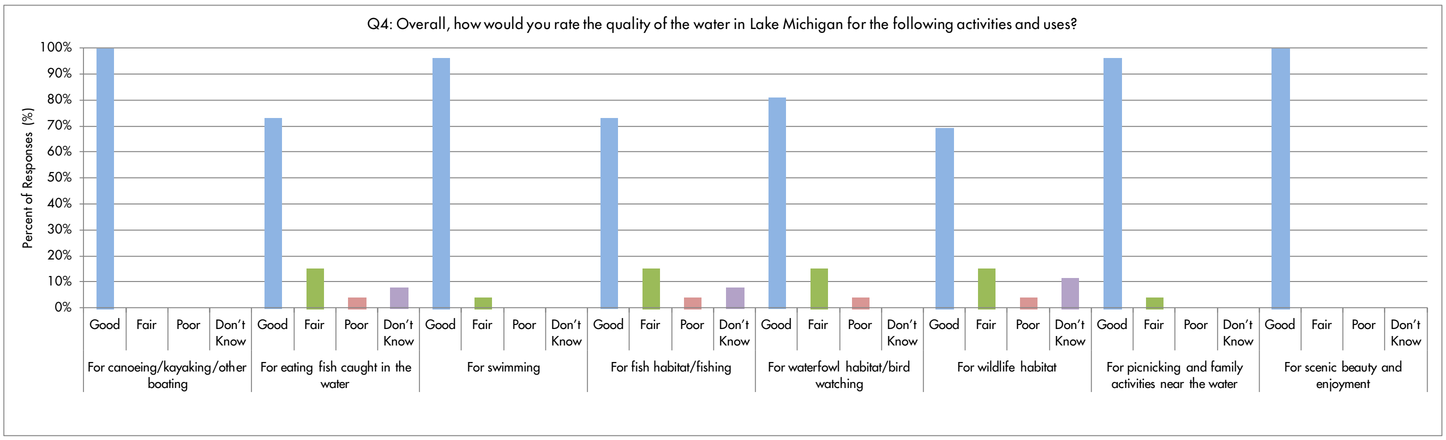
Graph 11: Survey Q3: "Good" Responses
Source: SurveyMonkey, 2015



Graph 12: Survey Q3: "Poor" Responses
Source: SurveyMonkey, 2015

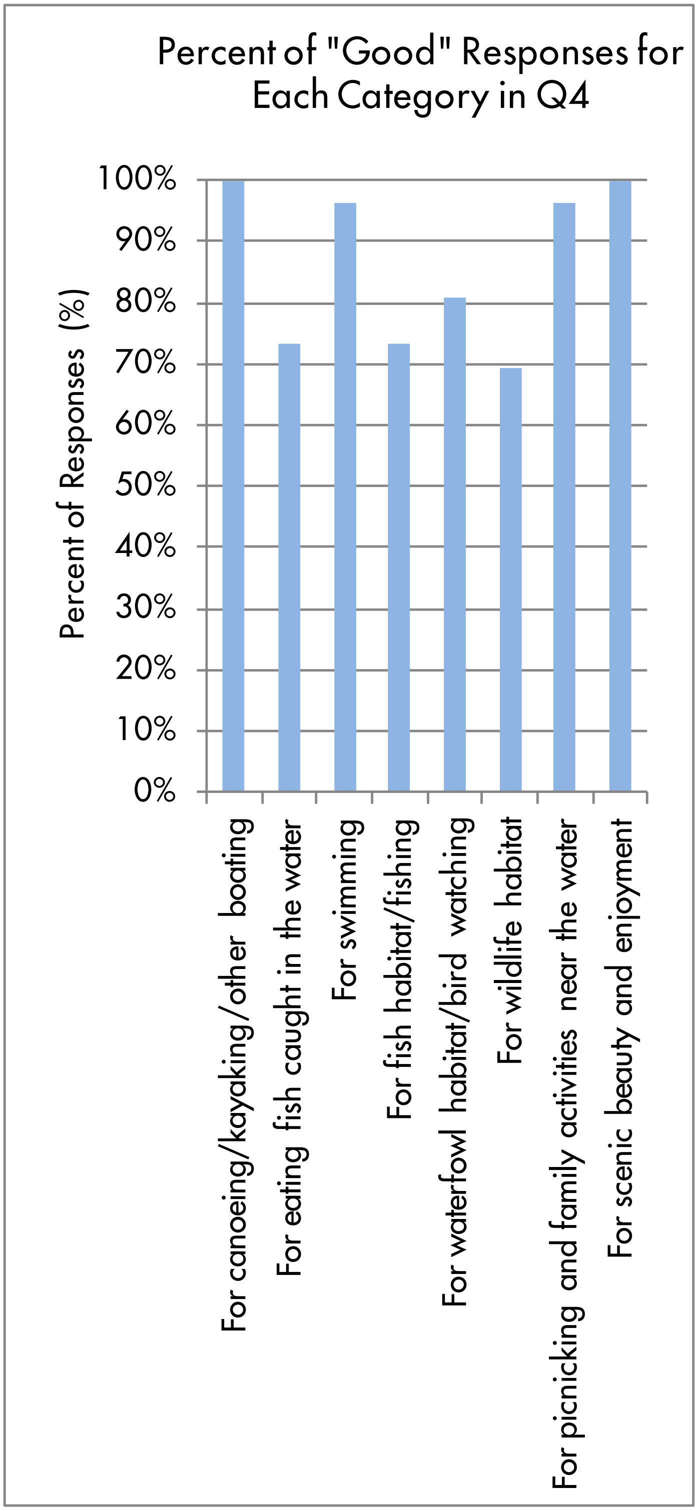


Graph 13: Survey Question Four
Source: SurveyMonkey, 2015



The fourth question asked respondents to rate the water quality of Lake Michigan for eight categories of activities and uses. As with the second and third questions, possible answer choices were Good, Fair, Poor, and Don't Know. 26 individuals answered the question; refer to Graph 13 for full results. For all activities and uses, the highest percent of responses was that the Lake's water quality is Good. Graphs 14 and 15 allow for a juxtaposition of the Good responses with the Poor responses to compare the two extremes; as the graphs show, the percent of Good responses is significantly higher for all categories of activities and uses than the percent of Poor responses. Graph 14 zooms in to the Good responses and provides a visual representation of the percent of Good responses received for various activities and uses of the Lake, while Graph 15 zooms in to the Poor responses. Of all the Good responses, the highest percent of responses (100.0%) was that the Lake is Good for canoeing/kayaking/boating and scenic beauty; the lowest percent was that the Lake is Good for wildlife habitat. Of the four Poor responses, one response for each of four activities and uses was that the Lake is Poor for fish consumption, fish habitat/fishing, waterfowl habitat/birdwatching, and wildlife habitat; the lowest percent of responses (0.0%) was that the Lake is Poor for canoeing/kayaking/boating, swimming, picnicking and family activities near the Lake, and scenic beauty. (SurveyMonkey, 2015)

Graph 14: Survey Q4: "Good" Responses
Source: SurveyMonkey, 2015



Graph 15: Survey Q4: "Poor" Responses
Source: SurveyMonkey, 2015

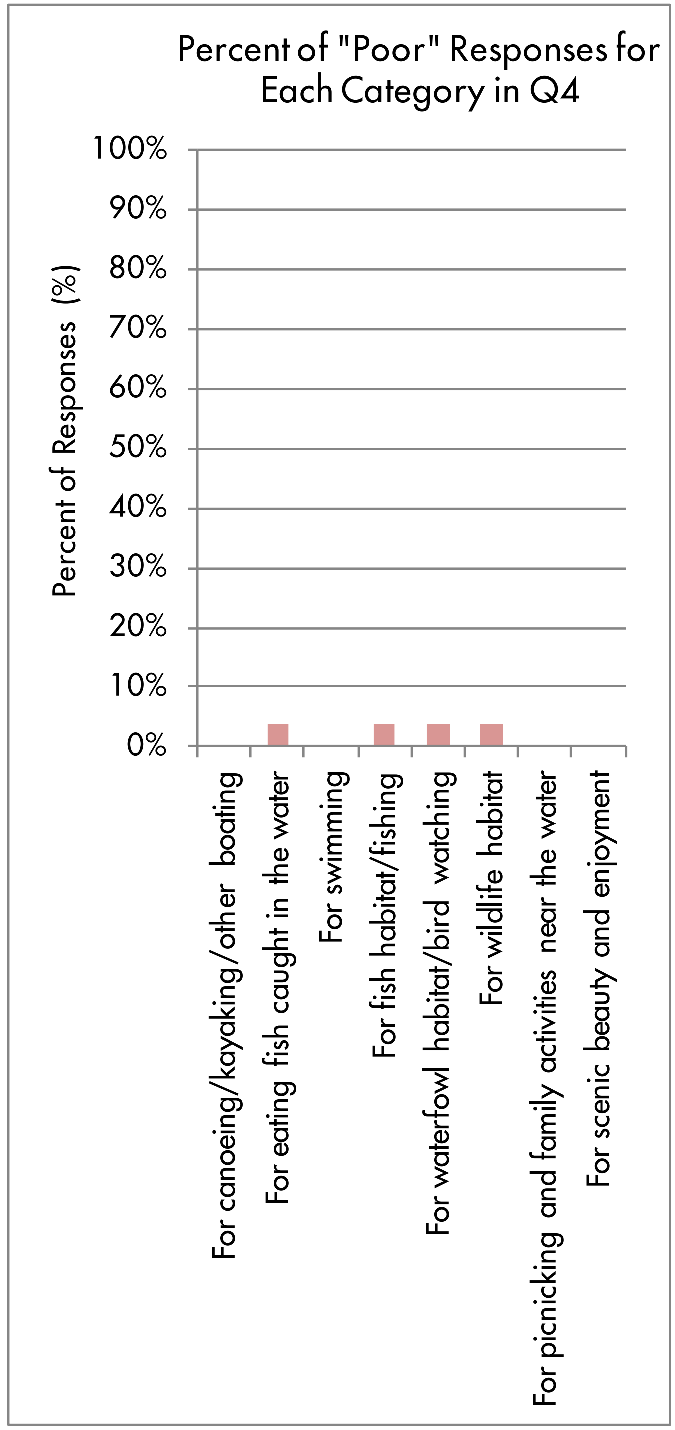
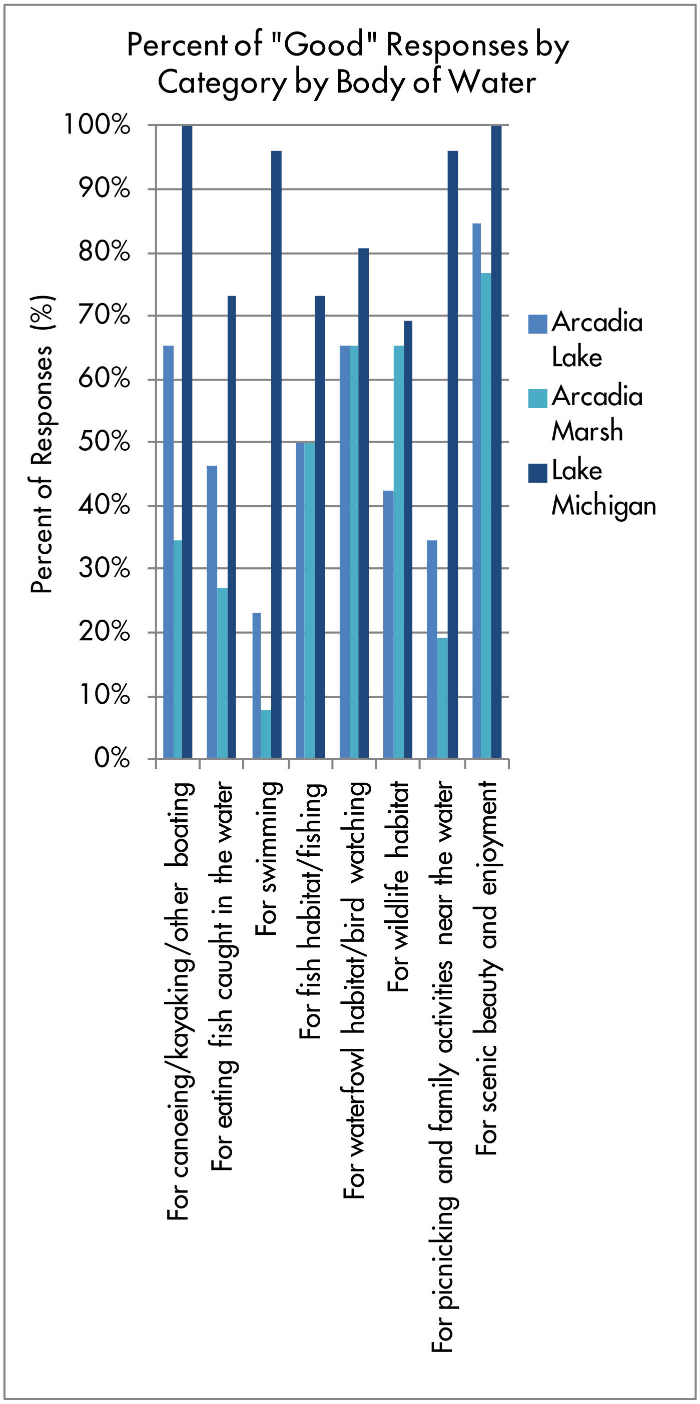


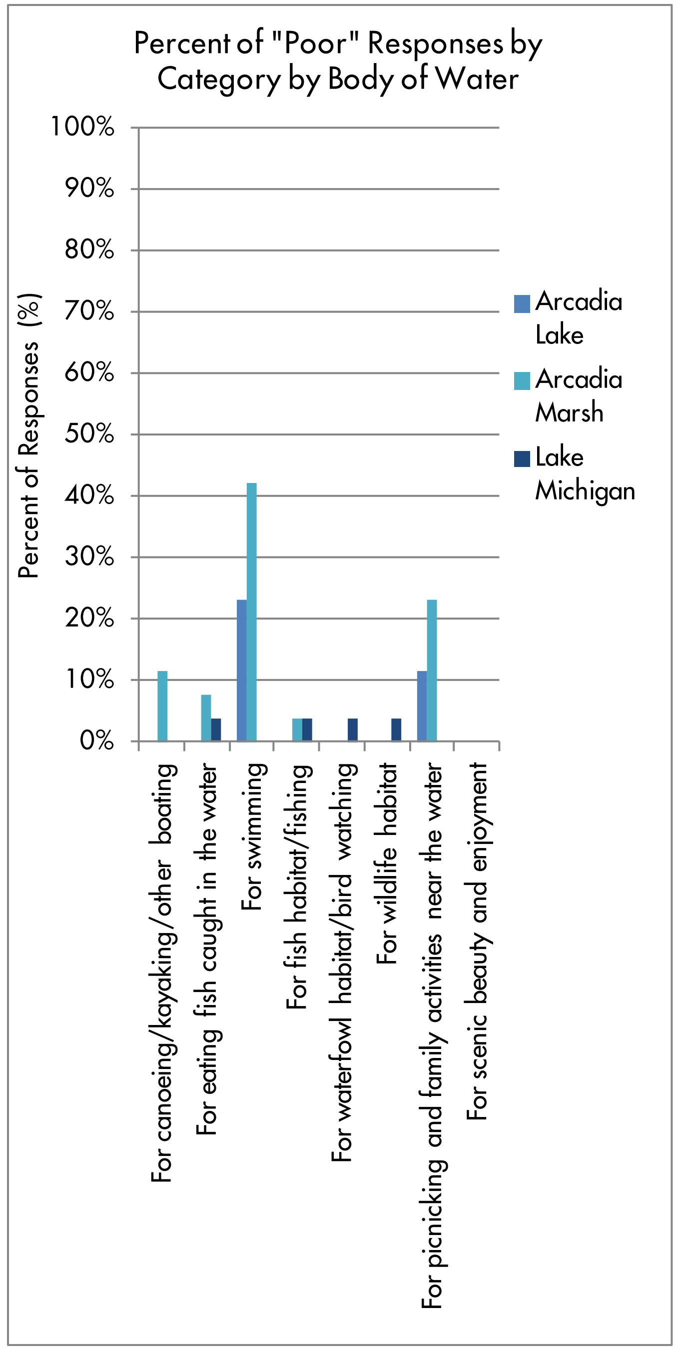
Figure 28: View of Arcadia Coastline from Inspiration Point

As Q2, Q3, and Q4 ask essentially the same question and have the same array of eight categories of activities and uses except focus on three different bodies of water, it is useful to analyze the percent of Good responses and the percent of Poor responses by body of water to compare the two extremes for the three bodies of water. Graphs 16 and 17 present these results; the colors of the bars correspond to the waterbodies. The percent of Good responses is highest for Lake Michigan in all eight activities and uses. The percent of Good responses is higher for Arcadia Lake than for Arcadia Marsh in five activities and uses; the percent of Good responses is the same for Arcadia Lake and Arcadia Marsh in two activities and uses (fish habitat/fishing and waterfowl habitat/birdwatching) and higher for Arcadia Marsh in one (wildlife habitat). The highest percent of Good responses (100%) is that Lake Michigan is good for canoeing/kayaking/boating and scenic beauty and enjoyment. The percent of Poor responses varies between the eight activities and uses and the three bodies of water, and there are fewer Poor responses overall than Good responses. The highest percent of Poor responses was that Arcadia Marsh is Poor for swimming.

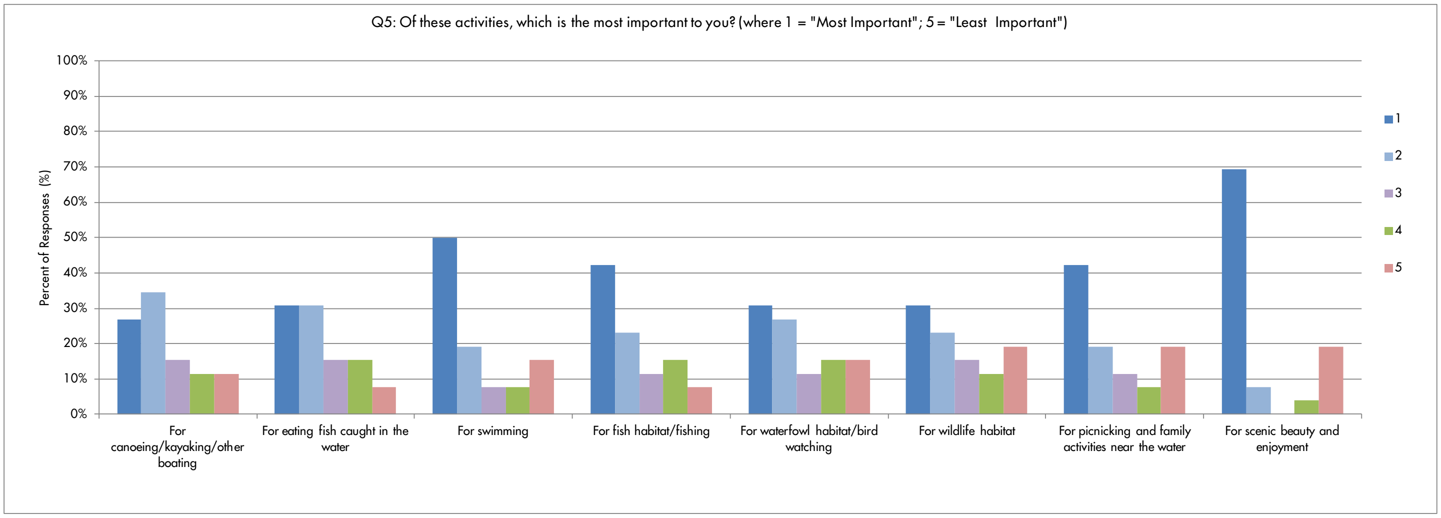
Graph 16: Comparison of Survey Q2, Q3, and Q4: "Good" Responses
Source: SurveyMonkey, 2015



Graph 17: Comparison of Survey Q2, Q3, and Q4: "Poor" Responses
Source: SurveyMonkey, 2015

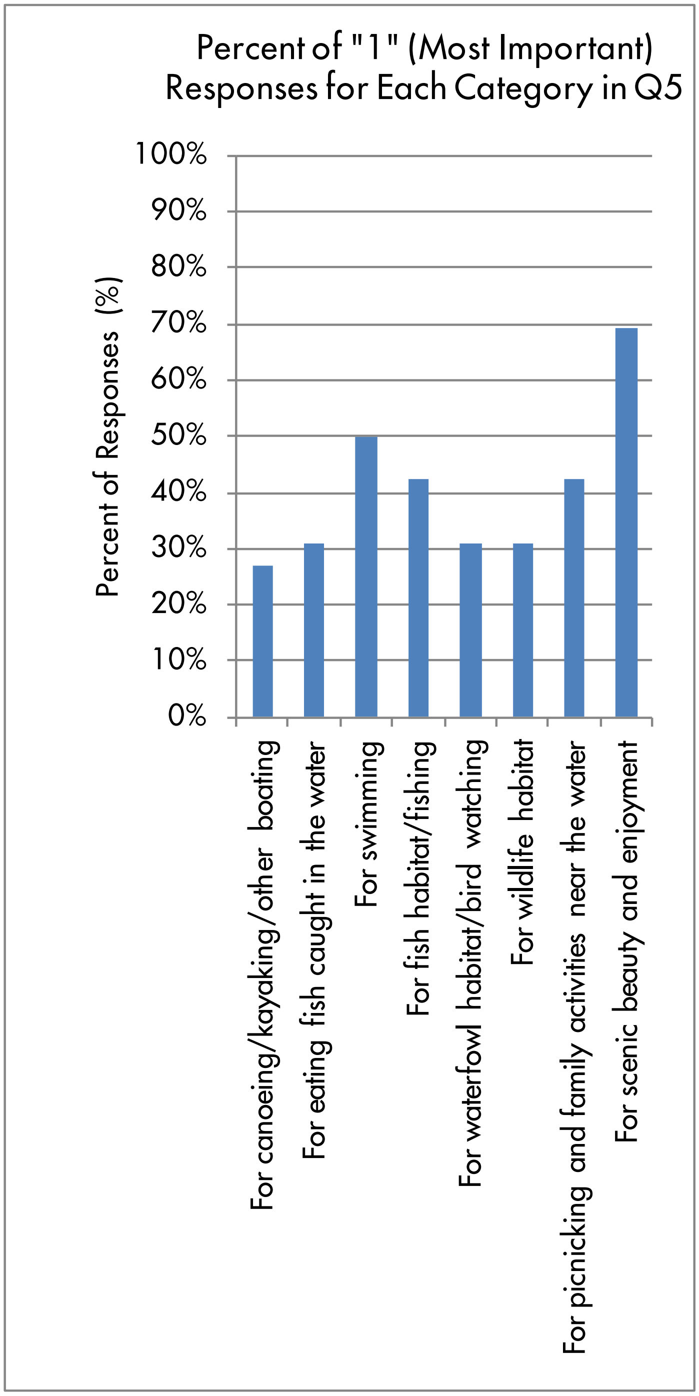


Graph 18: Survey Question Five
Source: SurveyMonkey, 2015

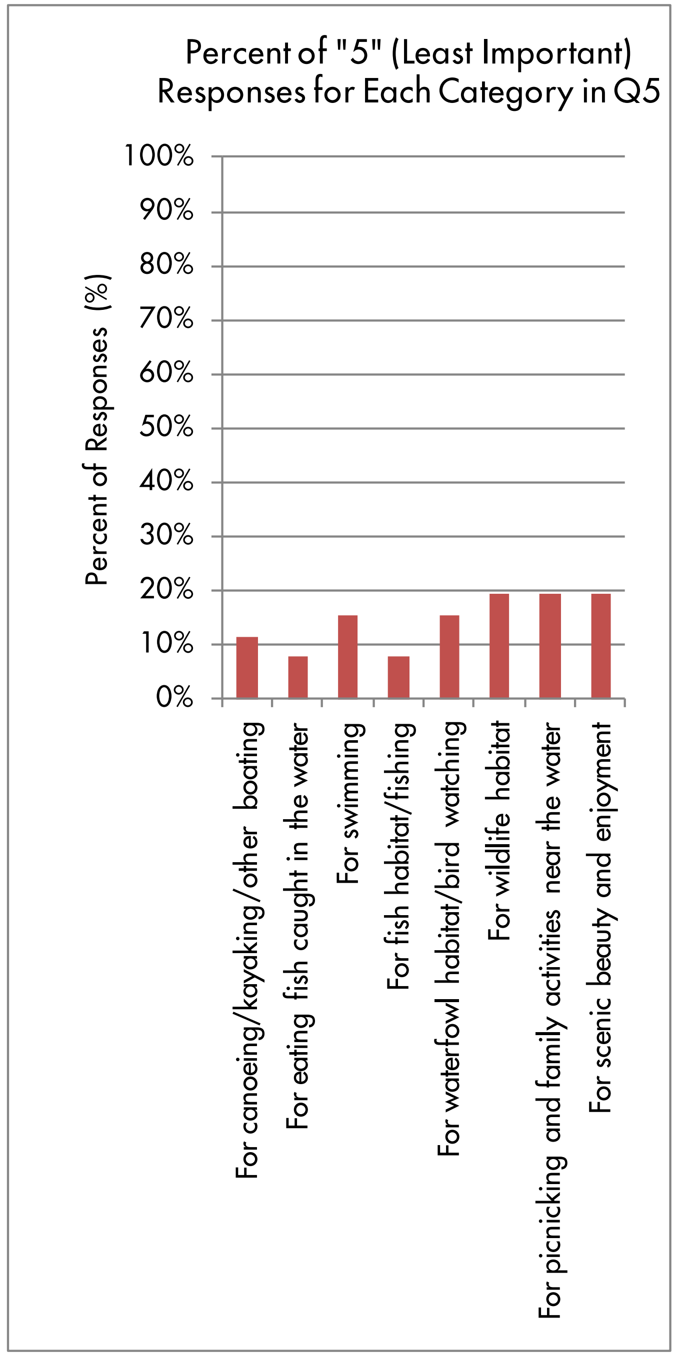


The fifth question asked respondents to rate the importance of the same eight categories of activities as in the preceding three questions on a scale of 1 to 5, with 1 being the most important. 26 individuals answered the question; refer to Graph 18 for full results. For the other activities besides canoeing/kayaking/boating and fish consumption, the highest percent of responses was that the activities are a "1" for Most Important. For canoeing/kayaking/boating, the highest percent of responses was that the activities are a "2" for slightly less important; and for fish consumption, the highest percent of responses was tied between a "1" and a "2." Graphs 19 and 20 allow for a juxtaposition of the "1" responses with the "5" responses to compare the two extremes; as the graphs show, the percent of "1" responses is higher for all activities than the percent of "5" responses. Graph 19 zooms in to the "1" responses and provides a visual representation of the percent of "1" responses received for various activities, while Graph 20 zooms in to the "5" responses. Of all the "1" responses, the highest percent of responses was for scenic beauty as being Most Important; the lowest percent was for canoeing/kayaking/boating. Of the "5" responses, the highest percent of responses was a three-way tie between wildlife habitat, picnicking and family activities near the water, and scenic beauty as being Least Important; the lowest percent was a tie between fish consumption and fish habitat/fishing. (SurveyMonkey, 2015)

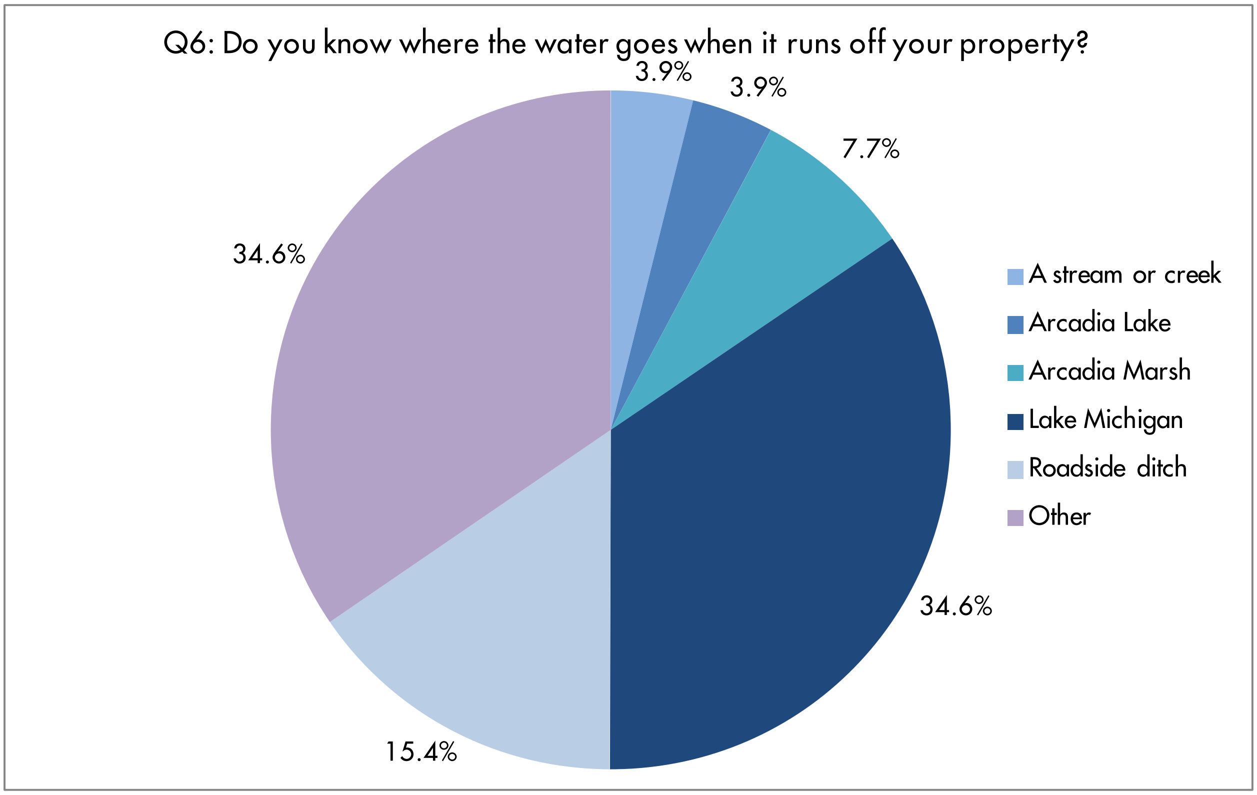
Graph 19: Survey Q5: "1" Responses
Source: SurveyMonkey, 2015



Graph 20: Survey Q5: "5" Responses
Source: SurveyMonkey, 2015



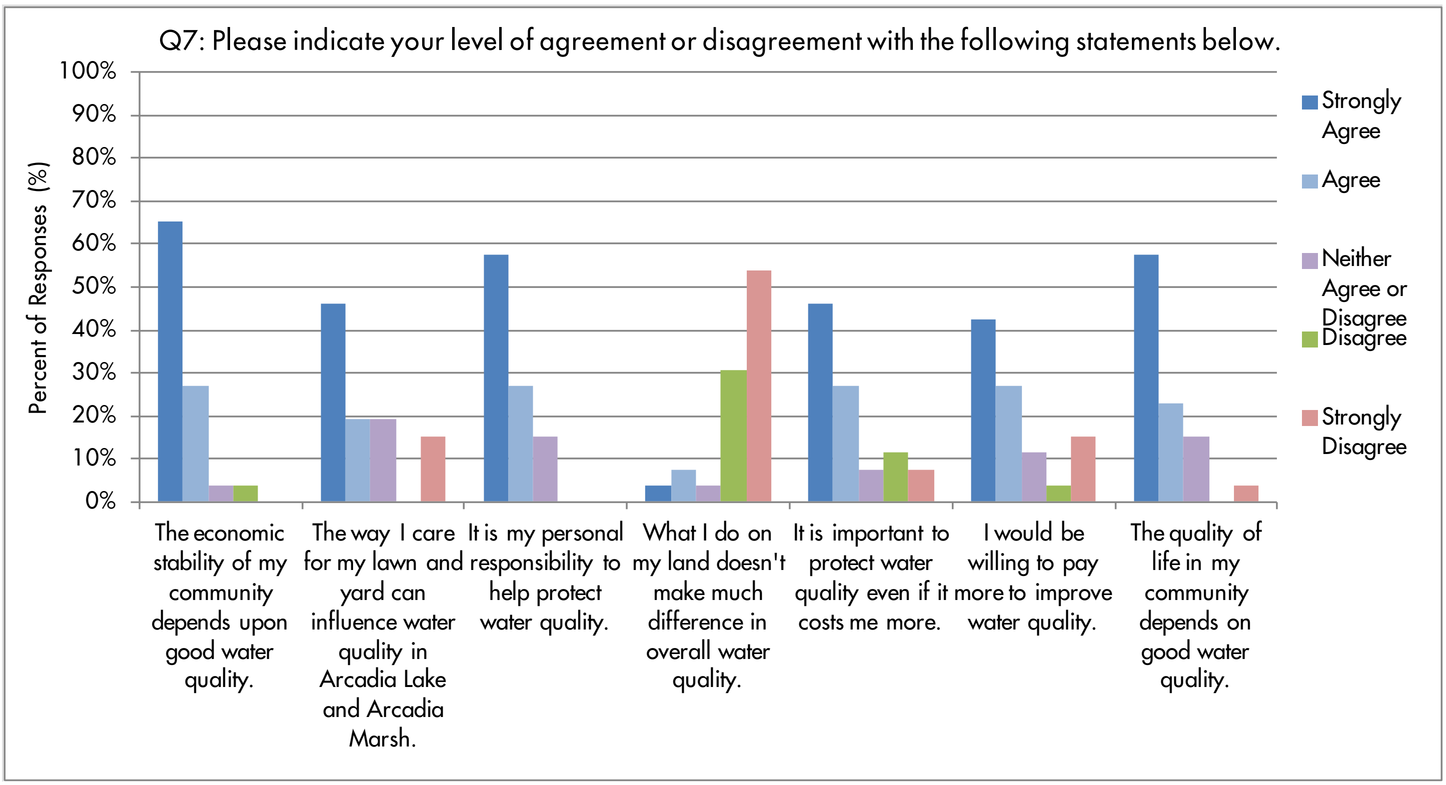
Graph 21: Survey Question Six
Source: SurveyMonkey, 2015



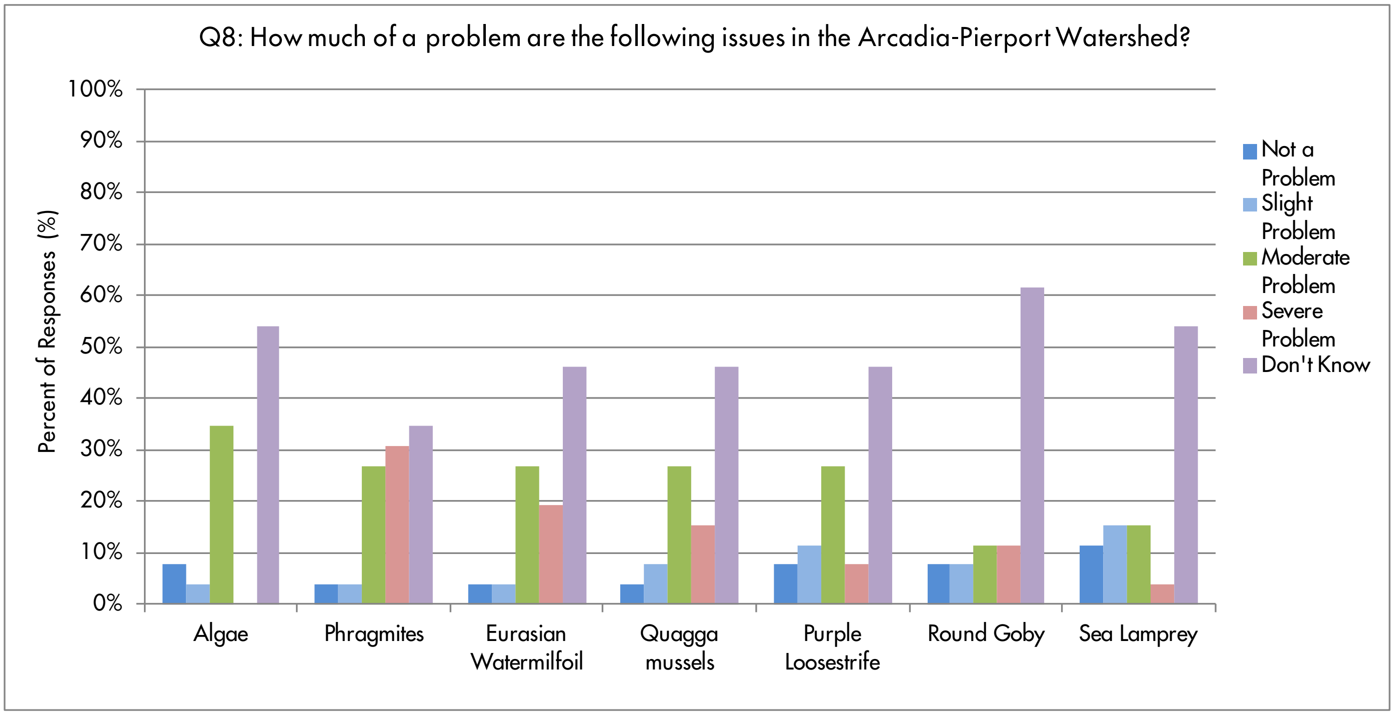
The sixth question asked respondents a factual question, testing their knowledge and awareness of where water goes after running off their own property. Possible answer choices were A stream or creek, Arcadia Lake, Arcadia Marsh, Lake Michigan, Roadside Ditch, or Other. 26 individuals answered the question; the percentage of each response is illustrated in Graph 21. The highest percent of responses was a tie between Lake Michigan and Other (respondents specified various answers for Other). The lowest percent of responses was a tie between A stream or creek and Arcadia Lake. (SurveyMonkey, 2015)

The seventh question asked respondents to indicate their level of agreement with seven statements related to water quality. 26 individuals answered the question; refer to Graph 22 for results. For all statements, the highest percent of responses was in favor of the statement that recognized the importance of water quality. The statement that received the highest percent of Strongly Agree responses relates to the correlation between a stable economy and good water quality. (SurveyMonkey, 2015)

Graph 22: Survey Question Seven
Source: SurveyMonkey, 2015



Graph 23: Survey Question Eight
Source: SurveyMonkey, 2015

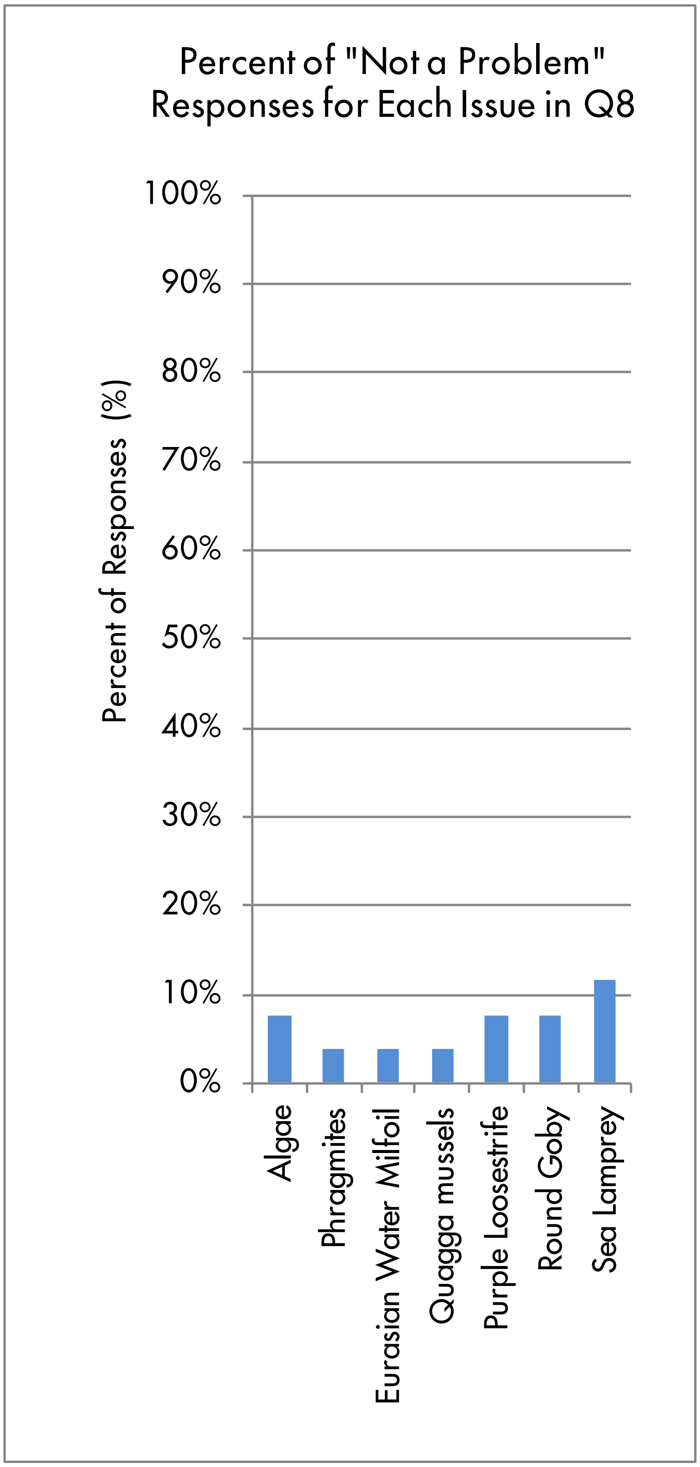


The eighth question asked respondents to indicate to what degree they considered seven issues problematic in the watershed. 26 individuals answered the question; refer to Graph 23 for full results. Responses varied but did tend to indicate that respondents may be aware the issues are problematic to some degree. However, for all issues, the highest percent of responses was Don't Know, which could demonstrate the need for education about invasive species and threats to water quality. Graphs 24 and 25 allow for a juxtaposition of the Severe Problem responses with the Not a Problem responses to compare the two extremes. Graph 24 zooms in to the Severe Problem responses and provides a visual representation of the percent of Not a Problem responses received for various issues in the watershed, while Graph 25 zooms in to the Severe Problem responses. Of all the Not a Problem responses, the highest percent of responses was that Sea Lamprey is Not a Problem in the watershed; one response for each of three issues was that Phragmites, Eurasian Water Milfoil, and Quagga mussels are Not a Problem. Of all the Severe Problem responses, the highest percent of responses was that Phragmites are a Severe Problem in the watershed; the lowest percent of responses (0%) was that Algae are a Severe Problem. The percent of Severe Problem responses is higher than the percent of Not a Problem responses for four issues, the percent of Severe Problem and Not a Problem responses is the same for one issue (Purple Loosestrife), and the percent of Not a Problem responses is higher than the percent of Severe Problem responses for two issues (Algae and Sea Lamprey). (SurveyMonkey, 2015)

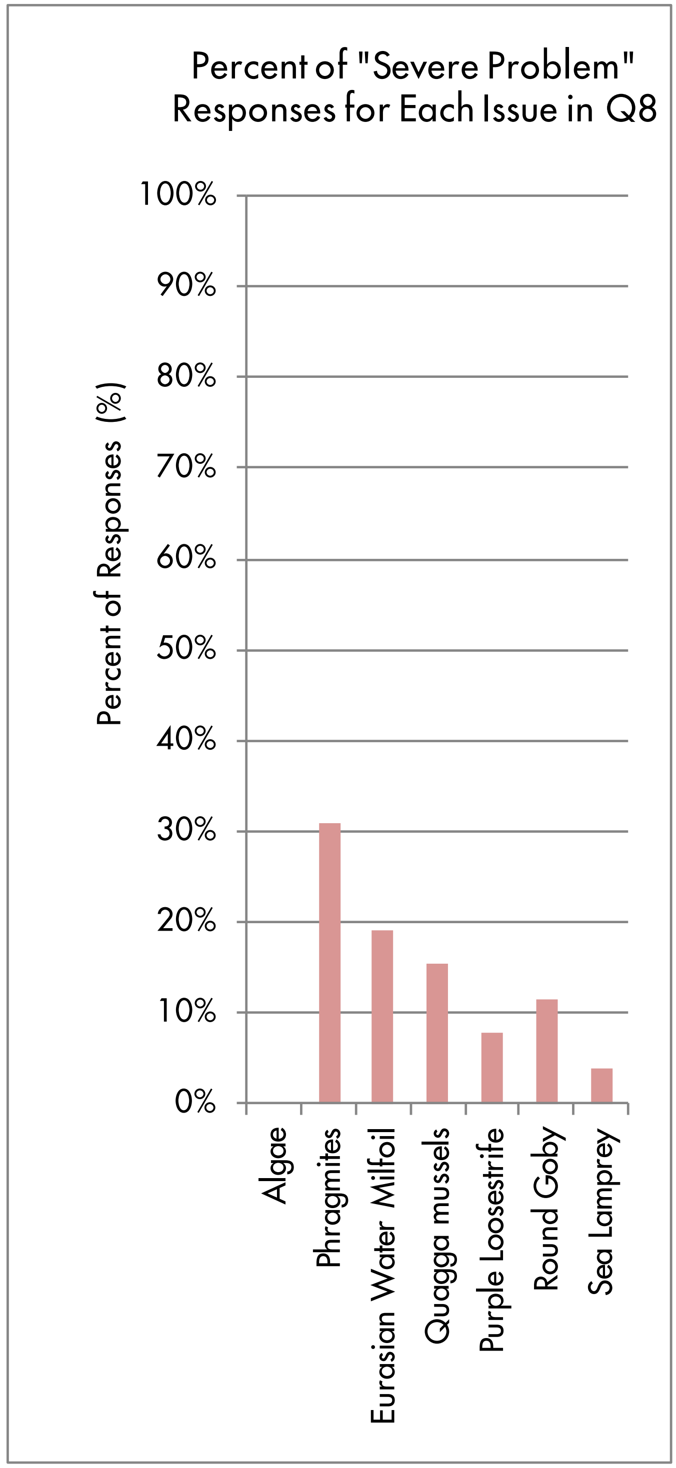
Although not addressed in the survey question, autumn olive may also be a concern, as identified by community input; there are gaps in regards to whether, where, and to what extent autumn olive may impact the Arcadia-Pierport Watershed, so the extent of this issue in the watershed cannot be confirmed.

Watershed Goals I, II, and III in Table 44 and Implementation Task IIIB in Table 46 address invasive species.

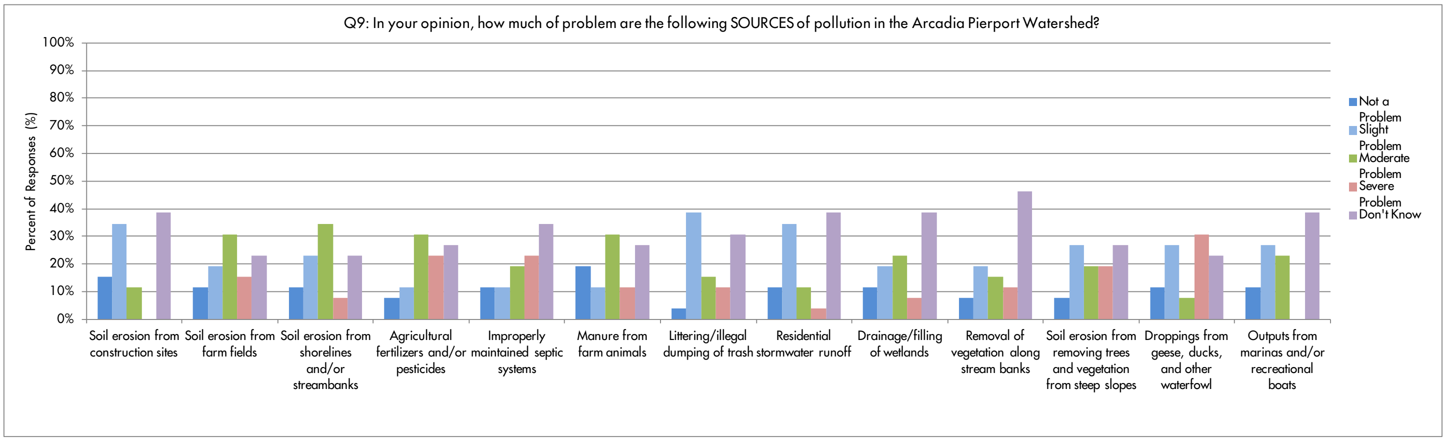
Graph 24: Survey Q8: "Not a Problem" Responses
Source: SurveyMonkey, 2015



Graph 25: Survey Q8: "Severe Problem" Responses
Source: SurveyMonkey, 2015

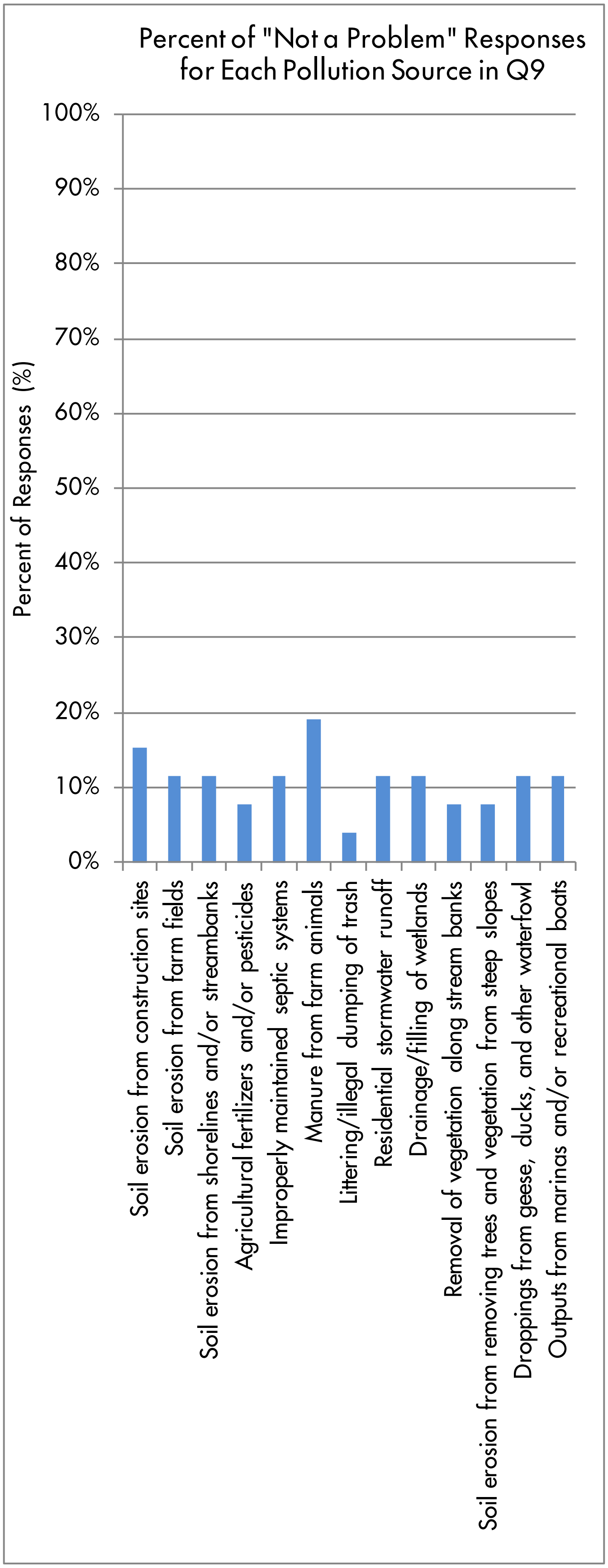


Graph 26: Survey Question Nine
Source: SurveyMonkey, 2015

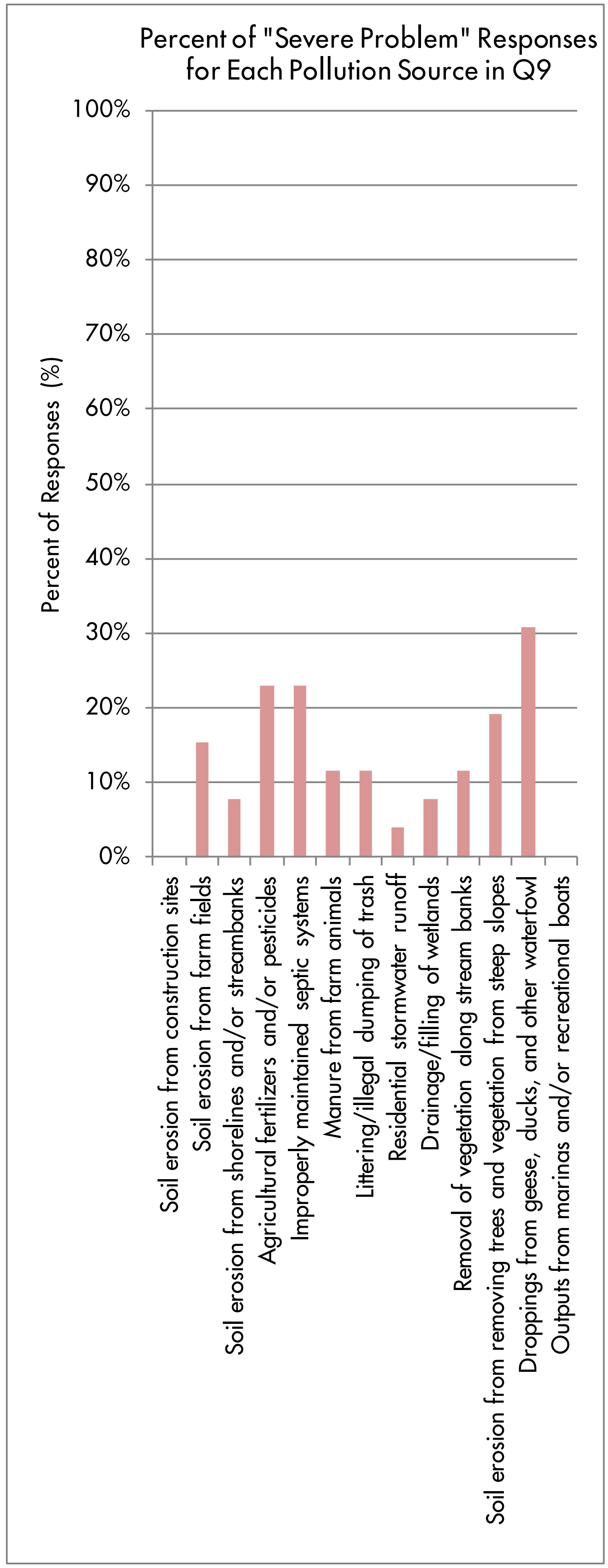


The ninth question asked respondents to indicate to what degree they considered 13 sources of pollution problematic in the watershed. 26 individuals answered the question; refer to Graph 26 for full results. Responses varied but did tend to indicate that respondents may be aware that pollution sources are problematic to some degree. However, for all pollution sources, numerous respondents indicated Don't Know in regards to the degree of the problems, which could demonstrate the need for education about pollution and threats to water quality. Graphs 27 and 28 allow for a juxtaposition of the Severe Problem responses with the Not a Problem responses to compare the two extremes. Graph 27 zooms in to the Severe Problem responses and provides a visual representation of the percent of Not a Problem responses received for various issues in the watershed, while Graph 28 zooms in to the Severe Problem responses. Of all the Not a Problem responses, the highest percent of responses was that Manure from farm animals is Not a Problem in the watershed; the lowest percent of responses was that Littering/illegal dumping is Not a Problem. Of all the Severe Problem responses, the highest percent of responses was that Droppings from waterfowl are a Severe Problem in the watershed; the lowest percent of responses (0%) was that Soil erosion from construction and Outputs from marinas and/or boats are Severe Problems. (SurveyMonkey, 2015) Watershed Goal III in Table 44 addresses citizen engagement, while Watershed Goals I, II, and III address pollution.

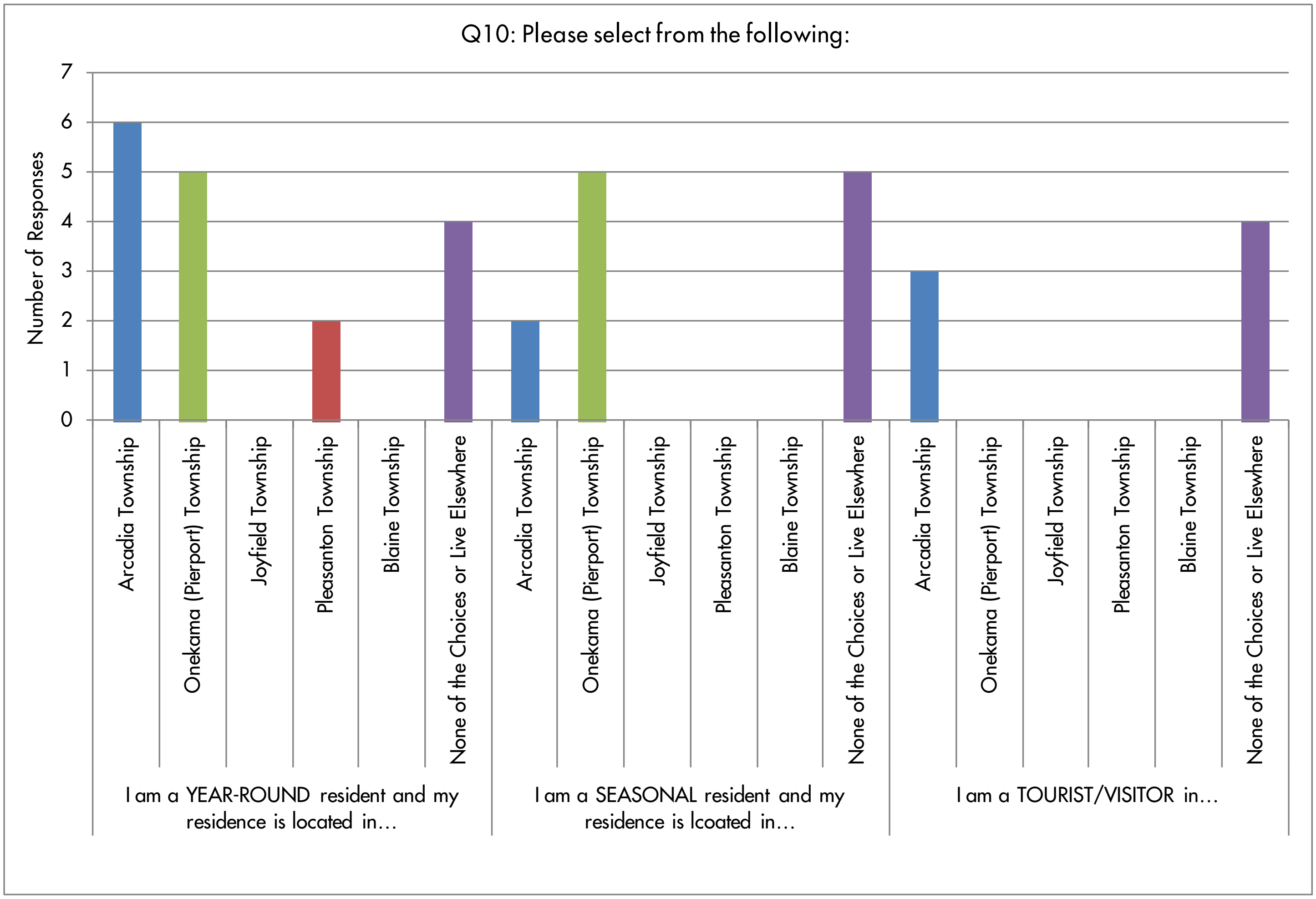
Graph 27: Survey Q9: "Not a Problem" Responses
Source: SurveyMonkey, 2015



Graph 28: Survey Q9: "Severe Problem" Responses
Source: SurveyMonkey, 2015



Graph 29: Survey Question Ten
Source: SurveyMonkey, 2015

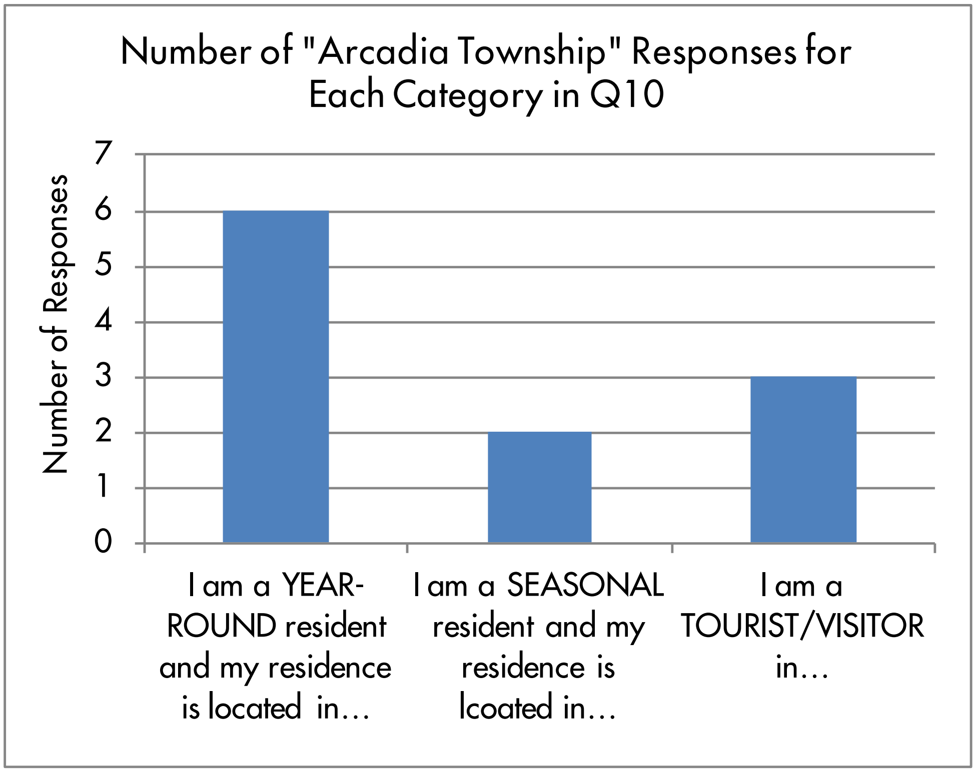


The tenth question asked respondents about what type of resident or visitor they are and where they live or are visiting. Possible answer choices were Arcadia Township, Onekama (Pierport) Township, Joyfield Township, Pleasanton Township, Blaine Township, or None of the Choices or Live Elsewhere. 26 individuals answered the question; results are shown in Graph 29. For Year-Round residents, the highest number of responses was Arcadia Township, followed by Onekama (Pierport) Township; for Seasonal residents, the highest number of responses was Onekama (Pierport) Township and None of the Choices or Live Elsewhere; and for Tourists/ Visitors, the highest number of responses was None of the Choices or Live Elsewhere, followed by Arcadia Township. No respondents chose Joyfield or Blaine Townships for any of the three categories, indicating no representation from those two townships in the survey. Graphs 30 and 31 allow for a juxtaposition of the Arcadia Township responses with the Onekama (Pierport) Township responses. The highest number of Arcadia Township responses was by Year-Round residents, while the highest number of Onekama (Pierport) Township responses was tied between Year-Round and Seasonal residents. (SurveyMonkey, 2015)

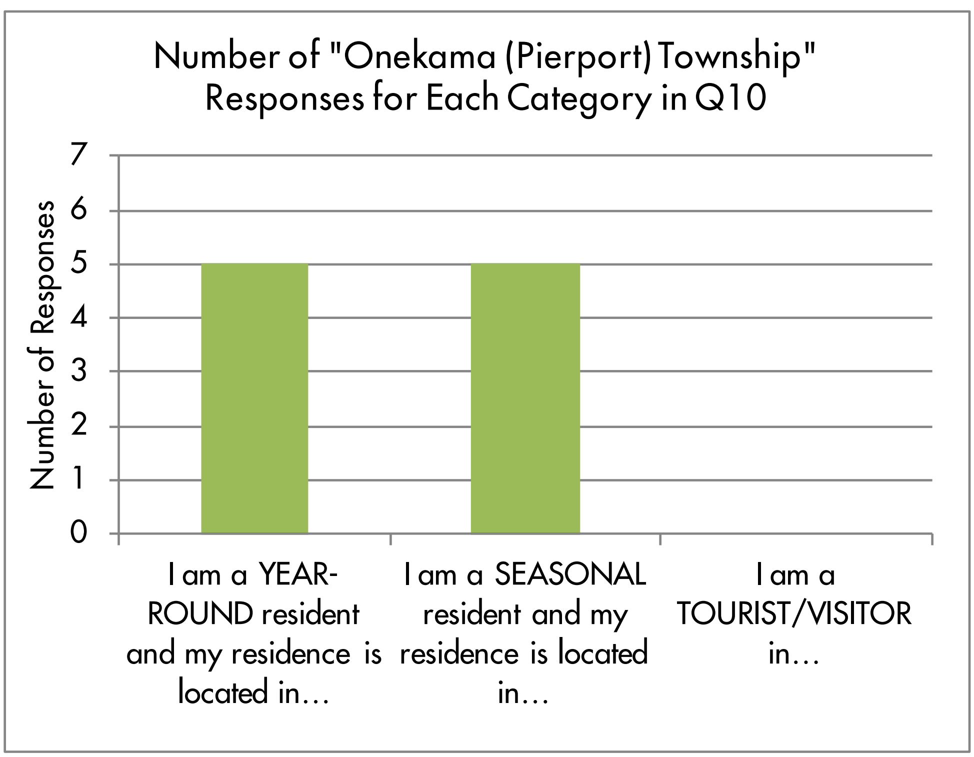
The eleventh question allowed respondents to comment with any suggestions they had about topics not addressed in the survey. The question was open-ended, rather than multiple choice. 10 individuals responded; three of the 10 referenced groundwater. The twelfth question allowed respondents to input their contact information if they wanted to receive updates; nine individuals did so. (SurveyMonkey, 2015)

The survey is still open for individuals to complete, and it is hoped that more residents will do so. Watershed Goal III in Table 44 addresses citizen engagement.

Graph 30: Survey Q10: "Arcadia Township" Responses
Source: SurveyMonkey, 2015



Graph 31: Survey Q10: "Onekama (Pierport) Township" Responses
Source: SurveyMonkey, 2015



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Lakes to Land Regional Initiative. (N.d.). http://www.lakestoland.org/.

State of Michigan. (2013). Michigan Center for Geographic Information (CGI) Data Library. Michigan Department of Technology, Management & Budget, Center for Shared Solutions and Technology Partnerships. http://www.mcgi.state.mi.us/mgdl/.

SurveyMonkey. (2015). Arcadia-Pierport Watershed Property Owner/Resident Survey.

CHAPTER FOUR:

DESIGNATED AND DESIRED USES OF THE WATERSHED, SOURCES AND CAUSES OF POLLUTANTS, AND PRIORITY AND CRITICAL AREAS

Data and information on water quality and pollutants in the Arcadia-Pierport Watershed and to assess compliance with designated uses and determine priority and critical areas are not extensive. This is another section of the Plan wherein there are gaps in terms of available data and information, but the watershed planning process is ongoing. Watershed Goals I, II, and III in Table 44 address water quality and pollutants, and completion of Implementation Tasks IA, IIA, IIB, IIID, and IIIE in Table 46 could help in this regard. The primary material used to write this chapter included statutes, existing county and township master plans, reports, and information provided by governmental entities. However, these sources do not necessarily focus on the watershed area or provide a complete or comprehensive overview of the entire Arcadia-Pierport Watershed; for instance, there is more information available on Benzie County than on Manistee County, the watershed is only situated within a portion of the relevant counties and townships, and not all sources are recent.

Figure 29: Arcadia Marsh

Water Quality Standards and Designated Uses

The first federal law in the United States intended to deal with water pollution was the Federal Water Pollution Control Act of 1948. This law was amended in 1972, wherein it became known as the Clean Water Act. (United States Environmental Protection Agency, 2015, June 1) States must report about the water quality, including point source and nonpoint source pollutants, of the waterbodies in their state to the United States Environmental Protection Agency and update the information on an annual basis, per "Title III – Standards and Enforcement" of 1972 PL 92-500. (1972 PL 92-500, 1972). The National Pollutant Discharge Elimination System is addressed in "Title IV – Permits and Licenses" of 1972 PL 92-500. (1972 PL 92-500, 1972) NPDES deals with point source pollution entering water systems in the U.S. and regulates discharge. (1972 PL 92-500, 1972) The MDEQ website describes NPDES and notes, "The purpose of the program is to control the discharge of pollutants into surface waters by imposing effluent limitations to protect the environment. Authority to administer this program was delegated to Michigan by the Environmental Protection Agency (EPA) in October of 1973. Thus, Michigan was one of the first states to be authorized to carry out this program. Currently, authority for NPDES permit issuance rests with the Michigan Department of Environmental Quality." (State of Michigan, 2015d)

The EPA provides a comprehensible overview of the Clean Water Act and its influence. According to the EPA, "The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters…Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry. We have also set water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls discharges." (United States Environmental Protection Agency, 2015, March 13)

Table 17: Water Quality Standards in Michigan
Source: Part 4. Water Quality Standards, n.d.

Select Parameter	*What the Rules Mean*	*Source in Part 4. Water Quality Standards*
Dissolved Solids	Dissolved solids ≤ **750 mg/l** (monthly average of dissolved solids ≤ **500 mg/l**) from point sources; monthly average of chlorides ≤ **50 mg/l** from Great Lakes and connecting bodies of water that are public water supply sources (monthly average of chlorides ≤ **125 mg/l** for public water supplies from other bodies of water)	R 323.1051 Rule 51
pH	pH **6.5-9.0 S.U.** in surface waters	R. 323.1053 Rule 53
Phosphorus	Monthly average of phosphorus ≤ **1 mg/l** from point sources	R. 323.1060 Rule 60
E. coli and Fecal Coliform	E. coli ≤ **300 E. coli/100 ml** in surface waters for total body contact recreation (30-day geometric mean ≤ **130 E. coli/100 ml**); E. coli ≤ **1,000 E. coli/100 ml** in surface waters for partial body contact recreation; 30-day geometric mean ≤ **200 fecal coliform bacteria/100 ml** in discharges with sewage (7-day geometric mean ≤ **400 fecal coliform bacteria/100 ml**)	R. 323.1062 Rule 62
Dissolved Oxygen in Great Lakes, Connecting Bodies of Water, and Inland Bodies of Water	Dissolved oxygen ≥ **7 mg/l** in Great Lakes, connecting bodies of water, and inland bodies of water (dissolved oxygen ≥ **5 mg/l** in other bodies of water except for inland lakes) for coldwater fish; dissolved oxygen ≥ **6 mg/l** in warm season (dissolved oxygen ≥ **7 mg/l** in other seasons) in surface bodies of water for coldwater fish; dissolved oxygen ≥ **4 mg/l** (daily average of dissolved oxygen ≥ **5 mg/l**) in warm season (dissolved oxygen ≥ **5 mg/l** in other seasons) in surface bodies of water (except for inland lakes) for warmwater fish; dissolved oxygen ≥ **5 mg/l** during migration period in surface bodies of water (except for inland lakes) for warmwater fish that are salmonid migration routes	R 323.1064 Rule 64
Temperature in Great Lakes and Connecting Bodies of Water	Temperature increase from heat load ≤ **3˚F** at edge of mixing zone; temperature ≤ **40˚F** in January, February, and March, ≤ **50˚F** in April, ≤ **55˚F** in May, ≤ **70˚F** in June, ≤ **75˚F** in July, August, and September, ≤ **65˚F** in October, ≤ **60˚F** in November, and ≤ **45˚F** in December	R 323.1070 Rule 70
Temperature in Inland Lakes	Temperature increase from heat load ≤ **3˚F** at edge of mixing zone; temperature ≤ **45˚F** in January and February, ≤ **50˚F** in March, ≤ **60˚F** in April, ≤ **70˚F** in May, ≤ **75˚F** in June, ≤ **80˚F** in July, ≤ **85˚F** in August, ≤ **80˚F** in September, ≤ **70˚F** in October, ≤ **60˚F** in November, and ≤ **50˚F** in December	R 323.1072 Rule 72
Temperature in Rivers, Streams, and Reservoirs	Temperature increase from heat load ≤ **2˚F** at mixing zone boundary for coldwater fish; temperature ≤ **38˚F** in January and February for coldwater fish, ≤ **43˚F** in March, ≤ **54˚F** in April, ≤ **65˚F** in May, ≤ **68˚F** in June, July, and August, ≤ **63˚F** in September, ≤ **56˚F** in October, ≤ **48˚F** in November, and ≤ **40˚F** in December; temperature increase from heat load ≤ **5˚F** at mixing zone boundary for warmwater fish; temperature ≤ **38˚F** in January and February for warmwater fish, ≤ **41˚F** in March, ≤ **56˚F** in April, ≤ **70˚F** in May, ≤ **80˚F** in June, ≤ **83˚F** in July, ≤ **81˚F** in August, ≤ **74˚F** in September, ≤ **64˚F** in October, ≤ **49˚F** in November, and ≤ **39˚F** in December; temperature increase from heat load ≤ **5˚F** at mixing zone boundary in migration period in rivers and streams that are salmonid migration routes but do not have trout	R 323.1075 Rule 75

According to *A Citizen's Guide to Water Quality Permitting: Understanding the National Pollutant Discharge Elimination System (NPDES) Program and Its Role in Michigan*, the state of Michigan has taken an active role in dealing with water pollution back to the 1920s. 1994 PA 451, the Natural Resources and Environmental Protection Act, is the mechanism that enforces the Clean Water Act in Michigan. This document is a comprehensive resource in regards to the NPDES program and permits. (Kohler, 2005)

Water quality standards in Michigan regulate dissolved, toxic, chemical, and radioactive substances, as well as dissolved oxygen, temperature, nutrients, and microorganisms. R 323.1041 Rule 41 of Part 4. Water Quality Standards of 1994 PA 451 states, "The purpose of the water quality standards…is to establish water quality requirements applicable to the Great Lakes, the connecting waters, and all other surface waters of the state, to protect the public health and welfare, to enhance and maintain the quality of water, to protect the state's natural resources…" (Part 4. Water Quality Standards, n.d.) A selection of standards relevant to this area from Part 4. Water Quality Standards is shown in Table 17. (Part 4. Water Quality Standards, n.d.)

Designated Uses

R 323.1100 Designated Uses
Rule 100 of Part 4. Water Quality Standards states that "all surface waters of the state are designated and protected for all of the following uses:
(a) Agriculture.
(b) Navigation.
(c) Industrial water supply.
(d) Warmwater fishery.
(e) Other indigenous aquatic life and wildlife.
(f) Partial body contact recreation.
(g) Fish consumption.

...All surface waters of the state are designated and protected for total body contact recreation from May 1 to October 31…"
(Part 4. Water Quality Standards, n.d.)
Coldwater fisheries, public water supply, and salmonid migration routes are also protected by this rule. (Part 4. Water Quality Standards, n.d.)

According to a 2014 Michigan Department of Environmental Quality (MDEQ), Water Resources Division, publication, monitoring is carried out by MDEQ, and the degree of compliance of surface waterbodies with designated uses is reported based on a five division scale: "fully supporting, partially supporting, not supporting, insufficient information, or not assessed." (*Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report*, 2014) To gauge support for designated uses, various kinds of assessments can be made, including studies of the biological, physical, environmental, chemical, and other conditions and indicators. Different types of evaluations are made for various designated uses. For instance, to evaluate a body of water in regards to the warmwater and coldwater fishery designated uses, data are gathered about parameters like temperature, pH, and dissolved oxygen, as well as fish species. To assess the body contact recreation designated uses, samples are taken to measure pH and E. coli. In regards to consumption of fish, the amounts of PCBs and other chemicals in the water and of mercury and other contaminants in fish tissues are assessed. For the water supplies for public consumption designated use, information is gathered about smell and taste of the water, as well as dissolved solids and harmful elements present in the waterbody. (*Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report*, 2014)

Following resolution of degree of compliance and georeferencing of bodies of water, categorization is made. There are five categories, with subcategories for Category 4. The five are:
"Category 1: All designated uses are supported, no use is threatened.
Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported.
Category 3: There is insufficient available data and/or information to make a designated use support determination.
Category 4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.
Category 4a: A TMDL to address the impairment-causing pollutant has been approved or established by the USEPA.
Category 4b: Other approved pollution control mechanisms are in place and are reasonably expected to result in attainment of the designated use within a practical time frame.
Category 4c: Impairment is not caused by a pollutant (e.g., impairment is due to lack of flow or stream channelization).
Category 5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed."
(*Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report*, 2014)
Results are published in the MDEQ report. (*Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report*, 2014)

TMDL stands for Total Maximum Daily Load. According to the MDEQ, "When a lake or stream does not meet Water Quality Standards (WQS), a study must be completed to determine the amount of a pollutant that can be put in a water body from point sources and nonpoint sources and still meet WQS, including a margin of safety. A TMDL is a document that describes the process used to determine how much pollutant load a lake or stream can assimilate." (State of Michigan, 2015g) The Clean Water Act requires TMDLs; states are in charge of determining which waterbodies need TMDLs, and the EPA approves them. (State of Michigan, 2015g)

Evaluation of Bodies of Water in the Arcadia-Pierport Watershed in Regards to Designated Uses

According to 2014 data from the MDEQ, Water Resources Division, bodies of water in the Arcadia-Pierport Watershed meet some of the designated uses of the state. Data gaps exist in regards to the designated uses marked Not Assessed. Arcadia Lake was considered to be Fully Supporting of the Navigation, Industrial Water Supply, Agriculture, and Other Indigenous Aquatic Life and Wildlife designated uses. It was Not Assessed for Total Body Contact Recreation, Partial Body Contact Recreation, Warmwater Fishery, Coldwater Fishery, and Fish Consumption Onekama, Arcadia Park, and Pierport Beaches on Lake Michigan were Fully Supporting of Total Body Contact Recreation, Partial Body Contact Recreation, Navigation, Industrial Water Supply, and Agriculture and were Not Assessed for the others. (***Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report: Final Draft 2014 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Report: Appendix B2 – Comprehensive list of assessment unit designated use support (HUCs 04060101 – 07070001)***, 2014) Attention to Watershed Goals I, II, and III in Table 44 and completion of Implementation Tasks IIA, IIB, IIID, and IIIE in Table 46 could help in regards to filling the data gaps.

Table 18 is based on the assessment of the MDEQ, Water Resources Division and indicates whether these bodies of water in the Arcadia-Pierport Watershed complied with, did not comply with, or were not evaluated for the designated uses listed. (The MDEQ classifies these bodies of water within the Betsie-Platte Watershed.) The table indicates that Arcadia Lake complied with four designated uses, the three Lake Michigan beaches complied with the same five designated uses and were not evaluated for the other four, and all four bodies of water were not appraised for several designated uses. (***Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report: Final Draft 2014 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Report: Appendix B2 – Comprehensive list of assessment unit designated use support (HUCs 04060101 – 07070001)***, 2014)

According to Mark Tonello's 2012 report, Arcadia Lake is good for fishing, and, "Most likely some of the fish from these lakes migrate out to Lake Michigan after spawning, move into Arcadia Lake seeking warmer water and richer forage opportunities, and then move back out to Lake Michigan, possibly to seek cooler water." (Tonello, 2012). From his report, it seems clear that Arcadia Lake is supporting of a fishery and of fishing and, thus, of partial body contact recreation. Tonello writes how migratory salmonids can sometimes be found in Arcadia Lake, so it seems that the lake is supporting of the designated use related to salmonid migration routes. It is not clear from this source whether the lake is supporting of consumption of fish. (Tonello, 2012)

Tonello surveyed Bowens Creek in 2008. The creek and tributaries and Arcadia Marsh contain fish communities, though the habitat was considered substandard at the time. According to his report, "Due to its small size, Bowens Creek will probably never be a 'destination' fishery, even though there are clearly some quality fish to be caught." (Tonello, 2008) Based on his report, it seems clear that the creek and tributaries are supporting of a fishery, albeit a small scale one, and of fishing and, thus, at least partial body contact recreation. Salmonids were surveyed, so it seems likely that the creek and tributaries are supporting of the designated use related to salmonid migration routes. The creek and tributaries flow near agricultural land. It is not clear whether they are supporting of navigation, industrial water supply, or consumption of fish. (Tonello, 2008) The LRBOI Natural Resources Department sampled Bowens Creek and tributaries and Arcadia Marsh from 2010-2013, both before and after restoration activities. According to their study, the creek and tributaries are home to coldwater fish and macroinvertebrates, though there were marked changes in species before versus after restoration. Based on the study, it seems that they are supporting of a coldwater fishery and other aquatic life. (***Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage***, 2013) In addition to fish, Arcadia Marsh is home to birds and other aquatic organisms, so it would be supporting of the other native species designated use. (Grand Traverse Regional Land Conservancy, n.d.e)

Table 18: Evaluation of Bodies of Water in Watershed in Regards to Designated Uses, 2014
Source: Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report: Final Draft 2014 Clean Water Act Sections 303(d), 305(b), and 314 Integrated Report: Appendix B2 – Comprehensive list of assessment unit designated use support (HUCs 04060101 – 07070001), 2014

Designated Use	Arcadia Lake	Onekama Beach (Lake Michigan)	Arcadia Park Beach (Lake Michigan)	Pierport Beach (Lake Michigan)
Total Body Contact Recreation	Not Assessed	Fully Supporting	Fully Supporting	Fully Supporting
Partial Body Contact Recreation	Not Assessed	Fully Supporting	Fully Supporting	Fully Supporting
Navigation	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting
Industrial Water Supply	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting
Agriculture	Fully Supporting	Fully Supporting	Fully Supporting	Fully Supporting
Warmwater Fishery	Not Assessed	Not Assessed	Not Assessed	Not Assessed
Other Indigenous Aquatic Life and Wildlife	Fully Supporting	Not Assessed	Not Assessed	Not Assessed
Coldwater Fishery	Not Assessed	Not Assessed	Not Assessed	Not Assessed
Fish Consumption	Not Assessed	Not Assessed	Not Assessed	Not Assessed

Figure 30: View North from Far South of Watershed

Desired Uses

Because visioning sessions were held in the community prior to creation of the Lakes to Land Regional Initiative master plans and addressed water, the Watershed Leadership Team felt that there was no need for an additional visioning session for the Arcadia-Pierport Watershed Plan. Thus, the desired uses of the Arcadia-Pierport Watershed must be obtained from goals expressed in the county master plans and the Lakes to Land Regional Initiative comprehensive plans.

Goals expressed in Chapter 5 of the ***Benzie County 2020 Comprehensive Plan*** include, "Natural resources in the County should be protected from inappropriate use or conversion," and "The pristine natural environment of the County should be protected from degradation," within which it states, "The clean air, water, and soil in the County is a natural asset of immeasurable importance. The extensive lakes, rivers, streams, wetlands, floodplains, and sand dunes are important parts of this natural environment which also contribute greatly to the scenic quality of the landscape. The abundant fish and wildlife populations are testimony to the relative purity of the natural environment in the County. The quality of the natural environment is a significant feature in attracting the huge number of seasonal residents and tourists to the County. The natural environment and especially sensitive natural features must be protected to sustain the scenic quality and economic potential of the County." (***Benzie County 2020 Comprehensive Plan***, 2000) The plan also outlines an "Environmental Protection Strategy," with numerous policies. (***Benzie County 2020 Comprehensive Plan***, 2000)

There are several relevant goals described in Chapter 7 of the ***Manistee County Master Plan 2008*** related to water and other resources. These include, "Encourage the reduction, and where possible, the elimination of environmentally contaminated lands which have a potential for damaging rivers, streams and groundwater," "Advocate for the maintenance of Manistee County's natural resources and the beauty of its landscape," and "Encourage local governments to develop guidelines and criteria which protect natural features and sensitive areas." (*Manistee County Master Plan 2008*, 2009)

Following review of the *Blaine Township Master Plan* document, water and watersheds seem to be prominent features of this community's plan, and residents of Blaine Township seem quite concerned about water and environmental issues and the watershed around the Herring Lakes. When locals were asked to "'Envision Your Community in 20 Years,'" the second highest priority was, "Cleaner water; maintain clean water for drinking and recreation; improved water quality; clean lake with no phragmites, mussels, etc.; still maintaining healthy lakes and streams." (*Blaine Township Master Plan*, 2014) Participants also voted in favor of "Protected water and wildlife resources," "Maintain clean lakes and forests...," and "Invasive aquatic species controlled; no invasive species." (*Blaine Township Master Plan*, 2014) In terms of priorities, the largest number of votes went towards, "Maintain health and quality of lakes, streams, forests; watershed planning." (*Blaine Township Master Plan*, 2014) A goal expressed in the *Blaine Township Master Plan* is, "Environmental Protection: Blaine Township will take steps to maintain the highest quality possible of ground and surface water in an effort to protect the Herring Lakes, their tributaries, and the drinking supply for residents' consumption and use," under which it says, "While the Building Blocks focus on environmental stewardship in general, there is an emphasis on water quality protection as a result of the vision session." (*Blaine Township Master Plan*, 2014) The Building Blocks include, "Watershed Protection: The township will evaluate the zoning ordinance for opportunities to include groundwater and surface water protection measures such as point source and non-point source pollution standards and ground water stewardship measures, and to determine whether any policies directly contradict water protection goals" and "Environmental Site Design Standards: Ensure the inclusion of these standards in the zoning ordinance:

- New development shall not pollute or degrade the quality of surface water or groundwater…;
- Impervious overlay zones, setback and vegetative buffer requirements, performance standards along water bodies, and measures for soil erosion and sedimentation control shall be established,
- New development shall be designed and constructed to avoid sensitive natural features in order to keep them pristine, and such features shall be protected and restored where damaged;
- New lakefront public access sites shall be carefully sited to minimize environmental degradation and managed to prevent overcrowding of the lake surface and nuisance impacts on abutting properties."

(*Blaine Township Master Plan*, 2014)

As indicated in the Arcadia Township Visioning Session Results, among other community desires expressed when "Envisioning Our Future," participants voted in favor of "Clean: environment, lakes...," "Lake Arcadia clean and free-flowing with consistent dredging," "Wildlife preservation; wildlife return to Arcadia Marsh," "Beaches: great, public, clean," and "Lake, weed-free." (Arcadia Township Visioning Session Results, n.d.) Among the Building Blocks for the goal of supporting the harbor in the *Arcadia Township Master Plan* is, "Work closely with the appropriate entities to address water quality issues, fisheries, invasive species removal, access management, and general watershed management best practices." (*Arcadia Township Master Plan*, 2014) One goal presented in the *Arcadia Township Master Plan* is, "Support efforts that are aimed at protecting, managing, enhancing, and providing appropriate access to the natural resources within the township," wherein it states, "Watershed planning will be essential to understanding key factors such as protecting wildlife habitat and improving natural resources…In addition, factors such as road access management into the undeveloped portions of the watershed, preserving the scenic rural character of the township, and the management of the watershed and associated lands are all natural resource enhancement and management issues that folks in Arcadia Township wish to address." (*Arcadia Township Master Plan*, 2014)

In Pleasanton Township, as indicated in the Pleasanton Township Visioning Summary, "Good sewage/waste disposal; waste treatment facility; wastewater collection system" and "Watershed action plans completed; scientifically based efforts to protect waterways" were two of the community desires expressed when "Envisioning Our Future." (Pleasanton Township Visioning Summary, n.d.) Among the Building Blocks for preserving the rural aspects of Pleasanton Township and its scenery in the *Pleasanton Township Master Plan* are, "Natural Landscaping: Encourage the state, particularly the Michigan Department of Environmental Quality, on their work overseeing our watershed" and "Environmental Site Design Standards…" (*Pleasanton Township Master Plan*, 2015)

Based on discussion at the visioning sessions, it appears that water and other natural resources are valued in the Arcadia-Pierport Watershed. None of the goals in Joyfield Township's master plan address waterbodies or resources. This is the only township among the five in which the Arcadia-

Figure 31: Road End Signage at Lake Michigan in Pierport

Pierport Watershed is located in which this is the case. (*Joyfield Township Master Plan*, 2014)

The *Onekema Community Master Plan* precedes the Lakes to Land Regional Initiative plans, but it, too, contains an emphasis on water and Onekama's local watersheds. Priorities from community visioning sessions included, "Sanitary sewer around the lake," "Maintain Water Quality," "Future watershed protection," "Healthy lake," and "Lots of open space around lake," while students, in their own visioning session, listed "Recreational Facilities" and "Healthy Natural Environment" as two of their three priorities. (*Onekama Community Master Plan*, 2010) According to the *Onekama Community Master Plan*, "Promoting low-impact development and preventing excess storm water runoff is a main priority for Onekama's immediate land area and also for the watersheds that eventually all drain into Lake Michigan." (*Onekama Community Master Plan*, 2010) Furthermore, "There's a strong interest in using the lakes as a major draw for recreation. Because of this, residents would like to see a number of safeguards and aesthetic principles in place," "There's interest in installing a sewer system around Portage Lake in order to protect the water quality," and "The preservation and protection of wetlands and floodplains are a concern of the community." (*Onekama Community Master Plan*, 2010)
A goal expressed in the *Onekama Community Master Plan* is, "To further the recommendations of the Portage Lake Watershed Forever Plan and enhance the water quality and fisheries habitat of Portage Lake," wherein it states, "Incorporate into the zoning ordinance stormwater best management practices (BMP's) regulating the collection, treatment, and discharge of stormwater runoff," "Establish a riparian area overlay district which contains site design

criteria addressing the development within this management zone. Criteria would include setbacks, vegetation clearance, controlling impervious surface runoff and abating the use of inappropriate fertilizers and pesticides," and "Inventory regulated and unregulated wetlands within the riparian area overlay district, and develop review standards for local (MDEQ unregulated) wetlands." (*Onekama Community Master Plan*, 2010) Under the goal to "Ensure that the Portage Lake Watershed has higher water quality than today" are the statements, "Treat all stormwater prior to discharge in Portage Lake," "Define high quality water recharge area and protect these areas with appropriate zoning and site development regulations," "Manage soil erosion and sedimentation," "Revise ordinance and codes to require low-impact storm water runoff techniques for existing and new development," and "As an initial phase install public sanitary sewers around Portage Lake." (*Onekama Community Master Plan*, 2010) Another goal is, "Preserve the wetlands along Portage Lake and the wooded hills within the watershed," for which approaches are, "Conduct a Natural Features Inventory for the Township," "Develop zoning ordinance provisions to control development on or adjacent to wetland areas," and "Encourage through public education forest stewardship practices." (*Onekama Community Master Plan*, 2010) Other objectives include, "Prepare a sanitary sewer master plan identifying service areas, costs, phasing, and funding sources," "Encourage redevelopment and new growth within the sanitary sewer service area by allowing smaller lots and higher densities," "Limit development in or adjacent to wetlands and flood-prone areas," "Incorporate into the zoning ordinance special provisions to protect groundwater recharge areas…," and "Allow only low-density, low-scale, and low-impact development within the Riparian Area." (*Onekama Community Master Plan*, 2010)

The ***Little River Band of Ottawa Indians Future Land Use Plan*** also precedes the Lakes to Land Regional Initiative plans. It conveys a deep sensitivity to and concern for natural resources and addresses water issues and riparian areas. Under the principle, "Maintain the natural corridors and patterns and weave them into the plan," wherein it states, "Guidelines and criteria that encourage development consistent with air, water, land, woodlands, and sensitive environmental protection objectives are important," are the statements, "Preserve and connect valuable resources that are on the Reservations, such as the rivers, streams, wetlands, and water bodies," "Create a variable width, naturally vegetated buffer system along all perennial streams that also encompass critical environmental features," "Enforce measures to preserve natural features, control pollution, and limit erosion," "Review local government master plans to insure they address the natural corridors and the protection of natural features," "Respect and protect the wildlife corridors and natural habitat, the unique natural vegetation and sensitive forestlands," "Provide incentives to establish continuous natural corridors," and "Guide regulations for land uses within this area." (*Little River Band of Ottawa Indians Future Land Use Plan*, 2005) Under the principle, "Be an advocate for lands within the Reservation's Boundaries," wherein it states, "An important part of the Tribe's legacy and mission is natural resource stewardship," are the statements, "Support remediation and clean-up efforts in polluted areas," "Promote natural resource management initiatives," "Educate others on how ecosystems work and the importance of natural resource management," and "Purchase land for environmental protection when necessary and economically feasible." (*Little River Band of Ottawa Indians Future Land Use Plan*, 2005) Another objective is creation of "A Tribal riparian management area plan…[which] should identify land use practices that cause environmental degradation and pollution in the river areas," as well as "a joint comprehensive lakeshore management plan that reflect[s] the Tribe's guiding principles for land uses along the lakeshore." (*Little River Band of Ottawa Indians Future Land Use Plan*, 2005)

From these varied plans, it can be inferred that desired uses of the Arcadia-Pierport Watershed include protection, management, conservation, and stewardship of water and other resources, assuring appropriate development in the watershed area, and minimizing harmful impact on the environment. Figure 32 displays desired uses of the watershed, in no particular order, based on the preceding discussion.

Figure 32: Desired Uses of Watershed
Sources: Arcadia Township Master Plan, 2014; Arcadia Township Visioning Session Results, n.d.; Benzie County 2020 Comprehensive Plan, 2000; Blaine Township Master Plan, 2014; Little River Band of Ottawa Indians Future Land Use Plan, 2005; Manistee County Master Plan 2008, 2009; Onekama Community Master Plan, 2010; Pleasanton Township Master Plan, 2015; Pleasanton Township Visioning Summary, n.d.

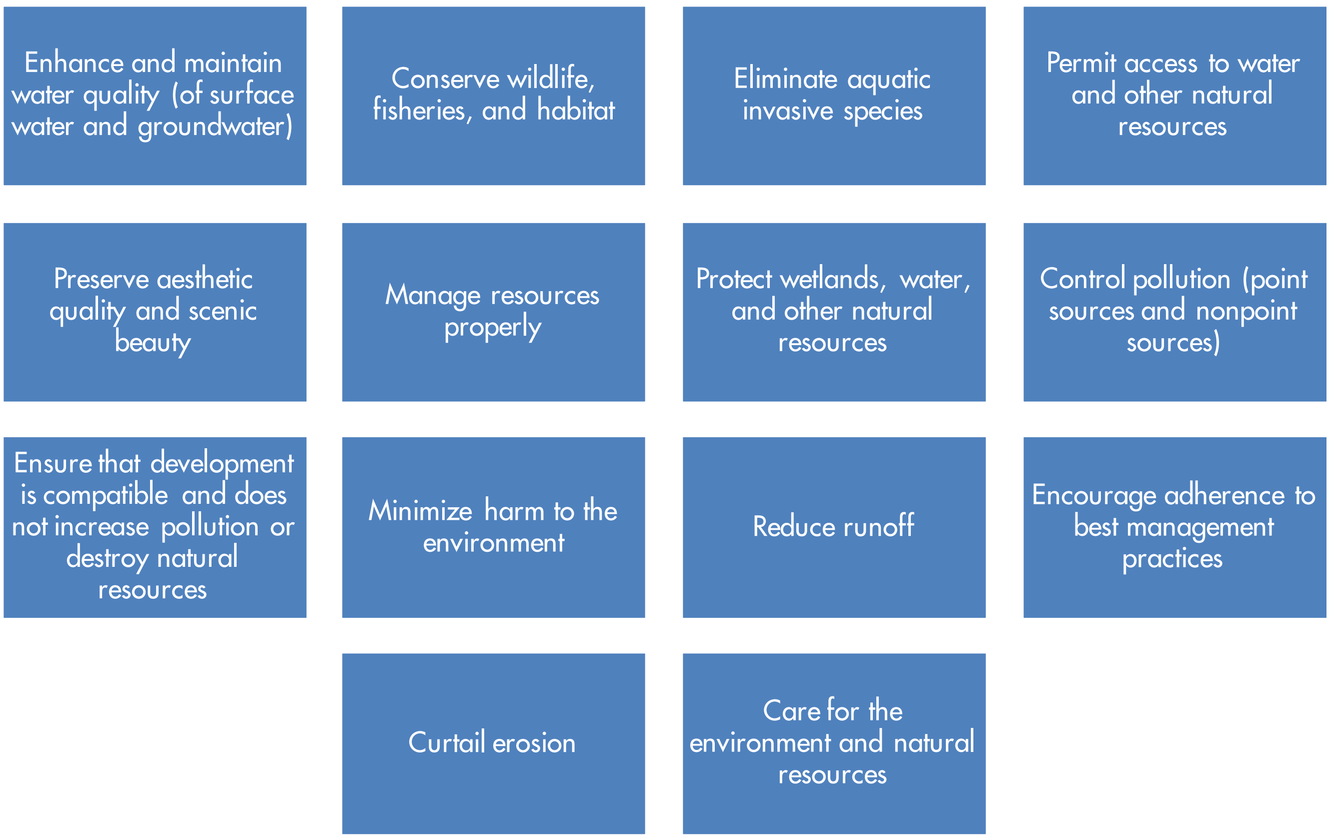
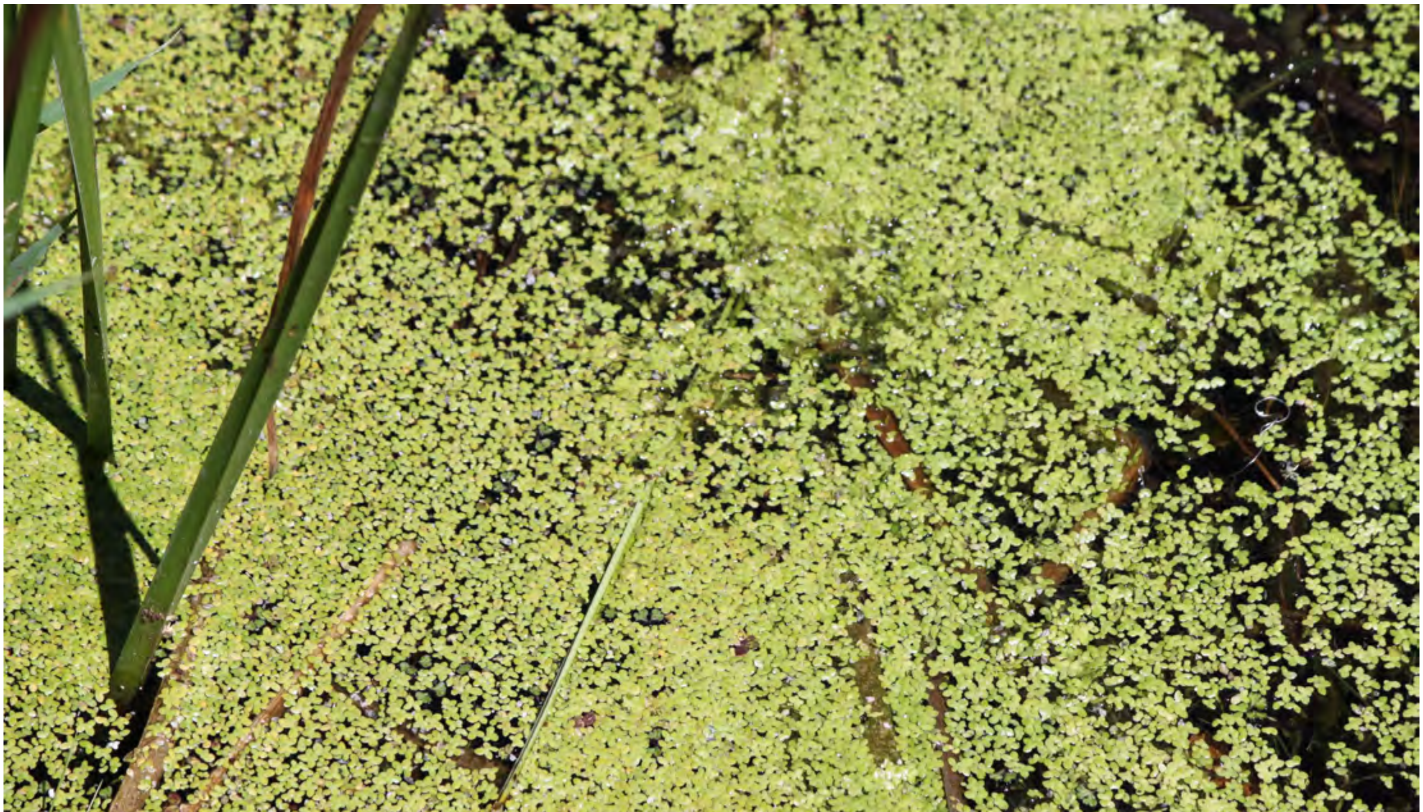


Figure 33: Arcadia Marsh



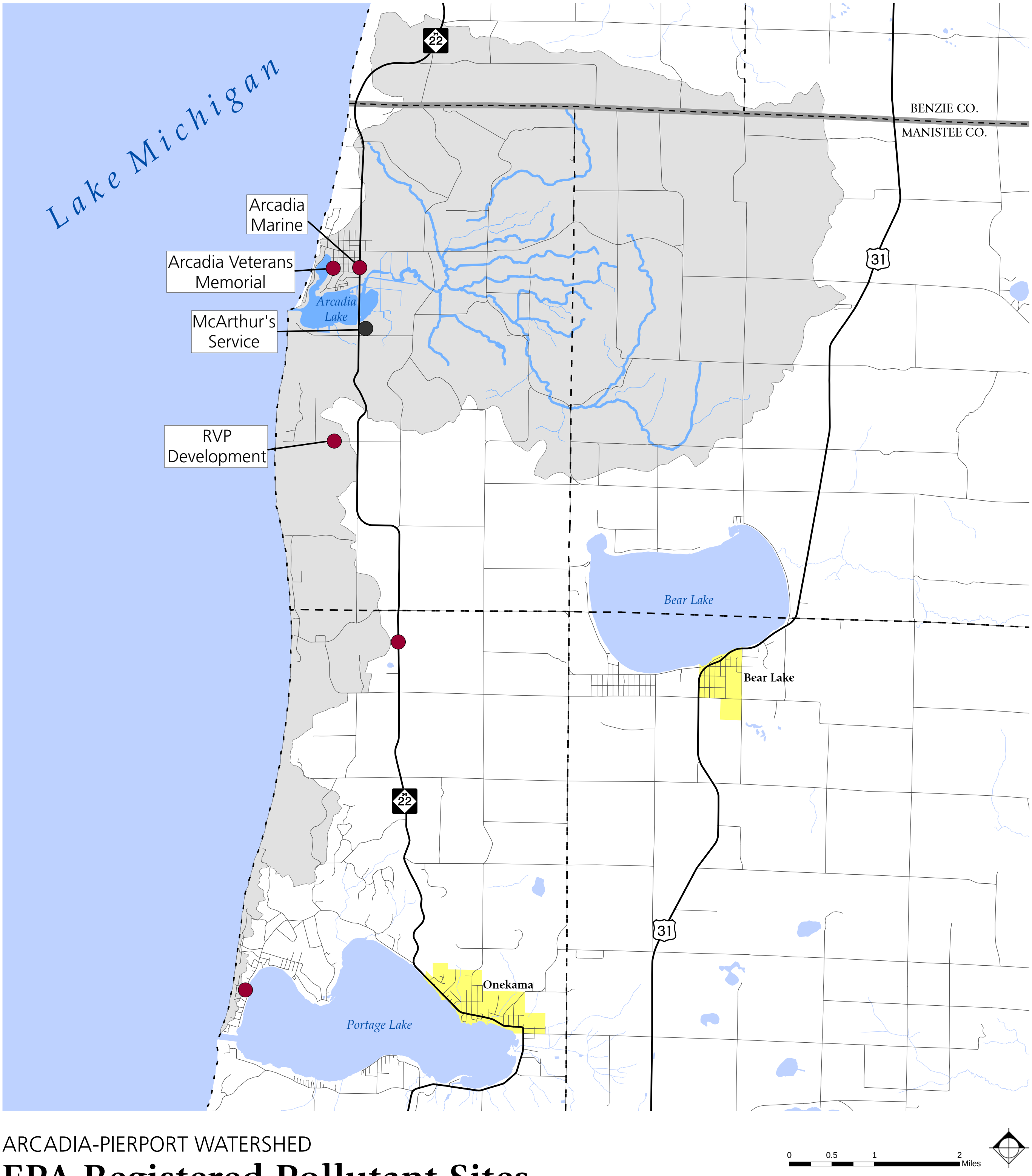
Sources and Causes of Pollutants in the Arcadia-Pierport Watershed

In this section, there are gaps in terms of available data and information, as the sources do not necessarily focus on the watershed area or provide a complete or comprehensive overview of the entire Arcadia-Pierport Watershed. Watershed Goals I, II, and III in Table 44 address pollution, and completion of Implementation Task IA, IIA, IIB, IIID, and IIIE in Table 46 could help in this regard.

Benzie County as a whole contains many undeveloped lands, natural environments, and fine bodies of water. Water quality is affected by activities throughout the watershed, and in Benzie County, there are threats to the environment from pollution, loss of resources, and careless land use. Water quality in some bodies of water has suffered due to excessive phosphorus, fecal coliform, hazardous substances, particulate matter, sediment, algae, and invasive species, among other things. (***Benzie County Comprehensive Plan Sensitive Lands & Water Resources Report***, 1998) The EPA's 2013 National Analysis dataset indicates that there was one Toxics Release Inventory (TRI) site (in the Transportation Equipment industry) in all of Benzie County, and it released 88,630 pounds into the air. The EPA indicates that "Benzie County, MI accounts for 0.13% of total TRI releases in Michigan." (United States Environmental Protection Agency, 2014a)

Though the majority of the Arcadia-Pierport Watershed lies in Manistee County, Manistee County does not have as much available information in regards to sources and causes of pollutants and threats to water quality, so it is difficult to assess pollutants and threats in Manistee County. However, the EPA's 2013 National Analysis dataset contains useful

Map 22: EPA Registered Pollutant Sites



ARCADIA-PIERPORT WATERSHED

EPA Registered Pollutant Sites

Data Sources: State of Michigan Geographic Data Library, EPA Environmental Dataset Gateway

- Watershed Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road
- NPDES Pollutant Source
- RCRA Solid Waste Sites

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information about TRI facilities in Manistee County. The EPA reports that there were five TRI sites in all of Manistee County, which released a combined 1,293,297 pounds. Of the on-site releases (621,352 pounds), 82,461 pounds entered waterbodies. 96% of those releases to water were nitrate compounds. According to the EPA, "Manistee County, MI accounts for 1.86% of total TRI releases in Michigan." (United States Environmental Protection Agency, 2014b)

According to EPA information, Benzie County as a whole has 10 year-round Community Water Systems, in addition to other sorts of water systems, while Manistee County has a total of 11 year-round Community Water Systems, in addition to other sorts of water systems, all of which use groundwater. (United States Environmental Protection Agency, 2015a, June 8; United States Environmental Protection Agency, 2015b, June 8) There are 610 sites in all of Benzie County and 228 sites in all of Manistee County that are regulated by the EPA, according to the EPA's Envirofacts Database. (United States Environmental Protection Agency, n.d.h; United States Environmental Protection Agency, n.d.i) Sources of pollution in Onekama include fertilizers and pesticides, sediments, septic systems, runoff, and chemicals. (*Onekama Community Master Plan*, 2010)

Various sources and causes of pollutants impact the Arcadia-Pierport Watershed. Map 22 shows the locations of EPA Registered Pollutant Sites in and directly adjacent to the watershed. (United States Environmental Protection Agency, 2015) NPDES relates to point source pollution and was addressed at the beginning of this chapter. (1972 PL 92-500, 1972) The Resource Conservation and Recovery Act of 1976, on the other hand, deals with solid and hazardous waste. (1976 PL 94-580, 1976) Popularly known as RCRA, the law also governs underground storage tanks. According to the EPA, "RCRA focuses only on active and future facilities and does not address abandoned or historical sites which are managed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – commonly known as Superfund." (United States Environmental Protection Act, 2015, April 24)

Within the Arcadia-Pierport Watershed boundary, there are four EPA Registered Pollutant Sites: McArthur's Service – Arcadia, Arcadia Marine, RVP Development (Arcadia Bluffs Golf Club), and Arcadia Veterans Memorial Marina. These are labeled on Map 22 and shown in Table 19, along with their address, type of pollutant site, EPA Environmental Interest Type, and the date last updated (1997 for one site, 2011 for three). These facilities can be found when conducting a search for the locations of Facility Registry Service Facilities in Manistee County on the EPA Envirofacts Database. (United States Environmental Protection Agency, n.d.a; United States Environmental Protection Agency, n.d.b; United States Environmental Protection Agency, n.d.c; United States Environmental Protection Agency, n.d.f; United States Environmental Protection Agency, n.d.g; United States Environmental Protection Agency, 2015) None of these four sites are located on the five very small parcels designated as Industrial in Map 13 in CHAPTER ONE (all of which are located in the Arcadia area) shown in CHAPTER ONE. (Arcadia Township, Michigan, 2011; United States Environmental Protection Agency, 2015)

The NAICS code system is a way to classify industries. According to the United States Census Bureau, "The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy." (United States Census Bureau, 2014) The EPA categorizes facilities by what it calls Environmental Interest Type; there are many of these, but only the relevant ones are described here. For instance, the EPA describes the Environmental Interest Type ICIS-NPDES NON-MAJOR as, "A Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) discharger of pollutants into waters of the United States that is not designated as a major is considered a non-major." (United States Environmental Protection Agency, 2013) An ICIS-NPDES MAJOR facility discharges one million or more gallons a day or provides services for 10,000 or more people or otherwise has a large effect on water quality. An Environmental Interest Type of UNSPECIFIED UNIVERSE means that "The handler is not currently classified in any hazardous waste universe." (United States Environmental Protection Agency, 2014) And the Environmental Interest Type CESQG is described as, "Hazardous Waste Conditionally Exempt Small Quantity Generators generate:

- 100 kilograms or less of hazardous waste per calendar month, and accumulate 1000 kg or less of hazardous waste at any time; or
- One kilogram or less of acutely hazardous waste per calendar month, and accumulate at any time:
- 1 kg or less of acutely hazardous waste; or
- 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste; or
- 100 kg or less of any residue or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste during any

Table 19: EPA Registered Pollutant Sites in Watershed
Sources: United States Environmental Protection Agency, n.d.a; United States Environmental Protection Agency, n.d.b; United States Environmental Protection Agency, n.d.c; United States Environmental Protection Agency, n.d.f; United States Environmental Protection Agency, n.d.g; United States Environmental Protection Agency, 2015

EPA Registered Pollutant Site	Address	Type of Pollutant Site	EPA Environmental Interest Type	Date Last Updated	Status
McArthur's Service - Arcadia	17161 Sixth Street, Arcadia, Manistee County	NPDES pollutant source	ICIS-NPDES NON-MAJOR	9/19/1997	Unknown
Arcadia Marine	17073 Sixth Street, Arcadia, Manistee County	RCRA waste site	CESQG	3/3/2011	Active
RVP Development	3224 Bischoff Road, Arcadia, Manistee County	RCRA waste site	CESQG	3/3/2011	Active
Arcadia Veterans Memorial Marina	17088 First Street, Arcadia, Manistee County	RCRA waste site	UNSPECIFIED UNIVERSE	3/3/2011	Inactive

calendar month, and accumulate at any time:
o 1 kg or less of acutely hazardous waste; or
o 100 kg or less of any residue or contaminated soil or contaminated soil, waste or other debris resulting from the cleanup of a spill, into or on any land or water, of acutely hazardous waste." (United States Environmental Protection Agency, 2013) This means that of these four sites, three are minor polluters, discharging or generating relatively little pollution, and one is unclassified. (United States Environmental Protection Agency, 2013)

These sites are not necessarily inconsequential, however. According to the EPA, "An underground storage tank system is a tank and any underground piping connected to the tank that has at least 10 percent of its combined volume underground. The federal UST regulations apply to only underground tanks and piping storing either petroleum or certain hazardous substances…Leaking underground storage tank systems pose a significant threat to groundwater quality in the United States. It has been reported that groundwater supplies drinking water to approximately 50 percent of the nation's overall population and 99 percent of the population in rural areas." (United States Environmental Protection Agency, 2013, February 28) According to the Storage Tank Information Database, "An OPEN LUST site means a location where a release has occurred from an underground storage tank system, and where corrective actions have not been completed to meet the appropriate land use criteria. An OPEN LUST site may have more than one confirmed release," while "A CLOSED LUST site means a location where a release has occurred from an underground storage tank system, and where corrective actions have been completed to meet the appropriate land use criteria. The MDEQ may or may not have reviewed and concurred with the conclusion that the corrective actions described in a closure report meets criteria." (State of Michigan, 2001-2013a) In regards to UST sites, "ACTIVE UST FACILITIES are those where there is at least one tank at the facility that is not closed in place or removed and is regulated under Part 211, Underground Storage Tank Regulations, of the Natural Resources and Environment Protection Act, 1994 PA 451, as amended (Act 451). There may be closed tanks and/or active non-regulated tanks (such as heating oil tanks) at the facility," while "CLOSED UST FACILITIES are those where all tanks at the facility that are regulated under Part 211 of Act 451 are closed. There may be non-regulated active tanks at the facility, such as heating oil tanks or tanks that are smaller than the regulatory cutoff. A CLOSED UST FACILITY DOES NOT MEAN THAT THE RELEASE(S) ASSOCIATED WITH THE TANKS AT THE UST FACILITY ARE CLOSED." (State of Michigan, 2001-2013b) These facilities are addressed in 1994 PA 451, Part 211 Underground Storage Tank Regulations, Part 213 Leaking Underground Storage Tanks, and Part 215 Underground Storage Tank Corrective Action Funding. (1994 PA 451, 1994)

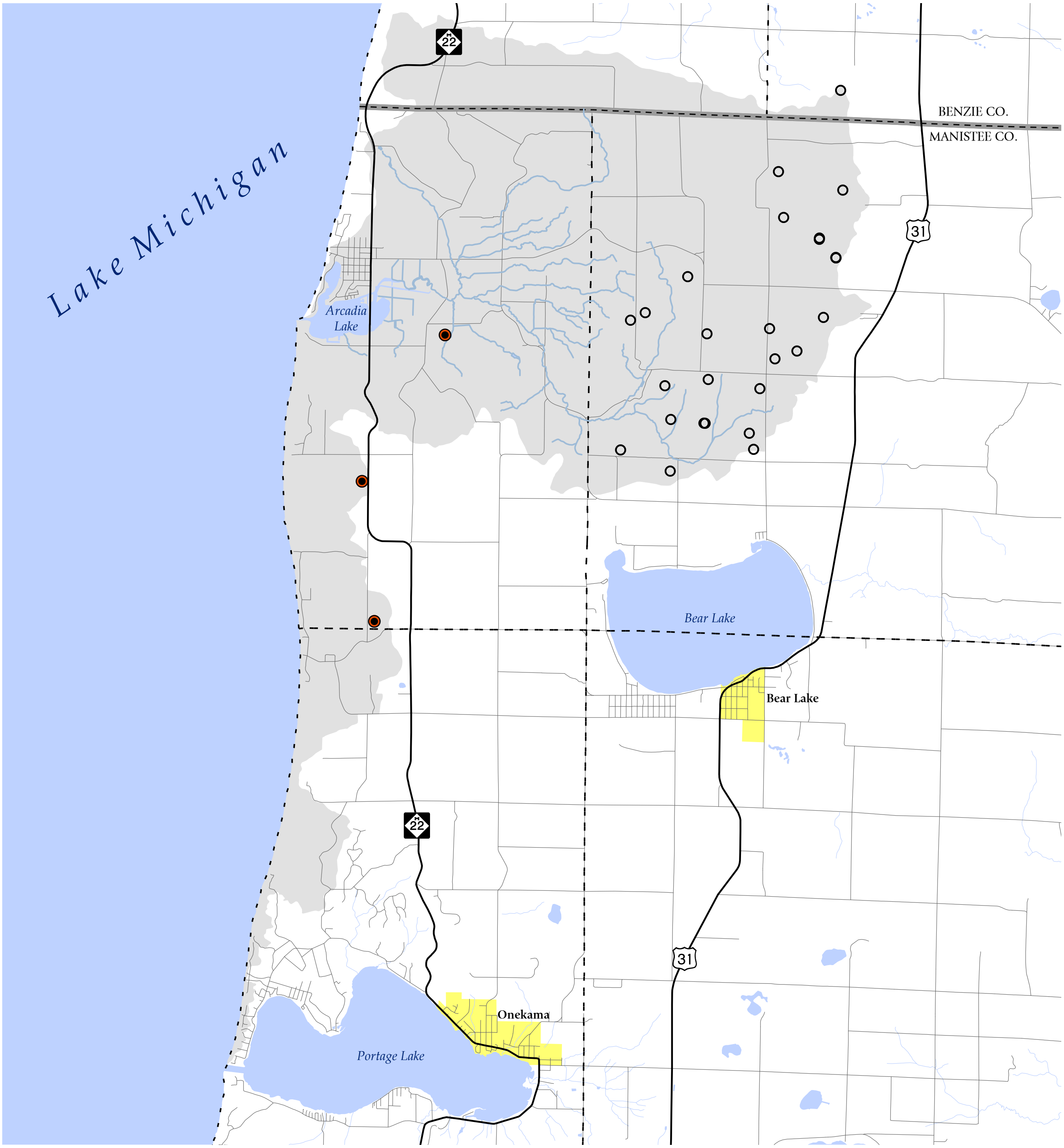
As these sites are important in regards to pollution, a search was conducted for the locations of both Open and

Closed Leaking Underground Storage Tanks (LUST) and both Active and Closed Underground Storage Tanks (UST) in Manistee and Benzie Counties on the MDEQ and Department of Licensing and Regulatory Affairs (LARA) Storage Tank Information Database. Numerous facilities can be found, including three of the four sites identified in the table. Though the address for McArthur's Service on Sixth Street (17135 Sixth Street, PO Box 36, Arcadia) provided on the MDEQ and LARA Storage Tank Information Database is a different address from the address provided by the EPA shown in Table 19, it appears that McArthur's Service is the site of an Open LUST and two Active USTs. Arcadia Veteran's Memorial Marina is the site of a Closed LUST and an Active UST. Arcadia Marine also is the site of a Closed UST, though the address for Arcadia Marine (17220 First Street, Arcadia) provided on the DEQ and LARA database is different from the EPA's. The only other facility in the Arcadia-Pierport Watershed on this database identified as containing a LUST or UST is Arcadia Gambles Hardware, which is identified as the site of a Closed UST; however, this site is not identified by the EPA in any databases as a known EPA Registered Pollutant Source. (State of Michigan, 2001-2013a; State of Michigan, 2001-2013b; United States Environmental Protection Agency, n.d.a; United States Environmental Protection Agency, n.d.c; United States Environmental Protection Agency, n.d.g; United States Environmental Protection Agency, 2015) It is difficult to find much additional information on these sites. Arcadia Marine has marina services, as well as a gas station. (Arcadia Marine, 2015) Arcadia Veterans Memorial Marina has a marina, as well as gasoline and diesel. (Michigan Economic Development Corporation, 2015)

RVP Development was the subject of a lawsuit in 1999 polluting Lake Michigan during the development of Arcadia Bluffs Golf Club. According to a 1999 article by Keith Schneider, "Construction at Arcadia Bluffs, located on a 160-foot dune midway between Manistee and Frankfort, caused the worst coastal erosion in the Lake Michigan basin…Attorney General Jennifer M. Granholm joined the Department of Environmental Quality in filing a lawsuit that called for $425,000 in fines against RVP Development of Grand Rapids, the owner of the course. It is the largest penalty ever sought in Michigan for water pollution caused by erosion, and instantly elevated what is known as 'non-point' water pollution to the same level of urgency in the state's view as toxic and fecal contamination…In 1997, RVP Development clear-cut at least 80 acres of forest at the edge of the high bluff that had absorbed rain and sheltered the 245-acre site from Lake Michigan's storms. In April 1998 heavy spring rains and winds pelted the bare site, overwhelming the water retention system and unleashing a torrent that swept down a gaping ravine and into the lake. According to state investigators, similar erosion occurred 12 more times in 1998, causing pollution and creating a peninsula in the lake. The Department of Environmental Quality was slow to act…RVP Development, the course's owner, launched a reverse mining operation, with bulldozers digging out sand and transporting it on huge trucks back up the bluff to the summit." (Schneider, 1999) Arcadia Bluffs opened in 1999 as a Golf Club on the bluffs of Lake Michigan, though its address (14710 Northwood Highway, Arcadia) is different from that in Table 19. (Arcadia Bluffs Golf

Figure 34: Arcadia Bluffs Golf Club

Map 23: Oil and Gas Well Infrastructure



ARCADIA-PIERPORT WATERSHED

Oil and Gas Well Infrastructure

Data Sources: State of Michigan Geographic Data Library, Michigan Department of Environmental Quality

0 0.5 1 2 Miles

- Watershed Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road
- Proposed Location Well (Undrilled)
- Dry Hole Well

Beckett&Raeder

Club, n.d.a; United States Environmental Protection Agency, n.d.f; United States Environmental Protection Agency, n.d.g; United States Environmental Protection Agency, 2015)

According to a 2004 article in ***Golfdom*** magazine, "Flash-forward to July 2004. There have been no more erosion problems and it has never been proven that the accident caused any harm to the lake. [Richard] Postma [owner and developer] has paid $125,000 in civil penalties to settle the lawsuit." (Aylward, 2004) Then-superintendent, Paul Emling, "has quietly helped Arcadia Bluffs heal its neglect-for-natural-resources image by implementing an aggressive and impressive golf course maintenance program with an emphasis on environmental awareness and integrated pest management (IPM)." (Aylward, 2004) Emling is now Vice President of Operations at Arcadia Bluffs. (Arcadia Bluffs Golf Club, n.d.b) According to the ***Golfdom*** article, attention is paid to the weather, spot treatment of herbicides is used, pesticides and fertilizers are applied with precision, water use is minimized, consideration is given to drainage and stormwater, and other practices are employed at Arcadia Bluffs out of concern for the environment. (Alyward, 2004)

The two EPA Registered Pollutant Sites located directly adjacent to the boundaries of the Arcadia-Pierport Watershed are the MI Dept/State Police and the Portage Point Inn. The locations of these sites are also shown on Map 22. Both are inactive RCRA waste sites of EPA Environmental Interest Type UNSPECIFIED UNIVERSE and were last updated on 3/3/2011. (United States Environmental Protection Agency, n.d.d; United States Environmental Protection Agency, n.d.e; United States Environmental Protection Agency, n.d.g; United States Environmental Protection Agency, 2015)

Data and information on oil and gas infrastructure in the Arcadia-Pierport Watershed are not extensive, but knowledge about this infrastructure is important because of the potential impact on waterbodies and sources and the environment. Activities associated with oil and gas production can contaminate water, including groundwater, and also impact soils and air quality. (Earthworks, n.d.) According to Chapter 3 of the ***Benzie County 2020 Comprehensive Plan***, "Benzie County has extensive mineral resources, such as oil, gas, sand and gravel...Oil and gas resources are primarily located in the southern and eastern part...There are problems associated with the extraction of those minerals. There is concern that extraction of oil, gas and sand and gravel by traditional methods could wreak havoc on the scenic quality and ecosystems that are important to other, larger economic sectors and the quality of life of residents." (***Benzie County 2020 Comprehensive Plan***, 2000) Though it is from 1998, and the situation may have changed since, the ***Benzie County Comprehensive Plan Forestry & Mineral Resources Report*** provides an insightful overview of oil and gas resources in the county and an inventory. According to the report, "Of the 103 wells drilled in Benzie County, 78 were dry wells, 15 actively provided oil and 8 wells provided gas." (***Benzie County Comprehensive Plan Forestry & Mineral Resources Report***, 1998) Highlights of the report can be found in the Appendix of this Plan. Manistee County, in contrast, has 1,933 extractive wells, according to Chapter 4 of the ***Manistee County Master Plan 2008***. (***Manistee County Master Plan 2008***, 2009) Oil and gas infrastructure is mentioned in the ***Onekama Community Master Plan*** as a threat to water quality and groundwater and a potential source of pollution. It states in the plan, "there are existing and dormant gas and oil exploration wells in this area." (***Onekama Community Master Plan***, 2010) Map 23 shows the locations of proposed and inactive oil and gas wells in the Arcadia-Pierport Watershed. There are no active wells or permits currently in the watershed, but there are three inactive dry hole wells and 30 proposed locations for wells. (Michigan Oil and Gas, n.d.)

Maps found on an MDEQ webpage show that nitrate, Volatile Organic Compounds, and arsenic have been detected in drinking water in Benzie and Manistee Counties, which can impact drinking water quality. (State of Michigan, 2015h) As described in the ***Arcadia Township Master Plan***, "Arcadia Township is not served by public water and sanitary sewer systems; water supply and sewage disposal are dependent upon well and septic systems. This isn't necessarily an issue in the greater township, where parcels are large enough for and soils are compatible with well and septic systems. However, challenges are encountered in Arcadia's small village setting, which has a density of 4 to 6 homes per acre on lots occupying 6,000 to 9,000 square feet." (***Arcadia Township Master Plan***, 2014) Currently, Arcadia is working with Fleis & Vandenbrink on a sanitary sewer feasibility study. Blaine, Joyfield, and Pleasanton Townships also do not have sewer or water systems, so residents have their own septic systems and wells. (***Blaine Township Master Plan***, 2014; ***Joyfield Township Master Plan***, 2014; ***Pleasanton Township Master Plan***, 2015) The Village of Onekama provides residents with sewer (but not water) service, but Onekama Township does not have public sewer or water systems. (***Onekama Community Master Plan***, 2010)

Septic systems require particular conditions to be effective, and if not met, they can be highly problematic sources of nonpoint pollution, impacting water quality and groundwater. The ***Onekama Community Master Plan*** describes the situation well: "In the watershed, contaminated groundwater has a potentially devastating effect. As a result, maintaining appropriate densities of development and proper disposal of sanitary sewer wastes are critical factors in ensuring the adequacy and quality of domestic water sources. Not all sites are suitable for septic systems. Of primary concern is the soil at the site. Soils that are too coarse or too fine can limit the effectiveness of the treatment system. A shallow, seasonally high water table can also cause problems. Some of these problems can be overcome by altering the design of the septic system. Where they are properly sited, such as in sparsely populated areas and in soils with good drainage above the water table, septic tanks generally pose little or no hazard. However, even where septic systems are well drained, they may eventually pollute the groundwater. An improperly sited, designed, installed, or operated septic system can pollute drinking and surface water. In such situations, sewage may contaminate wells in the area or move to the land surface, or both. A problem of growing concern is the cumulative impact of contamination of a regional aquifer from nonpoint sources, including septic systems, among others. For example, the Environmental Protection Agency in 1980 found that about a third of all septic tank installations were not operating properly and that the consequent pollution both above and below ground is substantial. Their conclusion was that the solution to groundwater contamination from septic systems, beyond better engineered on-site facilities or improved maintenance, may lie in better land-use control and in effective regulations for septic tank installation. Accordingly, point of sale inspection ordinances, creating a sewer service district or requiring connections to a public sanitary sewer for higher density residential development may be the best land use controls available to moderate this potential problem." (***Onekama Community Master Plan***, 2010)

Homes with wells rely on groundwater sources for drinking water. Groundwater and, therefore, drinking water from wells can become polluted from various sources, including nitrates from septic systems, pesticides and fertilizers, and other sources. This has implications for public and environmental health. (United States Environmental Protection Agency, 2012a; United States Environmental Protection Agency, 2012b)

Additionally, agricultural activities, including animal operations and use of fertilizers and pesticides, can be a source of sediment, nutrient, and pathogen pollution in general. (United States Environmental Protection Agency, 2014, July 9) Agricultural land uses are prominent in the Arcadia-Pierport Watershed, as shown on Map 13 in CHAPTER ONE. (State of Michigan, 2013)

Sediment Sources and Causes

Information on sediment sources and causes in the Arcadia-Pierport Watershed is not extensive, leading to data gaps in this section. Watershed Goals I, II, and III in Table 44 address water quality.

Sediment can be a pollutant when it enters bodies of water in large quantities. Because the soil in Benzie County erodes easily, and there are many steep slopes, as well as High Risk Erosion Areas and Critical Dune Areas, sediment pollution can occur when soil is uncovered during development, mining, farming, and forestry and from wind, water, disturbance, and use of off-road vehicles. Benzie County had a sand dune mine, but extraction does not take place there anymore; there are also gravel pits in the county. Road crossings can also release sediment into waterbodies. (***Benzie County Comprehensive Plan Sensitive Lands & Water Resources Report***, 1998)

Sedimentation is also of concern in Onekama and in the Portage Lake Watershed, and sediment can threaten aquatic habitats. Sediment sources and causes include erosion of stream banks and shoreline areas from crossings and access areas, runoff, and construction and development. (***Onekama Community Master Plan***, 2010; ***Portage Lake Watershed Forever Plan***, 2008)

Nutrient Sources and Causes

As with sediment, information on nutrient sources and causes in the Arcadia-Pierport Watershed is limited, so there are data gaps in this section as well. Watershed Goals I, II, and III in Table 44 address water quality, while Watershed Goal IV addresses septic tanks. Completion of Implementation Tasks IIA, IIB, IIID, IIIE, and IVA in Table 46 could help with water quality and to address problems with nutrients and septic systems.

In Benzie County, runoff from chemical fertilizers, herbicides, and pesticides that are applied to farmlands, roads and impervious surfaces, golf courses, and other locations can enter waterbodies and impact water quality. Phosphorus and other chemicals from these substances have infiltrated waterbodies. The presence of algae can indicate water pollution from nutrient sources. Also, faulty septic

Figure 35: View North of Shoreline from Pierport Road End

systems can release nutrient pollution. (*Benzie County Comprehensive Plan Sensitive Lands & Water Resources Report*, 1998)

Nutrient sources in Onekama include runoff and septic systems. (*Onekama Community Master Plan*, 2010) In the Portage Lake Watershed, nutrient sources and causes include fertilizer from agriculture and lawns, leaching of septic tile fields, algae, discharge of storm water, and decomposition. Septic systems are a real threat to the watershed, particularly with an increase in year-round residence in homes on waterbodies. Furthermore, they may fail and can threaten human and environmental health. These systems are a significant contributor to the phosphorus in the waterbodies of the watershed. (*Portage Lake Watershed Forever Plan*, 2008) The Village of Onekama has a sewer system, but when Onekama Township tried to transition from septic to sewer as well, public outcry prevented it. Onekama Township did, however, create a septic system ordinance compelling inspection of septic systems upon construction on or sale of property; Manistee County passed a comparable ordinance in 2008. (*The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools*, 2014)

Figure 36: Dunes at Arcadia Beach Natural Area

Priority Protection Areas and Priority Parcel Analysis

Data and information to suggest Priority Protection Areas in the Arcadia-Pierport Watershed are not extensive, so this section represents the best attempt to identify Priority Protection Areas in the watershed but should not be considered as providing a complete or comprehensive overview of the entire Arcadia-Pierport Watershed. There may be important areas that have not been included. The methodology and findings of the Priority Parcel Analysis are also provided in this section. Watershed Goals I and II in Table 44 address waterbodies and other resources, and Implementation Task IIB in Table 46 addresses High Priority Areas as identified by the Priority Parcel Analysis. The primary material used to write these sections included plans and information provided by governmental entities.

Priority Protection Areas

While there are gaps in terms of available data and information to inform selection of Priority Protection Areas, best efforts were made to identify features that would make areas worth protecting. This does not necessarily provide a comprehensive overview of all Priority Protection Areas in the Arcadia-Pierport Watershed. Watershed Goals I and II in Table 44 address waterbodies and other resources.

According to the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, "Priority areas are considered the areas within the Watershed with features that are most vulnerable to development and other land uses. Protecting these features, including steep slopes, riparian areas, groundwater recharge areas, and wetlands, will provide long-term protection of water quality within the Watershed." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Priority Protection Areas include Critical Dune Areas. The MDEQ website states, "Critical dune areas represent the tallest and most spectacular dunes along Lake Michigan's shoreline… where developmental, silvicultural and recreational activities are currently regulated by Part 353, Sand Dunes Protection and Management, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451 as amended." (State of Michigan, 2015e) Part 353 necessitates permits for any actions in Critical Dune Areas and forbids some activities in these locations. (1994 PA 451, 1994)

High Risk Erosion Areas along the Great Lakes, as designated by MDEQ, are also Priority Protection Areas. According to MDEQ, "High risk erosion areas are those shorelands of the Great Lakes where recession of the landward edge of active erosion has been occurring at a long-term average rate of one foot or more per year, over a minimum period of 15 years." (State of Michigan, 2015b) Because of their susceptibility to erosion, permits are required in High Risk Erosion Areas prior to development. High Risk Erosion Areas are addressed in 1994 PA 451, Part 323 Shorelands Protection and Management. (1994 PA 451, 1994)

Rivers designated Natural Rivers are critical to protect. Natural Rivers are addressed in 1994 PA 451, Part 305 Natural Rivers. 324.30502 states, "The department…may designate a river or portion of a river as a natural river area for the purpose of preserving and enhancing its values for water conservation, its free flowing condition, and its fish, wildlife, boating, scenic, aesthetic, floodplain, ecologic, historic, and recreational values and uses." (1994 PA 451, 1994). In Michigan, "The Natural Rivers Program was developed to preserve, protect and enhance our state's finest river systems for the use and enjoyment of current and future generations by allowing property owners their right to reasonable development, while protecting Michigan's unique river resources. Currently 2,091 miles of river and streams are designated as state Natural Rivers under authority of Part 305, Natural Rivers of PA 451 of 1994." (State of Michigan, 2015c)

Trout Streams and Lakes that are inland are also Priority Protection Areas. A Trout Stream is, "Any stream so designated by the state that contains a significant population of trout or salmon," while a Trout Lake is, "Any lake so designated by the state that contains a significant population of trout or salmon." (***2015 Michigan Fishing Guide***, 2015) Drowned Rivermouth Lakes (defined as, "An area of a river where it enters the Great Lakes"), like Arcadia Lake, have different rules in terms of when the fishing season occurs, what the possession limit and season are, and what minimum size fish that can be caught is. (***2015 Michigan Fishing Guide***, 2015)

Grand Traverse Regional Land Conservancy lands are also Priority Protection Areas. An accredited land trust, GTRLC works in Benzie and Manistee Counties, as well as three others, and has "protected over 38,000 acres of land and more than 114 miles of shoreline along the region's exceptional rivers, lakes and streams." (Grand Traverse Regional Land Conservancy, n.d.b) According to the organization's website, "our land protection experts use a variety of conservation tools to protect significant natural and working lands. Our stewardship team documents natural and man-made features on protected land, monitors over 200 conservation easements and maintains our 34 nature preserves…We focus our land conservation efforts to permanently protect crucial wildlife habitat and corridors; critical watersheds, which protect the water quality of our region; unique high-quality farm lands; valuable forestland; and ecologically significant dunes along Lake Michigan's beautiful and endangered shore. We protect land in several ways:

- By working with landowners to permanently protect private land through voluntary conservation easements
- By acquiring high quality natural lands by purchase or donation to create Conservancy owned nature preserves which are open to the public
- By assisting local units of government in creating or expanding public parks and natural areas that result in enhanced public access to nature and improved recreational opportunities
- By providing technical assistance to local units of government with the administration of farmland protection programs."

(Grand Traverse Regional Land Conservancy, n.d.b)

Lake Michigan and the major bodies of water in the Arcadia-Pierport Watershed are critical to preserve, not only due to their ecological value, but also for their recreational value. (***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014) Wetlands are also Priority Protection Areas, as they are vital yet very sensitive. They play an integral role in ecosystem health and function, serving as habitat, nurturing the young, and collecting and filtering runoff. (***Benzie County Comprehensive Plan Sensitive Lands & Water Resources Report***, 1998) Wetlands are addressed in 1994 PA 451, Part 303 Wetlands Protection. (1994 PA 451, 1994) The MDEQ regulates actions in wetland areas, and permits are required for certain activities. In addition, according to the MDEQ, "In 1984, Michigan received authorization from the federal government to administer Section 404 of the federal Clean Water Act." (State of Michigan, 2015f) Waterbodies and sources, high groundwater recharge areas, dunes, forests, agricultural areas, sensitive lands, critical habitats, parks, trails, slopes, scenic areas, and protected lands or lands that are not presently protected but ought to be due to their resources, location, or value throughout the Arcadia-Pierport Watershed are conservation priorities.

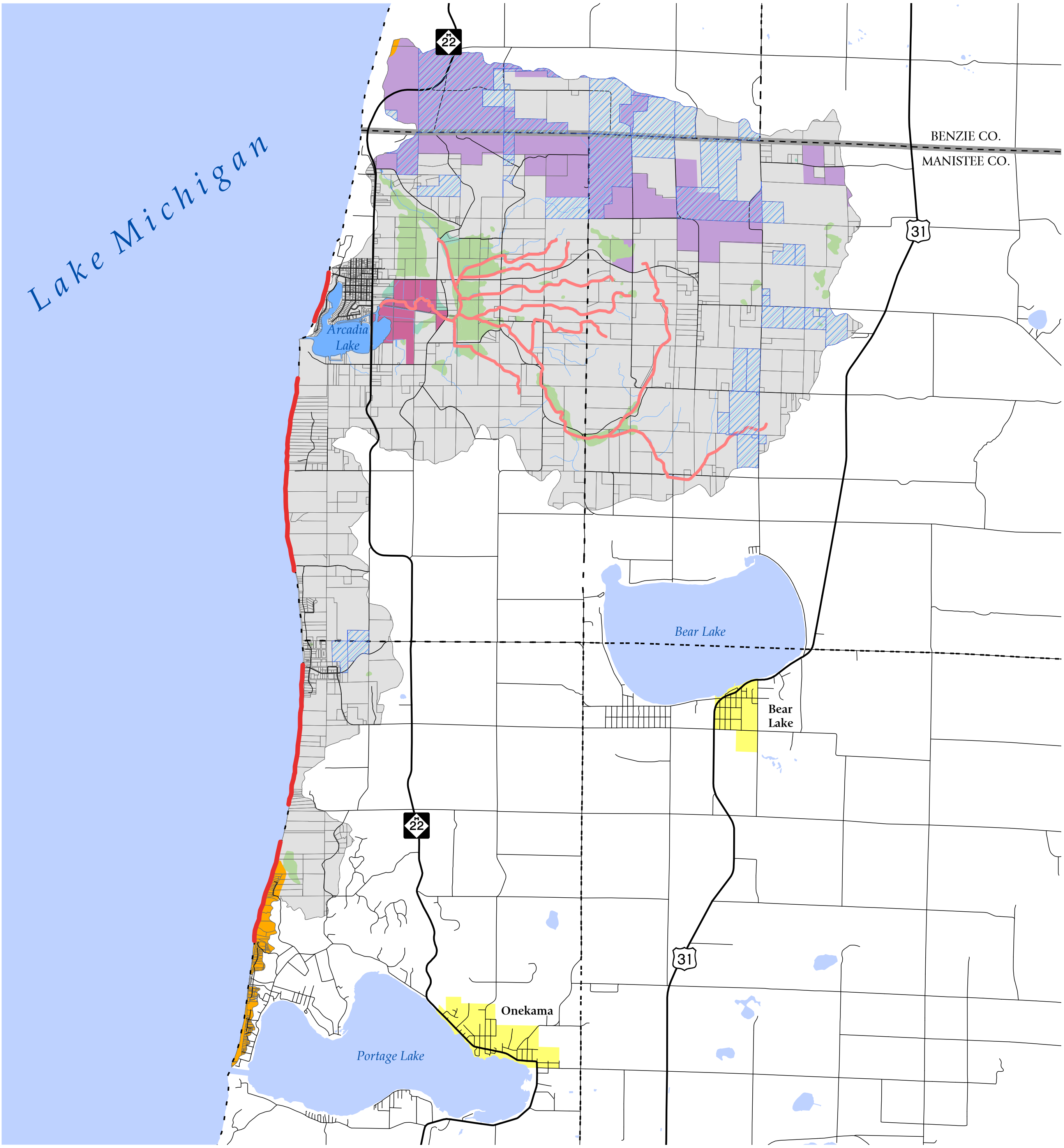
Priority Protection Areas include those identified in county and Lakes to Land Regional Initiative plans. In Benzie County, these include lands that have low purchase prices, have been developed in a fragmentary manner, and/or have faced a sharp increase in population. Farm and forest lands, dunes, important animal habitats, coastlines, floodplains, wetlands, waterbodies, buffer lands, scenic lands, and areas rich in natural, cultural, and historic resources are in need of conservation. For instance, areas alongside US 31 and M-115 and lands ripe for cherry growing in fast-developing Joyfield Township are several examples of Priority Protection Areas. (***Benzie County Open Space & Natural Resources Protection Plan***, 2002) Benzie County is also home to numerous wetlands. (***Benzie County Comprehensive Plan Sensitive Lands & Water Resources Report***, 1998) There are wetlands in Onekama Township. (***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014) The Critical Dune Areas in Onekama along Lake Michigan and near Portage Lake, waterbodies like Portage Lake, wetlands, forests, parks, trails, and lands suited for growing fruits due to the soil and topography would be Priority Protection Areas in the Village of Onekama and Onekama Township. (***Onekama Community Master Plan***, 2010; ***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014) High Risk Erosion Areas in the Arcadia-Pierport Watershed are found in Blaine, Arcadia, and Onekama Townships; specific locations can be seen on the maps provided on the MDEQ webpage. (State of Michigan, 2015b) In Arcadia Township, priorities are waterbodies, wetlands, dunes, slopes, and protected and recreational areas. (***Arcadia Township Master Plan***, 2014) Blaine Township contains Critical Dune Areas, waterbodies, Trout Streams, wetlands, and GTRLC-conserved lands. (***Blaine Township Master Plan***, 2014) Joyfield Township is also home to bodies of water, Trout Streams, and wetlands. (***Joyfield Township Master Plan***, 2014) Pleasanton Township has waterbodies, wetlands, Trout Streams, and protected lands. (***Pleasanton Township Master Plan***, 2015) And in regards to designated Natural Rivers, the only one in this area (though not technically in the Arcadia-Pierport Watershed) is the Betsie River, which flows through both Benzie and Manistee Counties. (State of Michigan, n.d.; State of Michigan, 2015a) Trout Streams and Lakes include Arcadia Lake, Portage Lake, and the Betsie River, while Arcadia and Portage Lakes are also Drowned Rivermouth Lakes. (***2015 Michigan Fishing Guide***, 2015) Other streams that support trout include Bowens, Chamberlain, Hull, Lucker, Richley, Shimke, Tondu, Van Bushkirk, and Ware Creeks. (State of Michigan, 2013) It should be noted that, unlike the other Lakes to Land Regional Initiative communities, Arcadia Township is the only one in which Critical Dune Areas have not been assessed by MDEQ. (***Arcadia Township Master Plan***, 2014) Attention to Watershed Goal II, which addresses inventorying and data collection, in Table 44 could help to close this gap.

Finally, there are two Preserves overseen by GTRLC in the watershed: Arcadia Dunes: The C.S. Mott Nature Preserve and Arcadia Marsh Nature Preserve. GTRLC defines its Preserves as "lands protected, owned and managed by the Grand Traverse Regional Land Conservancy." (Grand Traverse Regional Land Conservancy, n.d.f) The GTRLC website states, "The Grand Traverse Regional Land Conservancy works hard to balance property use and access with the protection of natural features, unique habitats, and scenic beauty. Our preserves are designed to handle less intense activities than lands managed by state and local units of government across northern Michigan with the preservation of the land and its natural features as our priority…Each preserve is best suited for certain activities…Hunting is allowed on designated preserves." (Grand Traverse Regional Land Conservancy, n.d.g)

Arcadia Dunes encompasses approximately 2,614.41 acres in the Arcadia-Pierport Watershed and is located in both Benzie and Manistee Counties, while Arcadia Marsh is approximately 270 acres and is all within Manistee County. (Grand Traverse Regional Land Conservancy, n.d.f; Sullivan, personal communication, 2015, July 22) According to GTRLC's website, "Arcadia Dunes, GTRLC's largest preserve, includes over 15 miles of trail to explore the dunes, forests and many other landscapes encompassed in this beautiful preserve. Adjacent working farms have also been permanently protected which insure the longevity of this area's rich agricultural heritage and add to the landscape tapestry. This incredibly diverse preserve provides a wide range of recreation opportunities and experiences from wandering to birding to mountain biking…One of Arcadia [Dunes'] birding sites is the Dryhill Grassland. This piece of the preserve is being managed into a grassland habitat which is a rare, beautiful and important Michigan landscape. Grasslands are immensely diverse and beautiful ecosystems and have nearly disappeared in a few short decades." (Grand Traverse Regional Land Conservancy, n.d.c) Various recreational activities can be pursued in Arcadia Dunes, and hunting is allowed as well. (Grand Traverse Regional Land Conservancy, n.d.c)

Arcadia Marsh also offers recreational opportunities and has a trail. The GTRLC website says, "Arcadia Marsh Preserve, located just south of Arcadia, MI, offers visitors access to a Great Lakes Coastal Marsh, a rare and declining natural community found only in Great Lakes coastal areas. It is estimated that over 80% of the original Great Lakes marshes have been destroyed. These marshes are some of the most productive ecosystems in the world, and Arcadia Marsh is one of only 15 or so remaining coastal marshes along Lake Michigan's Lower

Map 24: Priority Protection Areas



ARCADIA-PIERPORT WATERSHED

Priority Protection Areas

Data Sources: State of Michigan Geographic Data Library, GTRLC, Michigan DEQ, Benzie and Manistee Counties Soil Survey

0 0.5 1 2 Miles

- Watershed Boundary
- Parcel Boundary
- Major Road
- Minor Road
- County Boundary
- Township Boundary
- High Risk Erosion Areas
- Trout Streams
- City or Village
- Critical Dunes
- Arcadia Marsh Preserve
- Arcadia Dunes: CS Mott Nature Preserve
- Freshwater Forested/Shrub Wetland
- Freshwater Emergent Wetland
- High Groundwater Recharge Parcels

Beckett&Raeder

Table 20: Priority Protection Areas in Watershed
Sources: Grand Traverse Regional Land Conservancy, n.d.a; Soil Survey of Benzie and Manistee Counties, Michigan, 2008; State of Michigan, 2013; Sullivan, personal communication, 2015, July 22

Priority Protection Area Category	*Amount of Watershed in Priority Protection Area*
Critical Dunes	189.22 acres
High Risk Erosion Areas	5.70 miles of coastline
Trout Streams (not including Betsie River or Trout Lakes)	20.96 miles
Arcadia Marsh Preserve	~270 acres
Arcadia Dunes: C.S. Mott Nature Preserve	2,614.41 acres
Freshwater Forested/Shrub Wetland	877.97 acres
Freshwater Emergent Wetland	166.99 acres
High Groundwater Recharge Priority Parcels	2,701.73 acres

Peninsula shoreline. The marsh's hydrology has been affected by human alterations and invasive species are established within the marsh, yet it remains a high conservation priority and will greatly benefit from restoration." (Grand Traverse Regional Land Conservancy, n.d.d) Because of their ecological value, continued conservation of these sites is crucial.

Specific locations of the following types of Priority Protection Areas within the Arcadia-Pierport Watershed are shown in Map 24: Critical Dunes, High Risk Erosion Areas, Trout Streams, GTRLC Preserves, wetlands, and large parcels that are high groundwater recharge areas, meaning that they are areas with the highest priority for groundwater recharge in the watershed (large parcels were chosen so as not to block other Priority Protection Areas). Due to data limitations, Map 24 and Table 20 may not portray all potential Priority Protection Areas. Table 20 displays the acres or miles within the watershed of these various types of Priority Protection Areas. (Grand Traverse Regional Land Conservancy, n.d.a; State of Michigan, 2013)

Priority Parcel Analysis

The ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*** describes "a 'Priority Parcel Analysis'" as, "a GIS process that evaluates individual land parcels based on multiple ecological criteria and ranks parcels accordingly. The final product provides a tool…to assist in prioritizing land protection efforts in a manner that provides the greatest benefit to local ecosystems while also complementing existing land protection efforts." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012) The Priority Parcel Analysis used by the Tip of the Mitt Watershed Council, Grand Traverse Regional Land Conservancy, and Little Traverse Conservancy for the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*** was based on the following criteria. (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

- "Parcel Size: Larger blocks of contiguous land typically have higher ecological value due to their potential to harbor a greater diversity of habitat types and species. Larger parcels are also more time and cost effective to protect than smaller parcels. The selection threshold for parcel size criteria during this process was 10 acres. The larger the parcel, the more points it received." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)
- "Groundwater Recharge Potential: As previously discussed, groundwater plays an important role in water quality protection. Predominant soil type and associated permeability were determined for each parcel using the physical properties found in county soil surveys. Parcels were scored based on acreage containing soils with high groundwater recharge potential, the minimum threshold set at one acre." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)
- "Presence of Wetlands: As noted earlier, wetlands are critical to protecting water quality. Digital GIS data layers containing results of the National Wetlands Inventory (NWI) were used to determine the presence of wetlands on individual parcels. Parcels were scored based on wetland acreage identified in the NWI, any parcel with wetlands scoring at least one point." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)
- "Lake Shoreline/Riparian Ecosystems: Protecting the land/water interface, the riparian area, is essential to good water quality. The length of lake shoreline was determined for individual properties using hydrography GIS data layers

from the State of Michigan. Scores were based on the total shoreline distance contained within the parcel, with a minimum threshold of 100 feet." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

• "Stream Shoreline/Riparian Ecosystems: The length of streambank was determined for individual properties using hydrography GIS data layers from the State of Michigan. Scores were based on the total streambank distance contained within the parcel, with a minimum threshold of 200 feet." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

• "Steep Slopes: Land parcels with steep slopes should be permanently protected. GIS data from the State of Michigan was used to determine the highest percent slope on a parcel and scored accordingly. Properties with slopes greater than 20% received points." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

• "Protected Land Adjacency: Properties adjacent to protected lands such as State Forests or conservancy lands have a high ecological value because they provide a buffer to pre-existing protected lands and increase the contiguous protected area, which essentially expands the biological corridor for species migration and interaction. Protected lands include properties owned by the federal government, tribal governments, State of Michigan, local governments, universities, land conservancies, and private owners (conservation easements). Properties bordering protected lands were scored based on the number of adjacent protected land parcels." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

• "Presence of State or Federally Listed Threatened or Endangered Species: Threatened and endangered species represent an important aspect of biodiversity. The Michigan Natural Features Inventory developed a probability model and rarity index based on existing threatened and endangered species information. Properties within or touching upon the model's grid cells that had a high probability of threatened and endangered species occurrence scored points; receiving a higher score as the rarity index number increased." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

According to the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, "All 22,748 land parcels in the Lake Charlevoix Watershed were analyzed and scored using the eight listed criteria. The scores for each criterion were summed to produce a total 'priority' score for each land parcel. Nearly 200 parcels received a total score of 15 or greater and [were] grouped into the high priority tier as they are considered to be the most vital for water resource protection. Over 4,000 parcels were grouped into a second tier of medium priority, with total scores ranging from 5 to 14. The remaining parcels received a score of less than five and are considered low priority…Permanent protection or low-impact development in high priority areas will help maintain the ecological integrity of the most sensitive areas and protect water resources throughout the watershed." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012) The ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*** includes a map showing the final Priority Parcel Analysis for that watershed, as well as the scoring system for the analysis in an appendix. (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

For the Priority Parcel Analysis in the Arcadia-Pierport Watershed, a similar methodology was used. The general outline and procedure is based upon the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, but several adjustments made the process more applicable to the Arcadia-Pierport Watershed. (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012) Furthermore, additional criteria and weights were used to provide a holistic, customized approach to watershed management in the area. A total of 12 criteria were used and are explained below.

For many of the numeric parcels, the Natural Breaks (Jenks) algorithm distribution was used to assign weights; natural breaks are placed based on inherent groupings of data. The class or group "breaks" are assigned to bring together similar values and maximize the difference between groups. This is a good statistical grouping for datasets, where there are significant differences in the data values. This methodology was used for Parcel Size, Groundwater Recharge Potential, Wetland Preservation, Lake Shoreline/Riparian Ecosystems, Stream Shoreline/Riparian Ecosystems, Adjacency to Agricultural Lands, Agricultural Lands Adjacent to Tributaries, and Adjacency to Residential Lands. (Environmental Systems Research Institute, Inc., 2012) The discussion below outlines the methodology used for the Priority Parcel Analysis for the Arcadia-Pierport Watershed. The color scheme for the each of the 12 criteria maps (Maps 25-36) is as follows: Blue and light blue represent areas of low priority (values of 0-1); yellow represents areas of slightly higher priority (values of 2); orange represents areas of higher priority (values of 3); and red represents areas of greatest priority (values of 4). A map and a table accompany the description for each of the 12 criteria, and final maps are shown as well.

Figure 37: Wildflowers at Arcadia Marsh

1) **Parcel Size** (acreage): The ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*** only focused on parcel sizes between 10-120 acres. The parcel sizes in the Arcadia-Pierport Watershed have a greater variation in size and, therefore, require a different distribution of points based on these sizes. For instance, to exclude parcels even smaller than 1 acre would eliminate all of the community of Arcadia. The statistical size distribution ranges from 0.000002 acres to 534 acres; refer to Table 21. In general, as shown in Map 25, smaller parcels are found in the coastal areas, and larger parcels tend to be found in the northern portion of the watershed, where Preserves and agricultural uses are located. (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Map 25: Priority Parcel Analysis: Parcel Size

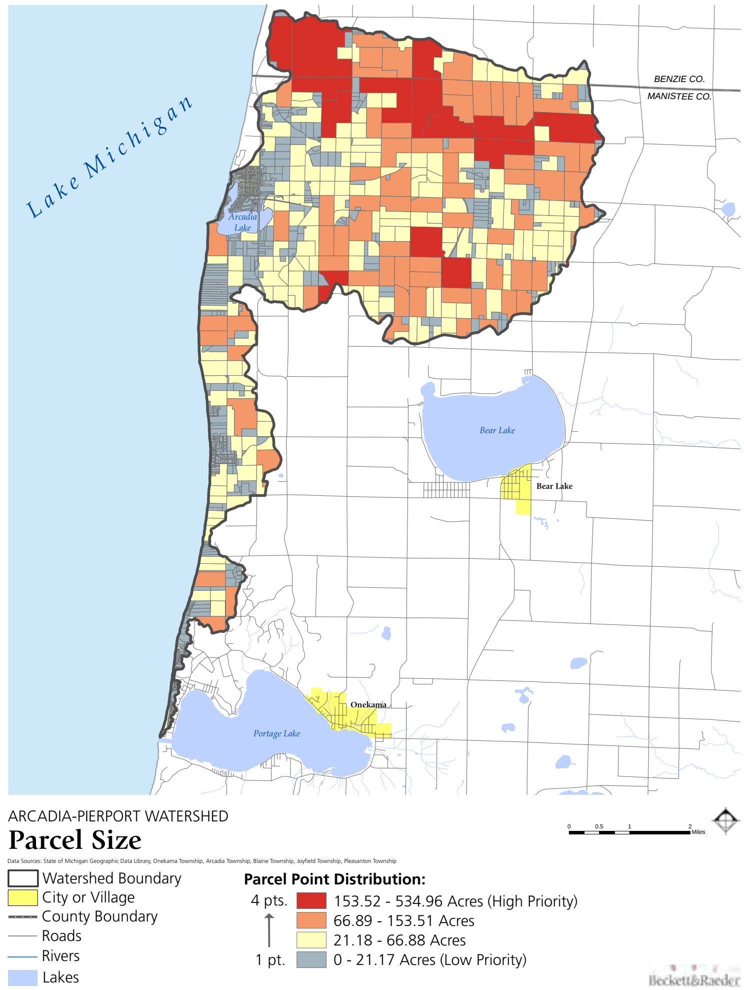
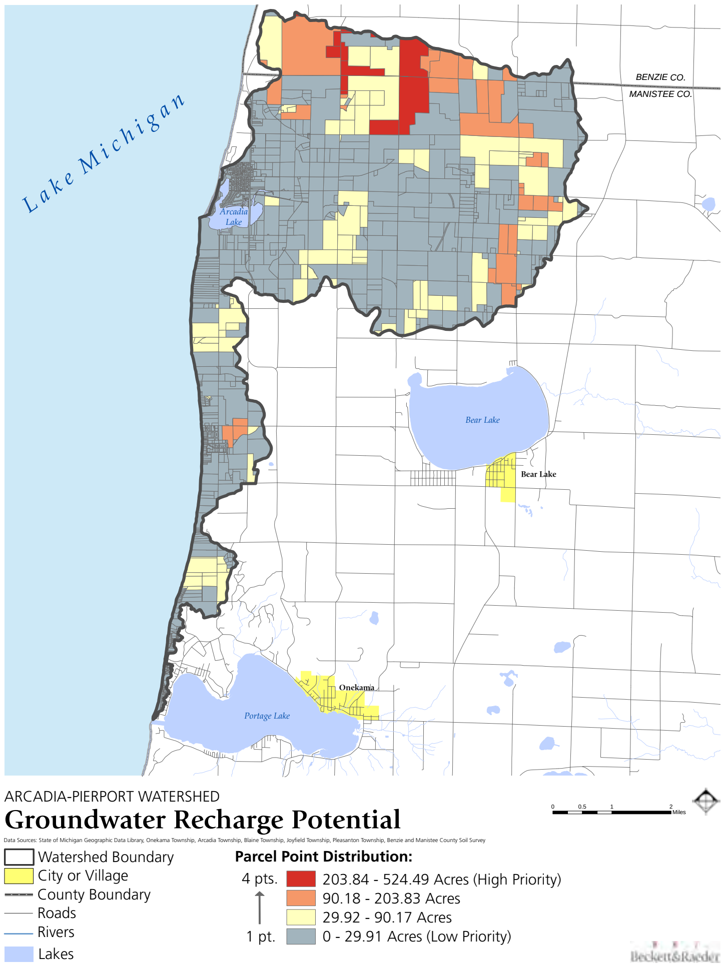


Table 21: Priority Parcel Analysis: Parcel Size

Range (acres)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Acres > 0 or ≤ 21.176663	1 point	14.71%
Acres > 21.176664 or ≤ 66.889708	2 points	32.68%
Acres > 66.889709 or ≤ 153.518510	3 points	30.70%
Acres > 153.518511 or ≤ 534.955855	4 points	21.90%

Map 26: Priority Parcel Analysis: Groundwater Recharge Potential



2) **Groundwater Recharge Potential** (acreage): Determined using the *Soil Survey of Benzie and Manistee Counties, Michigan*, soils were organized and grouped by soil series, and points were given based on permeability and soil texture. The soil characteristics were then added to parcel data to show permeable soil acreage within each parcel, and scored accordingly; refer to Table 22. The parcels with higher priority are the larger and faster-recharging groundwater recharge parcels and are located in the north and east of the watershed, as shown in Map 26. (*Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*, 2012; *Soil Survey of Benzie and Manistee Counties, Michigan*, 2008)

Table 22: Priority Parcel Analysis: Groundwater Recharge Potential

Range (acres)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Acres > 0 or ≤ 29.916334	1 point	66.54%
Acres > 29.916335 or ≤ 90.173906	2 points	19.60%
Acres > 90.173907 or ≤ 203.840390	3 points	10.79%
Acres > 203.840391 or ≤ 524.48543	4 points	3.07%

3) **Wetland Preservation** (acreage): Following the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*** methodology, any parcel with wetlands was given 1 point. Parcel scores are dependent on the size of the parcel relative to the amount of wetland found within each parcel; refer to Table 23. A greater presence of wetlands can be seen around Arcadia Lake and nearby residential uses, as shown in Map 27. (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Map 27: Priority Parcel Analysis: Wetland Preservation

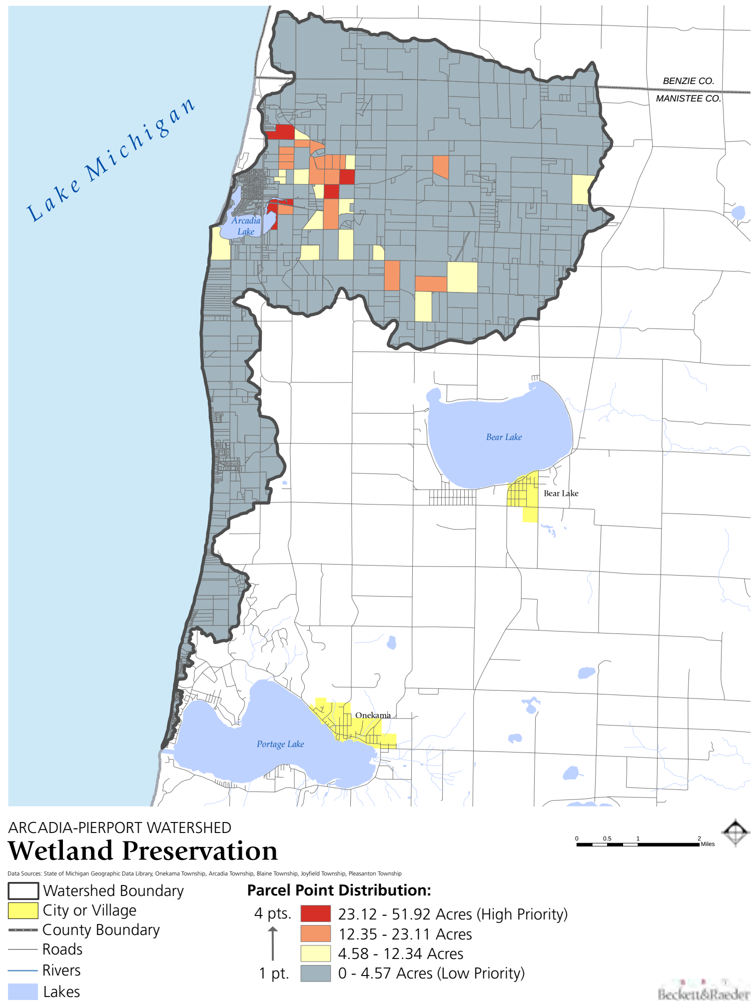
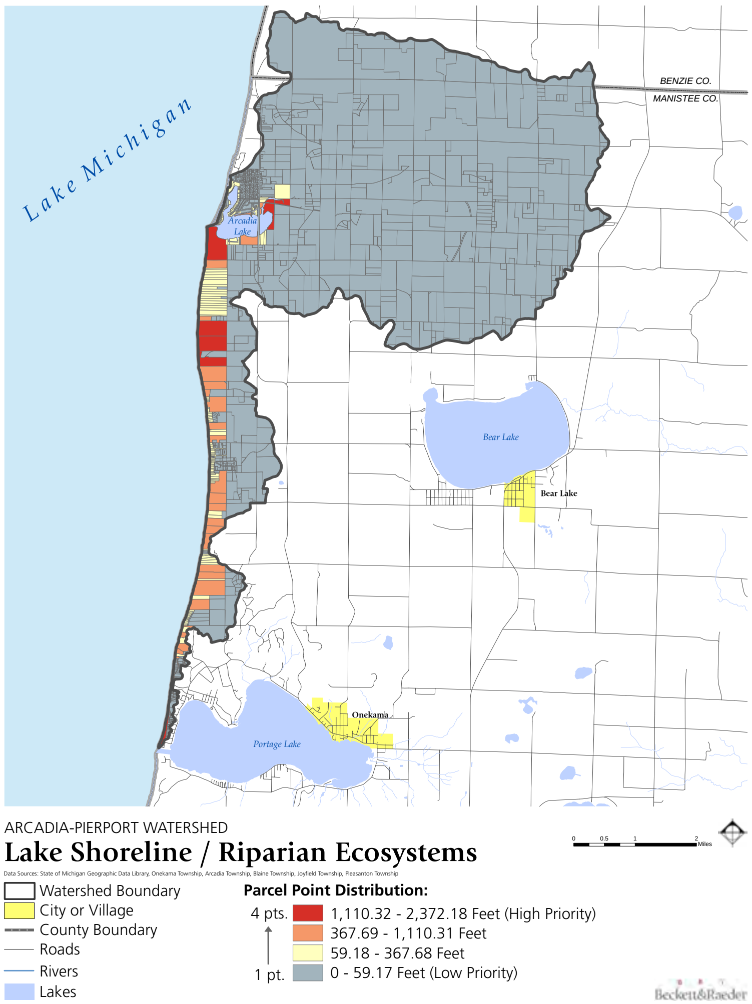


Table 23: Priority Parcel Analysis: Wetland Preservation

Range (acres)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Acres > 0 or ≤ 4.572977	1 point	92.63%
Acres > 4.572978 or ≤ 12.349266	2 points	4.33%
Acres > 12.349267 or ≤ 23.116997	3 points	2.32%
Acres > 23.116998 or ≤ 51.921345	4 points	0.72%

Map 28: Priority Parcel Analysis: Lake Shoreline/Riparian Ecosystems



4) **Lake Shoreline/Riparian Ecosystems**: Calculations were made of the length of lake shoreline for parcels, and scores were based on the total shoreline distance within each parcel, with no minimum threshold. The parcel with the shortest shoreline distance was only 1.05 feet, while the parcel with the longest distance was 2,372.18 feet; refer to Table 24. Priority was given to larger parcels containing greater amounts of coastline. The parcels with higher priority are found on the Lake Michigan and Arcadia Lake shorelines, as shown in Map 28. (*Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*, 2012)

Table 24: Priority Parcel Analysis: Lake Shoreline/Riparian Ecosystems

Range (feet)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Feet > 0 or ≤ 59.183291	1 point	92.50%
Feet > 59.183292 or ≤ 367.686718	2 points	2.25%
Feet > 367.686719 or ≤ 1,110.317418	3 points	4.06%
Feet > 1,110.317419 or ≤ 2,372.178922	4 points	1.19%

5) **Stream Shoreline/Riparian Ecosystems**: Calculations were made of the length of stream bank for parcels, and scores were based on the total stream bank distance within each parcel, with no minimum threshold. The parcel with the greatest stream distance was 4,669.177313 feet, and the parcel with the shortest stream distance was 12.786622 feet; refer to Table 25. The priority parcels are found in the central part of the Arcadia portion of the watershed, as shown in Map 29. (*Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*, 2012)

Map 29: Priority Parcel Analysis: Stream Shoreline/Riparian Ecosystems

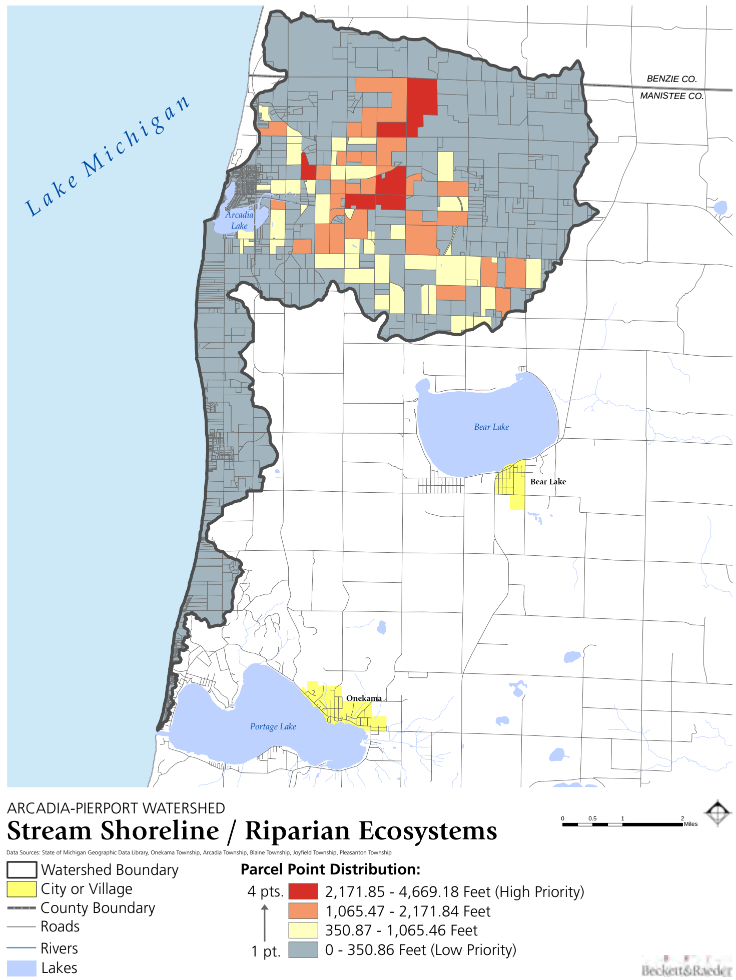
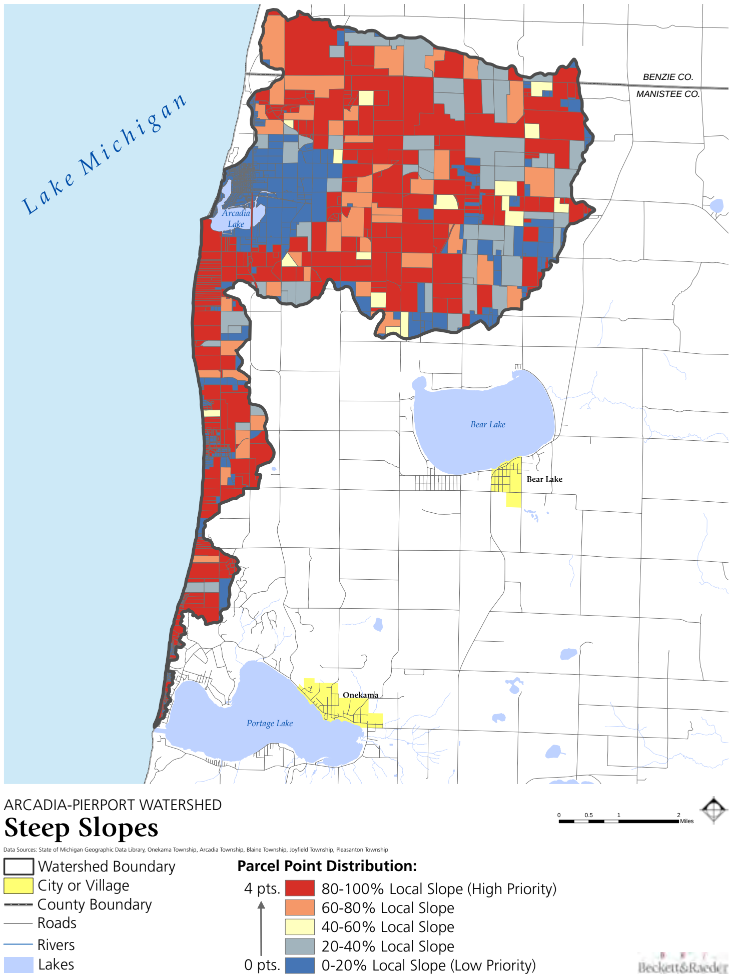


Table 25: Priority Parcel Analysis: Stream Shoreline/Riparian Ecosystems

Range (feet)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Feet > 0 or ≤ 350.866037	1 point	79.44%
Feet > 350.866038 or ≤ 1,065.463971	2 points	6.65%
Feet > 1,065.463972 or ≤ 2,171.846149	3 points	10.38%
Feet > 2,171.846150 or ≤ 4,669.177313	4 points	3.53%

Map 30: Priority Parcel Analysis: Steep Slopes



6) **Steep Slopes**: Steep slopes are important considerations when referring to transfer of material, susceptibility to erosion, and sensitivity. (*Onekama Community Master Plan*, 2010) Since slopes over 20% are considered at risk, slopes in the range of 0-20% of the local slope were excluded (refer to Table 26) and are shown on Map 29 in blue. The highest priority slope areas tend to be found along the coast (except around the area of Arcadia Lake), in the Pierport portion of the watershed, and in the central part of the Arcadia portion of the watershed, as shown in Map 30.

Table 26: Priority Parcel Analysis: Steep Slopes

Range (slope degree)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Parcels containing 0-20% local slope	0 points (excluded)	34.71%
Parcels containing 20-40% local slope	1 point	9.99%
Parcels containing 40-60% local slope	2 points	1.75%
Parcels containing 60-80% local slope	3 points	8.58%
Parcels containing 80-100% local slope	4 points	44.98%

7) **Steep Slopes on Agricultural Land**: Based on further analysis of 6) Steep Slopes, steep slopes were analyzed again for steep slopes that are located on agricultural land. Additional points were given to parcels that are used for agricultural purposes and are found on steep slopes; refer to Table 27. Priority parcels that are found on steep slopes and used for agricultural purposes tend to be located in the central, eastern, and northern parts of the Arcadia portion of the watershed, as shown in Map 31.

Map 31: Priority Parcel Analysis: Steep Slopes on Agricultural Land

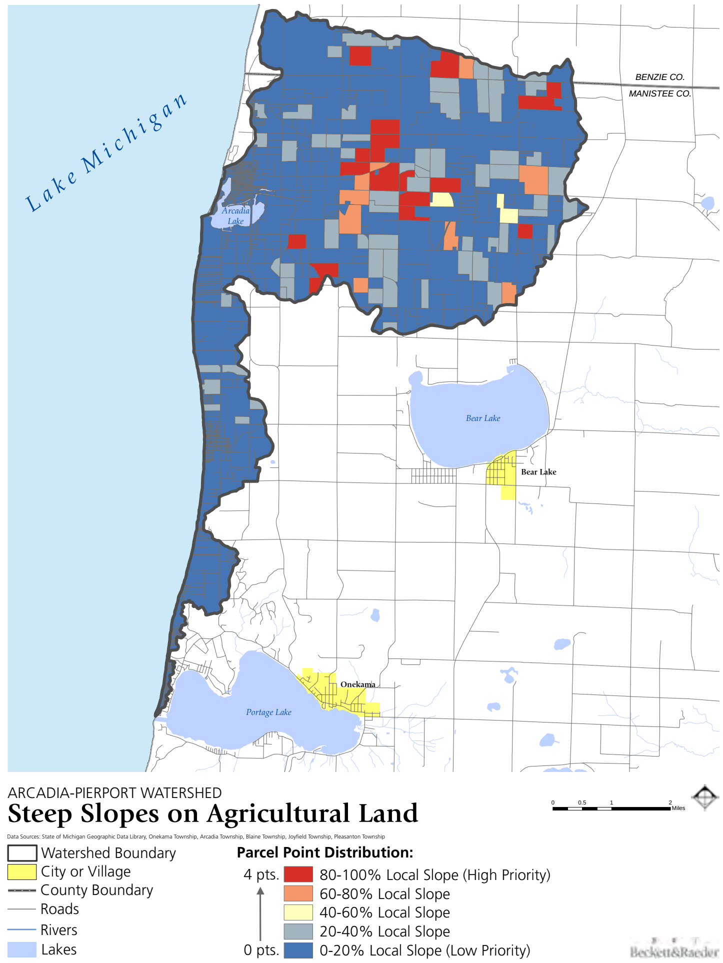
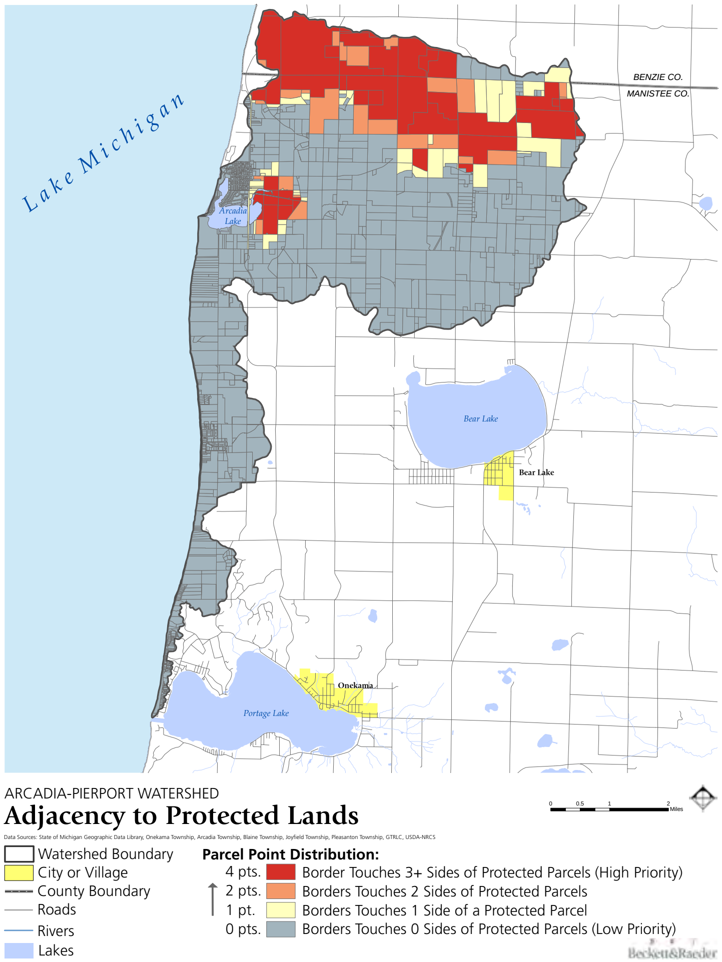


Table 27: Priority Parcel Analysis: Steep Slopes on Agricultural Land

Range (slope degree)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Agricultural parcels containing 0-20% local slope	0 points (excluded)	83.37%
Agricultural parcels containing 20-40% local slope	1 point	10.22%
Agricultural parcels containing 40-60% local slope	2 points	0.39%
Agricultural parcels containing 60-80% local slope	3 points	2.01%
Agricultural parcels containing 80-100% local slope	4 points	4.00%

Map 32: Priority Parcel Analysis: Adjacency to Protected Lands



8) **Adjacency to Protected Lands**: Any properties that are adjacent to protected lands have a higher ecological importance, and the properties that share a boundary to protected lands were ranked accordingly. Protected properties themselves and Preserve lands received 4 points; refer to Table 28. The priority parcels are surrounding the Preserves in the northern and western portions of the watershed and by Arcadia Lake, as shown in Map 32.

Table 28: Priority Parcel Analysis: Adjacency to Protected Lands

Range (adjacency)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Border does not touch any protected lands	0 points	72.87%
Border touches one side of protected parcel	1 point	3.63%
Border touches two sides of protected parcel	2 points	3.58%
Border touches three or more sides of protected parcel	4 points	19.92%

9) **Adjacency to Agricultural Lands**: Any properties that are adjacent to agricultural land uses are at a higher risk for pollution and runoff, as agricultural activities can be sources of pollution. Similar to 7) Adjacency to Protected Lands, parcels that border agricultural lands were ranked accordingly. Agricultural parcels themselves received 4 points; refer to Table 29. Many agricultural lands are found in the northern, central, and eastern portions of the Arcadia portion of the watershed, with some found on the eastern edge of the Pierport portion of the watershed, as shown in Map 33. (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Map 33: Priority Parcel Analysis: Adjacency to Agricultural Lands

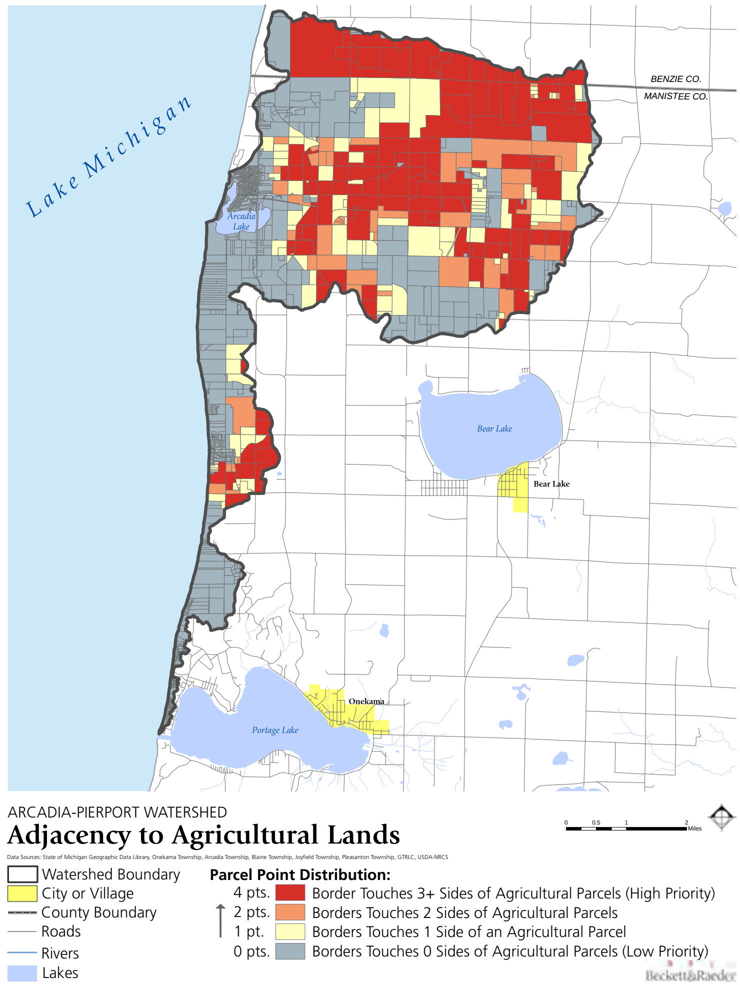
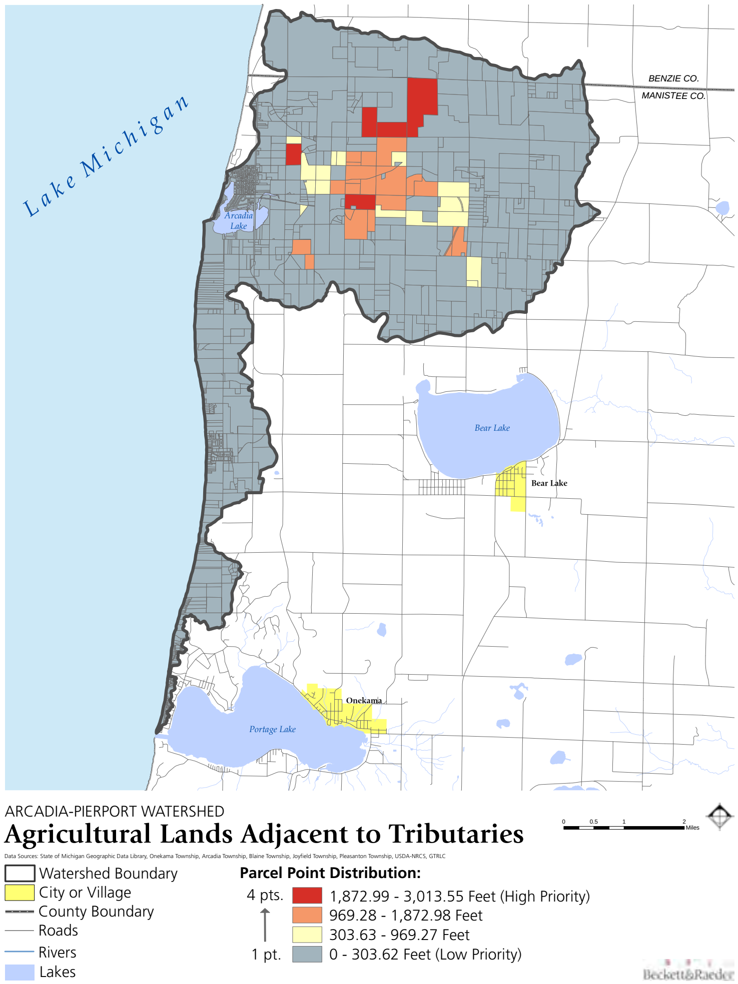


Table 29: Priority Parcel Analysis: Adjacency to Agricultural Lands

Range (adjacency)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Border does not touch any agricultural parcels	0 points	60.56%
Border touches one side of agricultural parcel	1 point	9.12%
Border touches two sides of agricultural parcel	2 points	6.91%
Border touches three or more sides of agricultural parcel	4 points	23.41%

Map 34: Priority Parcel Analysis: Agricultural Lands Adjacent to Tributaries



10) **Agricultural Lands Adjacent to Tributaries**: Since general agricultural uses have a tendency to create runoff from fertilizers, pesticides, etc., the location of these land uses near tributaries is of high importance. Parcels that contain tributaries in the watershed were compared to agricultural land use parcels. The lengths of tributary stream segments within the agricultural parcels were calculated, agricultural parcels were scored based on parcel size and relation to the length of the tributary on the property, and parcels with the longer stretches of creek tributaries received the highest points; refer to Table 30. Priority parcels are in the central part of the Arcadia portion of the watershed, as shown in Map 34. (*Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*, 2012)

Table 30: Priority Parcel Analysis: Agricultural Lands Adjacent to Tributaries

Range (feet)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Feet > 0 or ≤ 303.627184	1 point	90.49%
Feet > 303.627185 or ≤ 969.272560	2 points	2.27%
Feet > 969.272561or ≤ 1,872.988346	3 points	4.26%
Feet > 1,872.988347 or ≤ 3,013.551165	4 points	2.99%

11) **Adjacency to Residential Lands**: Parcels considered residential are likely to have septic tanks, which carry the risk of leaking and contaminating the surrounding areas. Adjacency was used to rank and score parcels based on this use. Given the high use of septic tanks in this area, residential uses were given priority importance for consideration of possible contamination and leaks; refer to Table 31. Priority parcels are found throughout the watershed, especially in the middle portion of the watershed, as shown in Map 35. (*Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*, 2012)

Map 35: Priority Parcel Analysis: Adjacency to Residential Lands

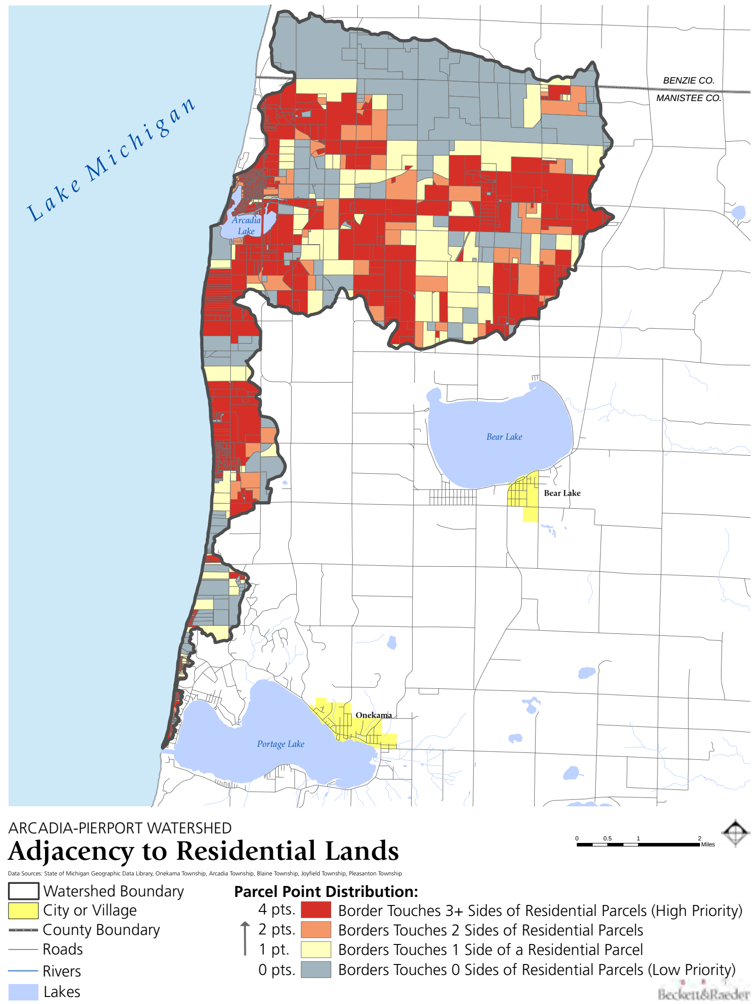
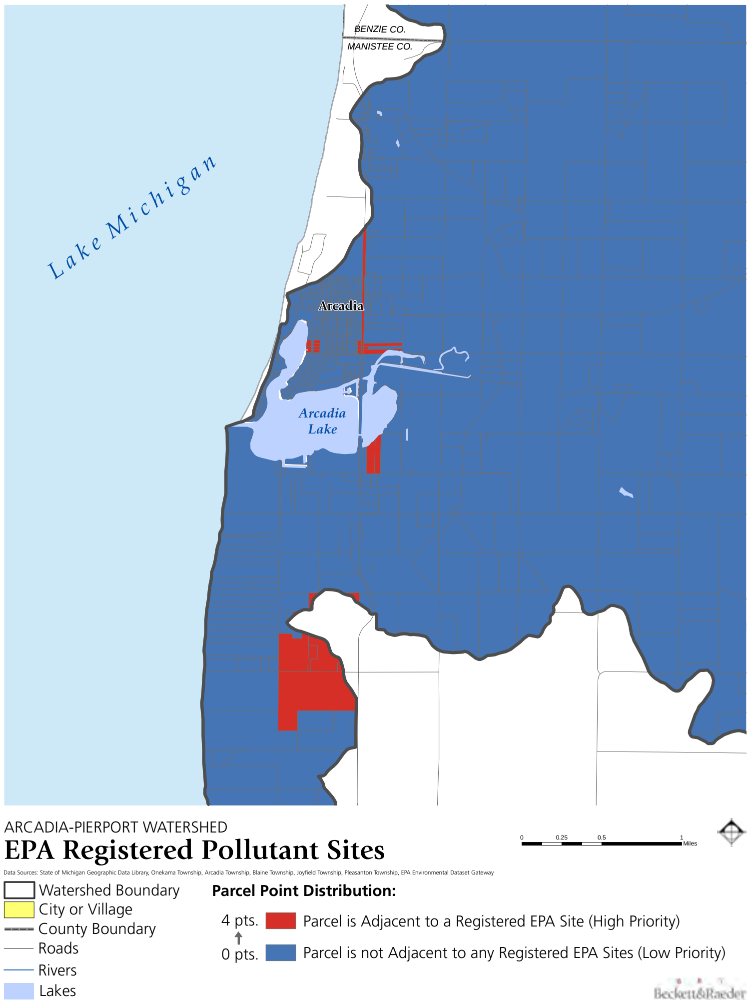


Table 31: Priority Parcel Analysis: Adjacency to Residential Lands

Range (adjacency)	*Number of Points*	*Total Percent of Parcels in Watershed (%)*
Border does not touch any residential parcels	0 points	53.74%
Border touches one side of residential parcel	1 point	13.44%
Border touches two sides of residential parcel	2 points	6.12%
Border touches three or more sides of residential parcel	4 points	26.71%

Map 36: Priority Parcel Analysis: EPA Registered Pollutant Sites

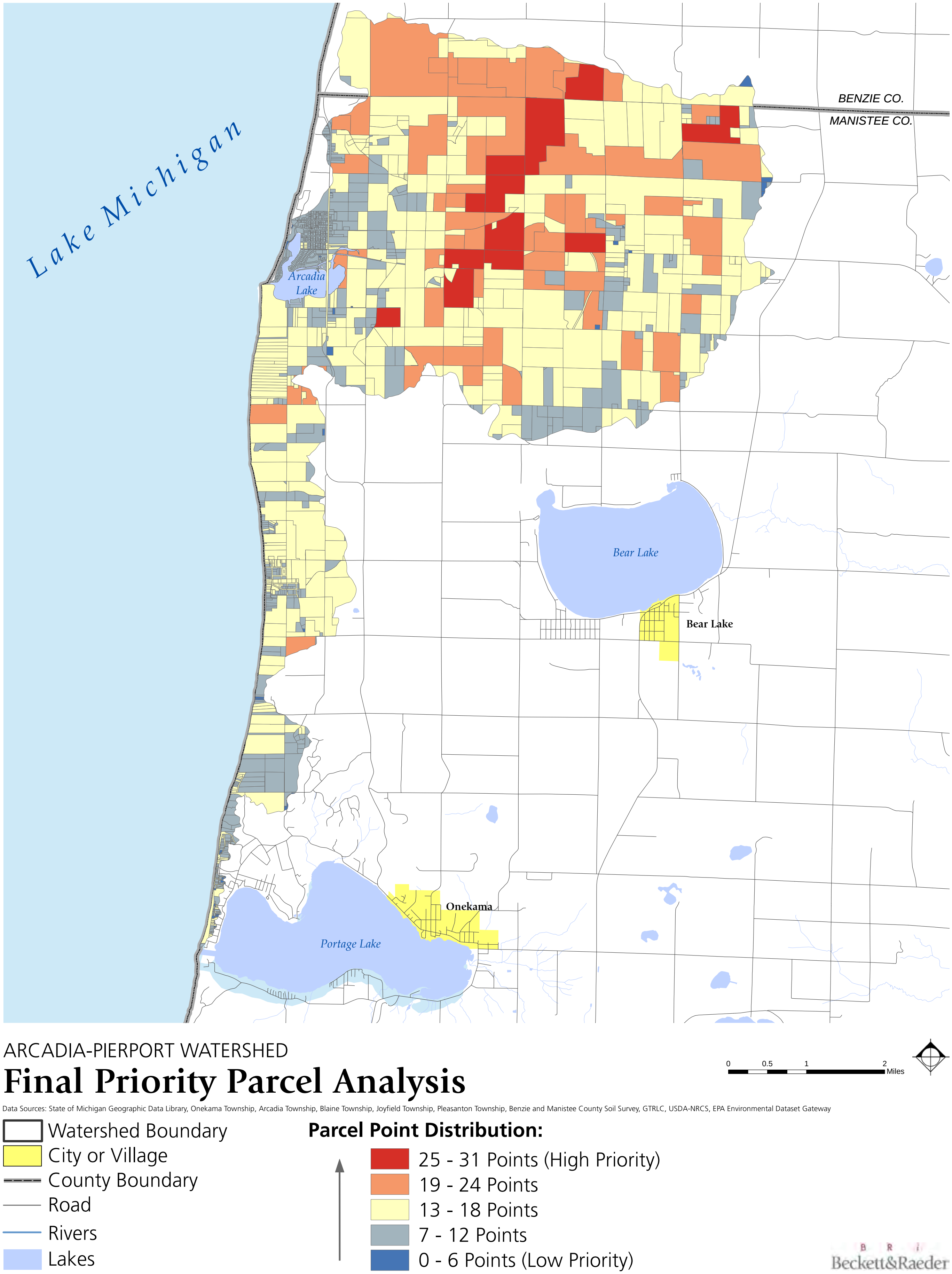


12) **EPA Registered Pollutant Sites**: Any site that is a designated EPA Registered Pollutant Site is of concern in the watershed, so any parcels adjacent to these sites were scored and given points; refer to Table 32. There are four active EPA sites in the watershed; refer to Map 36. (United States Environmental Protection Agency, 2015)

Table 32: Priority Parcel Analysis: EPA Registered Pollutant Sites

Range (adjacency)	*Number of Points*	*Total Acreage (acres)*	*Total Percent of Parcels in Watershed (%)*
Parcel is adjacent to any EPA Registered Pollutant Site	4 points	253.933325 acres	0.80%

Map 37: Final Priority Parcel Analysis



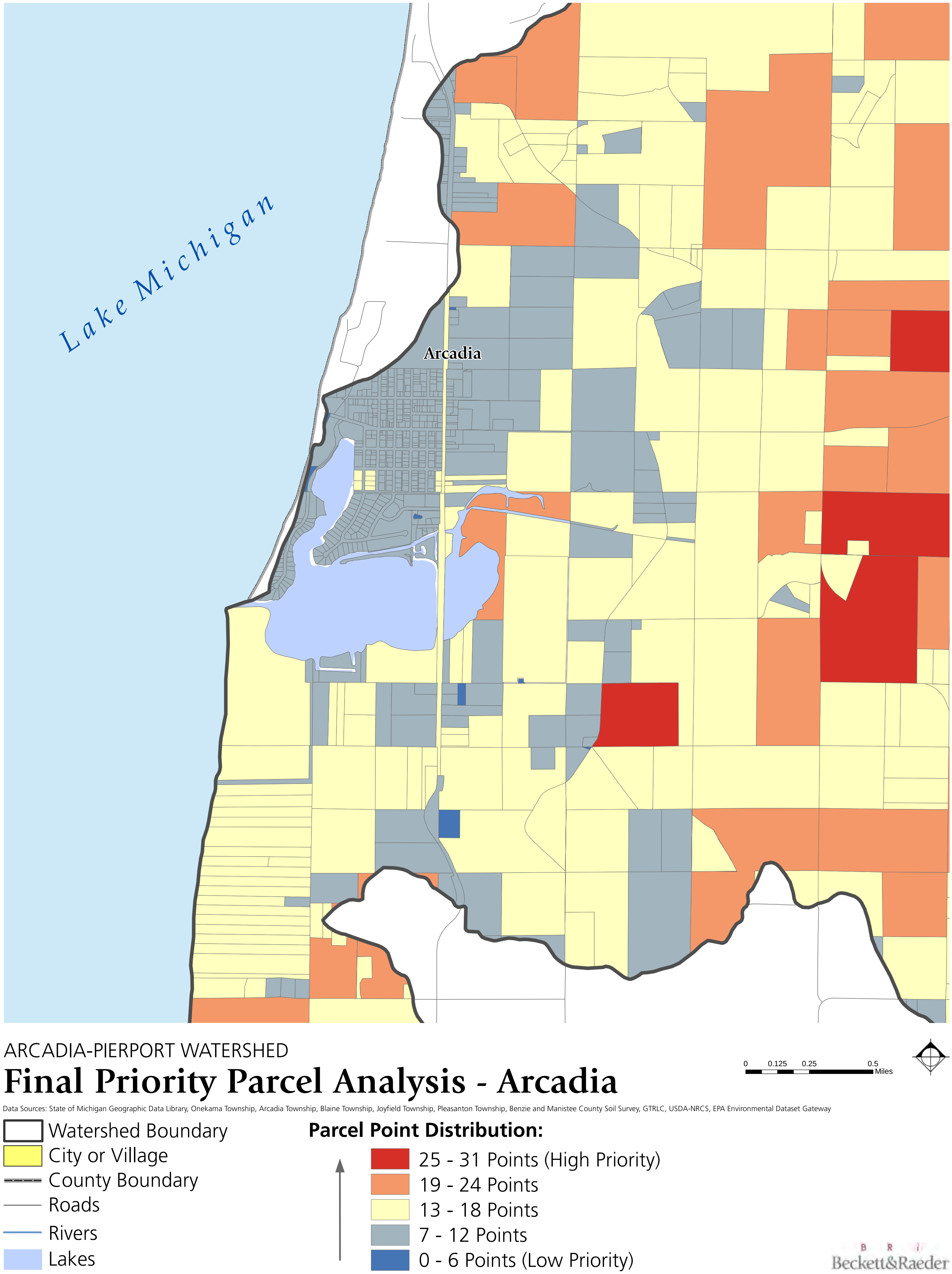
Final Priority Parcel Analysis (acreage): For the final priority parcel analysis, dark blue parcels have the lowest number of points (values of 0-6), light blue parcels have slightly more points (values of 7-12), yellow parcels have slightly more points (values of 13-18), orange parcels have more points (values of 19-24 points), and red parcels have the most points (values of 25-31). A value of 31 points per parcel represents total priority. Refer to Table 33. The highest priority areas are found in the northern and central areas of the Arcadia portion of the watershed, as shown in Map 37.

Maps 38 and 39 show the final priority parcel analysis zoomed in to the Arcadia and Pierport areas, respectively.

Table 33: Final Priority Parcel Analysis

Range of Points	*Total Percent of Parcels in Watershed (%)*	*Priority Level*
0-6 points (Low Priority)	1.23%	Lowest Priority
7-12 points	29.95%	Low-Medium Priority
13-18 points (Medium Priority)	47.66%	Medium Priority
19-24 points	17.17%	Medium-High Priority
25-31 points (High Priority)	3.98%	High Priority

Map 38: Final Priority Parcel Analysis: Arcadia



Map 39: Final Priority Parcel Analysis: Pierport

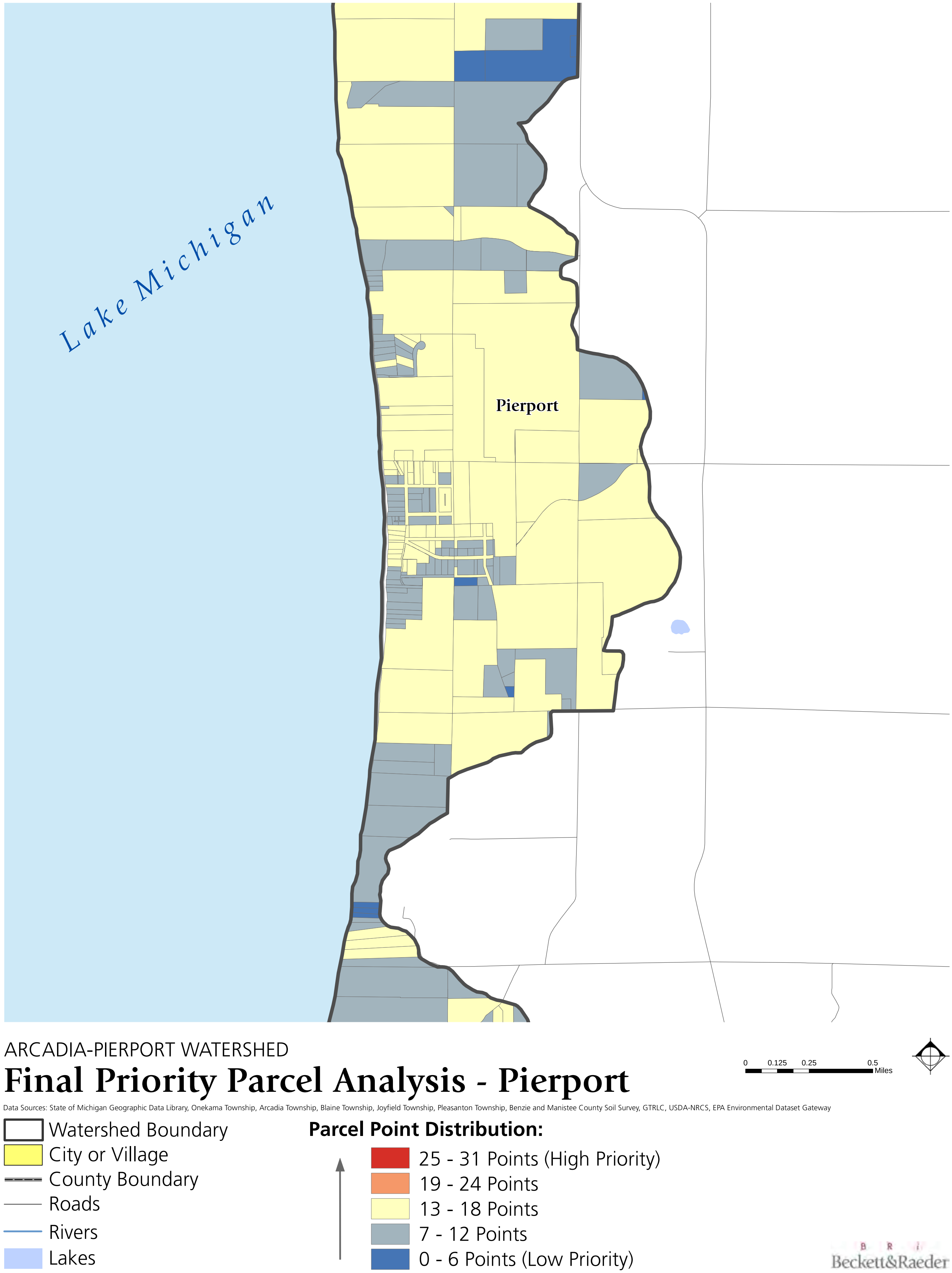


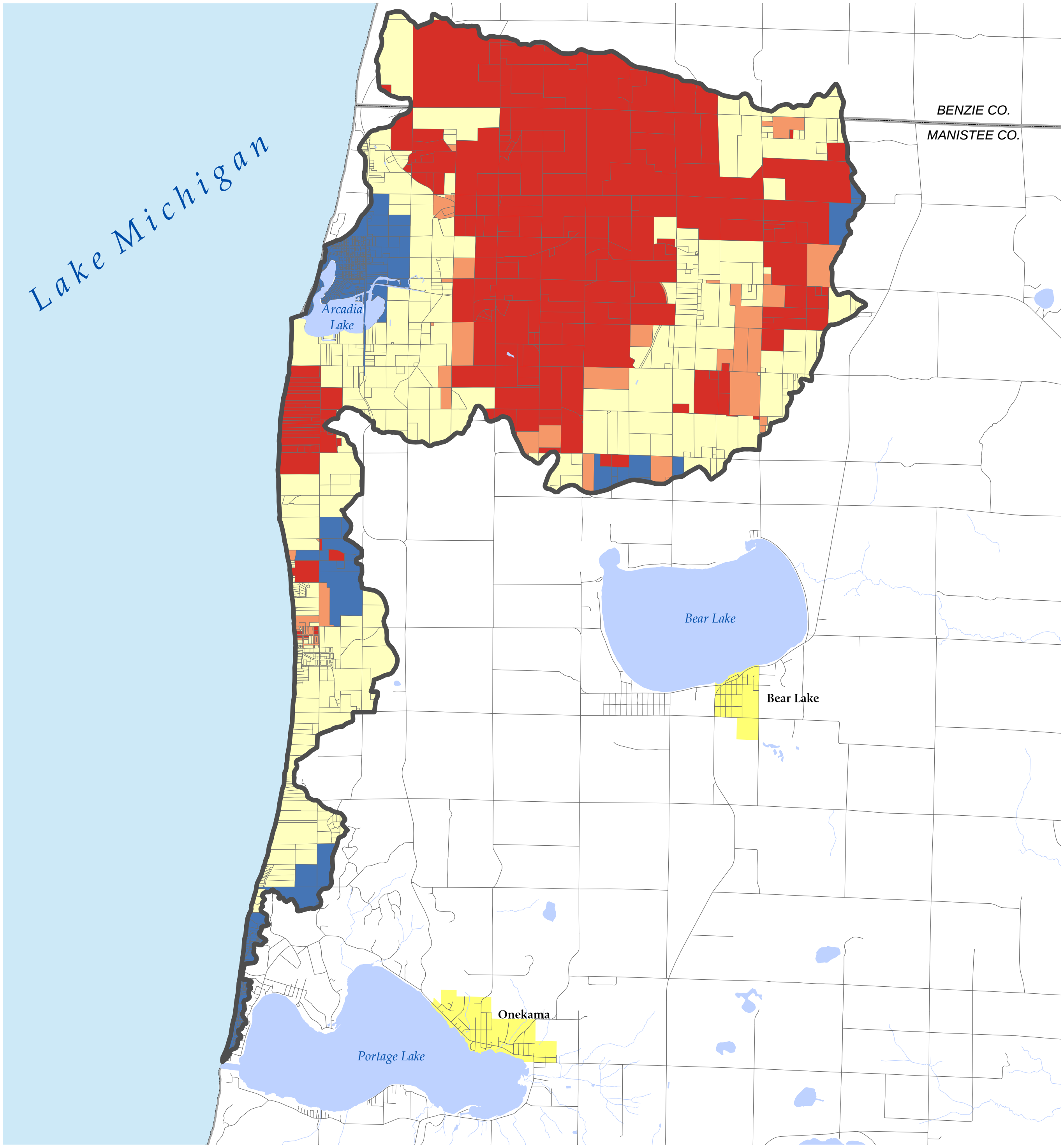
Table 34: Hot Spot Analysis

Priority Level Cluster	*Total Percent of Parcels in Watershed (%)*
Lowest Priority Cluster	9.77%
No statistical cluster of values	36.00%
Highest Priority Cluster	48.77%

Hot Spot Analysis (acreage): Using the Hot Spot Analysis tool in ArcGIS software, the total point values of each parcel can be compared spatially to determine significant clusters of high priority and low priority areas. High priority clusters are where groupings of high values are found. Low priority clusters are where groupings of low values are found. Refer to Table 34. In regards to the color scheme in Map 40, values in the deep hues of blue and red represent a 0.05 (or smaller) p-value, showing statistical significance that the values within the clusters are related. Values in the light blue and orange color have less statistical significance but are still somewhat clustered and related (specifically, a 0.5-0.10 p-value). Yellow values display areas with no statistical clustering and a mix of values. The "cold" (blue) and "hot" (red) spots represent low and high priority, respectively. (Environmental Systems Research Institute, Inc., 2014)

It should be noted that for the following steps, no points were given to parcels that did not meet the selected criteria.
• Wetland Preservation: Parcels with no wetlands received zero points.
• Lake Shoreline/Riparian Ecosystems: Parcels with no shoreline received zero points.
• Stream Shoreline/Riparian Ecosystems: Parcels with no stream shorelines received zero points.
• Steep Slopes: Parcels with 0-20% local slope were excluded and received zero points.
• Steep Slopes on Agricultural Land: Parcels with 0-20% local slope were excluded and received zero points.
• Adjacency to Protected Lands: Parcels that were not adjacent to these uses received zero points.
• Adjacency to Agricultural Lands: Parcels that were not adjacent to these uses received zero points.
• Adjacency to Residential Lands: Parcels that were not adjacent to these uses received zero points.
• EPA Registered Pollutant Sites: Parcels that were not adjacent to these sites received zero points.

Map 40: Hot Spot Analysis



ARCADIA-PIERPORT WATERSHED

Hot Spot Priority Parcel Analysis

0 0.5 1 2 Miles

Data Sources: State of Michigan Geographic Data Library, Onekama Township, Arcadia Township, Blaine Township, Joyfield Township, Pleasanton Township

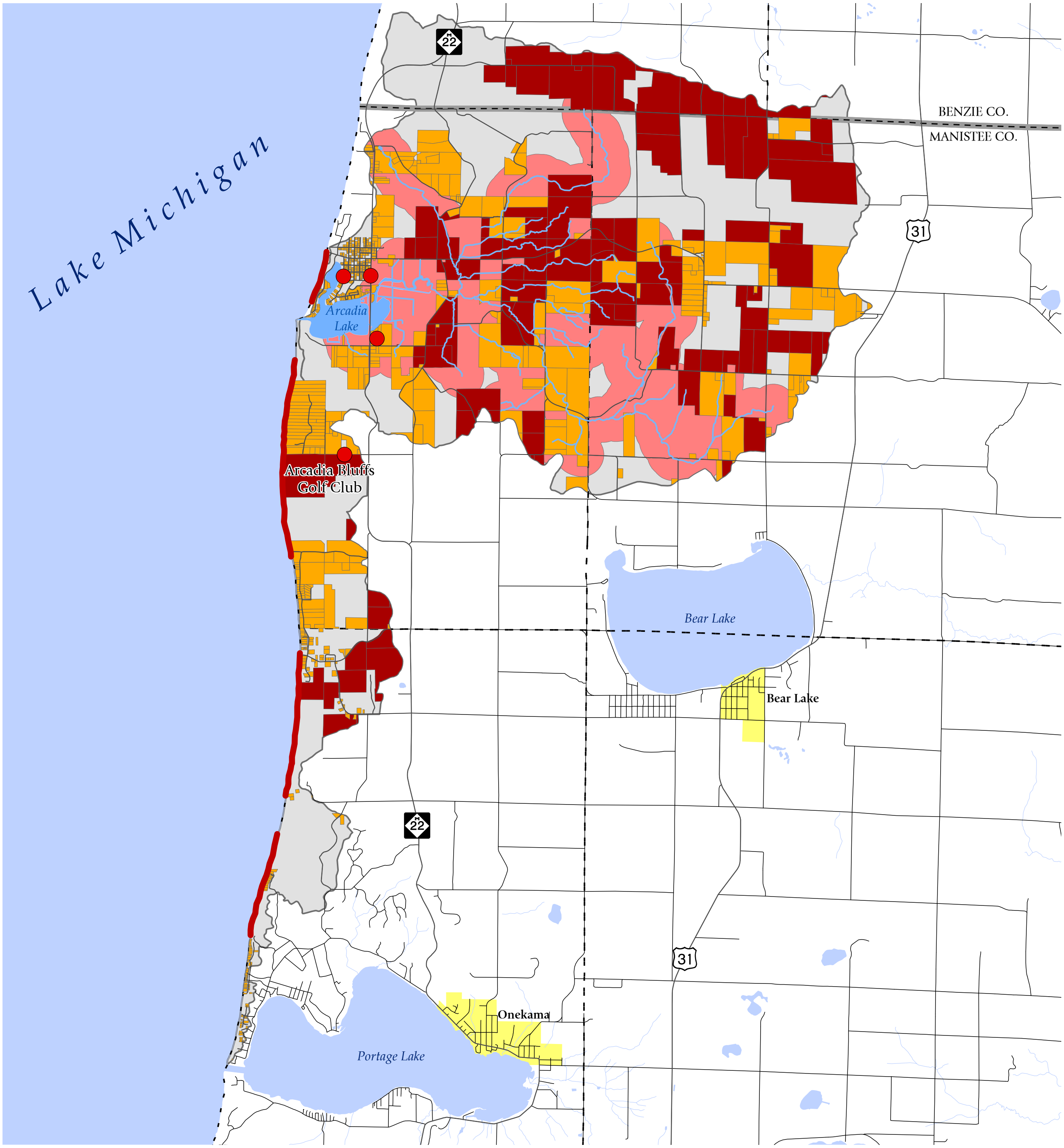
- Watershed Boundary
- City or Village
- County Boundary
- Roads
- Rivers
- Lakes

Parcel Point Distribution:

- Cluster of High Point Totals (High Priority)
- No Significant Cluster of Point Totals
- Cluster of Low Point Totals (Low Priority)

Beckett&Raeder

Map 41: Critical Areas



ARCADIA-PIERPORT WATERSHED

Critical Areas

0 0.5 1 2 Miles

Data Sources: State of Michigan Geographic Data Library, Arcadia Township, Onekama Township, Pleasanton Township, Blaine Township, Joyfield Township, Michigan DEQ, EPA Environmental Dataset Gateway

Watershed Boundary
City or Village
County Boundary
Township Boundary

Critical Areas:

1/4 Mile Creek Buffer
Residential Land Uses
Agricultural Land Uses
EPA Registered Pollutant Sites

Roads
Creeks
High Risk Erosion Areas

Beckett&Raeder

Critical Areas

This is another section of the Plan wherein there are gaps in terms of available data and information to inform selection of Critical Areas in the Arcadia-Pierport Watershed, so this section represents the best attempt to identify Critical Areas in the watershed but should not be considered as providing a complete or comprehensive overview of the entire Arcadia-Pierport Watershed. There may be important areas that have not been included. Watershed Goals I, II, and III in Table 44 address waterbodies and quality, and Implementation Tasks IA and IIIA in Table 46 address nonpoint source pollution and riparian buffers, respectively.

According to the EPA's ***Handbook for Developing Watershed Plans to Restore and Protect Our Waters***, critical areas are locations in need of additional management in order to decrease pollutant loads. (***Handbook for Developing Watershed Plans to Restore and Protect Our Waters***, 2008) The ***Lake Charlevoix***

Table 35: Critical Areas in Watershed
Sources: Beckett & Raeder, Inc., n.d.; State of Michigan, 2013

Type of Critical Area	*Size of Critical Area in Watershed (acres)*	*Percentage of Watershed (%)*
1/4 Mile Creek Buffer	7,462.17 acres	39.33%
Residential Land Uses	3,942.71 acres	20.78%
Agricultural Land Uses	6,105.62 acres	32.18%
Arcadia Bluffs Golf Club	234.39 acres	1.24%
Roads	71.03 miles	--
Creeks	37.06 miles	--
High Risk Erosion Areas	5.70 miles	--

Watershed Management Plan: Protecting Water Quality for Today and Tomorrow states, "Critical areas…are the areas in which management measures need to be implemented to achieve load reductions…" and "locations where actions are needed to address ongoing sources of nonpoint source pollutants." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012) Furthermore, according to ***Developing a Watershed Management Plan for Water Quality: An Introductory Guide***, "To identify critical areas, you should consider the pollutants in your watershed and how they might be reaching the water. Identify the pollutant sources, where they likely originate, and assess their movement from the source to the water. You should also consider areas that may be vulnerable to groundwater contaminants, such as areas with sandy soils (where pollutants can infiltrate the soils and reach groundwater) or abandoned wells." (Brown, Peterson, Kline-Robach, Smith, and Wolfson, 2000) Unfortunately, data on areas needing load reductions in the Arcadia-Pierport Watershed are not available, but based on these definitions, Critical Areas could be all areas with or releasing any pollution in the watershed. As this chapter addresses many sources and causes of pollution, yet, at the same time, contains gaps in terms of available data and information focused on pollutants in the watershed area, it is difficult to say what, exactly, are the critical areas in the watershed.

Map 41 may not be a complete inventory of all Critical Areas and sources and locations of pollution, but it does identify roads, a buffer area of ¼ mile extending from creeks, the EPA Registered Pollutant Sites in the watershed, Arcadia Bluffs Golf Club, High Risk Erosion Areas, and where Agricultural and Residential land uses are located within this area (these last can be significant sources of nonpoint source pollution that can then be transported via waterbodies). The sizes of these Critical Areas and the percentages of the watershed of some of these areas are shown in Table 35. (Beckett & Raeder, Inc., n.d.; State of Michigan, 2013)

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CHAPTER FIVE:

REVIEW OF NONPOINT SOURCE POLLUTION INVENTORIES

Data on nonpoint source pollutants in the Arcadia-Pierport Watershed and information on the inventories for this chapter are not extensive. This is another section of the Plan wherein there are gaps in terms of available data and information, but the watershed planning process is ongoing. Watershed Goals I, II, and III in Table 44 address pollution and inventorying, and Implementation Tasks IA, IB, and IIIC in Table 46 address inventories. The primary material used to write this chapter included existing county and township master plans, reports, and information provided by governmental agencies. However, these sources do not necessarily focus on the watershed area or provide a complete or comprehensive overview of the entire Arcadia-Pierport Watershed; for instance, there is more information available on Benzie County than on Manistee County, the watershed is only situated within a portion of the relevant counties and townships, and not all sources are particularly recent. Thus, the inventories are based only on the information that is available, which may not necessarily portray the situation in the Arcadia-Pierport Watershed area itself.

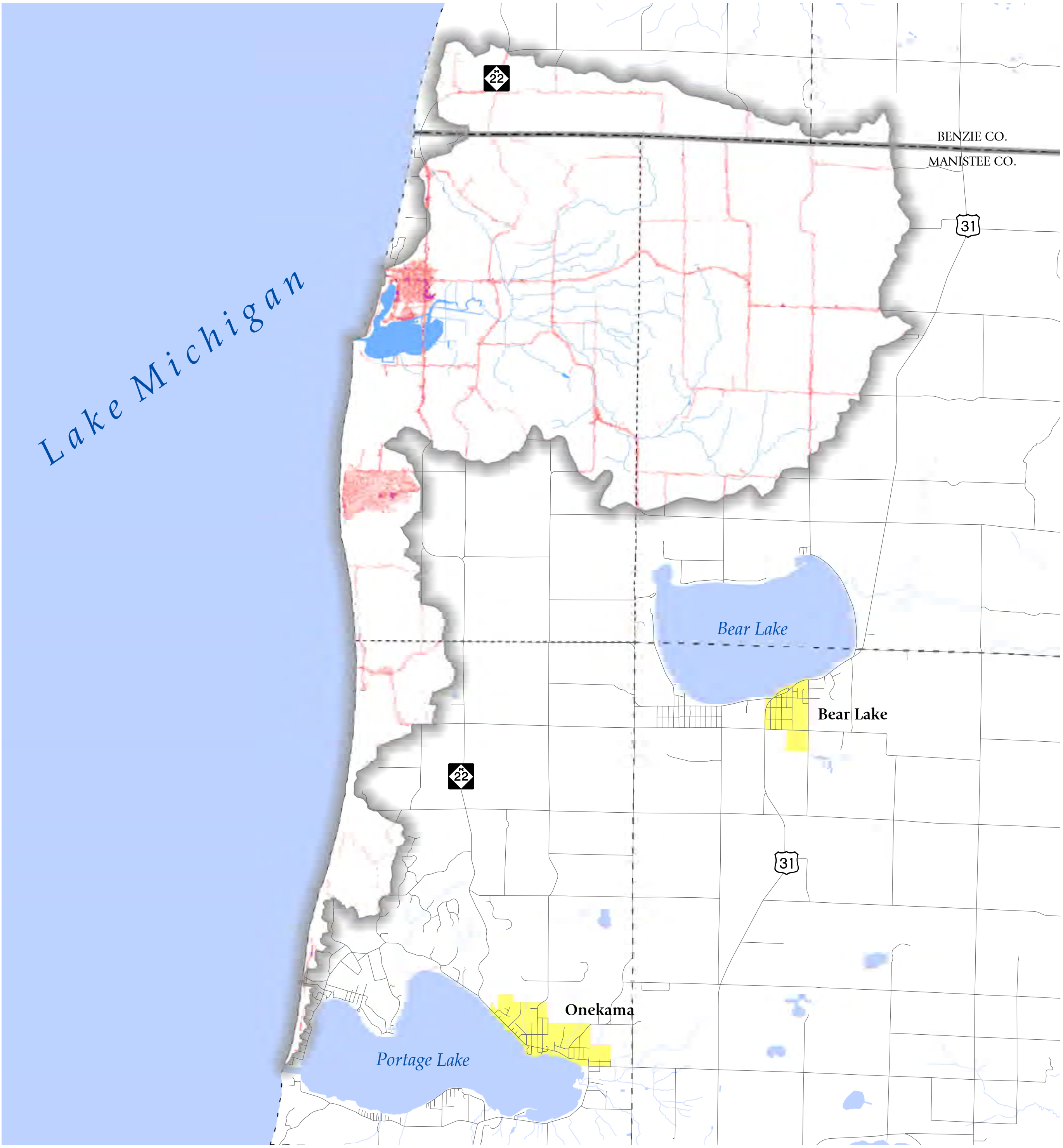
Nonpoint source pollution is a concern in Benzie County as a whole. Nonpoint source pollution can result from oil and gas drilling, soil erosion, leakage from septic systems and storage tanks, and stormwater runoff and runoff of chemicals, toxic materials, nutrients, and animal waste. Runoff can come from agricultural lands, lawns, golf courses, and impervious surfaces. Pollution can contaminate surface waterbodies and groundwater. (***Benzie County 2020 Comprehensive Plan***, 2000) It is critical to control these sources of pollution so that they do not negatively

Figure 38: View of Slopes from Inspiration Point

impact water quality. As stated in Chapter 3 of the ***Benzie County 2020 Comprehensive Plan***, "Water quality is affected by pollutants and the velocity of stormwater runoff. Pollutants occur in four forms: sediment, chemicals, pathogens and warmed water. Sediment comes from bare soil, other erosion sites and paved surfaces. It can be highly destructive of fish habitat. Sediment also carries chemical pollutants although these can be carried by stormwater runoff alone. Chemical pollutants include nutrients such as phosphorus and nitrogen; toxic materials, such as oils, pesticides and salts; and changed water chemistry, such as lowered or raised pH. Nutrients can increase nuisance aquatic plant growth. Toxic materials and changed water chemistry can kill animals in the water and be a human health hazard. Pathogens include bacteria and viruses that come from animal waste and untreated or improperly treated sewage from homes and businesses and can be a serious human health hazard. Warmed water, such as the stormwater runoff that travels over paved surfaces and lawns before entering lakes and streams can change the temperature of the stream, affecting the aquatic life of the stream. It can be damaging to fish populations. The application of fertilizers, pesticides and herbicides to watershed lands affects water quality when it runs off the land. These pollutants originate on croplands, livestock pens, orchards, golf courses, shore-side lawns and gardens, commercial enterprises, impervious surfaces such as roads and parking lots and residential properties…In addition to pollutants, storm water can cause damage to streams and lakes because it enters at a high velocity. This can cause scouring of streambeds and banks and result in damage to fisheries." (***Benzie County 2020 Comprehensive Plan***, 2000)

Septic systems can be sources of nonpoint source pollution, impacting water quality and groundwater. Among the jurisdictions in the Arcadia-Pierport Watershed, Arcadia, Blaine, Joyfield, and Pleasanton Townships do not have sewer systems, so residents have their own septic systems and wells. The Village of Onekama provides residents with sewer service; Onekama Township does not have a public sewer system but it does have a septic system ordinance. (***Blaine Township Master Plan***, 2014; ***Joyfield Township Master Plan***, 2014; ***Onekama Community Master Plan***, 2010; ***Pleasanton Township Master Plan***, 2015; ***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014)

Map 42: Percent Developed Imperviousness



ARCADIA-PIERPORT WATERSHED

Percent Developed Imperviousness

Data Sources: State of Michigan Geographic Data Library, NLCD 2011

0 0.375 0.75 1.5 Miles

Watershed Boundary
City or Village
County Boundary
Township Boundary
Roads

Percent Developed Imperviousness:

Low (1%) High (100%)

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Stormwater Inventory

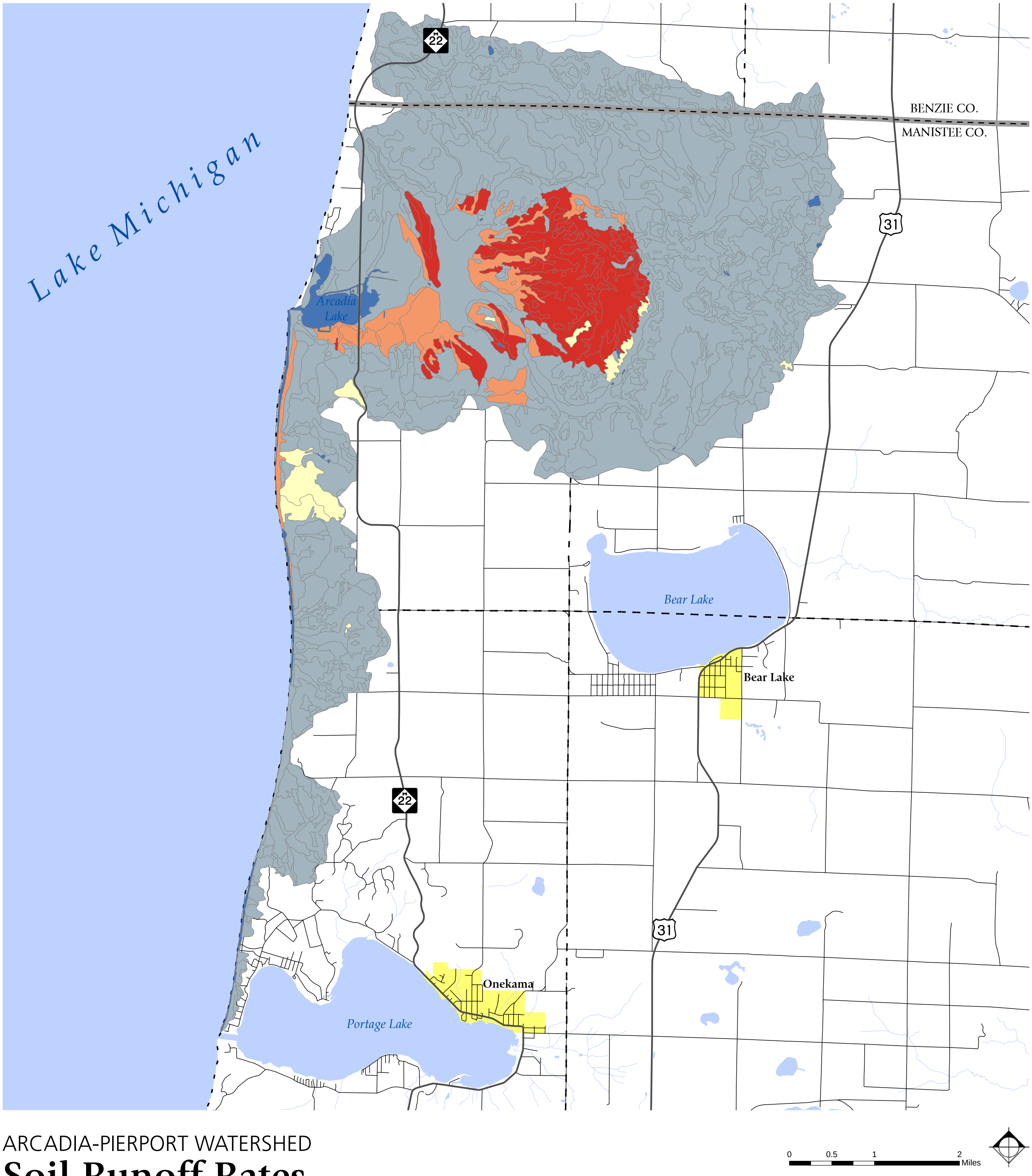
As there is no stormwater inventory specific to the Arcadia-Pierport Watershed, this is another section of the Plan wherein there are gaps in terms of available data and information, as well as about the relation between stormwater and pollution in the watershed. Watershed Goals I, II, and III in Table 44 address water quality and inventorying, and Implementation Tasks IA, IIIC, and VA in Table 46 address pollution and stormwater.

An EPA webpage describes how stormwater runoff can be a source of pollution because it can collect pollutants as it rushes over surfaces. According to the EPA, "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 debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated." (United States Environmental Protection Agency, 2015) The EPA states, however, "most stormwater discharges are considered point sources," not nonpoint sources of pollution. (United States Environmental Protection Agency, 2015)

Stormwater runoff can lead to streambank erosion. It can also impact habitats and water quality. (United States Environmental Protection Agency, 2012, November 5) Runoff from impervious surfaces in any developed areas in the Arcadia-Pierport Watershed could be a source of pollution upon entering waterbodies.

Map 42 identifies percent developed imperviousness in the Arcadia-Pierport Watershed on a scale from low to high. (Homer et al., 2015; State of Michigan, 2013) Map 43 represents the spectrum of runoff rate based upon soil structure and characteristics. For Map 43, the soils were ranked according to their ability to contribute to runoff. Soils with a high runoff rate do not absorb much water, and, instead, transfer materials along the surface. Soils with a slow runoff rate absorb and retain moisture and materials, preventing the movement of materials as runoff. Of concern is that, as shown in the map, the rate of soil runoff is very high in the central part of the Arcadia portion of the watershed, as this is an important agricultural area. (***Soil Survey of Benzie and Manistee Counties, Michigan***, 2008; State of Michigan, 2013)

Map 43: Soil Runoff



ARCADIA-PIERPORT WATERSHED

Soil Runoff Rates

Data Sources: State of Michigan Geographic Data Library, Soil Survey of Benzie and Manistee Counties, Michigan

- Watershed Boundary
- Parcel Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road

Soil Runoff Rates

- Negligible
- Very Low
- Moderate
- High
- Very High

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Figure 39: Arcadia Lake and Shoreline

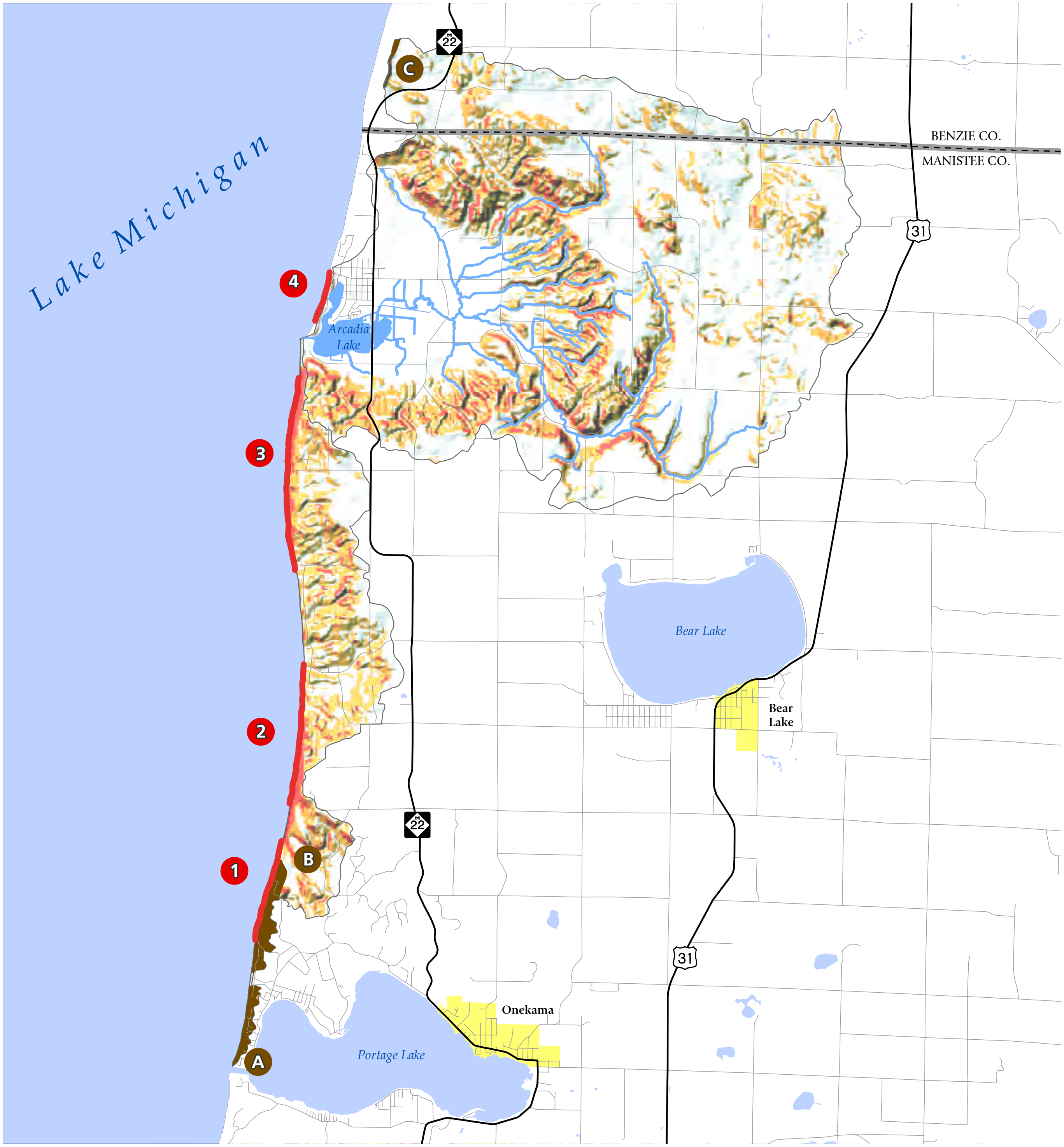
Arcadia Lake Shoreline Survey

As there is no Arcadia Lake shoreline survey, this is another section of the Plan wherein there are gaps in terms of available data and information, as well as about the relation between the Arcadia Lake shoreline survey and nonpoint source pollution in the watershed. Watershed Goals I and II in Table 44 address waterbodies and inventorying.

According to the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, the shoreline survey for that watershed was done "to identify locations of nutrient pollution…, bottom sediment type, and shoreline development characteristics…" (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Historically, the shoreline of Arcadia Lake was home to sawmills, and there is still some slabwood on the shoreline and the bottom of the lake. The shoreline today is mostly privately owned. The lake has one public access point, at the Arcadia Township-operated Veteran's Memorial Park, and a public boat launch, fishing pier, and marina. Development of the shoreline can impact aquatic species and habitat. (Tonello, 2012) Refer to CHAPTER TWO for some values of nutrients that were measured by MDEQ in Arcadia Lake in 2004. The nitrogen and phosphorus levels obtained are below the levels of nitrogen and phosphorus in effluent from septic tanks. (Part 4. Water Quality Standards, n.d.; State of Michigan, 2001-2015b; Tip of the Mitt Watershed Council, 2015)

Map 44: Lakeshore Erosion



ARCADIA-PIERPORT WATERSHED

Lakeshore Erosion

Data Sources: State of Michigan Geographic Data Library, Michigan DEQ

City or Village
Watershed Boundary
County Boundary
Streams
Major Road
Minor Road

High Risk Erosion Areas
1 2 3 4

Critical Dunes
A B C

Slope Degree:
High
Low

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Lakeshore Erosion Inventory

As there is no complete lakeshore erosion inventory specific to lakeshores in the Arcadia-Pierport Watershed, this is another section of the Plan wherein there are gaps in terms of available data and information, as well as about the relation between lakeshore erosion and nonpoint source pollution in the watershed. Watershed Goals I and II in Table 44 address waterbodies and inventorying.

The ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*** describes how there can be natural and anthropogenic causes of erosion. According to the plan, "Erosion and its resulting sediment pollution, also known as sedimentation, have many negative impacts. In an aquatic environment sediment pollution can degrade aquatic and nearshore habitats, thereby killing aquatic organisms and negatively impacting birds and animals which depend on aquatic habitats. Sedimentation also causes warming (which is most serious in coldwater trout streams), reduces water clarity and light penetration, and changes the bottom substrates." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

According to the EPA's ***National Management Measures to Control Nonpoint Source Pollution from Hydromodification*** report, "Shoreline erosion occurs in large open waterbodies, such as the Great Lakes or coastal bays and estuaries, when waves and currents sort coarser sands and gravels from eroded bank materials and move them in both directions along the shore away from the area undergoing erosion…human activities along or adjacent to streambanks or shorelines may increase erosion and other nonpoint sources of pollution." (***National Management Measures to Control Nonpoint Source Pollution from Hydromodification***, 2007)

Certain areas of Great Lakes shoreline have been designated High Risk Erosion Areas due to their susceptibility to erosion. Because of the impact of storms, wind, waves, and ice, among other weather occurrences, the shoreline can erode. This is especially problematic for those properties and structures built on or above the shoreline, which is why the High Risk Erosion Area program was begun. In High Risk Erosion Areas, the shoreline is retreating by at least

Figure 40: Steep Slopes

one foot per year. There are High Risk Erosion Areas in Benzie and Manistee Counties including in Blaine, Arcadia, and Onekama Townships. (State of Michigan, 2015c; State of Michigan, 2015e)

Critical Dune Areas are the most significant sand dunes on the shore of Lake Michigan, and they, too, are vulnerable. They have steep slopes and are susceptible to erosion. There are Critical Dunes in Blaine and Onekama Townships. Activities in Critical Dune Areas and High Risk Erosion Areas are regulated by the state, and permits must be obtained from MDEQ. (*Onekama Community Master Plan*, 2010; State of Michigan, 2015a; State of Michigan, 2015e) Barrier Dunes are addressed in 1994 PA 451, Part 637 Sand Dune Mining, wherein it states, "'Barrier dune' means the first landward sand dune formation along the shoreline of a Great Lake or a sand dune formation designated by the department." (1994 PA 451, 1994) It should be noted that, unlike the other Lakes to Land Regional Initiative communities, Arcadia Township is the only one in which Critical Dune Areas have not been assessed by MDEQ. (*Arcadia Township Master Plan*, 2014) Attention to Watershed Goal II, which addresses inventorying and data collection, in Table 44 could help to close this gap.

Erosion of slopes and land from such activities as construction and development can pollute lakes, streams, and other waterbodies and be visually unpleasant. As Benzie County has many steep slopes, erosion is a problem. Consequences of erosion: "property damage can result as roads or buildings are covered by windblown sand; fertile soil is lost in agricultural areas by either wind or water erosion; or roads are washed out of foundations undercut by water erosion." (*Benzie County Comprehensive Plan Sensitive Lands and Water Resources Report*, 1998)

Map 44 identifies where Critical Dunes, High Risk Erosion Areas, and slopes are located in the Arcadia-Pierport Watershed. Along the High Risk Erosion Areas are salmon-colored pieces that correspond to steep slopes. Table 36 indicates the sizes of these areas in the watershed, as well as why they are of particular importance. There are four High Risk Erosion Areas (identified in red on the map) and three Critical Dune Areas (identified in brown) in the watershed. The Critical Dunes are located mostly at the southern tip of the Arcadia-Pierport Watershed and are Barrier Dunes. (Grand Traverse Regional Land Conservancy, n.d.a; State of Michigan, 2013; State of Michigan, 2015e; State of Michigan, 2015, March 2)

Also of note is the lakeshore erosion that occurred with the development of the Arcadia Bluffs Golf Club on the bluffs of Lake Michigan in 1998. The water pollution caused by the erosion was so significant that the developer was sued by MDEQ and then-Attorney General Jennifer Granholm in 1999. (Schneider, 1999)

Table 36: Shoreline Features in Watershed
Sources: Grand Traverse Regional Land Conservancy, n.d.a; State of Michigan, 2013; State of Michigan, 2015e; State of Michigan, 2015, March 2

Shoreline Feature	*Identifying Number/Letter on Map 44*	*Size of Shoreline Feature in Watershed*	*Why Is This Feature Important?*
High Risk Erosion Area west of Arcadia and Arcadia Lake	4	0.59 miles	Area is near residential uses (Arcadia) and Arcadia Lake
High Risk Erosion Area south of Arcadia and north of Pierport	3	2.27 miles	Area is largest High Risk Erosion Area in size in watershed
High Risk Erosion Area near Pierport	2	1.64 miles	Area is near residential uses (Pierport)
High Risk Erosion Area north of Portage Lake	1	1.20 miles	Part of area coincides with Critical Dune Area
Critical Dune Area at northwestern tip of watershed	C	7.28 acres	Area is surrounded almost entirely by Grand Traverse Regional Land Conservancy's Arcadia Dunes Preserve and has little exposure to threat
Critical Dune Area northwest of Portage Lake	B	122.12 acres	Area is near residential and other uses
Critical Dune Area west of Portage Lake	A	59.81 acres	Area is surrounded by low-density residential uses

Figure 41: Stream Bank in Arcadia Marsh

Stream Bank Erosion Inventory

As there is no complete stream bank erosion inventory specific to the Arcadia-Pierport Watershed, this is another section of the Plan wherein there are gaps in terms of available data and information, as well as about the relation between stream bank erosion and nonpoint source pollution in the watershed. There is information on stream bank stability of several creeks in the watershed, however. Watershed Goals I and II in Table 44 address waterbodies and inventorying, and Implementation Task IIIA in Table 46 addresses stream banks.

According to the EPA's ***National Management Measures to Control Nonpoint Source Pollution from Hydromodification*** report, "Streambank and shoreline erosion are the wearing away of material in the area landward of the bank along non-tidal streams and rivers. Streambank erosion occurs when the force of flowing water in a river or stream exceeds the ability of soil and vegetation to hold the banks in place. Eroded material is carried downstream and redeposited in the channel bottom or in point bars located along bends in the waterway…human activities along or adjacent to streambanks or shorelines may increase erosion and other nonpoint sources of pollution." (***National Management Measures to Control Nonpoint Source Pollution from Hydromodification***, 2007)

Erosion from such activities as construction and development can pollute streams, lakes, and other waterbodies and be visually unpleasant. Consequences of erosion: "property damage can result as roads or buildings are covered by windblown sand; fertile soil is lost in agricultural areas by either wind or water erosion; or roads are washed out of foundations undercut by water erosion." (***Benzie County Comprehensive Plan Sensitive Lands and Water Resources Report***, 1998)

In Mark Tonello's 2008 report on Bowens Creek and its tributaries, he found that erosion had occurred at multiple sites from culverts that had been located improperly. (Tonello, 2008) However, seven culverts were replaced and

Table 37: Stability Data for Toohey, Alkire, Bowens, Hull, and Ware Creeks
Sources: Little River Band of Ottawa Indians, 2015; Mays, personal communication, 2015, July 8

Creek	Average Bank Stability	Average Bank Vegetation Stability
Toohey Creek	8.9	8.8
Alkire Creek	8.4	8.7
Bowens Creek	6.8	8.1
Hull Creek	6.0	6.8
Ware Creek	5.3	6.2

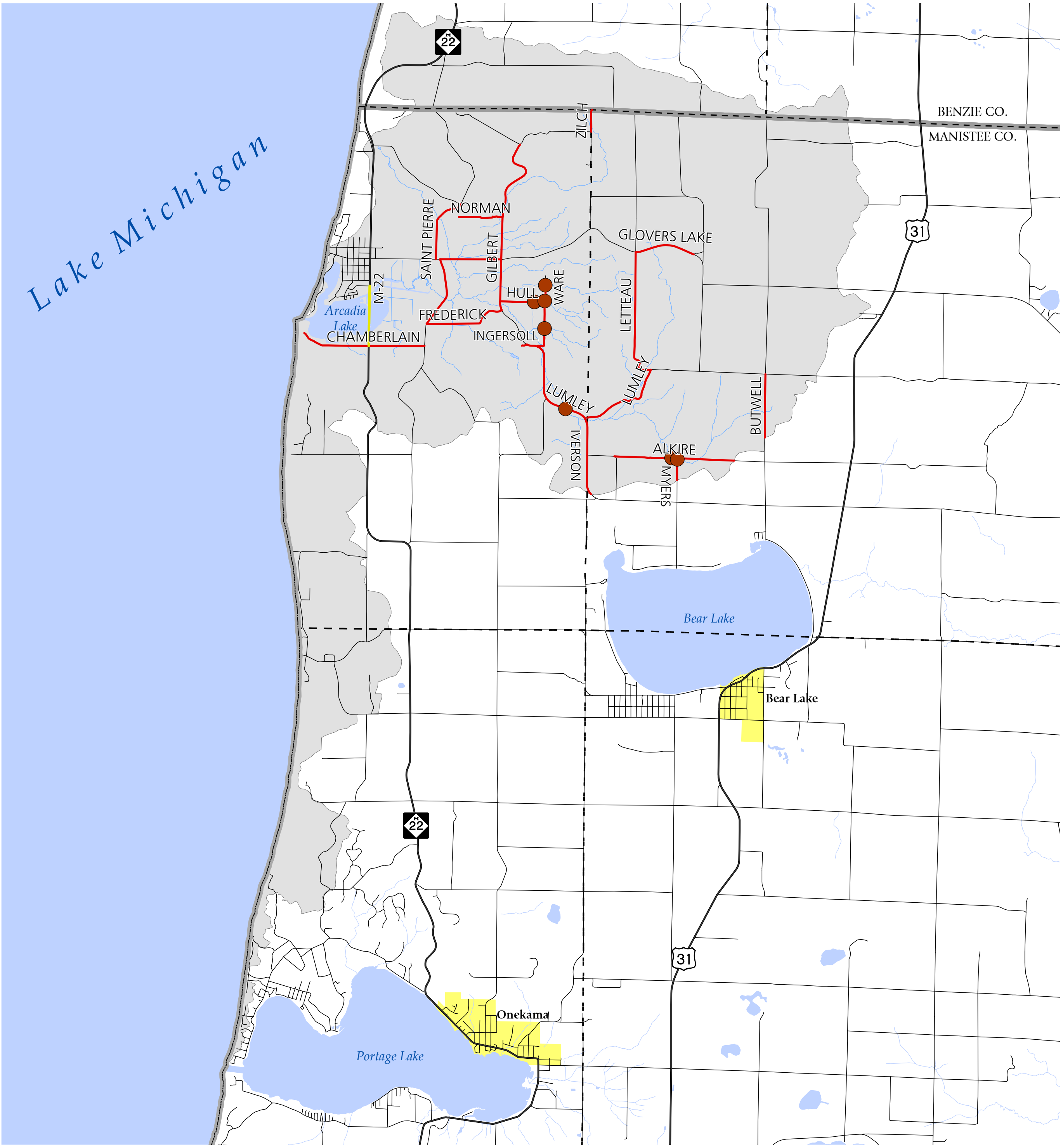
the channelized portion of Bowens Creek was redirected with 2009 grant money, and a noticeable impact in terms of species and species diversity was observed, but the effect on erosion in Bowens Creek and tributaries is not clear. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

According to information provided by Daniel Mays, Fisheries Biologist at the Natural Resources Department of the Little River Band of Ottawa Indians, the creeks vary in the stability of their stream banks, which was assessed at the various sampling stations on the creeks. Average bank stability at the sampling locations on five creeks ranged from 5.3-8.9 on a scale of 0 (least stable) to 15 (most stable), while bank vegetation stability ranged from 6.2-8.7 on a scale of 0 (least stable) to 10 (most stable), scored according to GLEAS Procedure #51, as outlined in *Chapter 25A* of *Manual of Fisheries Survey Methods II: with periodic updates*. Table 37 shows the average stability figures for the creeks. In this case, the relationship between bank stability and bank vegetation stability is parallel; higher bank stability numbers correspond to high bank vegetation stability numbers, and vice versa. (Little River Band of Ottawa Indians, 2015; Mays, personal communication, 2015, July 8; Schneider, 2000)

Chapter 25A of the *Manual of Fisheries Survey Methods II: with periodic updates* provides context for GLEAS Procedure #51 and the stability figures. According to Table 1 in the chapter, bank stability of 4-7 means, “Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks. High erosion potential in extreme floods,” while bank stability of 8-11 means, “Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40%. Slight erosion potential in extreme floods.” (Schneider, 2000) Bank vegetation stability of 6-8 means, “50-79% of the stream bank surfaces covered by vegetation, gravel or larger material.” (Schneider, 2000)

Based on these standards, in Bowens Creek, “Streambanks were moderately stable in the lower three stations both before and after a large restoration project re-routed the channelized section back into the historical stream channel in 2013. In the two upper most stations, bank stability scores were lower post-restoration…primarily due to water being over their banks in numerous locations. Current work is being conducted by Grand Traverse Bay of Ottawa and Chippewa Indians to address this issue,” according to information provided by Daniel Mays. (Little River Band of Ottawa Indians, 2015) In Alkire Creek, “Streambanks were very stable with little to no evidence of bank erosion. Side slopes were very steep near the two culverts within the sampling area, but most streambank side slopes appeared to be less than 30%.” (Little River Band of Ottawa Indians, 2015) Toohey Creek’s “Streambanks were very stable with little to no evidence of bank erosion. Side slopes were very steep near the two culverts within the sampling area, but most streambank side slopes were observed to be less than 30%.” (Little River Band of Ottawa Indians, 2015) Hull Creek’s “Streambanks were moderately stable, although several areas of un-vegetated banks and erosion were observed.” (Little River Band of Ottawa Indians, 2015) Finally, in Ware Creek, “Streambanks were moderately unstable to moderately stable. Areas of un-vegetated banks and erosion were observed.” (Little River Band of Ottawa Indians, 2015) (Mays, personal communication, 2015, July 8)

Map 45: Road/Stream Crossings



ARCADIA-PIERPORT WATERSHED

Road/Stream Crossings

Data Sources: State of Michigan Geographic Data Library, Little River Band of Ottawa Indians

- Watershed Boundary
- City or Village
- County Boundary
- Township Boundary
- Major Road
- Minor Road
- Stream-Crossing Roads
- Streams/Creeks/Rivers
- M-22 Crossing
- Replaced Culverts

Beckett&Raeder

Road/Stream Crossings Inventory

This is another section of the Plan wherein there are gaps in terms of specifics about road/stream crossings in the Arcadia-Pierport Watershed, as well as about the current relation between road/stream crossings and nonpoint source pollution in the watershed. Watershed Goals I and II in Table 44 address waterbodies and inventorying, and Implementation Task IB in Table 46 addresses road/stream crossings.

According to the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, the road/stream crossings inventory for that watershed was done "to comprehensively identify and document all of the road/stream crossing sites on the tributaries in the Lake Charlevoix Watershed." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Road/stream crossings can have many negative impacts to the environment, including allowing pollutants to enter waterbodies. A report, ***Potential Impact of Road-Stream Crossings (Culverts) on the Upstream Passage of Aquatic Macroinvertebrates***, describes the impacts not only on macroinvertebrates but on the environment as well. According to the report, "poorly designed road-stream crossings (i.e., culverts), have been recognized as posing a threat to fish migration in lower order streams. Besides blocking the upstream passage of fish, some culverts could disrupt the normal, within-stream movements of some macroinvertebrates…Disruptions to the movement and dispersal of stream macroinvertebrates could reduce available habitat and lead to genetic isolation of some populations…The separation of populations and subsequent reduction in genetic diversity may be especially important for relatively long-lived and highly threatened taxa such as the freshwater mussels. If designed without regard for all

Table 38: Road Crossings in Watershed
Sources: Mays, personal communication, 2015, August 17; State of Michigan, 2013

Name of Road with Crossings	*Number of Crossings in Watershed*	*Number of Culverts that Were Replaced*	*Creek Intersection(s) of Culverts that Were Replaced*
Alkire Road	4	1	Bowens Creek
Butwell Road	2	0	--
Chamberlain Road	4	0	--
Frederick Road	2	0	--
Gilbert Road	10	0	--
Glovers Lake Road	5	0	--
Hull Road	2	1	Hull Creek
Ingersoll Road	2	0	--
Iverson Road	2	0	--
Letteau Road	2	0	--
Lumley Road	8	1	Bowens Creek
Myers Road	2	1	Bowens Creek
Norman Road	2	0	--
Saint Pierre Road	4	0	--
Ware Road	4	3	Richley, Hull, Ware Creeks
Zilch Road	2	0	--
M-22	1	0	--
Total	58	7	--

stream organisms, culverts may pose barriers to the upstream movement and dispersal of invertebrates by disrupting the stream flow or structure in one or more of the following ways.

A. A culvert may break the continuity of water in a stream if its outflow is lifted above the water level downstream of the culvert.

B. The water velocity in a culvert may be higher than in the natural stream because the culvert is straight and constricts the stream into a narrower channel. Also, if the culvert contains little or no substrate (e.g. gravel, rocks, or cobbles), then the smoother bottom and sides will offer less resistance to the flowing water.

C. A culvert may break the continuity of the stream's substrate. It may have less, if any, substrate along its stream bottom and, presumably, the ground underneath the culvert would be compacted as a result of construction.

Culverts cause other problems in addition to obstructing upstream movement. These problems likely will affect many more streams and their macroinvertebrate communities and will have a much greater cumulative effect than barrier-culverts alone…

A. Culverts channelize the stream and do not allow it to migrate laterally across its floodplain. This channelization may cause increased erosion and sedimentation.

B. Culverts serve as an entry point of pollutants (e.g., salt, silt, or soot) that accumulate from water that runs off of roads into roadside ditches.

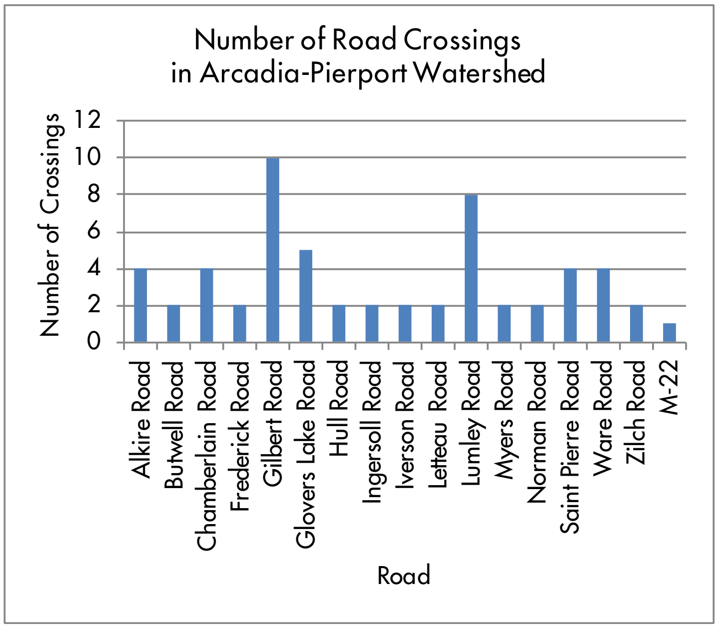
C. Culverts may change the temperature of the stream water. If the area around the culvert and road receives more energy from the sun because the tree canopy was removed, water temperatures may be elevated. However, if the stream is slow relative to the length of the culvert (i.e., if the stream in the culvert is very shallow, slow-moving, and has to travel over a long distance), then the water may be cooled."
(Vaughan, 2002)

In the Arcadia-Pierport Watershed, roads cross over creeks 57 times and the area between Arcadia Lake and Arcadia Marsh one time. (Grand Traverse Regional Land Conservancy, n.d.d.; State of Michigan, 2013)

Seven culverts in Bowens Creek and tributaries that were improperly located or sized were replaced with funding from a 2009 grant because of their impact on fish migration and movement, stream banks, and water quality. Following restoration of the culverts, connection of waterbodies was recovered, diversity of macroinvertebrates and fish increased at some sampling stations, and there was a change in species, especially in regards to prevalence of trout and salmon. (*Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage*, 2013)

In addition to the 57 road/stream crossings, another important crossing is that of M-22 over the area between

Graph 32: Road Crossings in Watershed
Source: State of Michigan, 2013



Graph 33: Replaced Culverts in Watershed
Sources: Mays, personal communication, 2015, August 17; State of Michigan, 2013

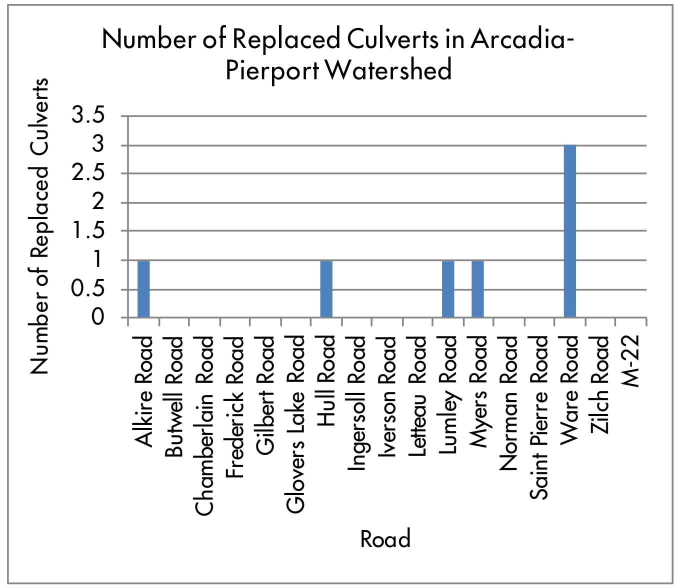


Figure 42: Old Culvert

Arcadia Lake and Arcadia Marsh. (Grand Traverse Regional Land Conservancy, n.d.d.; State of Michigan, 2013) According to the GTRLC, "the hydrology and ecological connection between the marsh and Arcadia Lake were permanently impacted when M-22 was constructed in its current location by means of a quarter mile filled causeway perforated only by a narrow bridge." (Grand Traverse Regional Land Conservancy, n.d.d.)

Map 45 indicates the locations of stream-crossing roads and of the M-22 crossing in the watershed, all of which are in the Arcadia portion of the watershed, as well as the locations of the seven culverts that were replaced. Table 38 and Graphs 32 and 33 show the number of crossings on various roads and the number and location of replaced culverts, and the table presents additional information about the crossings and replaced culverts.

As shown in the table and on the graphs, Gilbert and Lumley Roads have more crossings than the other roads with crossings in the watershed, and of the roads with replaced crossings, Ware Road has the most culverts that were replaced. (Grand Traverse Regional Land Conservancy, n.d.d.; Mays, personal communication, 2015, August 17; State of Michigan, 2013)

Figure 43: Orchard

Agricultural Inventory

As there is no agricultural inventory specific to the Arcadia-Pierport Watershed, this is another section of the Plan wherein there are gaps about the relation between agriculture and nonpoint source pollution in the watershed. There is a great deal of information about agriculture available at the county and township levels. Watershed Goals I, II, and III in Table 44 address water quality and inventorying.

An EPA webpage describes how agriculture can cause nonpoint source pollution. According to the EPA, "Agricultural activities that cause NPS pollution include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive or poorly timed application of pesticides, irrigation water and fertilizer." (United States Environmental Protection Agency, 2014, July 9)

According to the ***Farm and Food System Assessment***, "The top crops in Benzie and Manistee counties are corn for grain, corn for silage, and Christmas trees. A significant amount of food for human consumption is produced as well. The primary food crops are tart cherries and apples. Cattle, hogs, and sheep lead the livestock category." (***Farm and Food System Assessment***, 2014) There are over 30 different crops in Benzie and Manistee counties, and farms in the counties vary in terms of their size, their crops, and the value of their crops. (***Farm and Food System Assessment***, 2014)

Agriculture in Benzie County mostly takes place in the western portion of the county. According to Chapter 1 of the ***Benzie County Open Space & Natural Resources Protection Plan***, "There are…3,700 acres of State-owned agriculture in large parcels…" in the county, and there are "over 10,000 acres of large parcels in improved agriculture and nearly 7,000 acres of large parcels in vacant agriculture," making agricultural lands third to federal and residential lands in terms of the use of large-size parcels (minimum 30 acres) in the county. (***Benzie County Open Space & Natural Resources Protection Plan***, 2002) Additionally, "Noncontiguous acres of agriculture (about 2,600 acres) and forestry (over 600 acres) are not as extensive as contiguous agriculture (almost 15,000 acres) and forestry (nearly 6,300 acres)." (***Benzie County Open Space & Natural Resources Protection Plan***, 2002) As this plan is from 2002, the numbers may have changed.

Agriculture is important to Benzie County as a whole, but agriculture and agricultural land in the county are at risk. According to Chapter 1 of the ***Benzie County 2020 Comprehensive Plan***, "The two major economic sectors in Benzie County are recreation/tourism and agriculture." (***Benzie County 2020 Comprehensive Plan***, 2000) In regards to agriculture, "The major land uses in the County are forest and agriculture…There are orchard areas in the western part of the County, many just east of the dunes." (***Benzie County 2020 Comprehensive Plan***, 2000) Furthermore, "Most agricultural activities are associated with fruit production. The combination of soils, climate and near-shore hillsides make much land uniquely suited for cherries and applies (in particular)." (***Benzie County 2020 Comprehensive Plan***, 2000) However, according to Chapter 3 of the plan, "It is difficult to sustain agriculture in the County due to outside economic factors, local taxation policies and pressure from non-farm residents." (***Benzie County 2020 Comprehensive Plan***, 2000) Many farmers in Benzie County have to have supplemental jobs or sell farmland for financial purposes, and "most Benzie County farmers expect to fund their future retirement on the sale of their land for development, not farming." (***Benzie County 2020 Comprehensive Plan***, 2000)

Though it is from 1999, and the situation may have changed since, the ***Benzie County Comprehensive Plan Agriculture Report: Draft*** provides an insightful overview of agriculture in the county and a detailed inventory. (***Benzie County Comprehensive Plan Agriculture Report: Draft***, 1999) Highlights of the assessment can be found in the Appendix of this Plan.

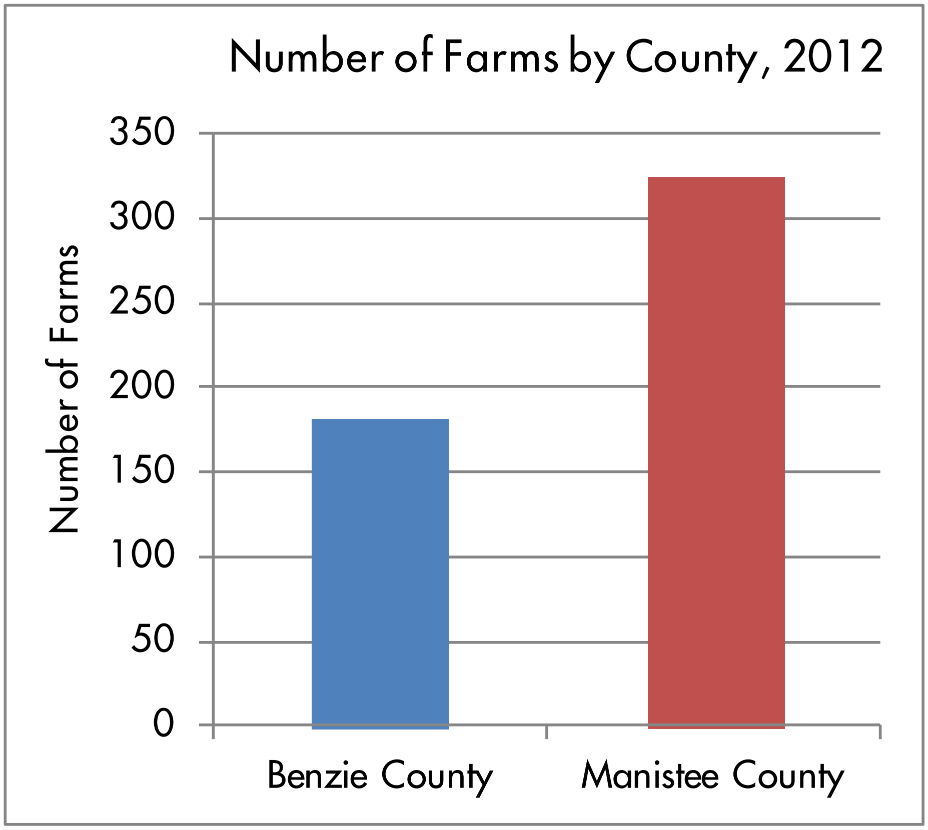
In Manistee County, according to the ***Onekama Community Master Plan***, "Based on the 2002 Census of agriculture, there are 315 farm operations in Manistee County, accounting for 46,442 acres, or 6% of the county land area. Of the 315 farms, 52% are operated as a primary occupation." (***Onekama Community Master Plan***, 2010) Furthermore, "The 315 farms in Manistee County comprise 46,000 acres of land. The average-size farm is approximately 147 acres and the mean acreage per farm is 110 acres. Of the seven counties in Northwest Michigan, Manistee County has the largest mean acreage per farm but ranks seventh in the same region in the value per acre. Orchards comprise 38 of the 315 agricultural operations in Manistee County, which ranks fifth in the region out of northwest Michigan's seven counties." (***Onekama Community Master Plan***, 2010) Like in Benzie County, agricultural land is being developed in Manistee County. According to predictions expressed in Chapter 3 of the ***Manistee County Master Plan 2008***, "In the future, agriculture will play a diminishing role in the economy of the county as well as that of the region and state. However, specialized agriculture and forestry industries such as high value crops, as well as on-site processing and direct sales will keep these industries an important part of the county." (***Manistee County Master Plan 2008***, 2009)

The United States Department of Agriculture's (USDA's) ***2012 Census of Agriculture*** is the most recently conducted ***Census of Agriculture***, which has been taken since 1840. According to the report, "The census of agriculture provides a detailed picture of U.S. farms and ranches every five years. It is the only source of uniform, comprehensive agricultural data for every State and county or county equivalent." (***2012 Census of Agriculture***, 2014) The ***2012 Census of Agriculture*** website provides links to various parts of the report, covering the entire United States, the states, and the counties; county-level data are the most detailed data that are presented in the ***2012 Census of Agriculture***. Table 39 presents a selection of the agricultural data from the ***2012 Census of Agriculture*** for the entirety of Benzie County and the entirety of Manistee County for 2012, which can be found in the Michigan portion of the report. Graphs 34-38 illustrate various statistics, allowing for a visual comparison of the agriculture of Benzie County versus the agriculture of Manistee County. More data from the 2012 Census of Agriculture can be found in the Appendix of this Plan. (***2012 Census of Agriculture***, 2014)

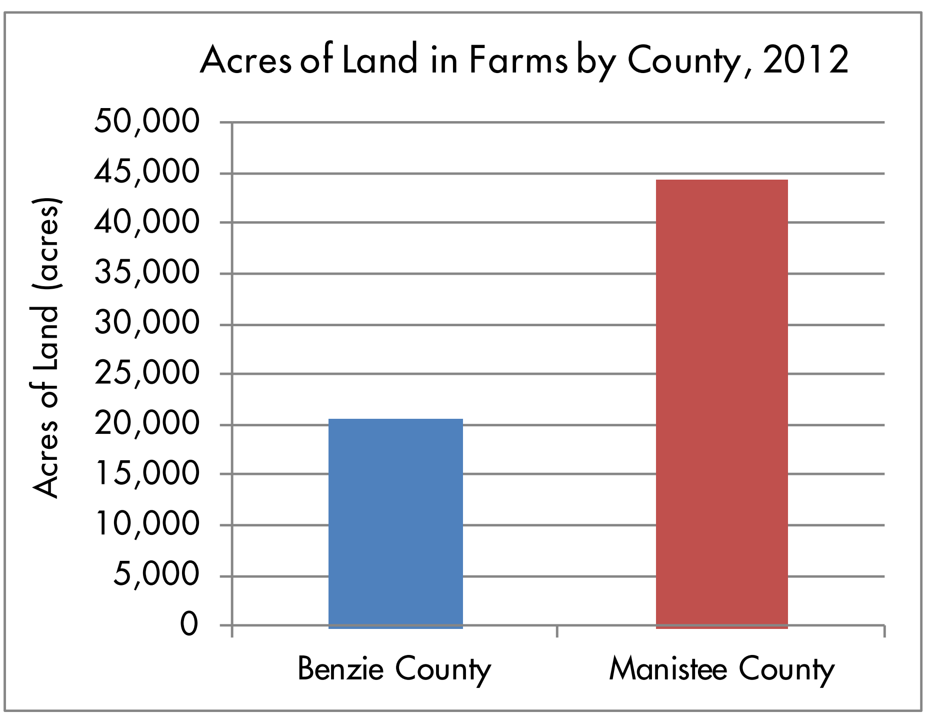
Table 39: Select Agricultural Data for Benzie and Manistee Counties, 2012
Source: 2012 Census of Agriculture, 2014

Select Parameter	*Benzie County, 2012*	*Manistee County, 2012*
Number of Farms	181	324
Acres of Land in Farms (acres)	20,646 acres	44,298 acres
Average Farm Size (acres)	114 acres	137 acres
Average Estimated Market Value of Land and Buildings per Farm ($)	$475,487	$393,091
Average Estimated Market Value of Machines and Equipment per Farm ($)	$65,179	$41,110
Number of Farms of 1-9 Acres	18	15
Number of Farms of 10-49 Acres	57	99
Number of Farms of 50-179 Acres	79	151
Number of Farms of 180-499 Acres	20	51
Number of Farms of 500-999 Acres	6	4
Number of Farms of 1,000+ Acres	1	4
Number of Farms with Cropland	143	282
Acres of Cropland (acres)	9,818 acres	20,081 acres
Number of Farms with Harvested Cropland	126	234
Acres of Harvested Cropland (acres)	7,560 acres	13,642 acres
Number of Farms with Irrigated Land	39	42
Acres of Irrigated Land (acres)	288 acres	1,295 acres
Average Market Value of Agricultural Products Sold per Farm ($)	$35,339	$23,544
Number of Cattle and Calves	1,062	1,741
Number of Beef Cows	229	--
Number of Hogs and Pigs	--	270
Number of Sheep and Lambs	--	282
Number of Layers	1,285	1,263
Number of Broilers and Other Meat Chickens	79	235
Acres of Harvested Corn for Grain (acres)	1,720 acres	3,937 acres
Acres of Harvested Corn for Silage or Greenchop (acres)	432 acres	400 acres
Acres of Harvested Wheat for Grain (acres)	8 acres	46 acres
Acres of Harvested Oats for Grain (acres)	--	56 acres
Acres of Harvested Soybeans for Beans (acres)	--	173 acres
Acres of Harvested Forage for Hay, Haylage, Silage, and Greenchop (acres)	1,893 acres	4,999 acres
Acres of Harvested Land for Vegetables for Sale (acres)	104 acres	332 acres
Acres of Land in Orchards (acres)	3,042 acres	1,442 acres

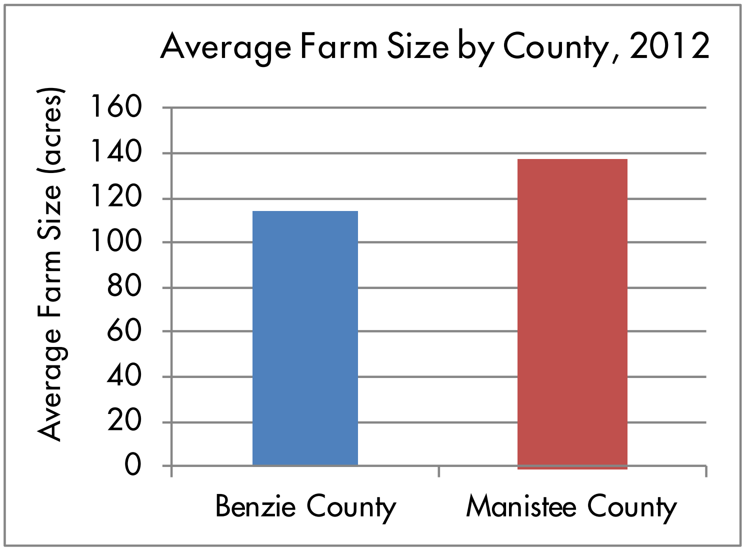
Graph 34: Number of Farms in Benzie and Manistee Counties, 2012
Source: 2012 Census of Agriculture, 2014



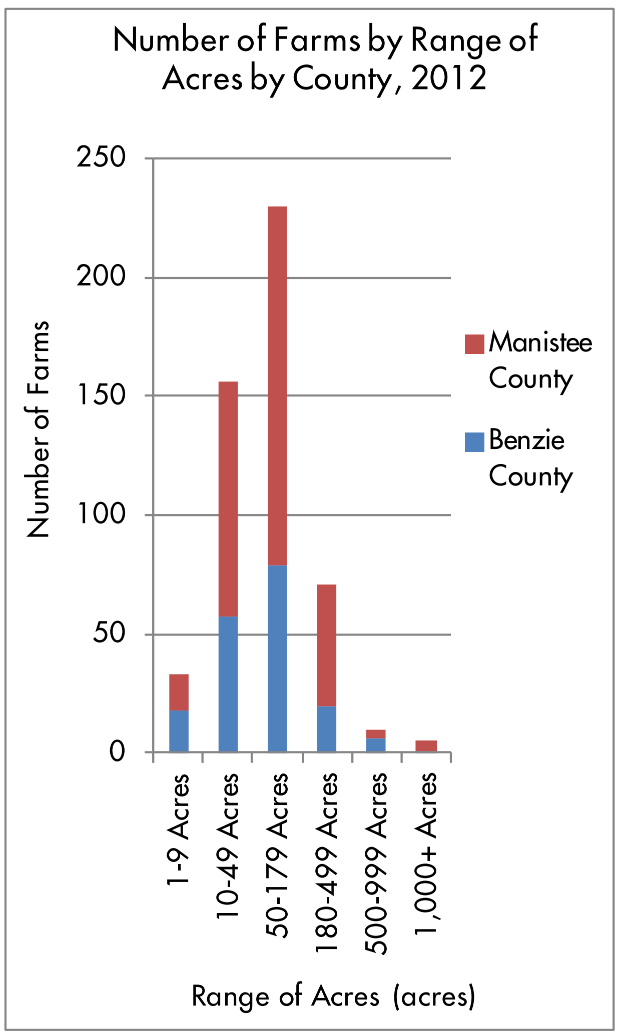
Graph 35: Acres of Land in Farms in Benzie and Manistee Counties, 2012
Source: 2012 Census of Agriculture, 2014



Graph 36: Average Farm Size in Benzie and Manistee Counties, 2012
Source: 2012 Census of Agriculture, 2014



Graph 37: Number of Farms in Benzie and Manistee Counties by Range of Acres, 2012
Source: 2012 Census of Agriculture, 2014



Graph 38: Acres of Cropland in Benzie and Manistee Counties by Cropland Category, 2012
Source: 2012 Census of Agriculture, 2014

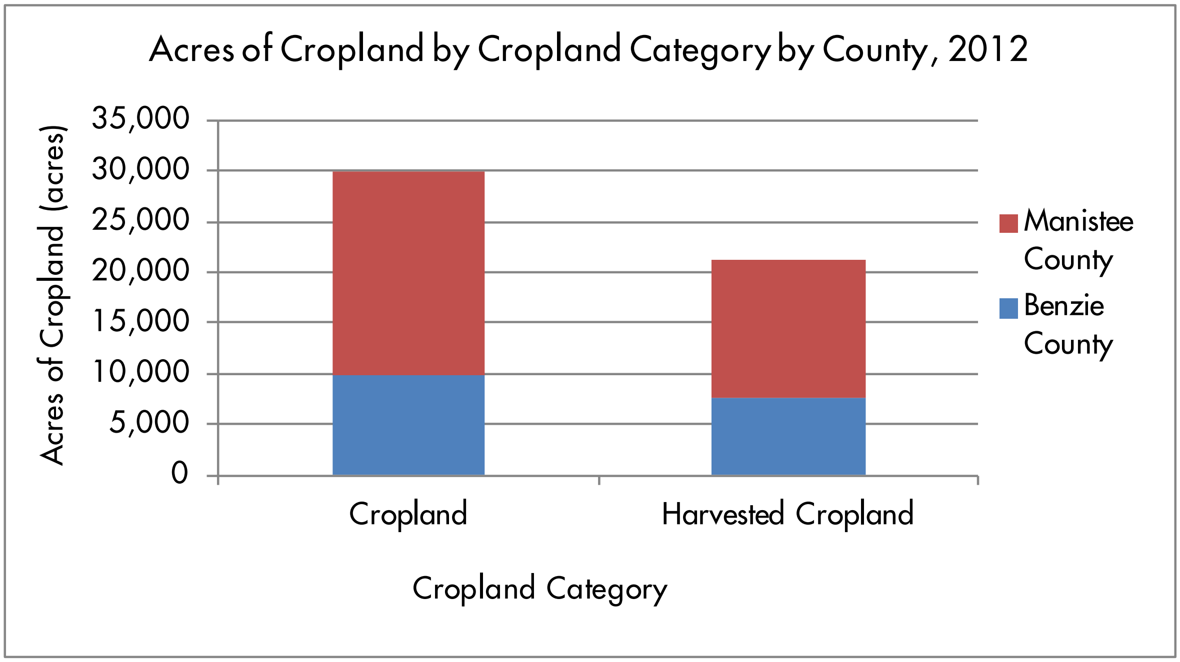


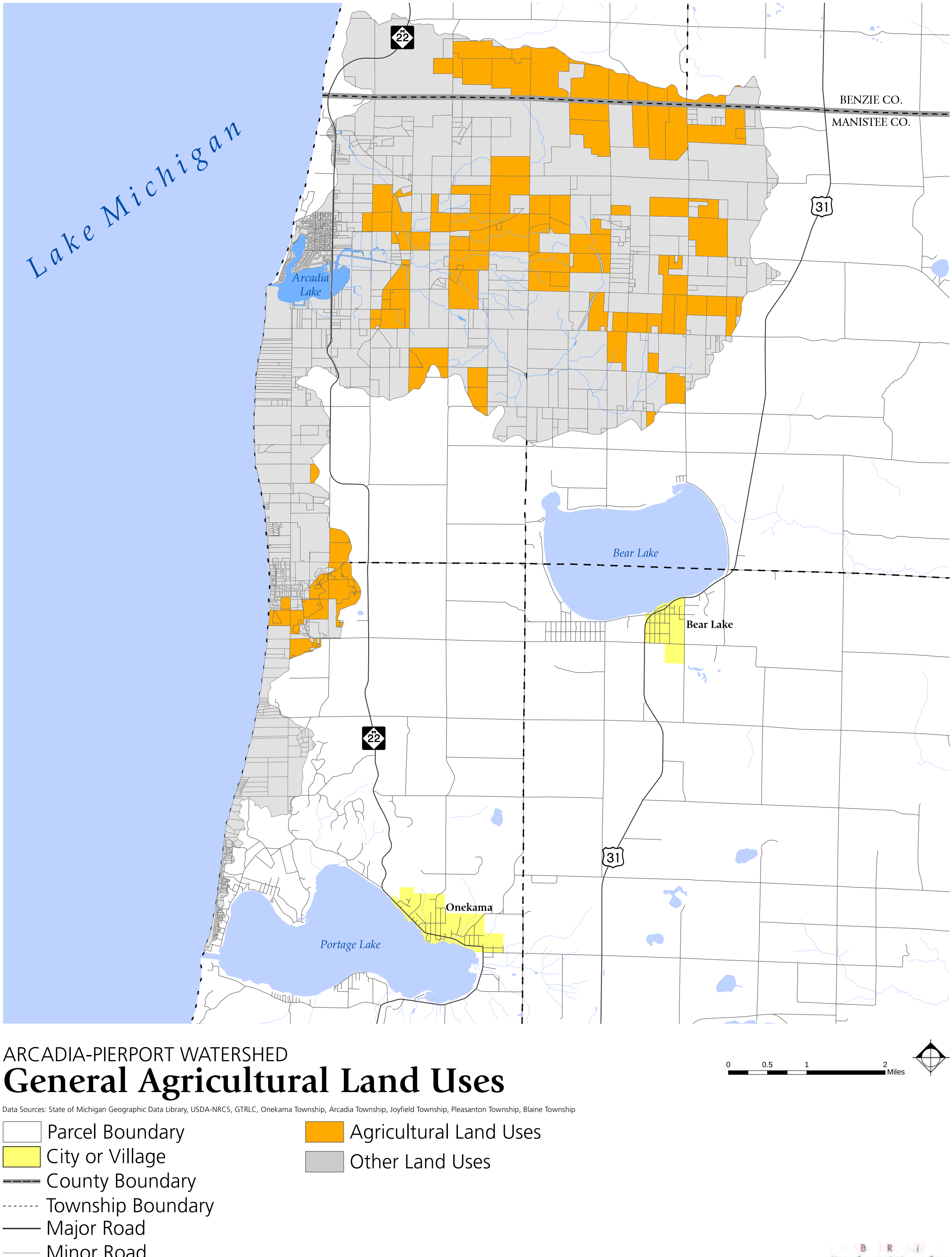
Figure 44: Fruit Trees

Figure 45: Fruit Trees

Based on this information, some general conclusions can be drawn about agriculture in Benzie and Manistee Counties. Manistee County has more farms, more farmland, more cropland, more irrigated land, and larger average farm sizes than Benzie County does. Benzie County has more land in orchards than does Manistee County. The average estimated market values per farm of land, buildings, machines, and equipment and the average market value of agricultural products sold per farm are higher in Benzie County than in Manistee County. A diverse range of livestock, poultry, and crops are raised on farms in both counties. (*2012 Census of Agriculture*, 2014)

Agricultural land uses in the Arcadia-Pierport Watershed itself are depicted on Maps 46 and 47, which allow for a comparison between agricultural land and other land uses and provide some level of detail in terms of type of agriculture. Total agricultural acreage in the watershed is 6,105.62 acres of the watershed's 18,973.004 acres, or 32.18%. These figures are different from those in Table 4 in CHAPTER ONE, as they include more updated agricultural data and are based on land cover rather than land use. In regards to Map 47, farming operations were inventoried in the summer of 2014 and are represented on the map by points. Information from GTRLC and the USDA, Natural Resources Conservation Service (NRCS), Bear Lake Field Office was used to complete the maps due to the limitations of the dataset, but the maps and associated table and graphs are still approximations based on the limited data available. Six farming operations are in the Arcadia-Pierport Watershed itself and are shown on Map 47. Table 40 provides more detail on the number of parcels in, the acreage in, and the percentage of the total agricultural acreage of different types of agricultural land uses. Based on Table 40, it is evident that the type of agricultural land use with the largest number of agricultural parcels in the watershed is Unspecified Agriculture (general agriculture), followed by Orchard; however, the type with the largest acreage, the highest percentage of total agricultural acreage, and the highest percent of the watershed is Orchard, followed by Unspecified Agriculture. Graph 39 shows the acreage in the watershed of each type of agricultural land use, Graph 40 shows the percentage of the total agricultural acreage of each type of agricultural land use, and Graph 41 shows the percentage of the watershed of each type of agricultural land use. (Beckett & Raeder, Inc., n.d.; Benzie County, Michigan County Government, 2015; *Farm and Food System Assessment*, 2014; Grand Traverse Regional Land Conservancy, personal communication, 2015, July 8; *M-22 Economic Development Strategy*, 2010; M-22 Study Committee; Manistee County, Michigan, 2009; State of Michigan, 2013; United States Department of Agriculture, Natural Resources Conservation Service, Bear Lake Field Office, personal communication, 2015, July 8)

Map 46: Agricultural Land Uses



Map 47: Agricultural Land Uses by Type

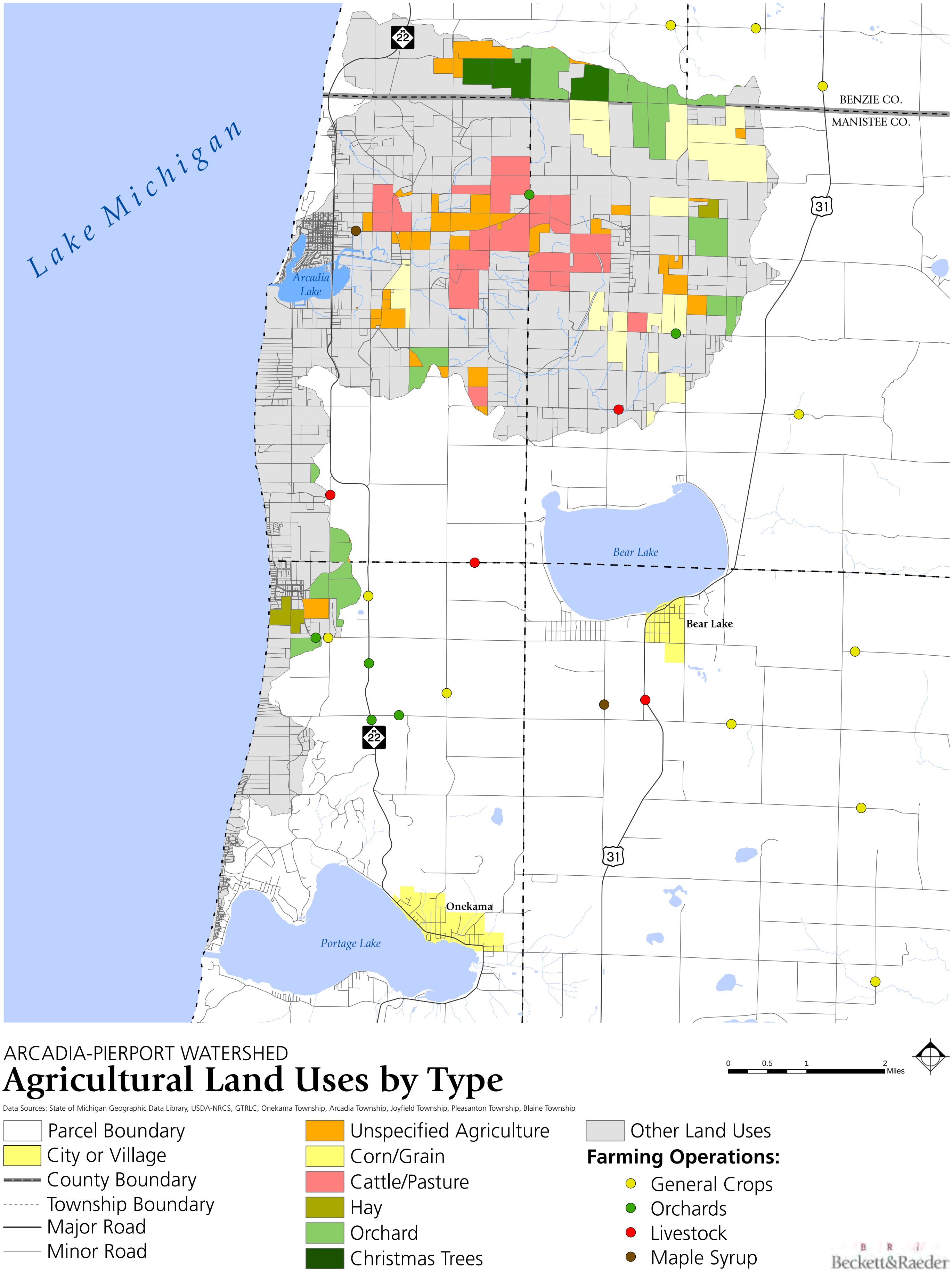
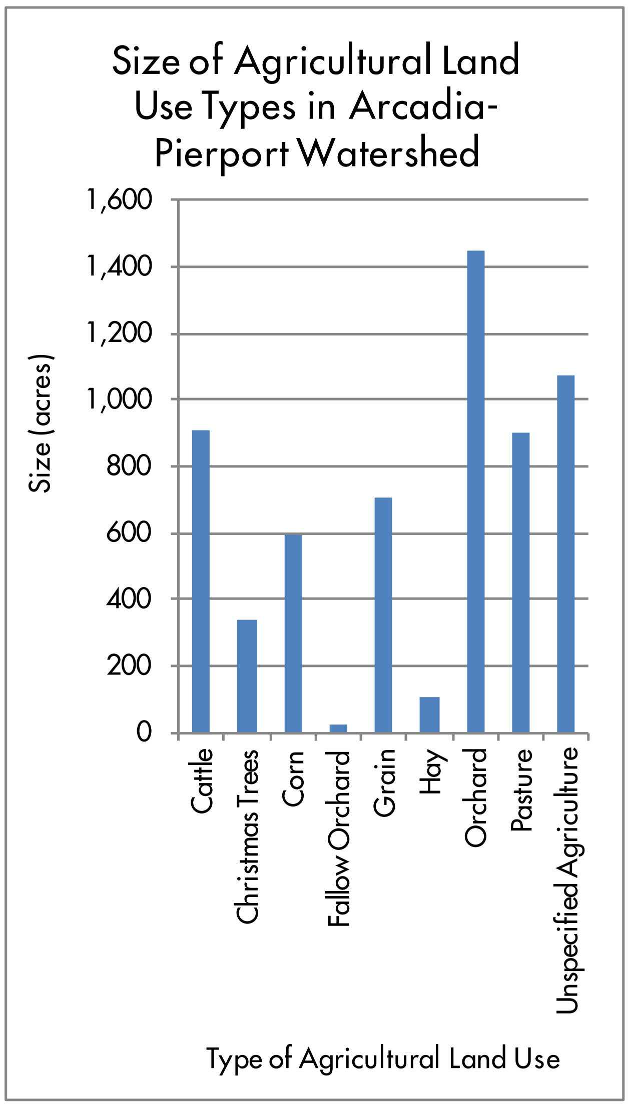


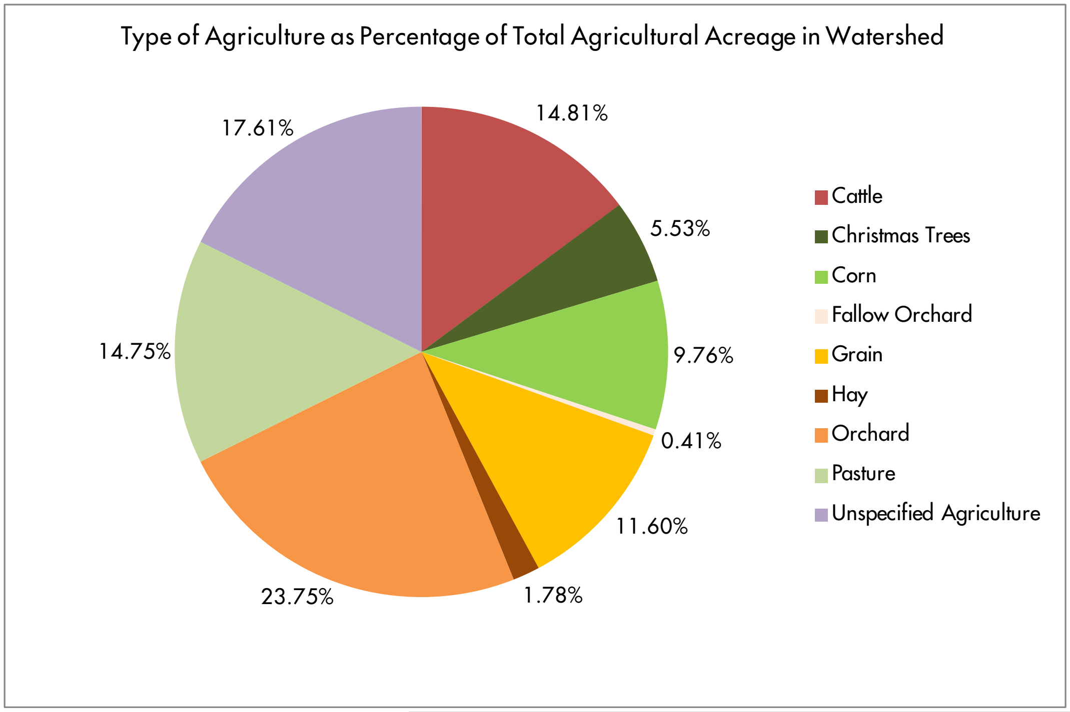
Table 40: Agricultural Land Uses in Watershed
Sources: Beckett & Raeder, Inc., n.d.; Benzie County, Michigan County Government, 2015; Grand Traverse Regional Land Conservancy, personal communication, 2015, July 8; M-22 Economic Development Strategy, 2010; M-22 Study Committee; Manistee County, Michigan, 2009; State of Michigan, 2013; United States Department of Agriculture, Natural Resources Conservation Service, Bear Lake Field Office, personal communication, 2015, July 8

Type of Agricultural Land Use	Number of Parcels in Watershed	Acreage in Watershed (acres)	Percentage of Total Agricultural Acreage in Watershed (%)	Percentage of Watershed (%)
Cattle	20	904.55 acres	14.81%	4.77%
Christmas Trees	3	337.41 acres	5.53%	1.78%
Corn	4	595.71 acres	9.76%	3.14%
Fallow Orchard	1	24.99 acres	0.41%	0.13%
Grain	17	708.52 acres	11.60%	3.73%
Hay	3	108.69 acres	1.78%	0.57%
Orchard	46	1,450.38 acres	23.75%	7.64%
Pasture	17	900.40 acres	14.75%	4.74%
Unspecified Agriculture	78	1,074.08 acres	17.61%	5.66%
Total	*189*	*6,104.73 acres*	*100.00%*	*32.16%*

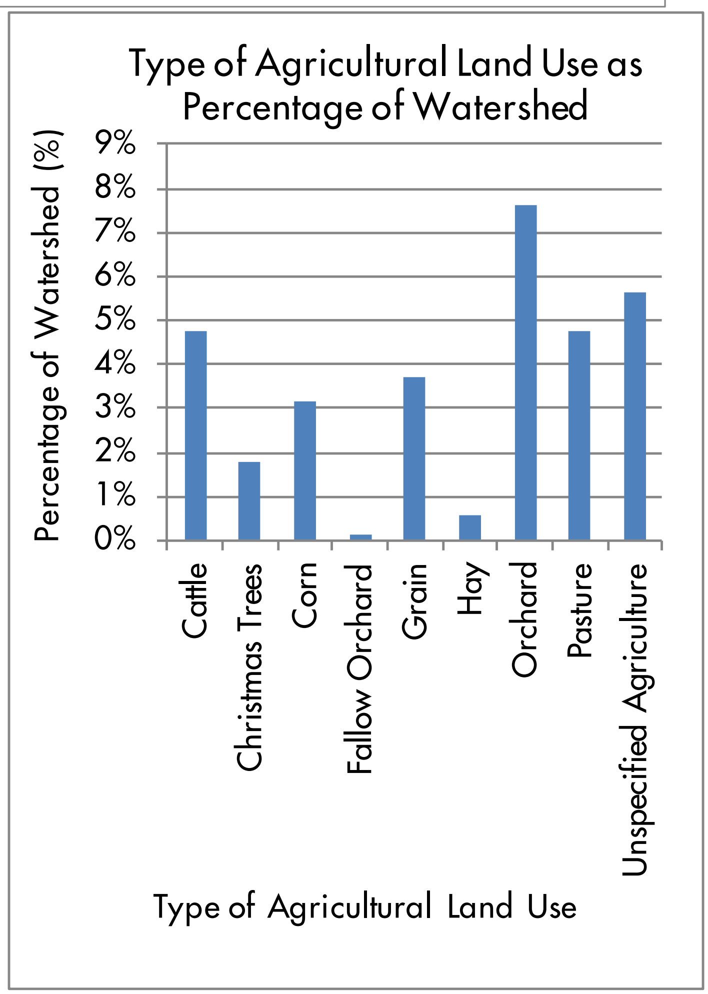
Graph 39: Size of Agricultural Land Use Types in Watershed
Sources: Beckett & Raeder, Inc., n.d.; Benzie County, Michigan County Government, 2015; Grand Traverse Regional Land Conservancy, personal communication, 2015, July 8; M-22 Economic Development Strategy, 2010; M-22 Study Committee; Manistee County, Michigan, 2009; State of Michigan, 2013; United States Department of Agriculture, Natural Resources Conservation Service, Bear Lake Field Office, personal communication, 2015, July 8



Graph 40: Type of Agriculture as Percentage of Total Agricultural Acreage in Watershed
Sources: Beckett & Raeder, Inc., n.d.; Benzie County, Michigan County Government, 2015; Grand Traverse Regional Land Conservancy, personal communication, 2015, July 8; M-22 Economic Development Strategy, 2010; M-22 Study Committee; Manistee County, Michigan, 2009; State of Michigan, 2013; United States Department of Agriculture, Natural Resources Conservation Service, Bear Lake Field Office, personal communication, 2015, July 8



Graph 41: Type of Agricultural Land Use as Percentage of Watershed
Sources: Beckett & Raeder, Inc., n.d.; Benzie County, Michigan County Government, 2015; Grand Traverse Regional Land Conservancy, personal communication, 2015, July 8; M-22 Economic Development Strategy, 2010; M-22 Study Committee; Manistee County, Michigan, 2009; State of Michigan, 2013; United States Department of Agriculture, Natural Resources Conservation Service, Bear Lake Field Office, personal communication, 2015, July 8



The Lakes to Land Regional Initiative plans describe agriculture in the region. According to the *Arcadia Township Master Plan*, for instance, "Between the urban areas to the north and south lies the agricultural stretch of the regional economy. Fruit farms growing apples, cherries, raspberries, blueberries, and plums are plentiful; other products include maple sugar, honey, corn, and general produce. Agricultural enterprises come in all types and sizes, from non-operative acreage to organic farms to large-scale production. A growing number of farms participate in Farm To Table endeavors such as Farmer's Markets, roadside stands, U-Pick and Community Supported Agriculture arrangements." (*Arcadia Township Master Plan*, 2014)

The *Farm and Food System Assessment*, part of the Lakes to Land Regional Initiative, provides a comprehensive agricultural inventory of the region and overview of farming and food in the area based on interviews and analyses. It is important to recognize that the Arcadia-Pierport Watershed is only situated within a portion of the entire Lakes to Land region, which itself is situated within a portion of Benzie and Manistee Counties, so the numbers might differ if only the watershed area had been assessed; nonetheless, the report provides insightful information about the area in general. According to the evaluation, there is a "large amount of land in agriculture with concentrations in Blaine, Joyfield, Arcadia, Pleasanton, Onekama, Bear Lake, and Manistee Townships." (*Farm and Food System Assessment*, 2014) Highlights of the assessment can be found in the Appendix of this Plan.

The Lakes to Land Regional Initiative master plans profile agriculture in various communities. In terms of acreage, agriculture is an important land use in Blaine Township. However, "the fields of agriculture/mining/forestry, professional services, real estate, transportation, finance, health care, and the arts each had fewer than 10 employees apiece." (*Blaine Township Master Plan*, 2014) Despite that, of all the land uses in the township, agriculture is the category with the most acreage. According to the *Blaine Township Master Plan*, "Of the 12,392 acres of land that make up Blaine Township, 4,310 (35%) have an existing land use category of 'Agriculture.' This land represents 81 or the 867 parcels (9%) in the township, and it is the greatest proportion of agricultural land in the Lakes to Land collaborative… Fifty-four of the 320 civilian workers living in Blaine listed 'Agriculture, forestry, fishing, and hunting' as their industry, making up just over 16% of the workforce." (*Blaine Township Master Plan*, 2014) Furthermore, "The greatest acreage of productive agricultural land in the region is found in Blaine, largely in the areas of higher elevation in the south and northeast portions of the township… Overall, just under two thirds of Blaine Township's land (61%) is preserved, agricultural, or forested…" (*Blaine Township Master Plan*, 2014)

Agriculture is a significant land use and economic sector in Joyfield Township, and agriculture is the land use category with the most acreage in the township. According to the *Joyfield Township Master Plan*, "Farming has been a mainstay in the Township since its settlement in 1863." (*Joyfield Township Master Plan*, 2014) As stated in the plan, "Joyfield Township has a land area of 12,763 acres. Agricultural uses account for 4,180 acres (33% of the land area) and 20% of the township's property valuation. When agricultural uses are combined with the 3,737 acres of forest land, nearly two-thirds of Joyfield Township is used for farms, orchards, and woodlots." (*Joyfield Township Master Plan*, 2014) 64 of the 669 parcels (9.6%) in the township are in the Agriculture land use category. To provide additional context, "This land represents 64 of the 669 parcels (10%) in the Township…About 9% of Joyfield's businesses and 4% of its workers can be directly coded as 'agricultural' according to the North American Industrial Classification System (NAICS) used by the US Census. This is a significant portion of any economy, but an accurate picture of agricultural influence in Joyfield must also include the 43% of workers in the category of 'wholesale trade' related to farming. We can see, then, that agriculture comprises almost half of Joyfield's overall economic engine." (*Joyfield Township Master Plan*, 2014) There are three agriculture businesses in Joyfield Township, but "Agriculture and farm-related wholesale businesses make up approximately 46% of the Township employment base," and "Of those employed…26% are employed in the farming, production, and construction professions." (*Joyfield Township Master Plan*, 2014)

About 1/5 of the land use in Arcadia Township is designated agricultural, but only a relatively small number of parcels are actually devoted to agriculture, and no residents consider their occupation to be farming. As stated in the *Arcadia Township Master Plan*, "Of the 11,745 acres of land that make up Arcadia Township, 2,386 (20%) have an existing land use category of 'Agriculture.' This land represents 61 of the 1,024 parcels (6%) in the township…The 2010 Census, however, does not capture any agriculture in Arcadia, as none of the 159 persons who make up the township's civilian employed population listed 'agriculture, forestry, fishing, hunting, and mining' as his or her industry. The Business Summary generated by ESRI records just one business within the township's borders bearing the North American Industrial Classification System (NAICS) code for 'Agriculture, Forestry, Fishing, and Hunting,' and it cites a grand total of one employee. Issues of succession, or passing the farm on to the next generation, while nationally known, also play a significant role in Arcadia. Retiring farmers may still farm their land during their retirement, and thus are unaccounted for in the Census data while they wait for the next generation to take over the business." (*Arcadia Township Master Plan*, 2014)

An important part of Pleasanton Township's economy is agriculturally based. Almost ¼ of the land use in Pleasanton Township is designated agricultural, agriculture is the land use category with the most acreage, and the township is home to various agricultural-related businesses. According to the *Pleasanton Township Master Plan*, "Of the 21,395 acres of land that comprise Pleasanton Township, 5,209 (24%) have an existing land use designation of 'Agriculture.' This land represents 92 of the 1,150 parcels (8%) in the township…Of Pleasanton's 353 civilian workers, 5% (18) listed their occupation as 'agriculture, forestry, fishing/hunting, mining.' The Esri business summary lists no businesses with that North American Industrial Classification System (NAICS) designation within the township's borders, but other data in the same summary are not clear cut: despite a complete lack of business establishments, it still lists one employee in the field, and two businesses and six employees are listed under the outdated Standard Industrial Classification (SIC) code for agriculture and mining (that system has been phasing out since 1997). Regardless of 'official' recognition, a number of agricultural businesses – some home-based and others as an extension of a farm – exist along the US-31 corridor and account for a significant employment opportunity. Centered around the US-31 corridor, Pleasanton is becoming known as an important economic hub of agriculture-based businesses." (*Pleasanton Township Master Plan*, 2015)

Onekama is agricultural in character, though agriculture does not comprise a significant land use or employment sector in the community. Agriculture and logging were original industries in the Village of Onekama. Now, according to the *Onekama Community Master Plan*, "Despite the large land base, farming only represents 5.3% of the Township's occupation field and 12.5% for the Village. However, presence of agricultural lands are viewed as a very important element in Onekama's quality of life. Approximately 18% of the township's land area is dedicated to agricultural use." (Onekama Community Master Plan, 2010) Per the plan, "although there are 315 farms in Manistee County they contributed $2.6 million in personal income, or less than 1% of the county's total personal income and 435 jobs." (*Onekama Community Master Plan*, 2010) The plan also states, "Farming in the Onekama Community is primarily orchards due to the micro-climate and proximity associated with Lake Michigan. Orchard and farm operations are an integral and important component of the Onekama Community economy." (*Onekama Community Master Plan*, 2010) Agriculture contributes to nonpoint source and point source water pollution in Onekama, and fallow land comprises just under 50% of Onekama's farmland. (*Onekama Community Master Plan*, 2010)

It should be noted that the impacts of crop farming differ from the impacts of animal agriculture in terms of the relationship between agriculture and pollution in the watershed.

Figure 46: Arcadia Bluffs Golf Club

Recreational Impact Assessment

As there is no complete recreational impact assessment of the Arcadia-Pierport Watershed, this is another section of the Plan wherein there are gaps in terms of available data and information, as well as about the relation between recreation and nonpoint source pollution in the watershed. Watershed Goals I and II in Table 44 address waterbodies and inventorying.

According to the ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, the recreational impact assessment for that watershed was done because recreational "activities are important for fostering an appreciation of natural resources and supporting the local economy that depends on nature-based tourism. However, recreational activities can be a source of nonpoint source pollution." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Boating and associated activities can cause pollution. According to the EPA, "Because marinas are located right at the water's edge, there is a strong potential for marina waters to become contaminated with pollutants generated from the various activities that occur at marinas – such a boat cleaning, fueling operations and marine head discharge – or from the entry of stormwater runoff from parking lots and hull maintenance and repair areas into marina basins." (United States Environmental Protection Agency, 2014, June 6) The Michigan Clean Marina Program is a way for marinas to "voluntarily pledge to maintain and improve Michigan's waterways by reducing or eliminating releases of harmful substances and phasing out practices that can damage aquatic environments." (Michigan Clean Marina, n.d.) Training, education, and evaluation are important components of this program. (Michigan Clean Marina, n.d.)

Recreation is a valuable part of Benzie County's economy, but recreation depends on sustaining the environment. According to Chapter 1 of the ***Benzie County 2020 Comprehensive Plan***, "The two major economic sectors in Benzie County are recreation/tourism and agriculture," and "The recreation and tourism industry is seen as potentially important in providing for higher levels of future employment in the County." (***Benzie County 2020 Comprehensive Plan***, 2000) Yet, as described in Chapter 3 of the plan, there are consequences of this recreational bounty: "The outdoor life in an attractive setting is a primary reason for many people to settle in Benzie County. Benzie County's economy is highly dependent on recreation, which, along with quality of life, is dependent on scenic quality and good to excellent quality lakes, rivers and forests. Thus, in Benzie County, a healthy economy depends on a healthy environment. The very attraction of Benzie County's scenery, boating, fishing, golf and other activities is compelling so many people to move to the County, that the very character of the County is in danger of being irrevocably altered." (***Benzie County 2020 Comprehensive Plan***, 2000) Benzie County has protected lands but is in need of more neighborhood parks, trails and trail connections, boat launches, and access points to waterbodies, and the county has insufficient funding. In fact, "Over 36% of Benzie County land is publicly owned" – by federal agencies and other government entities. (***Benzie County 2020 Comprehensive Plan***, 2000)

Due to its abundant natural resources, waterbodies, forests, and trails, recreation options abound throughout the year in Benzie County, including boating, skiing, hiking, swimming, and fishing. There are also numerous festivals and events. Recreation opportunities draw locals and tourists to the area, and recreation produces ample benefits in terms of economic development, jobs, quality of life, and health. Yet, there are downsides as well. According to the ***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, "The large influx of seasonal residents has a tremendous impact on the County's economy, and also on its recreation needs and opportunities. Activity at and demand for recreation facilities region-wide climbs dramatically, with boat launches, beaches, open spaces, and other outdoor facilities often experiencing large crowds. This increased activity brings added visitor spending at the region's businesses, but also comes with community costs in the form of added maintenance for trash removal, landscaping, and other activities. Transportation, too, is impacted as traffic volumes increase and some parking lots overflow. With limited recreation budgets and staff in many communities, some communities struggle to plan for, budget, and address seasonal usage patterns at local parks." (***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, 2015) In terms of positive effects of recreation, "Benzie County's recreation and cultural scene has an enormous indirect economic impact, forming the foundation of the County's thriving tourist economy. Visitors who come for recreation and cultural activities spend dollars on hotels, restaurants, and related expenses, supporting a significant number of related jobs and additional economic activity. Just the accommodation and food services industry alone employed over one third (33%) of the County's paid employees in 2012." (***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, 2015) The main organization responsible for recreation in the county is the Benzie County Parks and Recreation Commission, while several other organizations also assist in overseeing recreation. The ***Benzie County Recreation and Cultural Plan 2015-2019: Draft*** provides an inventory of recreation opportunities and facilities in the county. According to the plan, "Benzie County owns four recreation facilities: Railroad Point Natural Area, the Point Betsie Lighthouse, Zada Price Park, and the Betsie Valley Trail." (***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, 2015) The county also contains recreation facilities administered by other governmental entities. In Blaine and Joyfield Townships, these include parks, preserves, Arcadia Dunes, and other sites. There are more than 165 miles of trails in the county. (***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, 2015)

There are numerous opportunities for recreation in the Arcadia-Pierport Watershed region. Boating, fishing, golfing, skiing, biking, hiking, swimming, and hunting are among the recreational pursuits available. The Lakes to Land Regional Initiative plans profile recreation in the area. Recreation brings tourists and income to the area, particularly seasonally; the economic impact of boating, especially, is extraordinary. As the ***Arcadia Township Master Plan*** also notes, "forests and preserves attract tourists and contribute to the rural scenery of the region, impacts which must be balanced against the untaxable and undevelopable nature of these vast swaths of land." (***Arcadia Township Master Plan***, 2014)

The ***Arcadia Township Parks and Recreation Plan 2013-2018*** provides an overview of recreation in Arcadia, assesses recreational facilities and needs, and sets forth goals. According to the ***Arcadia Township Parks and Recreation Plan 2013-2018***, "The Township has five designated park areas: Veterans Memorial Park & Marina, Grebe Park, Pickert Park, Finch Part, Sunset Station & Arcadia Beach Natural Area. The Township has one piece of vacant land. Three of the parks are considered community parks (Veteran's Memorial Marina, Grebe Park, Sunset Station & Arcadia Natural Beach Area) and the other two are neighborhood parks (Pickert Park, Finch Park). The parks are all within

Figure 47: Arcadia Beach Natural Area Signage

a two-mile radius of each other and an easy walk to the urban center[,] linking cultural, civic, commercial and residential uses. Combined, the parks provide playground equipment, picnic areas, tennis courts, shuffle courts, trail systems, Arcadia and Lake Michigan access points for swimming, boating and fishing, open space and general gathering places. Several of the parks have restroom facilities and other amenities, however not all are universally accessible…The Parks and Recreation Committee is the primary [caretaker] of the parks…Arcadia has a partnership with the Grand Traverse Regional Land Conservancy to utilize Arcadia Marsh and other areas, as an important provider of access points to water resources for boating, fishing, bird watching and viewing scenery." (***Arcadia Township Parks and Recreation Plan 2013-2018***, 2013) Recreation facilities in Arcadia Township consist of playgrounds, basketball and tennis courts, golf courses, and boat launches, and recreational activities include running, walking, biking, hiking, camping, paddling, fishing, bird watching, skiing, skating, snowshoeing, and snowmobiling. In addition to the five parks, the aforementioned vacant parcel is a 20-acre piece of property on Erdman Road owned by Arcadia Township; it has forest land and is used for some recreational pursuits like running and skiing. The township's harbor is used by both residents and visitors and is an important facility for activities like boating, swimming, and fishing. Residents also make use of the end of Schaef Road to get to Lake Michigan. Additionally, the Onekama School District owns an 80-acre piece of vacant property on Norconk Road and a 120-acre piece of property on 13 Mile Road; the former has forest land, while the latter has pine trees and is utilized for pursuits like running and skiing. The township is home to abundant natural resources. (***Arcadia Township Parks and Recreation Plan 2013-2018***, 2013)

Recreation can be important economically, especially in terms of encouraging tourism. According to the ***Arcadia Township Parks and Recreation Plan 2013-2018***, "Money is made from visitors who stop in the Township to view and gaze at the breathtaking scenery from one of the many ridgelines of Lake Michigan and green (or the seasonally multi-colored) foliage of the tree stands, boating, cycling, ice fishing and access to Lake Michigan. While enjoying the outdoor amenities visitors may eat at the local restaurants, shop at the retail stores and stay at one of the local lodging establishments. Economic opportunities are centered on utilizing the natural resource assets of the community as recreation avenues and building upon them so that other sectors within the local economy benefit." (*Arcadia Township Parks and Recreation Plan 2013-2018*, 2013)

Arcadia Harbor is a Harbor of Refuge and is of great importance to the community, particularly economically and recreationally. According to the *Great Lakes Navigation System Fact Sheets*, Arcadia Harbor is a "Shallow draft recreational harbor" and has "Approximately 1,100 feet of maintained federal channel between Lake Michigan and Bar Lake" and "More than 2,400 feet of maintained federal piers." (*Great Lakes Navigation System Fact Sheets*, 2015) Furthermore, the harbor "supports charter fishing and recreational navigation interests" and "Supports over 60 recreational boat slips," and "The local community has established a significant infrastructure around the harbor facilities that generates income from harbor users and visitors to the area." (*Great Lakes Navigation System Fact Sheets*, 2015) In terms of "Harbor Structure Condition Assessments," Arcadia Harbor is considered to have a "Low Risk of Failure," according to the United States Army Corps of Engineers. (United States Army Corps of Engineers, n.d.) The harbor is dredged, and there would be considerable economic consequences if it were not dredged. As stated on the *Great Lakes Navigation System Fact Sheets*, "Dredged material is placed along the beach as beach nourishment," the harbor "Requires annual maintenance dredging of approximately 5,000 cubic yards. Arcadia Harbor was last dredged in 2010 using MI regional dredging provision funding. Minimal dredging was completed by the community in 2012, but access to the harbor is still constricted," and "The harbor currently requires maintenance dredging." (*Great Lakes Navigation System Fact Sheets*, 2015) As stated in the *Arcadia Township Master Plan*, "Without a clear and safe passage through the channel, the harbor cannot provide safe refuge, boating activity is crippled, and the economic vitality of Arcadia Township is substantially impacted." (*Arcadia Township Master Plan*, 2014) 2008 PA 94, the Water Resource Improvement Tax Increment Finance Authority Act, allows communities to establish such an authority, the board of which can plan for dredging and maintenance of harbors. (2008 PA 94, 2008)

Pleasanton Township has many recreational opportunities. According to the *Pleasanton Township Master Plan*, "Playground equipment, a ball diamond, and a picnic area exist at the Township Hall, three public access sites on Bear Lake, and the open space at the township park on Lakeside Drive are all avenues for recreation provided by the township. The State of Michigan owns 2,164 acres of the township's land, and the Grand Traverse Regional Land Conservancy holds 1,428 acres of land for recreation and other conservation purposes which provide multi-user trails, wildlife viewing, and general enjoyment of nature." (*Pleasanton Township Master Plan*, 2015)

Other impacts of recreation relate to housing units and employment. According to the *Arcadia Township Master Plan*, "Among the participating communities…34.8% of all housing units are for seasonal/recreational/occasional use. Growth in housing units among the participating communities, then, has been driven primarily by construction of seasonal, recreational, and second homes than primary residences. A look at individual Lakes to Land communities can provide even more striking examples as communities which saw their populations decrease experienced seemingly paradoxical growth in housing units. A third of the Village of Onekama's population, representing just under 1/6 of its households, departed between 2000 and 2010, yet there were 7.3% more houses at the end of the decade than at the beginning…Crystal Lake Township, Blaine Township, Joyfield Township, Manistee Township, Onekama Township, and the Village of Honor all saw the number of housing units grow at least twice as fast as the number of households. Only in Lake Township and Arcadia Township did housing units grow more slowly than households, and it is worth noting that resident households already accounted for a fairly small proportion of housing units in both communities (30% and 51% respectively)." (*Arcadia Township Master Plan*, 2014) To offer some context, "A high percentage of seasonal/recreational use homes provides concrete evidence of the value of the area for those purposes. It also provides a measure of a portion of the community which will have a somewhat nontraditional relationship with the community at large…" (*Arcadia Township Master Plan*, 2014)

According to the *Blaine Township Master Plan*, "seasonal housing comprises almost half of all housing units in Blaine Township (45%) – the third highest proportion in the Lakes to Land region." (*Blaine Township Master Plan*, 2014) The plan provides some further context: "This proportion is high even compared with Benzie and Manistee counties' aggregated percentages of 33.1% and 24.9%, and it represents a substantive departure from the state and national benchmarks of 5.8% and 3.5%." (*Blaine Township Master Plan*, 2014) In Blaine Township, "There are… significant concentrations of workers in arts, entertainment, recreation, accommodation, and food services (11%)…" (*Blaine Township Master Plan*, 2014) Joyfield Township has a much lower percentage of seasonal housing, as compared to the others. Per the *Joyfield Township Master Plan*, "In Joyfield Township, 15.1% of the houses are seasonal or recreational use." (*Joyfield Township Master Plan*, 2014) Yet, "a modest increase of 16.3% in housing units has seen an accompanying 47% increase in the proportion of those housing units that are for seasonal or recreational use." (*Joyfield Township Master Plan*, 2014) In Joyfield Township, "arts, entertainment, recreation,

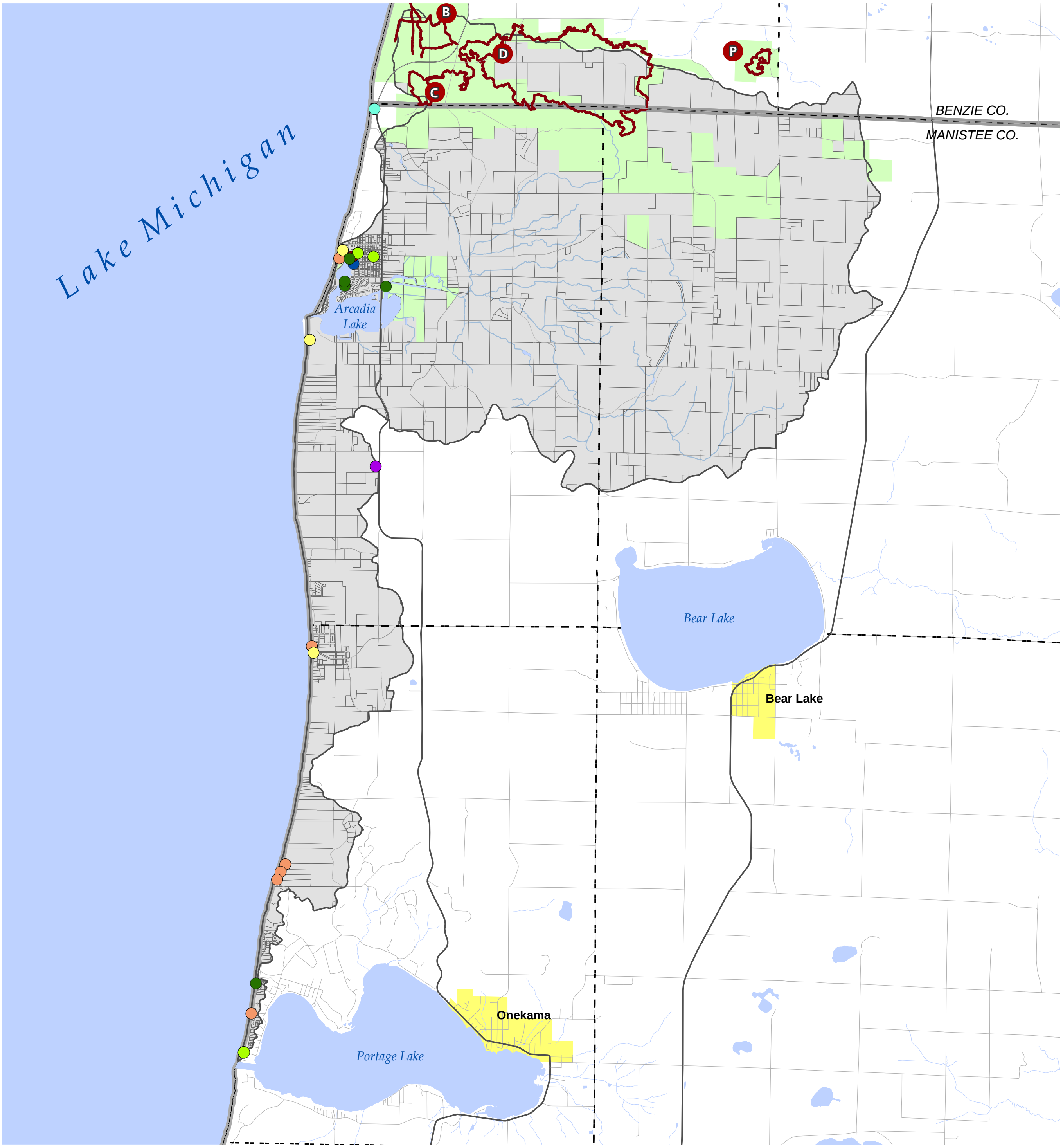
Figure 48: Arcadia Lake Recreation Opportunities

accommodation, and food services (15%)" makes up the third-largest employment category, but "none in art, entertainment, and recreation" actually work in the township. (***Joyfield Township Master Plan***, 2014) Arcadia Township has a lower percentage of seasonal housing than does Blaine Township. As stated in the ***Arcadia Township Master Plan***, "in this community, there [are] just about as many houses for seasonal or recreational use (242 homes, or 42% of all housing units) as there are occupied by the people who own them (266 homes, 46%)." (***Arcadia Township Master Plan***, 2014) In regards to the industries in which the largest numbers of people in Arcadia Township work, "arts, entertainment, recreation, and accommodation was third with 17 workers (11%)." (***Arcadia Township Master Plan***, 2014) Pleasanton Township has less seasonal housing (around 278 housing units, or 40% of the township's 694 housing units) than do Arcadia and Blaine Townships. Yet, according to the ***Pleasanton Township Master Plan***, "The greatest share of civilian workers, 16% (55 workers), listed 'arts, entertainment, recreation, accommodation, and food services' as their occupation." (***Pleasanton Township Master Plan***, 2015)

Recreation is also prevalent in Onekama, and there is a seasonal population increase in summertime, when the population doubles. According to the ***Onekama Community Master Plan***, "Hosting one of the largest inland lakes in Manistee County along with over 6 miles of Lake Michigan shoreline, the Onekama community surrounding Portage Lake is a natural fit for passive recreation and scenic view sheds. Recreational activities such as fishing, boating, hiking and a multitude of other outdoor activities attract visitors from urban areas of Michigan and from other states to the Onekama area every year. The area's natural beauty is one factor that convinces many long-time visitors to move to the area and retire. Because of the abundant outdoor recreation activities and scenic [viewsheds], the natural environment for recreational pursuits is a major economic base and income generator for the Onekama community." (***Onekama Community Master Plan***, 2010)

The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools provides an inventory of recreational facilities and opportunities in the Portage Lake community and sets forth goals. Onekama experiences a surge of tourists and seasonal residents. "The 2010 census shows that of 1,289 housing units in Onekama Township 552 or 42.8 percent were for seasonal, recreational, or occasional use. It also shows that of 338 housing units in the Village of Onekama 89 or

Map 48: Recreational Activities



ARCADIA-PIERPORT WATERSHED

Recreational Activities

0 0.5 1 2 Miles

Data Sources: State of Michigan Geographic Data Library, GTRLC, Pure Michigan, Michigan Department of Natural Resources, Arcadia Campground Marina, Arcadia Bluffs Golf Course, Onekama Township, Arcadia Township

- Watershed Area
- Parcel Boundary
- City or Village
- County Boundary
- Township Boundary
- Roads

GTRLC Arcadia Dunes Preserve

- Arcadia Dunes Trails
- D Dryhill Trails
- B Baldy Trails
- C Camp Trails
- P Pete's Woods Trail

- Camping
- Public Beach Access
- Canoe Access
- Neighborhood Parks
- Public Fishing Docks

- State Lookout Point
- Public Boat Launch
- Golf Club
- GTRLC Preserve Lands

B R
Beckett&Raeder

Table 41: Recreational Activities in Watershed
Sources: Arcadia Bluffs Golf Club, n.d.; Arcadia Campground Marina, 2015; Arcadia Township Parks and Recreation Plan 2013-2018, 2013; Environmental Systems Research Institute, Inc., 2015; Grand Traverse Regional Land Conservancy, n.d.c; Michigan Economic Development Corporation, 2015; Onekama.info, 2015; The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools, 2014; State of Michigan, 2001-2015a; State of Michigan, 2015b; State of Michigan, 2015d

Location	Camp	Public Beach Access	Canoe	Fish	State Lookout	Public Boat Launch	Golf	Picnic
Arcadia Marsh				X				X
Grebe Park			X	X				X
Arcadia Lake (near Grebe Park and Charters)				X				X
Arcadia Marina						X		
Arcadia Campground Marina	X		X	X				
Arcadia Bluffs Golf Club							X	
Canoe Launch (Lake Michigan)			X					
Canoe Launch (near Old Faceful in Pierport)			X					X
Arcadia Beach Natural Area		X						X
Pierport Road End		X						X
Canoe Launch (Arcadia Lake)			X					
Ninth Street Road End (Pierport area)		X	X	X				X
Captain John Langland Park (at southern tip of Pierport portion of watershed) (Onekama neighborhood park)		X	X	X				X
Finch Park (Arcadia neighborhood park)								X
Pickert Park (Arcadia neighborhood park)								X
Burnham Street Road End (in Onekama Township)		X						X
Thirteen Mile Road End (in Onekama Township)		X						X
Lakeisle Avenue Road End (in Onekama Township)		X						X
Ninth Street Road End (in Onekama Township)		X						X
Avenue East Road End at First Street (in Onekama Township)				X				X
Community Dock at Outlet Avenue Road End (in Onekama Township)			X	X		X		X
Inspiration Point* (west of northern part of Arcadia portion of watershed)					X			X

26.3 percent were for seasonal, recreational, or occasional use… Thousands of visitors are here for shorter times at the summer campgrounds, motels, religious camps, and bed-and-breakfast establishments." (***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014) Many water-based recreational opportunities in Onekama are centered on Portage Lake and Lake Michigan, the shoreline of which is over 16 miles. Recreation abounds in Onekama year-round; boating, swimming, fishing, hunting, and skiing are some popular activities. Recreational facilities include parks, beaches, docks, preserved areas, trails, the Manistee County Fairgrounds, and school sports facilities. (***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014)

Finally, the two Grand Traverse Regional Land Conservancy (GTRLC) preserves in the Arcadia-Pierport Watershed offer recreational opportunities as well. Arcadia Marsh Nature Preserve contains a trail and allows for hiking, birding, fishing, hunting, kayaking, and canoeing. Arcadia Dunes: The C.S. Mott Nature Preserve has more than 17 miles of trails and allows hiking, running, birding, mountain biking, hunting, skiing, and snowshoeing. (Grand Traverse Regional Land Conservancy, n.d.a; Grand Traverse Regional Land Conservancy, n.d.b; Grand Traverse Regional Land Conservancy, n.d.c)

Map 48 identifies locations in the watershed suitable for hiking, camping, accessing the beach, canoeing, fishing, looking at scenery, launching boats, and golfing and shows where the GTRLC Preserve lands are. Table 41 accompanies Map 48 and provides more details about recreational locations and types of activities; the table also identifies locations for picnicking. These may not encompass a complete inventory of the locations of all recreational activities, as some locations without specific addresses needed to be generalized. Some locations offer multiple recreational activities; Map 48 shows the primary recreational activity at each location, while Table 41 indicates all available activities at each location. The GTRLC Arcadia Dunes Preserve trails shown on the map, which are mostly in the Arcadia-Pierport Watershed but do extend a bit north of the watershed, constitute a total of 17.7 miles, as of 2015. It is worth noting that the state lookout, Inspiration Point, is near the Benzie-Manistee County border - though not technically within the watershed, it is just west of the northern part of the Arcadia portion of the watershed. (Arcadia Bluffs Golf Club, n.d.; Arcadia Campground Marina, 2015; ***Arcadia Township Parks and Recreation Plan 2013-2018***, 2013; Environmental Systems Research Institute, Inc., 2015; Grand Traverse Regional Land Conservancy, n.d.a; Grand Traverse Regional Land Conservancy, n.d.b; Grand Traverse Regional Land Conservancy, n.d.c; Grand Traverse Regional Land Conservancy, n.d.e; Michigan Economic Development Corporation, 2015; Onekama.info, 2015; ***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014; State of Michigan, 2001-2015a; State of Michigan, 2015b; State of Michigan, 2015d)

Canoeing

Canoeing, like kayaking, is a popular water-based recreational pursuit. According to the ***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, "Several water trails are being developed across the region to link existing water access sites in a way similar to land trails. Water trails provide opportunities for canoes and kayaks to navigate inland lakes and rivers as well as the Lake Michigan shoreline. Benzie County is now part of the Lake Michigan Water Trail, which with funding from the Michigan Department of Environmental Quality's Coastal Zone Management Program, has cataloged nearly 200 public access sites along the entire Lake Michigan. The County also has its own unique inland water trails. The Betsie River, a designated Natural Wild and Scenic River that runs from Grass Lake to Betsie Lake and into Lake Michigan, and the Platte River…have a number of existing water access sites, providing the public with a number of opportunities to enjoy these inland waterways by canoe and kayak." (***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, 2015)

In regards to the Lake Michigan Water Trail, "In 2013, a number of partners throughout the State of Michigan, including Michigan Sea Grant, the Land Information Access Association, the Michigan Department of Environmental Quality, the Parks Division of the Michigan Department of Natural Resources, and Networks Northwest, the National Park Service, and the Michigan Department of Natural Resources began work towards a 'water trail' plan for the Lake Michigan coastline. A water trail is a designated route along a river, lake, canal, or bay, specifically designed for people using small, non-motorized boats like kayaks, canoes, single sailboats, or rowboats. These trails often feature well-developed access and launch points, are near significant historical, environmental, or cultural points of interest; and often include nearby amenities such as restaurants, hotels, and campgrounds. They provide residents and visitors with increased access to the water, enhancing and enabling recreation and increasing knowledge about local bodies of water. The Lake Michigan Water Trail, which begins in the Upper Peninsula and traverses 760 miles of shoreline south to the Indiana state border, is oriented around increasing and improving public access to the Lake Michigan shoreline and the coastal waters within the State of Michigan, and connects water trail users to recreational assets like campgrounds, natural areas, trails, and cultural assets. The Water Trail provides numerous opportunities to improve, capitalize on, and connect Benzie County's recreation assets." (***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, 2015) A map showing the route of the Lake Michigan Water Trail in the area of Michigan that includes the Arcadia-Pierport Watershed can be found on the Lake Michigan Water Trail website. (Lake Michigan Water Trail, n.d.)

Map 48 and Table 41 identify areas in the watershed suitable for canoeing, among other activities. There are numerous areas where canoe access is provided, including Grebe Park, Arcadia Campground Marina, Captain John Langland Park, and at canoe launches. (Arcadia Campground Marina, 2015; ***Arcadia Township Parks and Recreation Plan 2013-2018***, 2013; Environmental Systems Research Institute, Inc., 2015; Grand Traverse Regional Land Conservancy, n.d.a; Grand Traverse Regional Land Conservancy, n.d.c; Michigan Economic Development Corporation, 2015; Onekama. info, 2015; ***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014; State of Michigan, 2015b)

Fishing

Recreational fishing is an important industry, but it has a noticeable environmental impact. Not only can it harm fish, but it can also cause water pollution and habitat damage. The cumulative impact of all the fishermen in the United States can be significant. According to an article, "sport fishing isn't without its environmental flaws. Trash discarded by fishermen as well as gas and oil leaks from their boats can pollute the waterways. Negligent anchoring can harm the shorelines and lead to habitat destruction." (Conger, n.d.)

Fishing is a popular activity in and is economically important to Benzie County, as it draws people to the area. But fishing also impacts the environment and can lead to problems. As described in the ***Benzie County Comprehensive Plan Sensitive Lands and Water Resources Report***, "Lake Michigan, inland lakes and rivers are economically important to Benzie County. Fishermen come from other states as well as all around Michigan to fish all year round. However, fishing creates environmental issues and land use conflicts. There is concern that fishing in some of the lakes is not what it used to be… Other complaints regarding fishing deal with the behavior of persons fishing, in the trash they leave both summer and winter and the lack of respect for private property owners as they trespass on shore lands to gain access to the water to fish. Ice fishermen cross private property in the winter and in the summer, fishermen park on private property. This reflects both on the poor behavior of persons fishing and on the lack of public access sites. In a rapidly growing Benzie County, there are more persons fishing and formerly undeveloped, large tracts of land along waterways are rapidly being subdivided and built upon." (***Benzie County Comprehensive Plan Sensitive Lands and Water Resources Report***, 1998)

According to the Lakes to Land Regional Initiative plans, fishing is a very important industry and recreational pursuit in the area. As stated in the ***Arcadia Township Master Plan***, for instance, "Fishing is a huge industry in the region, whether it is winter or summer. All types exist in plenty: enterprise or recreation, fly or bait and tackle. The region's rivers, streams, and lakes are heavily scrutinized for their freshwater inhabitants, and they are home to some of the finest fly fishing the country has to offer." (***Arcadia Township Master Plan***, 2014) There are also numerous trout streams in the Arcadia-Pierport Watershed. (***Arcadia Township Master Plan***, 2014) People can also fish at Grebe Park and Arcadia Harbor in Arcadia. (***Arcadia Township Parks and Recreation Plan 2013-2018***, 2013) Fishing is available at various parks in Onekama. (***The Portage Lake Community Five-Year Plan for Parks and Recreation in the Village of Onekama, Onekama Township, and the Onekama Consolidated Schools***, 2014) Fishing is also an activity at Arcadia Marsh Nature Preserve. (Grand Traverse Regional Land Conservancy, n.d.b)

Arcadia Lake is considered to be good for fishing. Brown trout were stocked by the Michigan Department of Natural Resources (MDNR) into Arcadia Lake in 2011 and 2012. According to fisheries biologist Mark Tonello, "The brown trout fishery created by this stocking effort is typically a spring fishery, taking place during March, April, and early May. The appeal for anglers is that the fishery is typically a shallow water, near-shore fishery that does not require large boats or expensive equipment. While much of the angling effort involves trolling along the lake Michigan shoreline, brown trout are also caught in Arcadia Lake each spring. In addition, anglers fishing the Arcadia piers and the beaches adjacent to the piers also catch the stocked brown trout." (Tonello, 2012) As Tonello writes, "Arcadia Lake has long had a good reputation as a fishing lake. In addition to its spring brown trout fishery, it is known for its good fishing for yellow perch, northern pike (both summer and through the ice) and bass, both largemouth and smallmouth. It is known as a very good bowfishing lake for common carp, particularly during the June spawning period. Migratory salmonids like Chinook salmon (fall) and steelhead (late fall, winter, and early spring) can also be caught from Arcadia Lake at times." (Tonello, 2012) Arcadia Lake is also used for bowfishing for carp. 2,012 individual fish (32 species of fish), representing panfish, game fish, and nongame fish, were caught in an MDNR survey of Arcadia Lake on several days in 2012. They included brown bullhead (the species with the largest number of fish caught was brown bullhead), northern pike, bowfin, yellow perch, smallmouth bass, bluegill, black crappie, pumpkinseed sunfish, walleye, largemouth bass, rainbow trout, and numerous others; refer to Graph 3 in CHAPTER TWO for a visual representation of the number of various fish species that were collected. Unfortunately, however, fishing is impacted by the invasive species, Eurasian watermilfoil. (Tonello, 2012)

According to the Harbor Master at the Arcadia Veterans Memorial Marina on Arcadia Lake, as the water was still cold as of July 2, 2015, the fish were south, and the fishermen were not catching as many fish. MDNR is trying to create a more sustainable fishery, and its fish stocking practices are changing; the fish and aquatic species are also changing. These all have an impact on fishing. (Harbor Master, Arcadia Veterans Memorial Marina, personal communication, 2015, July 2)

Bowens Creek and tributaries are also suitable for fishing. According to Tonello's 2008 report, "Bowens Creek and all of its tributaries are Designated Trout Streams by Michigan Department of Natural Resources (MDNR), and all are classified as Type 1 streams." (Tonello, 2008) Fish were collected in a survey at 18 sites in Bowens Creek and tributaries on several days in 2008. They included rainbow trout, brown trout, coho salmon, brook trout, sculpin, and others; refer to Graph 4 in CHAPTER TWO for a visual representation of the number of sites at which various fish species were collected. It is probable that these waterbodies also contain Chinook salmon. Tonello writes, "Due to its small size, Bowens Creek will probably never be a 'destination' fishery, even though there are clearly some quality fish to be caught. However, Bowens Creek and its tributaries can certainly offer excellent small-stream angling opportunities. In addition, the migratory salmonids naturally produced in Bowens Creek (steelhead, coho salmon, Chinook salmon, and possibly brown trout) will continue to provide recreation for Lake Michigan anglers, including boat anglers, pier anglers, and shore anglers." (Tonello, 2008) Tonello argues, "The most critical fisheries habitat project for the watershed is the restoration of Bowens Creek as it flows through the Arcadia Marsh." (Tonello, 2008) Restoration activities since have addressed road/stream crossings, redirection of Bowens Creek, invasive species, and the habitat of Arcadia Marsh. (***Final Technical Report – Arcadia Marsh/ Bowens Creek Restoration and Fish Passage***, 2013; Grand Traverse Regional Land Conservancy, n.d.d) Fish observed by the Little River Band of Ottawa Indians Natural Resources Department changed before versus after restoration, but following restoration, observed species in 2012 and 2013 included coho salmon, brown trout, slimy sculpin, brook trout, rainbow trout, yellow perch, northern pike, and white sucker. (***Final Technical Report – Arcadia Marsh/ Bowens Creek Restoration and Fish Passage***, 2013)

Map 48 and Table 41 identify areas in the watershed suitable for fishing, among other activities. The fishing pier at Grebe Park by Arcadia Lake is near the public boat launch on Arcadia Lake. There are numerous other areas where fishing is available, including Arcadia Marsh, Arcadia Lake, Arcadia Campground Marina, Captain John Langland Park, and at road ends. (Arcadia Campground Marina, 2015; Environmental Systems Research Institute, Inc., 2015; Grand Traverse Regional Land Conservancy, n.d.c; Michigan Economic Development Corporation, 2015; Onekama.info, 2015; State of Michigan, 2015b; State of Michigan, 2015d)

Hiking

Despite the pleasure of hiking, the activity has an effect on the environment. According to an article, "Most people who enjoy walking and hiking as a pastime also tend to be aware of the environment to some degree or another. However many do not [realize] that it's their very activities which are carried out in areas [that] are often quite ecologically fragile that can actually destroy the environment that they love so much and which they want to protect. In many instances, it may not be their own individual impact which is causing any great harm but multiply their tiny effects by hundreds or even thousands of people who are all doing the same thing and, collectively, they could be contributing to ecological damage." (Durham, 2015) For instance, hiking and associated activities can cause erosion and water pollution and harm vegetation and wildlife. (Durham, 2015)

There are multiple types of trails in Benzie County. Hikers can explore Arcadia Dunes and other conserved areas in Blaine Township. According to the ***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, "The County boasts over 165 miles of motorized and non-motorized trails. From small township parks to the Sleeping Bear Dunes National Lakeshore, Benzie County has numerous trails located throughout its parks and recreation areas. Some are used only by the surrounding neighborhoods, while others…serve as regional trail systems." (***Benzie County Recreation and Cultural Plan 2015-2019: Draft***, 2015)

Hiking is possible at both Arcadia Dunes and the Arcadia Marsh Nature Preserve. The GTRLC Arcadia Dunes Preserve trails shown on Map 48, which are mostly in the Arcadia-Pierport Watershed but do extend a bit north of the watershed, constitute a total of 17.7 miles, as of 2015. The names and lengths of these trails are shown in Table 42 and Graph 42. The trails in the northwestern corner of the watershed are called the Baldy Trails (labeled B on the map) and are 3.3 miles; the trails are through forests and provide scenic views of Lake Michigan. The Dryhill Trails (D) (10.4 miles) and Camp Trails (C) (2.5 miles) are also in the watershed; they can be used for hiking, as well as running and mountain biking. The small trail above the watershed is the Pete's Woods Trail (P), which is included because it is part of Arcadia Dunes; it is 1.5 miles and provides views of wildflowers. (Grand Traverse Regional Land Conservancy, n.d.a; Grand Traverse Regional Land Conservancy, n.d.b; Grand Traverse Regional Land Conservancy, n.d.c; Grand Traverse Regional Land Conservancy, n.d.e)

Arcadia Lake Boat Counts

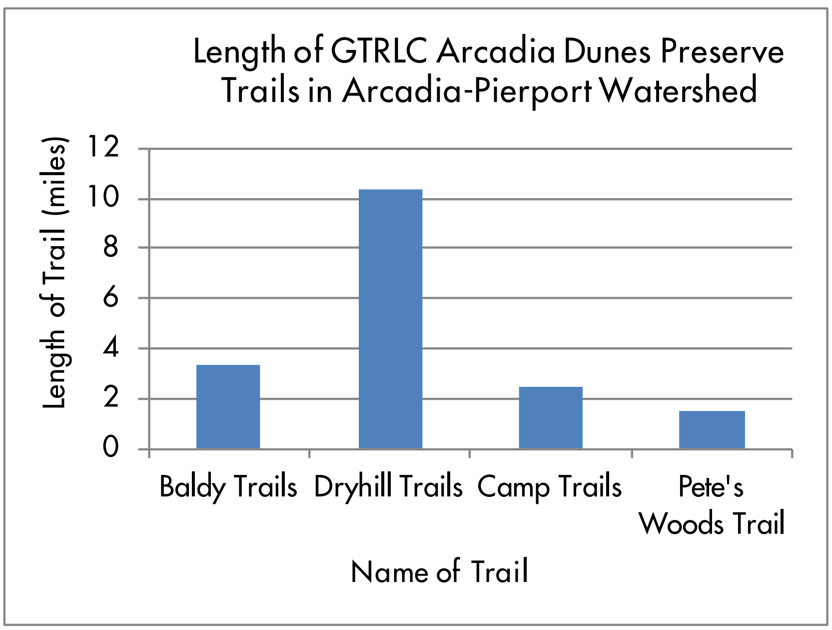
As there are no complete data on Arcadia Lake boat counts, this is another section of the Plan wherein there are gaps in terms of available data and information. Thus, the material used to write this section came from personal communication. Watershed Goals I and II in Table 44 address waterbodies and inventorying.

According to the Harbor Master at the Arcadia Veterans Memorial Marina, the marina had sold 32 season passes and had 150 daily launches and 15 transient guests through July 2, 2015. The Marina has a total of 32 boat slips; half of those are seasonal and are fully occupied with a waitlist, while the other half are for transients. There had not been a large amount of transient traffic through July 2, 2015, as compared to 2014, which may be correlated to the economy, the cold temperature of the water, which means

Table 42: Grand Traverse Regional Land Conservancy's Arcadia Dunes Preserve Trails in Watershed
Sources: Grand Traverse Regional Land Conservancy, n.d.a; Grand Traverse Regional Land Conservancy, n.d.e

Name of Trail	*Identifying Letter on Map 48*	*Length of Trail (miles)*
Baldy Trails	B	3.3 miles
Dryhill Trails	D	10.4 miles
Camp Trails	C	2.5 miles
Pete's Woods Trail	P	1.5 miles
Total	--	*17.7 miles*

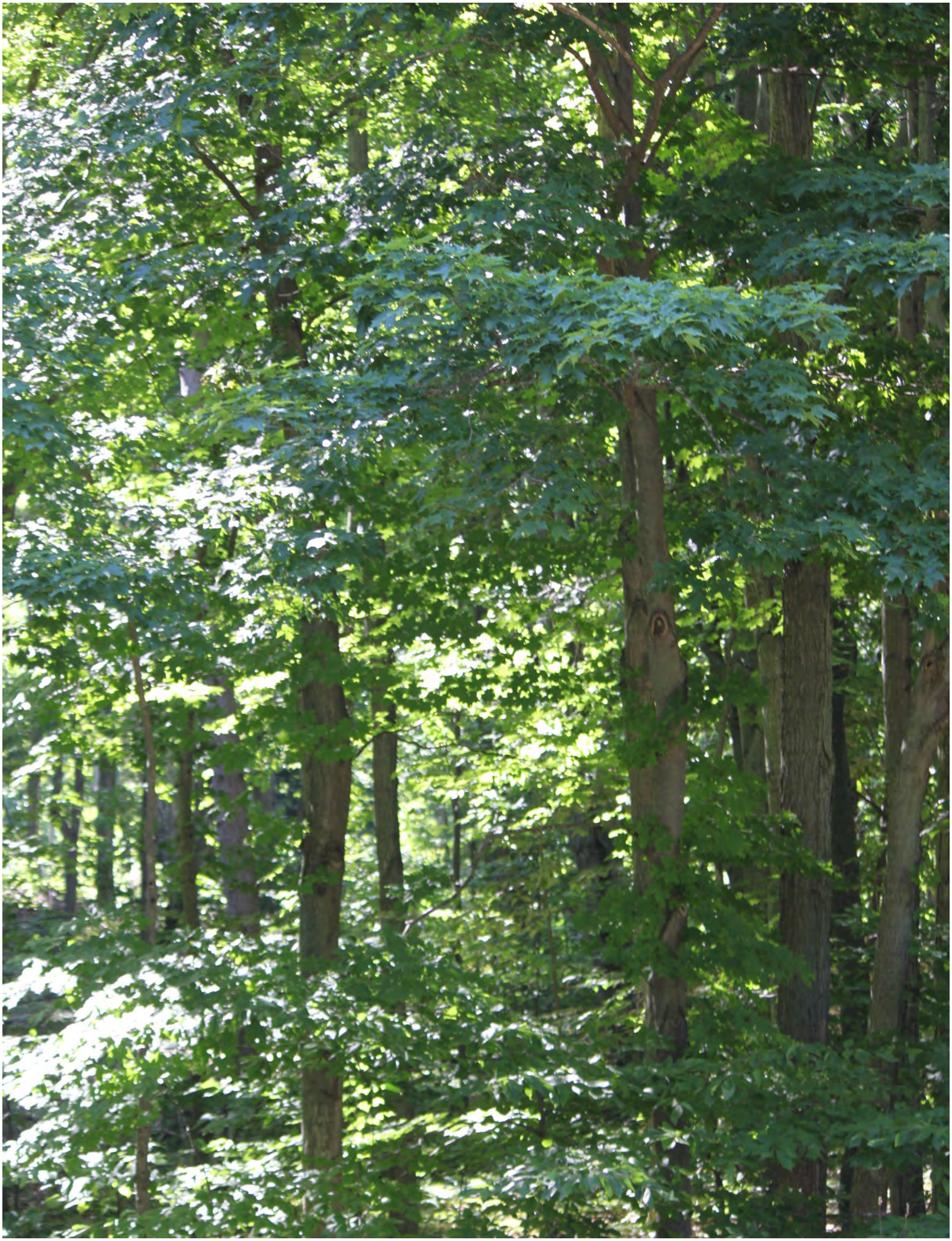
Graph 42: Length of Grand Traverse Regional Land Conservancy's Arcadia Dunes Preserve Trails in Watershed
Sources: Grand Traverse Regional Land Conservancy, n.d.a; Grand Traverse Regional Land Conservancy, n.d.e



that the fish are not as far north as Arcadia, or the changes in fish stocking and species, all of which can impact traffic and fishing. However, the marina typically experiences more business after the Fourth of July and during July and August. Besides the Arcadia Veterans Memorial Marina, other spots on Arcadia Lake where boats can berth or launch include Arcadia Marine, Arcadia Campground and Marine, a public access point, and the private docks of residents on the lake. (Harbor Master, Arcadia Veterans Memorial Marina, personal communication, 2015, July 2)

One of the owners of Arcadia Marine estimated that there are 100-120 boat slips and boats in Arcadia Lake and that it had been somewhat slow through July 2, 2015. Arcadia Marine has 17 slips, all of which are seasonal and are full. The owner thought that there are about 50 residential slips on Arcadia Lake, though some are used by non-residents. (Co-owner, Arcadia Marine, personal communication, 2015, July 2)

Figure 49: Forest



Forest Inventory

This is another section of the Plan wherein there are gaps in terms of available data and information. Here, gaps consist of data in regards to the amounts in the Arcadia-Pierport Watershed of conserved forestland versus harvestable timberland versus vacant land that has reverted to forest, types of tree and forest species, and relation between forests and nonpoint source pollution in the watershed. Watershed Goals I, II, and III in Table 44 address water quality and inventorying.

An EPA webpage describes how forestry can cause nonpoint source pollution. According to the EPA, "Sources of nonpoint source (NPS) pollution associated with forestry activities include removal of streamside vegetation, road construction and use, timber harvesting, and mechanical preparation for the planting of trees. Road construction and road use are the primary sources of NPS pollution on forested lands, contributing up to 90 percent of the total sediment from forestry operations. Harvesting trees in the area beside a stream can affect water quality by reducing the streambank shading that regulates water temperature and by removing vegetation that stabilizes the streambanks. These changes can harm aquatic life by limiting sources of food, shade and shelter." (United States Environmental Protection Agency, 2012)

Forests in Benzie County are varied and occupy much of the county's open space, slopes, and wetlands, though there are fewer forests in the western portion of the county. Forests have recreational value and also provide important animal habitats. According to Chapter 1 of the ***Benzie County Open Space & Natural Resources Protection Plan***, of large-size parcels (minimum of 30 acres) in the county, "Forest lands include about 7,200 acres of large parcels in the timber cut-over class and just over 900 acres in unimproved Commercial Forest Reserve." (***Benzie County Open Space & Natural Resources Protection Plan***, 2002) Additionally, "Noncontiguous acres of agriculture (about 2,600 acres) and forestry (over 600 acres) are not as extensive as contiguous agriculture (almost 15,000 acres) and forestry (nearly 6,300 acres)." (*Benzie County Open Space & Natural Resources Protection Plan*, 2002)

There are significant forests in Benzie County as a whole, and forestry is important to the county's economy and scenic beauty. According to Chapter 1 of the *Benzie County 2020 Comprehensive Plan*, "The major land uses in the County are forest and agriculture." (*Benzie County 2020 Comprehensive Plan*, 2000) As stated in Chapter 3 of the plan, "Forest is the largest land cover category in Benzie County. According to the US Forest Service, in 1993 there were 137,000 acres of timberland (forest producing marketable wood) in Benzie County, or 67% of the County land area. There are both publicly and privately owned forests in Benzie County...48.6% of forestland is state-owned. The remaining 51.4% is in private, corporate or miscellaneous private ownership. Thus, 32.6% of the County is state-owned forestland…The primary forest vegetation type in Benzie County is beech-maple, which was also the predominate vegetation type in Benzie County during pre-settlement times. Other current vegetation types include red pine (10%), elm-ash-soft maple (8.9%), aspen (6.6%) and others of lesser percentage cover…Woodlands are being affected by fragmentation of the land through lot splits and construction of multiple access roads. Management of forestlands is increasingly difficult, as ownership patterns on private, undeveloped land become increasingly fragmented into smaller and smaller parcels." (*Benzie County 2020 Comprehensive Plan*, 2000) Another concern is that development could negatively impact forests. In Benzie County, furthermore, "State Forest lands are used for timber harvesting and gas and oil extraction. State Forest lands are highly fragmented, with irregular boundaries and many private in-holdings. This makes management of those lands for recreation and forestry more difficult." (*Benzie County 2020 Comprehensive Plan*, 2000)

According to the *Benzie County Comprehensive Plan Sensitive Lands and Water Resources Report*, "Forests are a valuable land cover because they contribute to the Benzie County economy through tree harvesting, land for hunting and other forms of recreation and scenic backdrop to the tourist industry. Forests also moderate, filter and cool stormwater runoff, helping to maintain high water quality and groundwater recharge... There were 2,207 acres enrolled in the Commercial Forest Program in Benzie County in 1997, according to an examination of the plat maps. Parcels ranged in size from 24 acres to 210 acres. There is a large amount of forested land in 5-10 acre parcels. This can result in poorly coordinated forest management to no management at all. Some of the important values of forests require forests to remain in large blocks. Continued land fragmentation of forestland will eventually destroy that portion of the County forest products industry that relies on private land." (*Benzie County Comprehensive Plan Sensitive Lands and Water Resources Report*, 1998)

Though it is from 1998, and the situation may have changed since, the *Benzie County Comprehensive Plan Forestry & Mineral Resources Report* provides an insightful overview of forests and forestry in the county and a detailed inventory. (*Benzie County Comprehensive Plan Forestry & Mineral Resources Report*, 1998) Highlights of the report can be found in the Appendix of this Plan.

In regards to Manistee County, according to the *Onekama Community Master Plan*, "45% of Manistee County is publicly owned in the form of large federal and state forest tracts…" (*Onekama Community Master Plan*, 2010) Manistee County also has a high percentage of forest land, but the county's forest land is being developed. According to Chapter 4 of the *Manistee County Master Plan 2008*, "Approximately 73% of the some 356,000 acres of land area in the county is forested, accounting for some 253,200 acres." (*Manistee County Master Plan 2008*, 2009) Based on predictions expressed in Chapter 3 of the plan, "specialized agriculture and forestry industries such as high value crops, as well as on-site processing and direct sales will keep these industries an important part of the county." (*Manistee County Master Plan 2008*, 2009)

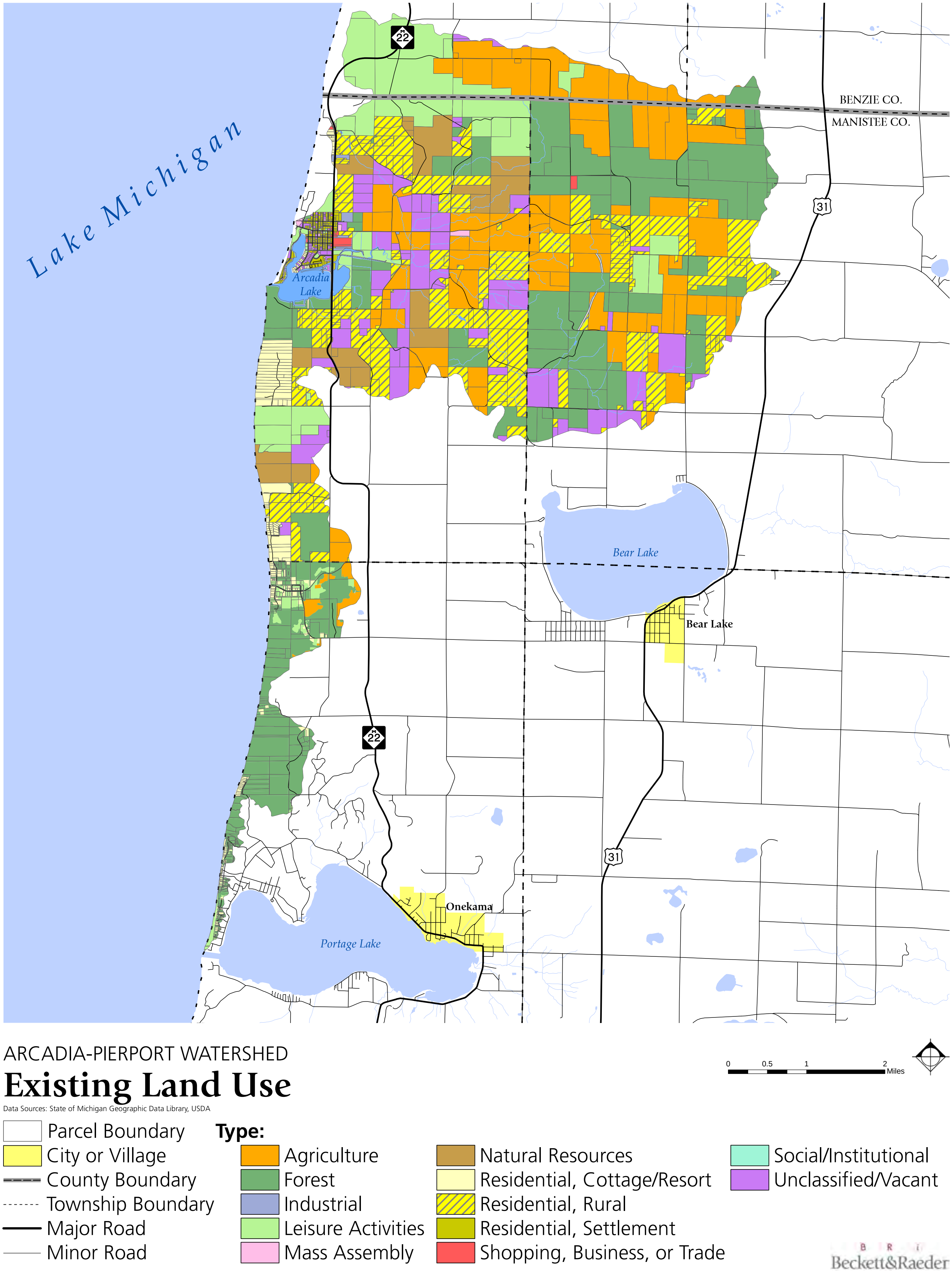
Forestland in the Arcadia-Pierport Watershed is shown as green on Map 49, while the percentage of tree canopy cover throughout the watershed can be seen on Map 50. As shown in the maps, there are significant forest land and tree cover in the watershed; furthermore, forest land and land with tree canopy tend to be clustered. (Homer et al., 2015; State of Michigan, 2013)

Map 51 and Table 43 show the types of forests in the Arcadia-Pierport Watershed. The map indicates the spatial locations and sizes of the types of forests, while the table presents data about the size of each forest type and percentage of forest and of total land in the watershed that each type of forest occupies. The total forest figures are different from those in Table 4 in CHAPTER ONE, as they include more updated forest data and are based on land cover rather than land use. Graphs 43-45 depict the sizes of the various types of forest in the watershed, as well as the types of forest as percentages of the total forest and of the total land in the watershed. As shown, deciduous forest is the forest type that represents the largest percentage of forest in the watershed. (Homer et al., 2015)

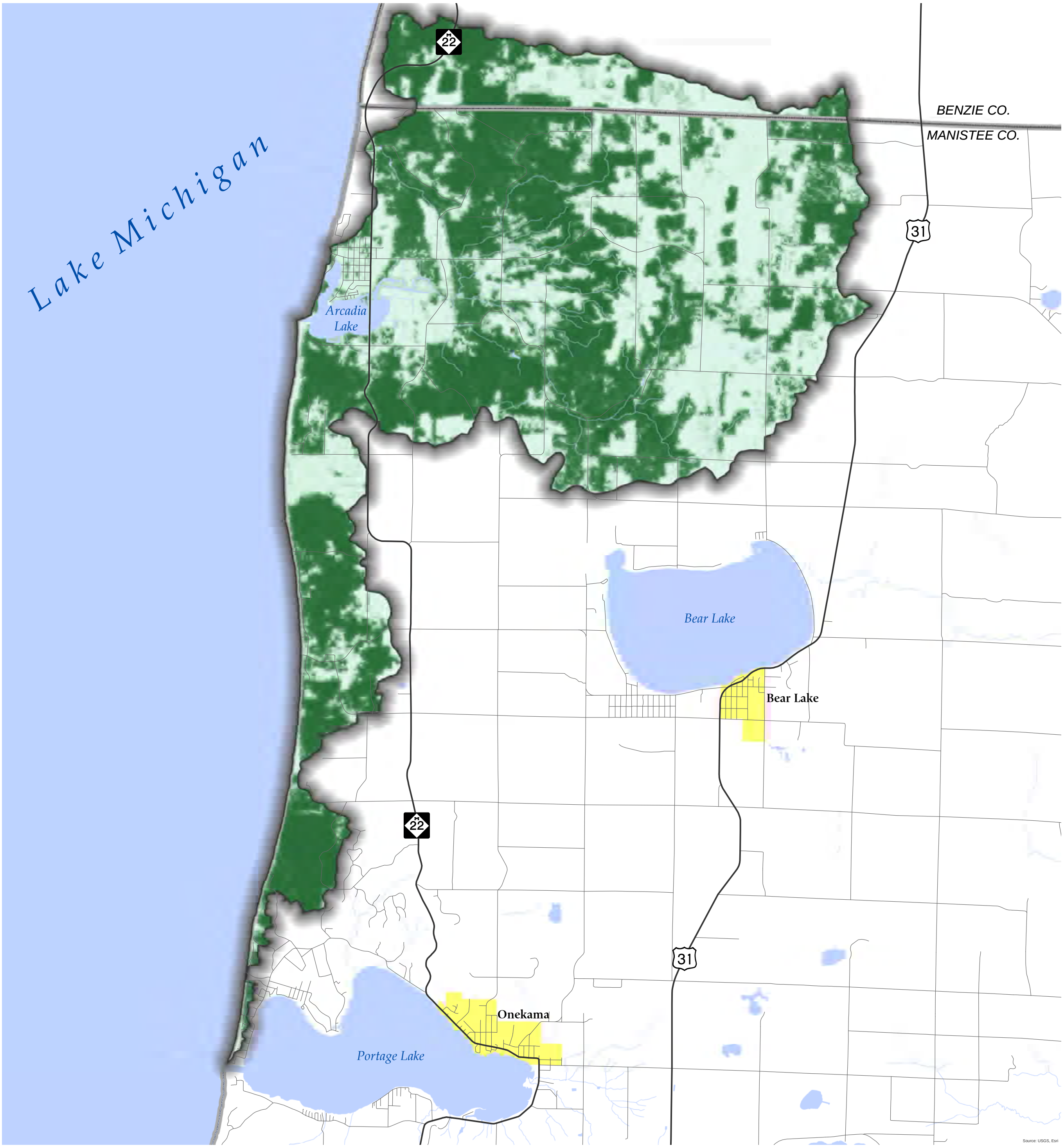
The Lakes to Land Regional Initiative plans describe the natural resources and land uses in the region, including forests. According to the *Arcadia Township Master Plan*, for instance, "The vast majority of land within both Benzie and Manistee Counties is designated as Forest…" (*Arcadia Township Master Plan*, 2014)

In Blaine Township, 1,735 of the 12,392 acres (14%) and 57 of the

Map 49: Existing Land Use



Map 50: Tree Canopy



ARCADIA-PIERPORT WATERSHED

Tree Canopy Cover

Data Sources: State of Michigan Geographic Data Library, National Land Cover Database

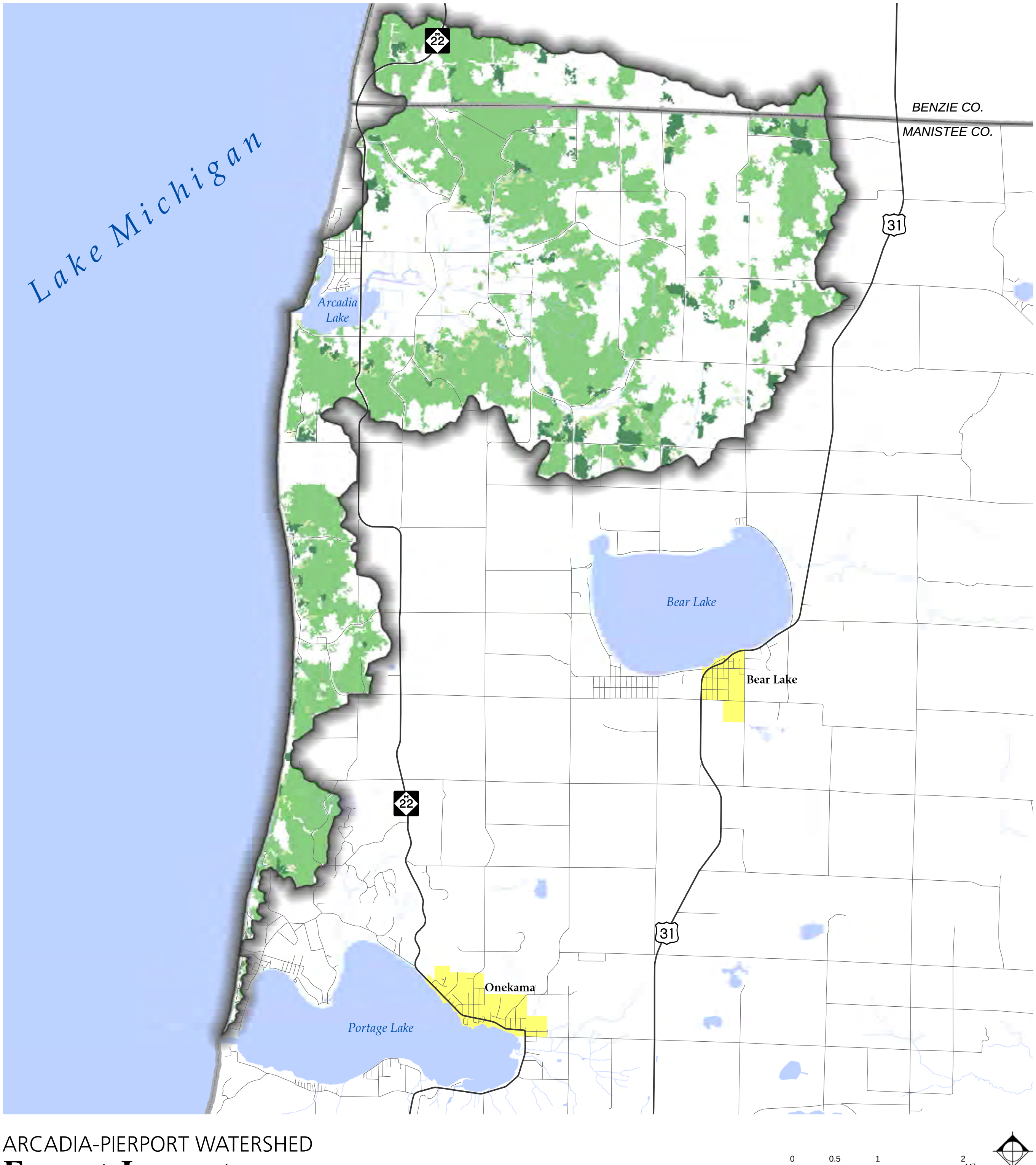
- Watershed Boundary
- City or Village
- County Boundary
- Major Road
- Minor Road

Percent Tree Canopy:

Low, 0% High, 100%

Beckett&Raeder

Map 51: Forest Inventory



ARCADIA-PIERPORT WATERSHED

Forest Inventory

Data Sources: State of Michigan Geographic Data Library, National Land Cover Database

Watershed Boundary
City or Village
County Boundary
Major Road
Minor Road

Forest Type:

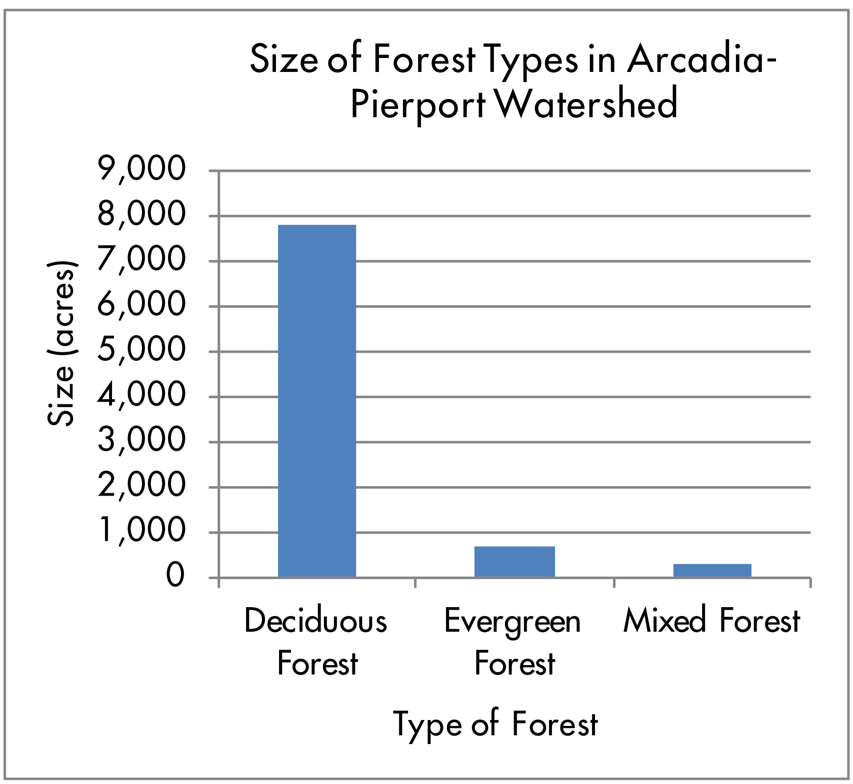
Deciduous Forest
Evergreen Forest
Mixed Forest

Beckett&Raeder

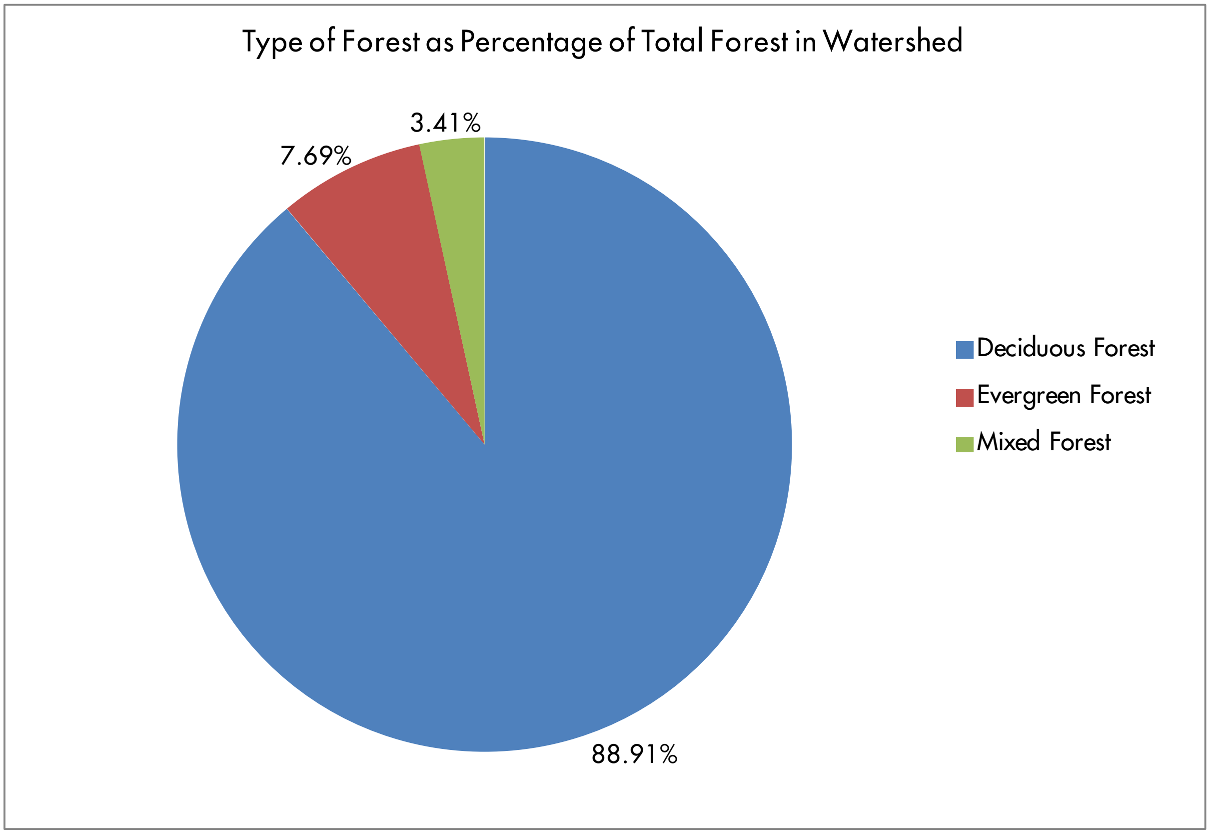
Table 43: Forest Inventory in Watershed
Source: Homer et al., 2015

Type of Forest	*Size (acres)*	*Percentage of Total Forest in Watershed (%)*	*Percentage of Total Land in Watershed (%)*
Deciduous Forest	7,773.87 acres	88.91%	40.96%
Evergreen Forest	672.14 acres	7.69%	3.54%
Mixed Forest	297.90 acres	3.41%	1.57%
Total	*8,743.91 acres*	*~100%*	*46.07%*

Graph 43: Size of Forest Types in Watershed
Source: Homer et al., 2015



Graph 44: Type of Forest as Percentage of Total Forest in Watershed
Source: Homer et al., 2015



Graph 45: Type of Forest as Percentage of Total Land in Watershed
Source: Homer et al., 2015

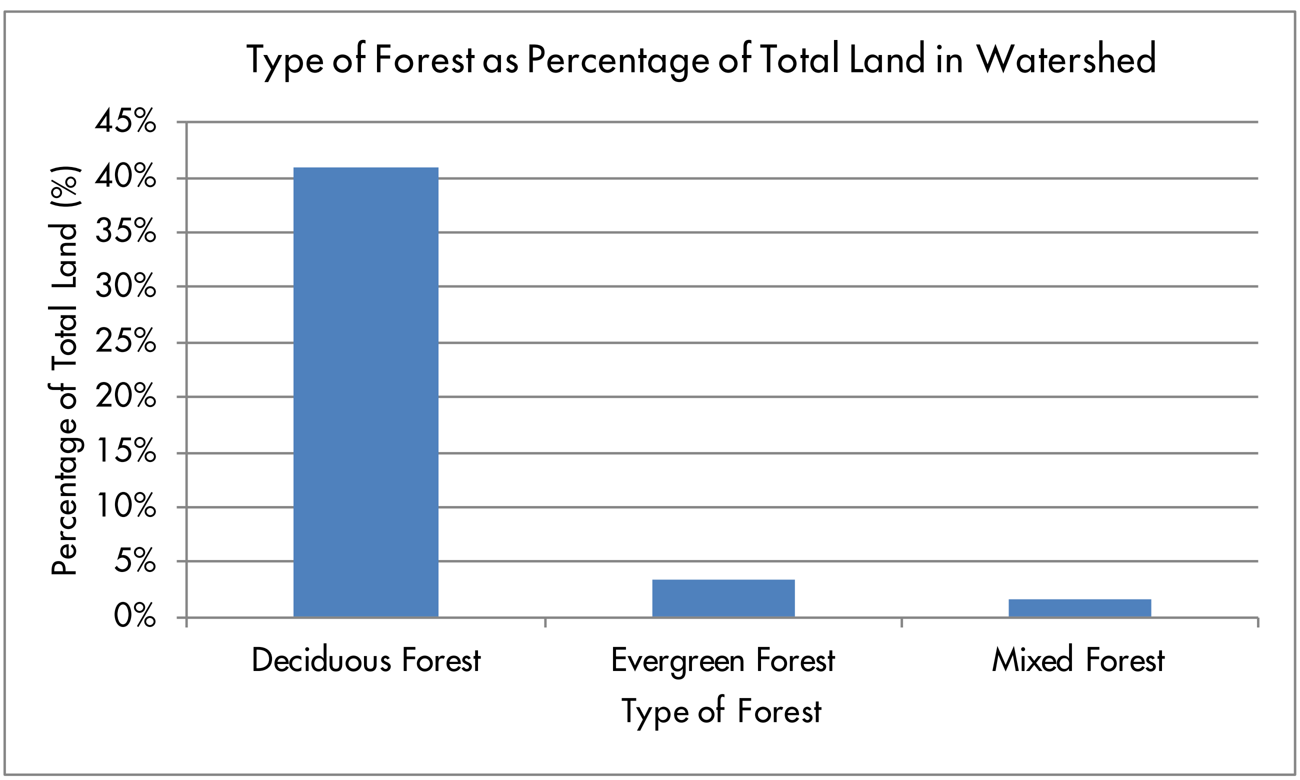


Figure 50: Scenic Forest Landscape

863 parcels (6.6%) are in the Forest land use category. (***Blaine Township Master Plan***, 2014) Joyfield Township has a larger percentage of forestland. 3,737 of the 12,763 acres (29.3%) and 141 of the 669 parcels (21.1%) are in the Forest land use category. There are three forestry businesses in Joyfield Township. (***Joyfield Township Master Plan***, 2014) Arcadia Township has much less forestland. In Arcadia Township, 999 acres of the 11,746 (8.5%) and 30 parcels of 1,024 (2.9%) are in the Forest land use category. (***Arcadia Township Master Plan***, 2014) Pleasanton Township has a larger percentage of forestland than Arcadia Township does but not as much as Joyfield Township does. Forest covers 4,273 of the 23,395 acres (18.3%) in Pleasanton Township, and 114 of the 1,150 parcels (9.9%) are in the Forest land use category. The township has over 2,000 acres of State Forest. (***Pleasanton Township Master Plan***, 2015) Finally, according to the ***Onekama Community Master Plan***, Onekama has 6,272 acres of woodlands, all of which are owned privately. (***Onekama Community Master Plan***, 2010)

Despite the amount of forestland in the watershed, according to the USDA, Forest Service datasets, as of 2015, there is no disclosed timber harvesting and there are no National Forest Lands, National Wilderness Areas, or National Forest System Trails that have been recorded in the watershed itself. (United States Department of Agriculture, Forest Service, n.d.; United States Department of Agriculture, Forest Service, 2015)

There are gaps in regards to whether, where, and to what extent oak wilt disease and emerald ash borer may impact the Arcadia-Pierport Watershed. Oak wilt is a fungal disease that has been greatly impacting the oak tree population in Michigan and elsewhere in the United States. Related to Dutch elm disease, oak wilt kills oak trees. According to a Michigan State University Extension publication, "The fungus that causes oak wilt is likely an exotic species but to date it has not been identified anywhere outside the U.S. The spread and impacts of oak wilt have recently atttracted more attention in Michigan due, in part, to an extensive oak resource across much of the state, which comprised 10 percent of the forest volume in the state. Home construction or utility work in woodland areas, and other human activity, can increase the spread of oak wilt. The disease is present throughout much of the oak range in both the Lower Peninsula and Upper Peninsula." (Cook, 2012) According to MDNR, oak wilt has been confirmed in Benzie and Manistee Counties, and infection centers have been established in federal and state forests in these two counties, as well as six others in the northern portion of the Lower Peninsula. Treatments were given in 2014, and oaks in the infection centers were to be cleared by April 2015. Emerald ash borer has also afflicted many of Michigan's ash trees, leading to mortality, though according to MDNR, Benzie and Manistee Counties have low percentages of ash mortality (***2014 Forest Health Highlights***, n.d.) Watershed Goals I, II, and III in Table 44 address disease and invasive species issues.

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CHAPTER SIX:

PREVIOUS WATERSHED MANAGEMENT EFFORTS

As discussed in CHAPTER TWO, with grant money from a 2009 grant, restoration efforts in Bowens Creek and its tributaries could be funded. Seven culverts were restored, a portion of Bowens Creek was redirected back to its original path, and monitoring of aquatic organisms and habitats was conducted. In the upper watershed sites sampled by the Little River Band of Ottawa Indians Natural Resources Department, habitats were not found to have improved significantly following culvert replacement in 2011, though macroinvertebrate and fish species did change before versus after restoration and diversity increased. In the lower watershed sites sampled by the LRBOI, water quality and fish species changed to more coldwater species than coolwater species following the redirection of Bowens Creek and restoration efforts in Arcadia Marsh. (***Final Technical Report – Arcadia Marsh/Bowens Creek Restoration and Fish Passage***, 2013; Grand Traverse Regional Land Conservancy, n.d.) However, it should be noted that post-restoration monitoring and evaluation are still in progress and may require years. (Sullivan, personal communication, 2015, August 17)

Watershed plans have been completed for adjoining watersheds. A plan was written for the Herring Lakes area in 2003, the ***Portage Lake Watershed Forever Plan*** was written in 2008 with a focus on the area around Portage Lake in Onekama Township, and the ***Greater Bear Watershed Management Plan*** was completed in 2013. However, none of these plans really focused on the area contained in the Arcadia-Pierport Watershed. (***Greater Bear Watershed Management Plan***, 2013; ***Herring Lakes Watershed Management Plan***, 2003; ***Portage Lake Watershed Forever Plan***, 2008) Refer to Map 1 in CHAPTER ONE to see a depiction of adjoining watersheds.

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CHAPTER SEVEN:

ARCADIA-PIERPORT WATERSHED GOALS AND OBJECTIVES

Five Watershed Goals and Objectives for the Arcadia-Pierport Watershed are discussed below and shown in Table 44. These Watershed Goals and Objectives were determined based on the information included in this Plan and consideration of water resources. Refer to CHAPTER NINE for specific tasks/actions based on these Goals and Objectives.

A very important goal for this Plan is to **I. Protect waterbodies, sources, and quality within the watershed and other resources that affect the watershed**. An objective is to reduce pollution from potential sources in the watershed, including those discussed in CHAPTER FOUR, whether residential, agricultural, commercial, or development-related. Inventorying nonpoint sources of pollution would be a good first step. According to the EPA, "Water pollution prevention and control measures are critical to improving water quality and reducing the need for costly wastewater and drinking water treatment. Because water pollution can come from many different sources, a variety of pollution prevention and control measures are needed." (United States Environmental Protection Agency, 2013) On the webpage, the EPA provides information on green infrastructure, runoff and sediments, and conservation of water sources, among other things. (United States Environmental Protection Agency, 2013) Another objective is to protect water and other natural resources, Priority Protection Areas, and High Priority Areas in the watershed through, for example, best management practices, including permanent conservation easements. One recommended action is analysis of the road/stream crossings in the watershed and their impacts. A third objective is to identify, control, and treat disease and invasive species issues, including those mentioned in the Plan.

A second goal is to **II. Increase and complete comprehensive monitoring, inventorying, and data collection on water quality and other resources that affect the watershed**. There is a real need for additional scientific and technical data specific to the Arcadia-Pierport Watershed. One particular objective would be to complete a detailed water quality study in the watershed on a variety of parameters, including nitrates. Other objectives are to complete studies of potential pollutants in the watershed and a variety of detailed inventories of the watershed, including of invasive species. This is a particularly important goal because information obtained from these studies and inventories could be used to update this Plan and could also help to focus watershed management efforts. Additional monitoring focused on areas identified as high priorities in the Priority Parcel Analysis discussed in CHAPTER FOUR is recommended.

A third goal is to **III. Promote citizen engagement and create support programs for the watershed**. Objectives are to educate citizens about water quality, pollution, and invasive species and other issues and involve citizens in water quality monitoring. As Ellen J. Kohler discusses in ***A Citizen's Guide to Water Quality Permitting: Understanding the National Pollutant Discharge Elimination System (NPDES) Program and Its Role in Michigan***, local citizens can get involved in monitoring. Kohler writes, "Water quality monitoring includes a wide range of activities involving observation and measurement of selected features in order to assess the health of the aquatic ecosystem, determine its ability to support human uses, detect early warnings of changes, gather information about causes of problems, and determine whether management goals have been achieved." (Kohler, 2005) Citizens can look for point source pollution and report offenses to the MDEQ, but there is protocol to follow, so those wanting to get involved should familiarize themselves it. The assistance of residents in monitoring is especially important in places where there is little staff support. As Kohler puts it, "Particularly with limited enforcement staff, citizens can serve as a watershed's 'eyes and ears' to help protect water quality." (Kohler, 2005) Increased water quality monitoring and data collection would serve two key purposes. First, more water quality data would be available, which would be beneficial in terms of filling data gaps, assessing the watershed's water quality on a more long-term and large-scale basis, and determining key areas to protect, monitor, and target for pollution prevention activities. Secondly, it is a relatively simple way to get local residents involved in the Arcadia-Pierport Watershed; the more people are involved, the more they are likely to care about the watershed.

Another objective is to encourage formation of a local watershed organization or participation with other watersheds to form a regional watershed organization that could spearhead the more technical studies, inventories, and monitoring needs, work on controlling invasive species, and serve as the point organization responsible for the Arcadia-Pierport Watershed. The Watershed Center Grand Traverse Bay is one example of a Michigan organization centered around a watershed – specifically, the Grand Traverse Bay Watershed. According to The Watershed Center Grand Traverse Bay's website, "The Watershed Center advocates for clean water in Grand Traverse Bay and acts to protect and preserve the Bay's watershed." (The Watershed Center Grand Traverse Bay, 2011d) With a staff of just eight people, the organization has achieved a great deal on behalf of the Grand Traverse Bay Watershed. (The Watershed Center Grand Traverse Bay, 2011a; The Watershed Center Grand Traverse Bay, 2011c) As stated on the organization's website, "Since 2003, The Watershed Center has brought more than $7 million to our region to implement our EPA-approved Grand Traverse Bay Watershed Protection Plan." (The Watershed Center Grand Traverse Bay, 2011a)

Another notable organization in Michigan is the Tip of the Mitt Watershed Council in Petoskey, which works in support of numerous waterbodies and watersheds. According to its website, "The Tip of the Mitt Watershed Council speaks for Northern Michigan's waters. We are dedicated to protecting our lakes, streams, wetlands, and groundwater through respected advocacy, innovative education, technically sound water quality monitoring, thorough research and restoration actions…Tip of the Mitt Watershed Council is the lead organization for water resources protection in Antrim, Charlevoix, Cheboygan, and Emmet Counties." (Tip of the Mitt Watershed Council, 2015a) With nine employees, the help of volunteers, and the support of over 2,000 members, the Tip of the Mitt Watershed Council has been working since 1975 to protect, advocate for, and monitor the waters of its service area in northern Michigan. (Tip of the Mitt Watershed Council, 2015b; Tip of the Mitt Watershed Council, 2015d) Both organizations also work on management of invasive species in their respective watersheds. (Tip of the Mitt Watershed Council, 2015c; The Watershed Center Grand Traverse Bay, 2011b) An organization similar to these would be particularly beneficial in the Arcadia-Pierport Watershed, not only for technical support, but to help protect the watershed and implement and coordinate watershed activities and implementation of this Plan. As it is also important to control and eliminate aquatic invasive species like Eurasian watermilfoil, phragmites, and reed canary grass in the Arcadia-Pierport Watershed, a watershed organization would also be an asset in this regard. (Grand Traverse Regional Land Conservancy, n.d.; Tonello, 2012) Though it may start smaller than The Watershed Center Grand Traverse Bay or the Tip of the Mitt Watershed Council, creation of such an organization in the Arcadia-Pierport Watershed is a worthwhile objective.

A final objective within this goal is to create support programs. For instance, adoption of Riparian Buffer Ordinances is recommended. A ***Riparian Buffers and Ordinance*** Zoning Template was developed as part of the Lakes to Land Regional Initiative, and, according to the Riparian Buffers and Ordinance document, "One simple, yet extremely effective tool for protecting the health and integrity of waterways is the use of vegetated buffers along its riparian (streamside) corridors. These riparian buffers are areas of vegetation located immediately adjacent to a water body or stream system." (***Riparian Buffers and Ordinance***, n.d.) The document provides guidance for writing a Riparian Buffer Ordinance and designing riparian buffers. (***Riparian Buffers and Ordinance***, n.d.) Other programs that could be useful include stormwater management and installation of a boat washing station. A floodplain protection overlay district could also be of value, although currently there are major gaps in Federal Emergency Management Agency-defined floodplain boundaries for the watershed area. (Federal Emergency Management Agency, 2015)

A fourth goal is to **IV. Install public utilities to replace septic tanks in areas where densities exceed three housing units per acre**, as this would help to protect waterbodies from pollution. As discussed in CHAPTER FOUR, most of the jurisdictions in the Arcadia-Pierport Watershed do not have public sanitary sewer and water systems, instead relying on septic tanks and wells. The Village of Onekama does provide sewer service but does not have a public water system. (Arcadia Township Master Plan, 2014; ***Blaine Township Master Plan***, 2014; ***Joyfield Township Master Plan***, 2014; ***Onekama Community Master Plan***, 2010; ***Pleasanton Township Master Plan***, 2015) Thus, replacement of septic systems and wells with public utilities is an important goal. The EPA can provide small communities with financial and professional support in regards to smaller scale public water and wastewater systems and has resources online. (United States Environmental Protection Agency, 2012a, March 6; United States Environmental Protection Agency, 2015) Another option is a cluster system, which can be used in communities with smaller populations. According to a report entitled ***Small Community Wastewater Cluster Systems***, "Cluster systems…collect wastewater from a small number of homes, usually 2 to 10, and transport it via an alternative sewer to a pretreatment and land absorption area with no surface discharge of effluent." (Jones, Bauer, Wise, and Dunn, 2001) There are various types of alternative sewers, which are discussed in the report. Though the report is a publication of the Purdue University Cooperative Extension Service and some information is specific to Indiana, it is nonetheless a valuable resource. Cluster systems can have environmental benefits, and in Indiana, at least, cluster systems are advantageous as they can be lower-cost alternatives. There are important considerations with this type of system, which are outlined in the report. (Jones, Bauer, Wise, and Dunn, 2001) Objectives are for the watershed communities to choose and install public sanitary sewer systems or alternative systems to replace septic tanks in watershed communities and install public water systems to replace wells in watershed communities. Currently, Arcadia Township is a recipient of a Stormwater, Asset Management, and Wastewater Grant to perform a feasibility study of a public sanitary sewer system. In regards to wells and septic systems, an important objective is to maintain existing septic tanks and wells. Educating residents about their wells and septic systems is critical; the EPA's ***Do your Part – Be SepticSmart!: A Homeowners' Guide to Septic Systems*** publication can be helpful in this endeavor. (United States Environmental Protection Agency, 2012b, March 6; United States Environmental Protection Agency, 2012, September)

A fifth goal is to **V. Use green infrastructure in the watershed** because of the benefits that green infrastructure provides in terms of water quality. The EPA describes green infrastructure on its website as, "Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. (United States Environmental Protection Agency, 2014) There are many types of green infrastructure, including rain gardens and rain barrels, bioswales, green roofs and green streets, permeable pavement, and trees and open spaces. According to the EPA website, "Rain gardens (also known as bioretention cells) are shallow, vegetated basins that collect and absorb runoff from rooftops, sidewalks, and streets. Rain gardens mimic natural hydrology by infiltrating and evapotranspiring runoff. Rain gardens are versatile features that can be installed in almost any unpaved space"; rain barrels allow for the collection of rainwater; "Bioswales are vegetated, mulched, or xeriscaped channels that provide treatment and retention as they move stormwater from one place to another. Vegetated swales slow, infiltrate, and filter stormwater flows. As linear features, vegetated swales are particularly suitable along streets and parking lots"; "Green roofs are covered with growing media and vegetation that enable rainfall infiltration and evapotranspiration of stored water"; "Green streets and alleys integrate green infrastructure elements into the street and/or alley design to store, infiltrate, and evapotranspire stormwater. Permeable pavement, bioswales, planter boxes, and trees are among the many green infrastructure features that may be woven into street or alley design"; "Permeable pavements are paved surfaces that infiltrate, treat, and/or store rainwater where it falls. Permeable pavements may be constructed from pervious concrete, porous asphalt, permeable interlocking pavers, and several other materials"; and trees and open spaces allow for natural infiltration of water. (United States Environmental Protection Agency, 2014) In addition to the stormwater management benefits of green infrastructure, it also has assets in terms of water management and water quality in general, air quality, and wildlife habitat, among others, and can work in rural, as well as urban, environments.

Table 44: Watershed Goals and Objectives

Watershed Goals and Objectives
I. Protect waterbodies, sources, and quality within the watershed and other resources that affect the watershed
• Reduce pollution from potential sources in the watershed
• Protect water and other natural resources, Priority Protection Areas, and High Priority Areas in the watershed through, for example, best management practices, including permanent conservation easements
• Identify, control, and treat disease and invasive species issues, including those mentioned in the Plan
II. Increase and complete comprehensive monitoring, inventorying, and data collection on water quality and other resources that affect the watershed
• Complete a detailed water quality study in the watershed on a variety of parameters, including nitrates
• Complete studies in the watershed on potential pollutants
• Complete a variety of detailed inventories of the watershed, including of invasive species
III. Promote citizen engagement and create support programs for the watershed
• Educate citizens about water quality, pollution, and invasive species and other issues
• Involve citizens in water quality monitoring
• Encourage formation of a local watershed organization or participation with other watersheds to form a regional watershed organization
• Create support programs
IV. Install public utilities to replace septic tanks in areas where densities exceed three housing units per acre
• Choose and install public sanitary sewer systems or alternative systems to replace septic tanks in watershed communities
• Install public water systems to replace wells in watershed communities
• Maintain existing septic tanks and wells
V. Use green infrastructure in the watershed
• Support and invest in green infrastructure in watershed communities
• Review and adopt stormwater management ordinances

The Regional Plan Association's report, ***9 Ways to Make Green Infrastructure Work for Towns and Cities***, provides a thorough and fascinating overview of green infrastructure at various scales and ideas for and examples of successful implementation from around the country, including incentive-based programs. According to the report, "Green infrastructure systems – which help manage stormwater and wastewater through conservation of forests, fields and wetlands as well as engineered processes that draw inspiration from nature – offer great promise for improving water resource management in urban areas. Green infrastructure systems encourage infiltration and reduce peak flows to streets and storm sewers. They have been used to successfully address a variety of critical water management goals, including protecting clean drinking water, providing water for irrigation and protecting people and property from flooding." (Winters, Piasecki, and Pirani, 2012) An objective is to support and invest in green infrastructure in watershed communities. Because of the many benefits of green infrastructure, installation and use of green infrastructure throughout the watershed, even if only on a small scale, is the ultimate goal. Another objective is to review and adopt stormwater management ordinances. Adoption of an innovative ordinance focusing on stormwater management is recommended. The Regional Plan Association report addresses "Wetlands, Stream Corridors (man-made and restored), and Floodplain Ordinances," saying, "Sensitive hydrological functions are protected to provide stormwater storage capacity and minimize flooding." (Winters, Piasecki, and Pirani, 2012)

Table 44 displays the five Watershed Goals (highlighted) and the Objectives within those Goals based on the preceding discussion.

Table 45 describes how the goals could address or relate to various designated and desired uses.

Table 45: How Watershed Goals Could Address Designated and Desired Uses of Watershed
Sources: Arcadia Township Master Plan, 2014; Arcadia Township Visioning Session Results, n.d.; Benzie County 2020 Comprehensive Plan, 2000; Blaine Township Master Plan, 2014; Little River Band of Ottawa Indians Future Land Use Plan, 2005; Manistee County Master Plan 2008, 2009; Onekama Community Master Plan, 2010; Part 4. Water Quality Standards, n.d.; Pleasanton Township Master Plan, 2015; Pleasanton Township Visioning Summary, n.d.

Watershed Goal	*Potentially Relevant Designated Uses*	*Potentially Relevant Desired Uses*
I. Protect waterbodies, sources, and quality within the watershed and other resources that affect the watershed	Coldwater fisheries; warmwater fisheries; other native species; partial body contact recreation; total body contact recreation; consumption of fish; public water supply; industrial water supply; salmonid migration routes; agriculture; navigation	Enhance and maintain water quality; conserve wildlife, fisheries, and habitat; eliminate aquatic invasive species; preserve aesthetic quality and scenic beauty; manage resources properly; protect wetlands, water, and other natural resources; control pollution; ensure that development is compatible and does not increase pollution or destroy natural resources; minimize harm to the environment; reduce runoff; encourage adherence to best management practices; curtail erosion; care for the environment and natural resources
II. Increase and complete comprehensive monitoring, inventorying, and data collection on water quality and other resources that affect the watershed	Coldwater fisheries; warmwater fisheries; other native species; partial body contact recreation; total body contact recreation; consumption of fish; public water supply salmonid migration routes	Enhance and maintain water quality; conserve wildlife, fisheries, and habitat; eliminate aquatic invasive species; manage resources properly; protect wetlands, water, and other natural resources; control pollution; encourage adherence to best management practices; care for the environment and natural resources
III. Promote citizen engagement and create support programs for the watershed	Coldwater fisheries; warmwater fisheries; other native species; partial body contact recreation; total body contact recreation; consumption of fish; public water supply; salmonid migration routes; agriculture; navigation	Enhance and maintain water quality; conserve wildlife, fisheries, and habitat; eliminate aquatic invasive species; preserve aesthetic quality and scenic beauty; manage resources properly; protect wetlands, water, and other natural resources; control pollution; ensure that development is compatible and does not increase pollution or destroy natural resources; minimize harm to the environment; reduce runoff; encourage adherence to best management practices; curtail erosion; care for the environment and natural resources
IV. Install public utilities to replace septic systems in areas where densities exceed three housing units per acre	Coldwater fisheries; warmwater fisheries; other native species; partial body contact recreation; total body contact recreation; consumption of fish; public water supply	Enhance and maintain water quality; protect wetlands, water, and other natural resources; control pollution; ensure that development is compatible and does not increase pollution or destroy natural resources; minimize harm to the environment; encourage adherence to best management practices; care for the environment and natural resources
V. Use green infrastructure in the watershed	Other native species; public water supply	Enhance and maintain water quality; permit access to water and other natural resources; preserve aesthetic quality and scenic beauty; manage resources properly; protect wetlands, water, and other natural resources; ensure that development is compatible and does not increase pollution or destroy natural resources; minimize harm to the environment; reduce runoff; encourage adherence to best management practices; care for the environment and natural resources

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CHAPTER EIGHT:

LOCAL PROGRAMS, PROJECTS, AND PLANNING

This chapter provides an overview of planning and programs in the area but is not necessarily a complete or comprehensive overview of all programs, projects, ordinances, and organizations in the Arcadia-Pierport Watershed. The primary material used to write the chapter included information from websites for jurisdictions and organizations.

Figure 51: Benzie County and Blaine Township Signage

Local Government Planning and Zoning

As discussed in CHAPTER THREE, two counties (Benzie and Manistee Counties), five townships (Blaine, Joyfield, Arcadia, Pleasanton, and Onekama Townships), and two communities (Arcadia and Pierport) are a part of the Arcadia-Pierport Watershed. Refer to Figure 24 and Graph 5 in CHAPTER THREE. (State of Michigan, 2013)

In regards to planning and zoning in Benzie County, the Planning and Zoning Department closed, but there is a Planning Commission and Equalization Department. Zoning is done at the township level in Benzie County; Blaine Township has a Zoning Administrator, but Joyfield Township does not. (Benzie County, Michigan County Government, 2011; Benzie County, Michigan County Government, 2015, June 19) Among the Benzie County planning documents are a master plan from 2000, other plans on more specific topics, including natural resources and recreation, and reports on topics ranging from agriculture and forestry to water resources. (Benzie County, Michigan County Government, 2015, March 26)

There are seven members of the Planning Commission in Benzie County. According to the Benzie County website, the aims of the Planning Commission include the following:

- "Adopt, amend or review the county master plan;
- Work to objectively implement the county master plan;
- Encourage intergovernmental cooperation and communication by identifying common planning goals among local units of government for county wide comprehensive planning;
- Provide an annual oral and[/]or written report to legislative bodies of the county concerning its operation and status of planning activities;
- Engage the public on planning issues within the county and provide educational opportunities wherever possible;
- Provide an annual capital improvement plan. Review and comment on proposed capital improvement projects of the county."

(Benzie County, Michigan County Government, 2015, March 26)

In Manistee County, there is a Planning Department with a County Planner and a Planning Commission. (Manistee County, Michigan, 2013) Zoning in Manistee County is at the township or village level. (Manistee County, Michigan, 2009) The Planning Department is tasked with the following:

- "To make studies, surveys on the physical development of the county.
- To formulate plans and recommendations for the most effective economic, social and physical development of the county.
- To coordinate with federal, state, municipal, public agencies.
- To coordinate planning programs in adjacent counties and to avoid conflicts in overall county plans.
- Prepare long-range development plans."

(Manistee County, Michigan, 2011a)

Arcadia and Pleasanton Townships each have a Planning Commission and a Zoning Administrator (Arcadia Township, Michigan, 2011a; Arcadia Township, Michigan, 2011b; Pleasanton Township, Manistee County, Michigan, n.d.a; Pleasanton Township, Manistee County, Michigan, n.d.b) Onekama Township has a Planning Commission, Zoning Administrator, and Zoning Board of Appeals; the Village of Onekama has a Planning Commission and Zoning Administrator. (Onekama.info, 2015c; Onekama.info, 2015d)

Master plans for Arcadia, Blaine, Joyfield, and Pleasanton Townships were created as part of the Lakes to Land Regional Initiative. (Lakes to Land Regional Initiative, n.d.a) The ***Onekama Community Master Plan*** is from 2010 and represents a joint planning effort between Onekama Township and the Village of Onekama. (***Onekama Community Master Plan***, 2010)

The Little River Band of Ottawa Indians has a Planning Department and a Planner. According to the LRBOI website, the department is "Responsible for Planning, Development and Management of all aspects of Community Planning, master plan development, comprehensive, natural resources, and redevelopment planning: ordinance development; plan implementation strategies; and the design and facilitation of related public participation programs." (Little River Band of Ottawa Indians, 2015c) Among the LRBOI planning documents are plans on future land use, transportation, and renewable sources of energy. (Little River Band of Ottawa Indians, 2015c)

Local Ordinance Analysis

Ordinances in Benzie County relate to the Planning Commission, soil erosion, off-road vehicles, animal control, and trails in the Betsie Valley. (Benzie County, Michigan County Government, 2015, July 11) The ***Benzie County Soil Erosion, Sedimentation and Stormwater Control (SESSC) Ordinance*** addresses waterbodies and resources, stormwater, erosion, pollution, groundwater, and construction and development activities that may induce erosion. According to the ordinance, "The purpose of this Ordinance is to prevent the pollution, impairment, or destruction of a natural resource or the public trust in Benzie County." (***Benzie County Soil Erosion, Sedimentation and Stormwater Control (SESSC) Ordinance***, 2002)

Blaine Township, Benzie County, Michigan: Zoning Ordinance was adopted in 2012. The ordinance addresses waterbodies and resources, properties with access to water, stormwater, groundwater, buffers (though a riparian buffer is only mentioned once and in the definitions section), and sewer and water facilities and the zoning districts in the county with provisions for these services. (***Blaine Township, Benzie County, Michigan: Zoning Ordinance***, 2012)

Zoning Ordinance: Arcadia Township, Manistee County, Michigan became effective in 2005. It addresses waterbodies, properties on water, a "natural vegetation strip," and sewer and water facilities. (***Zoning Ordinance: Arcadia Township, Manistee County, Michigan***, 2005)

According to Pleasanton Township's website, "Due to the age of the Zoning Ordinance that was posted on this site it has been removed. We will be posting a revised version as soon as we can in 2014." (Pleasanton Township, Manistee County, Michigan, n.d.b) As of July 2015, no updated ordinance has been added to the webpage. (Pleasanton Township, Manistee County, Michigan, n.d.b)

Onekama Township has numerous ordinances. They relate to zoning, subdivisions, infrastructure, sewer systems, floods, and pollution, among others. (Onekama.info, 2015a) The ***Onekama Township Permanent***

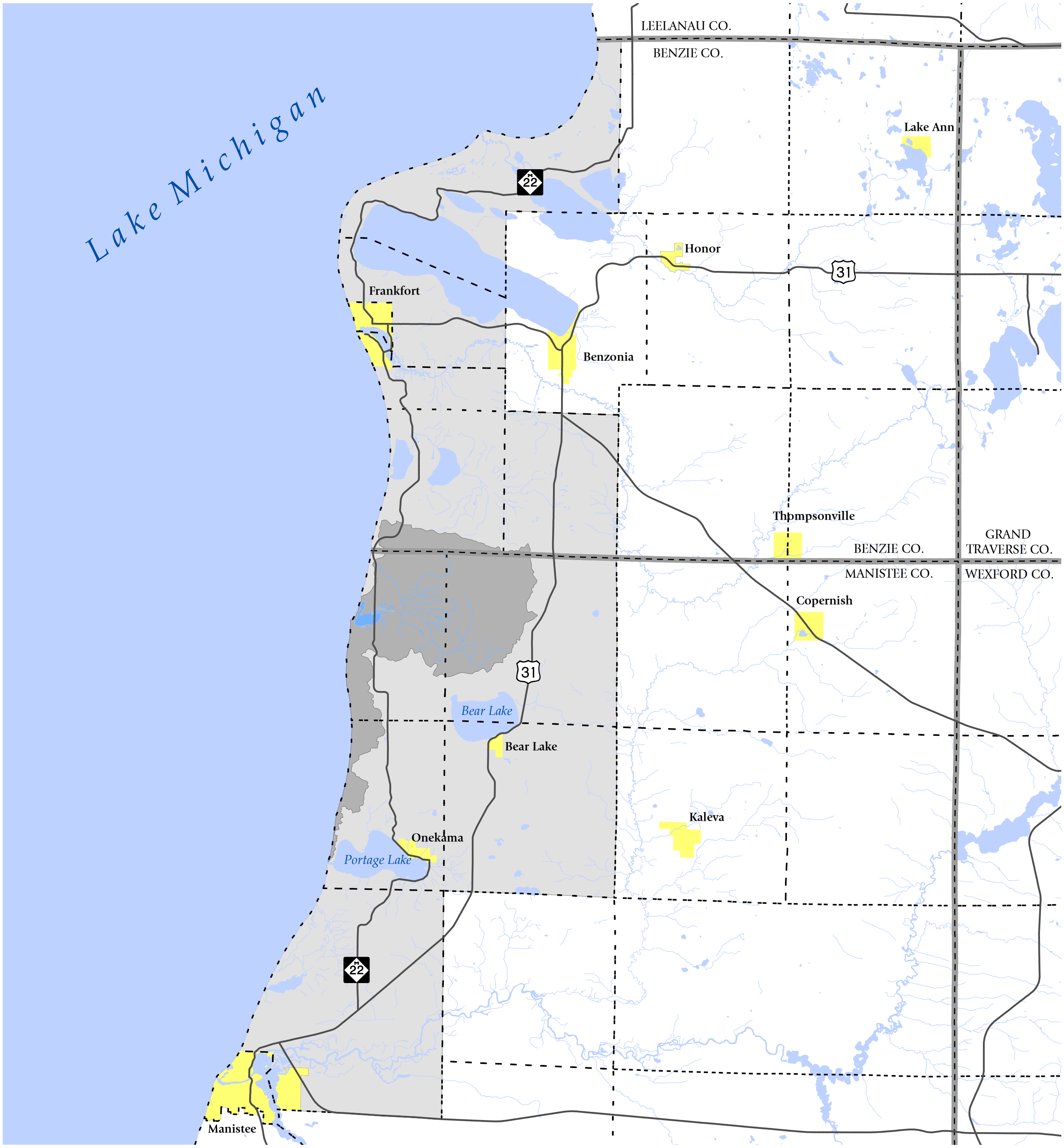
Figure 52: Onekama Township Signage

Zoning Ordinance of 1991 addresses water resources, properties with access to water, groundwater, stormwater, sewer and water facilities, and buffers (but not riparian buffers). (***Onekama Township Permanent Zoning Ordinance of 1991***, 2008)

The Village of Onekama also has numerous ordinances, including its zoning ordinance. (Onekama.info, 2015b) The ***Onekama Village Zoning Ordinance*** addresses waterbodies and resources, water and sewer facilities, pollution, impervious surfaces, stormwater, properties with access to water, pollution, and a "Riparian Setback." (***Onekama Village Zoning Ordinance***, 2014) In regards to these setbacks, there are various regulations, including that "Each parcel in the Village which has a stream or creek within or adjacent to the property lines of the parcel shall be subject to the Riparian Setback of ten (10) feet from the banks of a stream or creek…," and that "The Riparian Setback from the shoreline of Portage Lake shall be thirty (30) feet measured on a horizontal plane landward from the Ordinary High-Water Mark." (***Onekama Village Zoning Ordinance***, 2014)

The Little River Band of Ottawa Indians has various regulations, though none relates to zoning. Regulations do, however, concern environmental issues and camping. (Little River Band of Ottawa Indians, 2015d) The ***Chapter 500 – Environmental: Part 1 Natural Resources Commission Regulations*** addresses waterbodies and resources, fishing, and "the 1836 treaty [ceding] waters of Lakes Superior, Huron, and Michigan." (***Chapter 500 – Environmental: Part 1 Natural Resources Commission Regulations***, 2005)

Map 52: Arcadia-Pierport Watershed within Lakes to Land Region



ARCADIA-PIERPORT WATERSHED

Watershed Within Lakes to Land Region

Data Sources: State of Michigan Geographic Data Library

0 1.5 3 6 Miles

- City or Village
- County Boundary
- Township Boundary
- Major Road
- Arcadia-Pierport Watershed Boundary
- Lakes to Land Regional Boundary

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Joint Planning - Lakes to Land Regional Initiative

The Arcadia-Pierport Watershed Plan is part of the Lakes to Land Regional Initiative (L2L). Refer to Map 52 to see how the watershed fits within the Lakes to Land region. (Lakes to Land Regional Initiative, n.d.b)

According to the Lakes to Land Regional Initiative website, "The Lakes to Land Regional Initiative is a unique joint planning effort among the northwestern Michigan townships of Arcadia, Blaine, Crystal Lake, Gilmore, Bear Lake, Joyfield, Lake, Manistee, Onekama, and Pleasanton; the Villages of Honor, Onekama, Bear Lake, and Elberta; the Cities of Frankfort and Manistee; and the Little River Band of Ottawa Indian tribe. It seeks to bring voices from throughout the region into an articulation of a vision for the region's future. This process resulted in a series of nine master plans, adopted in 2014-2015, which include a detailed assessment of the community, coming to consensus on a shared vision, and translating this vision into policy and action statements…The communities have now begun collaborating on a clear set of strategies for achieving that vision, erasing municipal boundaries to view the region as a whole. Two zoning templates have been written to address common regional themes. A Food and Farm System Assessment was undertaken to provide a comprehensive understanding of the substantial agricultural outputs of the region. The Arcadia-Pierport Watershed Committee has formed to protect the water quality that emerged as a priority in nearly all of the Visioning Sessions. Each of these efforts grew from a wider understanding of the common challenges and opportunities experienced by participating communities, and has been fueled and supported by the relationships developed over the course of over two years of intense planning work… The Lakes to Land process has been a grass-roots, bottom-up effort conducted by the hardworking citizens dedicated to serving and preserving this majestic region." (Lakes to Land Regional Initiative, n.d.a)

Of the jurisdictions within the L2L region that are relevant to the Arcadia-Pierport Watershed, new plans were created for Arcadia, Blaine, Joyfield, and Pleasanton Townships. (Lakes to Land Regional Initiative, n.d.a) The new master plans created as part of the Lakes to Land Regional Initiative contain the same first sections (Introduction, Context, and Community Engagement), as well as the Implementation section towards the end, with a unique focus on each community at the center. The plans themselves provide a fascinating overview of the Lakes to Land Regional Initiative planning process, a remarkable and unprecedented regional effort. According to the ***Arcadia Township Master Plan***, for instance, "A project that began as five townships striving for better coordination has expanded into the largest planning effort of its kind in the state. Ten townships, four villages, and two cities have come together to define themselves as belonging to one cohesive region with the potential to become more than the sum of its parts…For the purposes of this planning process, a collaborative master plan is a document that contains an articulated vision, with defined goals and strategies, for the future development of a geographic area based upon input from members of more than one community…The process of developing the collaborative and individual master plans began with the formal development of a Leadership Team." (***Arcadia Township Master Plan***, 2014) Visioning sessions were held in many of the participating communities to gather citizen input as part of the planning process, and following the writing of the plans, the entire Lakes to Land Regional Initiative community came together to share with and learn from each other. As described in the ***Arcadia Township Master Plan*** document, "the Priority Sharing Meeting accomplished much of what was hoped would be done at the Convention of Communities by providing a forum to view and discuss the collaboration as a whole with fresh plans in hand, and by presenting the collaboration to a wider audience." (***Arcadia Township Master Plan***, 2014)

The plans that resulted from the Lakes to Land Regional Initiative are not only comprehensive and beautifully designed plans but also exhibit a regional, in addition to local, focus. Implementation is another important aspect of the Lakes to Land Regional Initiative, and continued collaboration is stressed, for, as stated in the ***Arcadia Township Master Plan***, "Being armed with knowledge is important, but putting that knowledge to use is what L2L is all about. With the master plans written, communities are faced with the charge of implementing them." (***Arcadia Township Master Plan***, 2014)

In addition to the comprehensive plans, several other documents emerged from the Lakes to Land Regional Initiative. The ***Arcadia Township Parks and Recreation Plan 2013-2018*** provides an overview of recreation in Arcadia, assesses recreational facilities and needs, and sets forth goals. (***Arcadia Township Parks and Recreation Plan 2013-2018***, 2013) The ***Farm and Food System Assessment*** provides a comprehensive agricultural inventory of the region and overview of farming and food in the area based on interviews and analyses. (***Farm and Food System Assessment***, 2014) Three Zoning Templates were also developed as part of the Lakes to Land Regional Initiative. The ***Riparian Buffers and Ordinance*** document provides guidance for writing a Riparian Buffer Ordinance and designing riparian buffers. (***Riparian Buffers and Ordinance***, n.d.) The ***Dark Sky Ordinance*** and ***Blight Ordinance*** documents provide guidance for writing those types of ordinances. (***Blight Ordinance***, 2014; ***Dark Sky Ordinance***, n.d.).

There are multiple instances of public outreach and communication as part of the Lakes to Land Regional Initiative. The numerous tabs on the Lakes to Land Regional Initiative website (http://www.lakestoland.org/) direct visitors to the multitude of plans and documents that have been created as part of the Lakes to Land Regional Initiative, as well as information about the project and participating communities. In addition to the website, the Lakes to Land Regional Initiative maintains a Facebook page (https://www.facebook.com/LakesToLand) and Twitter account (https://twitter.com/lakestoland) that provide updates, news, and interesting links.

Figure 53: View of Coastline from Inspiration Point

Figure 54: Grand Traverse Regional Land Conservancy's Arcadia Dunes Preserve Signage

Other Agencies and Local Organizations

State agencies like the Michigan Department of Natural Resources and the Department of Environmental Quality both have a presence in the northwestern Michigan region. (State of Michigan, 2015a; State of Michigan, 2015b) MDNR has a Customer Service Center in Cadillac for Benzie, Manistee, and eight other counties. According to the website, "These customer service centers are open to the public Monday through Friday 8 a.m. to 5 p.m., and staff there is ready to help customers who want to buy a license, ask a question, learn about seasonal regulations, invite the DNR to participate in a school or community program, or simply learn more about Michigan's terrific outdoor recreation opportunities." (State of Michigan, 2015b) Among other things, MDNR is responsible for fishing and recreation. (State of Michigan, 2015b) MDEQ also has a District Office in Cadillac which serves Benzie and Manistee Counties and eight others. According to its website, "The Michigan Department of Environmental Quality has established district and field offices to provide department services throughout the state. District and field office employees provide information about department programs, review and process permit applications, provide pollution prevention assistance to regulated entities, assess the compliance status of regulated entities, and meet with stakeholder groups to encourage public participation in the regulatory process." (State of Michigan, 2015a) MDEQ is responsible for Michigan's water, land, and air. (State of Michigan, 2015a; State of Michigan, 2015c) In regards to water, "The DEQ ensures Michigan's water resources remain clean and abundant by establishing water quality standards, overseeing public water supplies, regulating the discharge of industrial and municipal wastewaters, monitoring water quality and the health of aquatic communities, developing policy, and fostering stewardship. Water-related program staff provide for the protection, restoration and conservation of Michigan's Great Lakes, inland lakes and streams, wetlands, and groundwater." (State of Michigan, 2015c)

The Conservation Districts in Michigan are also state agencies. The Benzie Conservation District is in Beulah, and the Manistee Conservation District is in Bear Lake. (Michigan Association of Conservation Districts, 2010a; Michigan Association of Conservation Districts, 2010b) According to the Michigan Association of Conservation Districts website, "Michigan's Conservation Districts are 'unique' local units of State Government, that utilize state, federal and private sector resources to solve today's conservation problems. The guiding philosophy of all Conservation Districts is that decisions on conservation issues should be made at the local level, by local people, with technical assistance provided by government. Created to serve as stewards of natural resources, Michigan's Conservation Districts take an ecosystem approach to conservation and protection. Conservation Districts provide conservation programs and services, as well as linking land owners and managers to other programs and opportunities available…Programs carried out by Conservation Districts are as diverse as the landscape in Michigan, ranging from the Michigan Agriculture Environmental Assistance Program to water quality and wildlife programs." (Michigan Association of Conservation Districts, 2010b) The Benzie Conservation District has programs related to waterbodies and quality, conservation, farms, forests, and invasive species. According to the website, "The District's purpose is to foster the best use of land for the present and future benefits of the community, based on the land's capabilities and landowners goals. Combating soil erosion, managing surface and groundwater quality and promoting the maintenance of the lands[-]related resources and the aesthetic values are vital to the community's long range economic well being, from food and timber production to natural resources[-] related industries and tourism. To these ends, the District strives to be a 'gateway' to resource management information and service providers, so that citizens may manage their lands for a healthier Benzie County. The Benzie Conservation District provides information and assistance for...conservation and environmental concerns." (Benzie Conservation District, 2012a) It has an invasive species program, wherein, "The Benzie Conservation District is working hard to increase the awareness of the number of invasive species that have invaded terrestrial, wetland, and aquatic habitats in Benzie County. In addition to education, we are leading the effort to inventory, monitor, and control invasive species," including Eurasian watermilfoil and phragmites. (Benzie Conservation District, 2012b) The organization's watershed work encompasses the Herring Lakes, Betsie River/Crystal Lake, and Platte River Watersheds. (Benzie Conservation District, 2012c)

The Manistee Conservation District has various programs, including a water testing program and a forestry program. Among the staff members is an Invasive Species Specialist. According to the organization's website, "Located just south of Bear Lake, the Manistee Conservation District has been serving Manistee County since 1945, connecting private landowners to numerous services, information, access to government programs and technical land-management assistance." (Manistee Conservation District, n.d.b) The Manistee Conservation District also tests samples from drinking water wells for nitrate and nitrite. Interested individuals must take their samples to the Manistee Conservation District office or the LRBOI Department of Natural Resources; results are mailed with advice on appropriate actions to take if nitrate or nitrite levels are high. According to the webpage, "This service is for private drinking-water wells only. Public water supplies are tested regularly." (Manistee Conservation District, n.d.a)

The Little River Band of Ottawa Indians in Manistee has a Natural Resources and a Planning Department, among others. The Natural Resources Department offers various programs, including a Water Quality Program, Watershed Initiative Program, and Inland Fisheries Program. The Planning Department's programs relate to land use, planning, and natural resources. (Little River Band of Ottawa Indians, 2015b; Little River Band of Ottawa Indians, 2015c) In regards to the Water Quality Program, LRBOI works on monitoring of water quality, habitats, and aquatic organisms and restoration work in the Manistee River Watershed. According to the LRBOI webpage, "Monitoring for aquatic insects and fish communities allows the Tribe to assess ecosystem health," "Basic sampling occurs seasonally to determine trends and shifts in water chemistry…Long-term seasonal sampling will give us the ability to tease out trends as well as notice indicators of a problem," "Yearly habitat assessments are completed at fixed stations...These assessments are also used to monitor improvements or restoration projects that are ongoing in the watershed," and "The water quality program and the inland fishery program are working collaboratively to monitor for Mercury, PCB's and pesticides that are a known problem." (Little River Band of Ottawa Indians, 2015e) None of the LRBOI sites are

Figure 55: Arcadia Marsh and Bowens Creek Restoration Signage

in the Arcadia-Pierport Watershed. (Little River Band of Ottawa Indians, 2015e)

In regards to the Watershed Initiative Program, LRBOI received a grant from the EPA, which "has allowed the Tribe to study the effects of common restoration practices over a watershed. Research focused on measurable results and alterations in water quality. We will be looking at the response of water chemistry, habitat, macroinvertebrates and fish communities over time." (Little River Band of Ottawa Indians, 2015f) The program is focused on the Big Manistee Watershed, and as part of the study, LRBOI is analyzing five restored road/stream crossings, four restored stream banks, and three sites where access was enhanced, none in the Arcadia-Pierport Watershed. (Little River Band of Ottawa Indians, 2015f) Pertaining to the Inland Fisheries Program, LRBOI works on assessing fisheries, raising and releasing lake sturgeon, studying northern pike and walleye, and monitoring fish communities, among other initiatives. According to the LRBOI website, "The Inland Fisheries Program is designed to preserve, protect and enhance the Tribal Fishery while providing subsistence fishing opportunities to LRBOI Membership. Through ongoing biological assessments, Tribal outreach activities, inter-agency cooperation, and litigation support, the right of Tribal fish harvest is promoted. Special focus is given to culturally significant animals, such as, doodem (clan) fish and those historically harvested, to assure that these populations are healthy and abundant. Another primary objective is to maintain biologically sound harvest opportunities within Reservations and 1836 Ceded-Territory. This is accomplished by performing fishery assessments on numerous species both in lakes and rivers. An important component of the LRBOI cultural identity is defined by inland fishing. LRBOI members harvest and eat fish, a lifeway that the Inland Fishery Program aims to preserve, protect and enhance." (Little River Band of Ottawa Indians, 2015a) Though these webpages do not attest to the LRBOI's work in the Arcadia-Pierport Watershed area, the LRBOI's ***Final Technical Report - Arcadia Marsh/ Bowens Creek Restoration and Fish Passage*** does, for, "As a collaborator on the Arcadia Marsh Restoration Project, the Little River Band of Ottawa Indians (LRBOI) Natural Resources Department was contracted to monitor streams before and after restoration for biological parameters," including Bowens Creek and tributaries in the Arcadia-Pierport Watershed. (***Final Technical Report - Arcadia Marsh/ Bowens Creek Restoration and Fish Passage***, 2013)

The Grand Traverse Regional Land Conservancy works and has preserves in Benzie and Manistee Counties, as well as three others. According to the organization's website, "The Conservancy owns and maintains nature preserves and has assisted in creating municipally owned parks and natural areas which are open to the public year-round in Antrim, Benzie, Grand Traverse, Kalkaska, and Manistee counties. Many of these special places have managed trails which provide lots of opportunities for outdoor pursuits." (Grand Traverse Regional Land Conservancy, n.d.) The organization works on issues related to water, land, shorelines, and other natural resources. Per information on the website, "At the Grand Traverse Regional Land Conservancy, we think about our landscape in terms of watersheds, rivers, scenic transportation corridors, and the vital clusters of our region's working farms and forests. By thinking about our community in this way, we are able to evaluate how certain land uses and protection and stewardship efforts in specific areas will impact the things our community members value the most – access to our region's majestic shorelines; opportunities for hiking, biking, hunting, canoeing, birding, fishing and other outdoor activities; safe, clean water; a sense of rural character; respect for private property rights; and a healthy economy." (Grand Traverse Regional Land Conservancy, n.d.) Refer to CHAPTER ONE, CHAPTER TWO, and CHAPTER FOUR for more about GTRLC and its work and preserves in the Arcadia-Pierport Watershed area.

Michigan State University (MSU) has an Extension office in Benzie County; programs include the Land Use Education Services, Michigan Citizen Planner, and Irrigation Programs, and there are local experts on planning and water and other natural resources. (Michigan State University, 2014a, January 23) MSU also has an Extension office, an Irrigation Program, and local experts on planning and water and other natural resources in Manistee County. (Michigan State University, 2014b, January 23) In regards to the Land Use Education Program, "MSU Extension Land Use Educators offer a broad variety of training courses and presentations on topics related to local planning and zoning tools and techniques, planning policy options, land use and environmental issues, local government, public participation programs and leadership development. These training opportunities are intended for local elected and appointed officials, planners, planning and zoning administrators, professional groups in fields related to community planning, interest groups, civic organizations, and the public at large. Extension will provide accurate information on basic planning and zoning techniques, as well as current 'best practices.' Classes will address land use, community development and environmental issues facing Michigan communities today. Extension educators will also assist local officials by offering training in planning and project management, funding tools, budgeting and record keeping." (Michigan State University, 2014, December 9) There is even a class on water resources and protection, as well as one on green infrastructure. (Michigan State University, 2014, December 9)

The Michigan Citizen Planner Program also has relevance to planning, zoning, and natural resources. According to the MSU Extension webpage, "The Michigan Citizen Planner program at Michigan State University offers land use education and training to locally appointed and elected planning officials throughout Michigan…Michigan Citizen Planner participants report that the program fosters a greater awareness of land use decision makers' roles and responsibilities, resulting in more livable communities, the protection and conservation of natural resources, and better overall land use decisions throughout Michigan." (Michigan State University, 2015, January 26) The Irrigation Program provides myriad resources related to water use, irrigation scheduling, and reporting. (Michigan State University, 2015, May 5)

The Michigan Sea Grant Extension places Benzie, Manistee, and five other counties into the Northwest Counties district of the state, which has an Extension Educator. The Michigan Sea Grant program is focused on the coastal communities and activities and fish habitats. According to the website, "Michigan Sea Grant Extension helps apply research, conducts educational activities and is connected to more than 40 coastal counties. Extension educators provide technology transfer by interpreting scientific knowledge for decision-makers, public officials, community leaders, businesses and industries. MSG Extension facilitates events, including workshops, training and educational programs. Michigan Sea Grant Extension provides targeted support focusing on marinas and other businesses, restoring coastal habitats and related industries, such as commercial and recreational fishing. In partnership with state and federal agencies, Extension educators are responsive and proactive in addressing local, regional and national issues relevant to Michigan. In collaboration with scientists, communication specialists and others, Extension educators help implement Michigan Sea Grant's strategic focus areas." (Michigan Sea Grant, n.d.)

The USDA, NRCS has a Field Office in Bear Lake for Benzie and Manistee Counties. (United States Department of Agriculture, Natural Resources Conservation Service, Michigan, n.d.a) In Michigan, NRCS programs relate to conservation, water and other natural resources, watersheds, forests, habitats, agriculture, soils, and other topics. According to the website, "NRCS's natural resources conservation programs help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. Public benefits include enhanced natural resources that help sustain agricultural productivity and environmental quality while supporting continued economic development, recreation, and scenic beauty…NRCS has several programs that provide financial assistance to agricultural producers to implement new conservation measures. Other programs allow landowners to sell development rights to their land that require the land to be maintained as wetlands or for specific agricultural uses." (United States Department of Agriculture, Natural Resources Conservation Service, Michigan, n.d.b)

The Conservation Resource Alliance works in Benzie and Manistee Counties, as well as 11 others in northwest Michigan. Programs address land use, rivers, wildlife, and forests. According to the organization's website, "Conservation Resource Alliance (CRA) is a private, not-for-profit corporation committed to 'sensible stewardship of the land.' Established in 1968 as part of a nationwide network of Resource Conservation and Development Councils, the organization serves a 13-county area in northwest lower Michigan. Staffed with wildlife biologists, fisheries biologists, engineers and field technicians, CRA works with landowners to plan, locate funding options, cut through red tape, and implement programs to enhance the habitat value and beauty of the region. CRA is known for its collaborative land-use solutions among private landowners, government agencies and commercial businesses…CRA's RiverCare Program is an example of a program aimed at reaching specific regional stewardship goals. The RiverCare Program was created to guarantee that natural resource professionals maintain a consistent and prioritized action plan for each river in CRA's region, find and repair physical problems before they become worse, and maintain efficient, coordinated river committees of agency, resident and interest group representatives. Northern Michigan's unique combination of rivers, streams, forests, and wildlife attracts thousands of seasonal residents and over 500,000 visitors each year…It is critical for our community to realize that the quality of the area's scenery and resources are not automatically preserved or enhanced. That is why the Conservation Resource Alliance exists." (Conservation Resource Alliance, 2015a) The only waterbodies near the Arcadia-Pieport Watershed area (though not technically in the watershed) on a CRA webpage are the Betsie River, Manistee River, and Bear Creek. (Conservation Resource Alliance, 2015b)

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CHAPTER NINE:

RECOMMENDED IMPLEMENTATION TASKS AND ACTIONS

As information about the Arcadia-Pierport Watershed is not extensive, it is difficult to set forth a detailed analysis of implementation tasks and actions, including timeframe, potential responsible parties, and costs. The Implementation Tasks are extensions of the Watershed Goals and Objectives in CHAPTER SEVEN and are presented in Table 46. The watershed planning process is ongoing, so the Implementation Tasks and other material in this chapter can be updated as needed.

Figure 56: Fields in Watershed

Goal of Implementation Tasks and Actions

The overall goal of implementation is provision and preservation of a healthy watershed with exceptional water quality and natural resources and abundant opportunities for recreation and enjoyment.

Figure 57: Arcadia Lake and Shoreline

Detailed Implementation Tasks and Actions

Table 46 illustrates the Watershed Goals and Implementation Tasks, as well as timeframes, responsible parties, and budget. For the purposes of this Plan, near-term can be considered the next one to two years, mid-term can be considered between two and five years, and long-term can be considered five or more years. The Implementation Tasks are extensions of the Watershed Goals and Objectives presented in CHAPTER SEVEN and can be changed or updated as necessary.

Table 46: Watershed Goals and Implementation Tasks

GOAL	TASK	TIMING	RESPONSIBLE PARTY/PARTIES	BUDGET
I. Protect waterbodies, sources, and quality within the watershed and other resources that affect the watershed				
	A. Complete Private Parcel Nonpoint Source Pollution Inventory	Mid-Term	WLT	$19,500
	B. Inventory and rate the severity of improper road/stream crossings on aquatic habitats; this information would be used to prepare a plan to reconstruct the most "severe" crossings	Mid-Term	WLT, Benzie County Road Commission, Manistee County Road Commission	$15,000
II. Increase and complete comprehensive monitoring, inventorying, and data collection on water quality and other resources that affect the watershed				
	A. Coordinate with LRBOI and GTB to perform watershed-wide water quality testing for nitrates, nitrites, phosphorus, dissolved oxygen, pH, turbidity, and conductivity	Near-Term	WLT	$35,000
	B. Focus additional water quality monitoring in High Priority Areas, which have the greatest impacts on water quality	Near-Term	WLT	$10,000
III. Promote citizen engagement and create support programs for the watershed				
	A. Adopt Riparian Buffer Ordinance to establish an aquatic management zone from 25 to 50 feet adjacent to stream bank	Near-Term	Arcadia Township, Blaine Township, Joyfield Township, Pleasanton Township, Onekama Township	Riparian buffer ordinance template provided through L2L
	B. Install a boat washing station to prevent the spread of invasive species	Mid-Term	WLT, Arcadia Township	$10,000
	C. Assess stormwater runoff within the unincorporated village of Arcadia and develop strategies based on findings	Long-Term	WLT, Arcadia Township	$25,000
	D. Establish a local watershed organization or partner with several watersheds to create a broader, more regional watershed organization	Mid-Term	WLT, Lakes to Land Non-Profit Board	N.A.
	E. Establish a water quality testing volunteer program to perform basic water quality testing at defined locations throughout the watershed	Near-Term	WLT	$7,500
IV. Install public utilities to replace septic systems in areas where densities exceed three housing units per acre				
	A. Conclude current sanitary sewer feasibility study being performed by Fleis & Vandenbrink through Arcadia Township	Near-Term	Arcadia Township	Being funded through an MDEQ SAW grant
V. Use green infrastructure in the watershed				
	A. Prepare and adopt uniform ordinance that focuses on innovative stormwater management	Near-Term	Arcadia Township, Blaine Township, Joyfield Township, Pleasanton Township, Onekama Township	$7,500

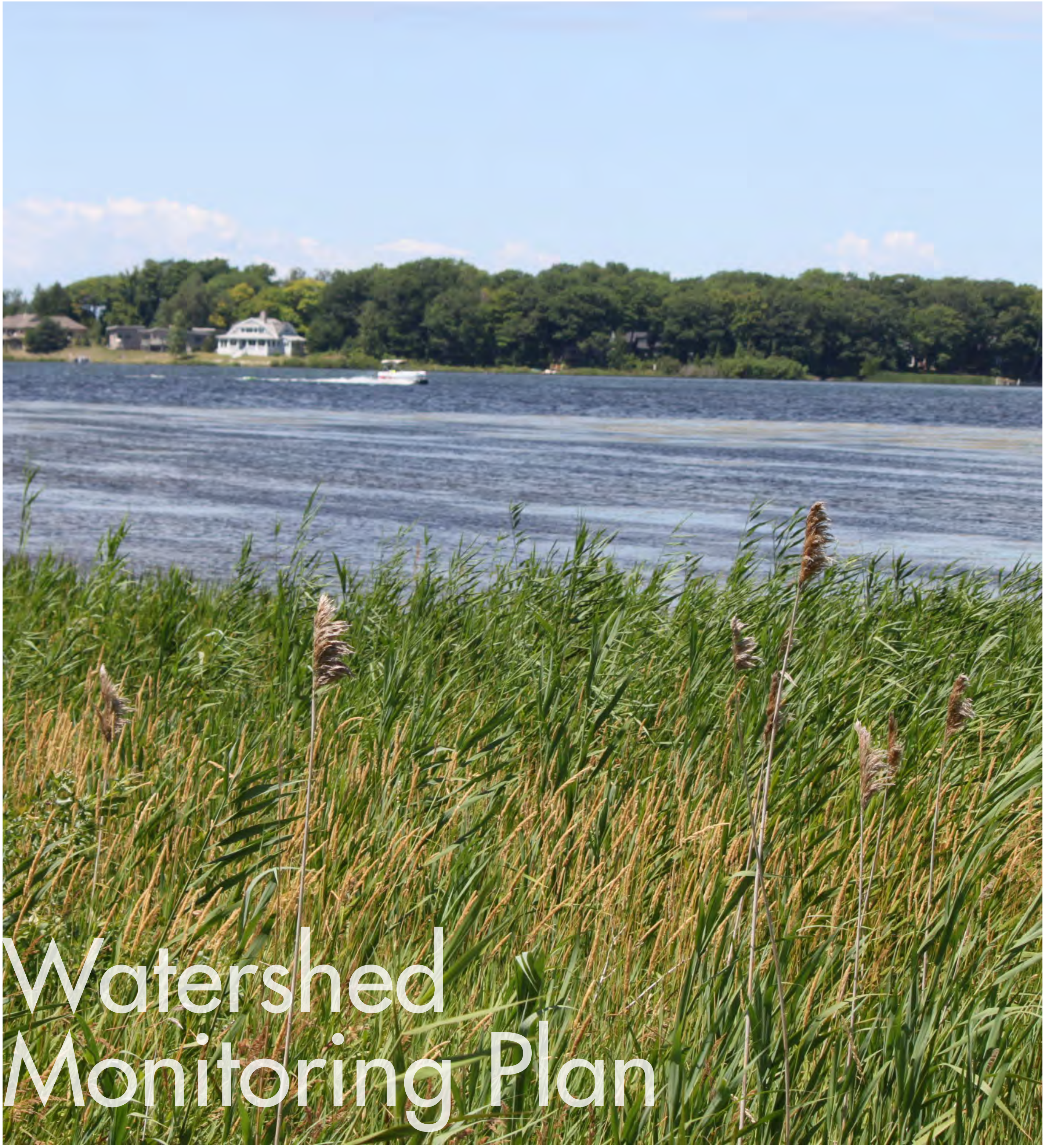
Figure 58: Watershed Landscape

Figure 59: Arcadia Lake and Homes on Shoreline

Information and Education Plan/Strategy

As data and information on the Arcadia-Pierport Watershed are not extensive and do not necessarily focus on the watershed area or provide a complete or comprehensive overview of the entire Arcadia-Pierport Watershed, there is a real need for information. For instance, information on water quality, potential pollutants, road/stream crossings, and stormwater runoff would be valuable. Education is also important. As only 27 individuals responded to the Arcadia-Pierport Watershed Property Owner/Resident Survey, it is difficult to draw conclusions about local perceptions, knowledge, and beliefs in order to inform specific education strategies. (SurveyMonkey, 2015) Nonetheless, educational opportunities likely exist. Refer to CHAPTER THREE for more information about the survey. Watershed Goal II in Table 44 addresses the need for information, while Watershed Goal III addresses eduation. Completion of Implementation Tasks IA, IB, IIA, IIB, IIIC, IIID, IIIE, and IVA in Table 46 could help in this regard.

Figure 60: Orchard



Watershed Monitoring Plan

Monitoring in the Arcadia-Pierport Watershed Plan over time is important. Furthermore, as there are gaps in terms of available data and information, and as the watershed planning process is ongoing, monitoring is even more critical. For instance, information on water quality, potential pollutants, and inventories is needed; these studies and inventories should not only be completed but should also be updated periodically over time. Watershed Goals I, II, and III in Table 44 and Implementation Tasks IIA, IIB, IIID, and IIIE in Table 46 address watershed monitoring and support.

Reference List

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CHAPTER TEN:

EVALUATION STRATEGY

Updating and evaluating the Arcadia-Pierport Watershed Plan over time is important. Furthermore, as there are gaps in terms of available data and information, and as the watershed planning process is ongoing, filling the data and information gaps is critical. Adopting this Plan and beginning implementation are important first steps, while evaluating the Plan over the course of time is also crucial.

The ***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*** describes the purpose of an evaluation strategy well. According to the plan, "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. The evaluation step 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." (***Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow***, 2012)

Figure 61: Wildflowers beside Arcadia Lake

Evaluation Strategy for Plan Implementation

According to the *Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow*, "An evaluation strategy for plan implementation will be used to determine progress in completing the recommended actions and tasks identified in the plan. The Advisory Committee will review the recommended tasks and actions annually during one of their quarterly meetings and identify what has been accomplished during the last year. A more thorough assessment every 5 years will also identify what actions and tasks have been completed, as well as review the priority ranking of individual actions. As priority actions are accomplished, lower priority actions may be reassigned to be medium or high priority. In addition, new recommendations may be added in response to new issues and concerns, methodologies, data, and as other information is learned." (*Lake Charlevoix Watershed Management Plan: Protecting Water Quality for Today and Tomorrow,* 2012)

A similar evaluation strategy can be used for the Arcadia-Pierport Watershed Plan. The Watershed Leadership Team could review the goals, objectives, tasks, and actions at least annually, updating them as necessary. The Plan itself could be updated every five years.

Reference List

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ARCADIA-PIERPORT WATERSHED PLAN APPENDIX

Appendix

The Appendix includes additional information relevant to the Arcadia-Pierport Watershed Plan that could be of interest to readers. Most of the reports referenced here are from Benzie County, as Manistee County does not have the breadth of plans that Benzie County does.

Oil and Gas

Though it is from 1998, and the situation may have changed since, the ***Benzie County Comprehensive Plan Forestry and Mineral Resources Report*** provides an insightful overview of oil and gas resources in the county and an inventory. Highlights of the assessment are provided here; refer to the report for more information.

- "The primary minerals of importance in Benzie County are oil and gas and sand and gravel. Benzie County is on the edge of the geologic formations holding deposits of oil and gas. These are the Niagran and Antrim formations. Extensive sand and gravel deposits are located in the glacial and dune formations, generally in the western half of the County."
- "Associated with oil and gas exploration activities are a series of natural resource threats. These include potential damage to wetlands, wildlife, vegetation, streams, rivers and lakes and ground water."
- "A human health risk exists with some wells in the form of hydrogen sulfide gas. This is a greater risk with Niagran formation wells than with Antrim formation wells, and most wells in Benzie County drill into the Antrim formation."
- "As of 1997, a total of 103 oil and gas wells have been drilled in Benzie County. While this is less than other energy

producing counties in the region, Benzie County's hydrocarbon development has been an important source of income to some landowners, and has provided useful fuel to the state's hydrocarbon market."

• "According to the Michigan Oil and Gas Association, Benzie County's wells have produced 5.6 million barrels of oil and 4.6 million cubic feet of gas."

• "Of the 103 wells drilled in Benzie County, 78 were dry wells, 15 actively provided oil and 8 wells provided gas. This compared to 9 in Leelenau County, 1,419 in Manistee County, 1,493 in Grand Traverse County and 180 in Wexford County."

• "The Michigan DEQ exercises most of the regulatory responsibility over the oil and gas industry, and does not coordinate the permitting of wells, pipelines, or processing facilities with local units of government. Nor does the state consider local land use plans or zoning ordinances when deciding whether or not to issue permits. This lack of coordination has caused widespread conflicts between the industrial operations of oil and gas development and residential and recreational land uses. Extensive state and federal regulations apply to extraction of oil and gas."

• "Oil and gas activities can have great [effects] on the landscape and may have either temporary or lasting impact on surrounding land uses, depending on the activity and abutting land uses. The reverse is also true where new (especially residential) development occurs adjacent to an oil or gas processing facility after that facility is in operation."

(*Benzie County Comprehensive Plan Forestry & Mineral Resources Report*, 1998)

Agriculture and Food

Though it is from 1999, and the situation may have changed since, the *Benzie County Comprehensive Plan Agriculture Report: Draft* provides an insightful overview of agriculture in the county and a detailed inventory. Highlights of the assessment are provided here; refer to the assessment for more information.

• "Agriculture is important to both those in the business of agriculture and to citizens of Benzie County who enjoy the food and fiber it produces and the scenic qualities of agricultural land."

• "Agriculture is a difficult business to sustain under present circumstances. As a result, agricultural land is being converted to other uses at a high rate."

• "People have been farming in Benzie County for several generations."

• "Row crops, beef and dairy cattle have been important components of Benzie County agriculture, but cherry and apple orchards are the primary agricultural activities now."

• "The primary crops in Benzie County are cherries and apples. However, there are more acres planted in corn and hay than in either apples or tart cherries."

• "The value of fruit production was over $6 million in 1997, according to estimates by the Northwest Michigan Agriculture Experiment Station. This is in spite of very low prices farmers were receiving for fruit produced. Production of fruit was nearly 20 million pounds. A portion of that crop was processed (canned, frozen, or dried) in the region, a portion was shipped fresh, and a portion was pressed for juice concentrate."

• "In an informal survey of Benzie County farmers, 99% ranked those cherries and apples as first most important in the County…About the same percentage as chose cherries first chose apples second. About 25% of farmers and growers identified corn as the third most important crop with hay fourth and Christmas Trees fifth."

• "The general trend of farms and farmland in Benzie County has been one of declining farms and area in farming."

• "The number of farms in Benzie County increased in the 1990s, according to the 1997 Census of Agriculture…In part this is due to a change in the definition of a farm from earlier years and in part to fallow land being converted to active farming. In 1992 there were 120 farms and in 1997 there were 140 farms. The 1997 Census of Agriculture added the categories of Christmas Tree farms, nurseries and forest stands producing maple syrup to the definition of agricultural products. If these categories of farms were removed, there would only be ten more farms in 1997 than in 1992. The other additional ten farms were in categories not well documented or in corn, hay or livestock farms."

• "The average size of farms declined between 1992 to 1997 from 165 acres to 161 acres."

• "The number of farmland acres increased between 1992 and 1997, from 19,844 acres to 22,556 acres. This is due, in part, to 630 acres in Christmas tree farms being included for the first time, and in part to over 1,000 acres being farmed for hay and corn that were not farmed during the previous census."

• "The number of cropland acres also increased from 10,723 acres in 1992 to 12,086 acres in 1997."

• "The trend over a longer time period shows a decline. Over the fifteen-year period of 1982 to 1997, there was a 14% decline of farmland acres (even when adding new categories in 1997) and a 9% decline in cropland. The number of farms declined during this period by 24%."

• "While fruit production was up between 1992 and 1997, there were fewer orchards (56 in 1992 and 47 in 1997) and fewer acres of orchards 3,759 in 1992 and 3,205 in 1997)."

• "The average size of farms has increased 13% between 1982 and 1997. However, all of this increase occurred between 1982 and 1987, and average farm size has fluctuated between 161 acres and 165 acres since then."

• "Benzie County depends on migrant labor."

• "As of 1998, 997.5 acres of land in Benzie County was enrolled in the PA 116 program to protect farmland, with contract expiration dates of the year 2000 or beyond. In addition, 155.75 acres were enrolled under the open space portion of the program. This represents twelve parcels of farmland and two parcels of open space."

• "38 businesses…[provide] support services to agriculture. These include chemicals and fertilizers, processing, feed, equipment, fuel, financing and waste disposal."

• "services that are needed to

maintain Benzie County's agricultural business sector…are:

o Chemical fertilizer distributors. These cannot be supported only by... agricultural activity within Benzie County…

o Removal of Toxic Waste."

- "Farm income has been variable in the last few decades."
- "Farm owners derive income from their products plus from jobs off the farms and, for some, government payments."
- "the experience of Benzie County farmers is one of high costs and variable and marginal income from farm production."
- "net total income for farmers in Benzie County [rose] dramatically from the 1970s and 1980s to a high in 1990 with a subsequent drop in 1994."
- "Total income from farm products rose from 1970 ($2,080,000) to 1997 ($6,636,000), with a slight dip from 1992 ($4,568,000) to 1994 ($4,563,000). Expenses to produce those crops and livestock and to own the land and equipment varied during that period."
- "net farm income from crops and livestock varied widely, but in many years was a negative. Outside income and government payments helped keep many farms from folding."
- "Total income from all sources rose dramatically between 1980 and 1990. This was probably due to many farmers finding employment outside of farming. It is also a period when many farmers began (or continued) selling off parts of the farm as lots to supplement income."
- "with the exception of 1997, net income from the produce of the farm was either very low or a negative. That, combined with an over $2,000,000 increase in income from products contributed to a $2,049,000 net farm income from farm products."
- "income from farm products rose substantially between 1994 ($4,563,000) and 1997 ($6,636,000). In part this is due to additional crops being included, such as Christmas Trees and maple syrup, that were not included in previous years."
- "Christmas trees, forestry and syrup were over one-fifth of the total agricultural income of Benzie County in 1990."
- "Labor, interest and chemicals are among the greatest expenses facing fruit farmers in Benzie County…In 1997, these accounted for 18%, 16% and 14% of expenses, respectively, for eleven fruit farmers in Northern Lower Michigan who took part in the Telefarm (voluntary, annual phone survey) study by Michigan State University Extension."
- "Labor expenses declined (as a percentage of total expenses – this does not mean labor rates declined) between 1995 (28%) and 1997, interest increased from 9% of expenses in 1995 and chemicals were about the same. The probable reason for the decline in labor expenditure was a general reduction in the size of picking crews from about 6-12 to 2, used to harvest cherries. The category of repairs was the next greatest expense, at 10% in 1997, up from 9% in 1995."
- "The economic importance of agriculture is substantial…Agriculture accounted for 27% of the Benzie County economy in 1990."
- "Fruit was the largest segment of the Benzie County economy, with over $8 million in 1990. The next largest segments were Christmas trees, at over $2 million in 1990, livestock at nearly $2 million and forest products at nearly $1.6 million."
- "trends in the late 1990s are that tart cherry production is falling. This should improve prices, possibly to the point where it is once again profitable to grow them."
- "A very serious problem for fruit production is disease. A root fungus (Shoestring Root Rot) that attacks stone fruit trees infects some orchards in Benzie County."
- "many farmers and growers plan to decrease the acreage in cherries, apples, Christmas Trees and pickle cucumbers."
- "Farming is a tenuous business in Benzie County. Farmers are not generally optimistic about the future of farming in Benzie County."
- "Because many property owners of 'estate farms,' are interested in raising horses for riding or a small number of sheep or other animals for educational or passive recreational benefits, conflicts are arising among neighboring property owners or are anticipated because this is being done on lots as small as 5 acres."
- "Active cropland and orchards are being converted from agriculture to another use in Benzie County for the following reasons:

o The farmer retires and sells his land to finance his retirement. The new owner is often someone who does not farm it. The new owners may subdivide it for residential development, or they may let it lie fallow as a natural area for their own enjoyment.

o Portions of the farmland are sold incrementally to supplement income. These are usually lots of five to twenty acres in size and may be built upon shortly after purchasing or at some time in the future.

o The owner of a large parcel who leased the land for agricultural use can no longer find someone to lease the land for agriculture and the land becomes fallow.

o Orchard trees (primarily stone fruits) may succumb to a disease that prevents replanting as an orchard, and the land lays fallow until another use is identified by the present or a future owner.

o "Farmers may find it so troublesome dealing with complaints from adjacent, non-farming residents that they stop farming and let the land lay fallow until another use or a buyer is found."

- "While farmland has declined in Benzie County over the past several decades, there has been a recent conversion of fallow land into active farming. A portion of this conversion was for Christmas trees and a portion for orchards."
- "The rate of conversion of agriculture, forest and vacant land to residential can be estimated by three methods (figures are rounded):

o The change in land use/land cover as interpreted from aerial photography finds that there were 16,913 acres of agricultural land in 1978 and 18,657 acres in 1996. This is an increase of 1,744 more agriculture acres in nearly twenty years. There was a decline of 468 acres of orchard, but increases of 1,056 acres of cropland, 744 acres of pasture and 403 acres of other agriculture. There were 6,275 acres of residential land in 1978 and 15,442 acres in 1996. This is a change of 9,167 more acres in nearly twenty years. All but about 50 acres of this increase was in the category of single family/duplex residential.

o At the rate of residential building…about 80 acres of subdivisions and 286 acres of site condominiums have been built in the past ten years. In addition, there have been 1,332 lot splits (1,374 lots splits minus 42 subdivision lots platted) in the past five years, and at an average of ten acres per new parcel, this accounts for 13,320 acres for a total of 13,686 new residential acres. If all of this were on farmland, nearly all farmland in the County would be gone by 2020. However, this is not likely…"

- "The towns with the most agriculture, Blaine, Joyfield, and Gilmore Townships…combined only account for 76 building permits over the five years 1990-1995."
- "conflicts with nonfarm land owners in farming areas is a serious problem."
- "The main problem animal in Benzie County is deer. Deer eat the buds and twigs of orchard trees."
- "Farming is not appropriate everywhere in Benzie County. Soils are marginally suitable for orchards where well drained…The steepest slopes, which comprise a large proportion of Benzie County lands, are unsuitable for most row crops. Other sensitive lands, such as wetlands and floodplains, are also unsuitable for farming. In addition, there are large areas of the County in public ownership…"
- "The likely future for much of Benzie County may be:

o Incremental sale of 5 to 10 acre parcels by farmers needing to supplement their income may result in strip residential development (a home every two hundred feet) along most rural roads…

o A portion of the farmers ready to sell for development but finding no buyer because of limited market demand for large parcels. This situation may expand as more and more farmers reach retirement age within the next decade. Developers and land speculators will have a wider selection of properties with the possible result of a drop in prices offered. Certain large parcels will likely be more favorable to development speculators than others, so not all farmers may receive buy-out offers.

o Farmers facing increased difficulty with complaints from a greater number of non-farm residents.

o Farmers facing declining support businesses due to a drop in the number of active farms in Benzie County."

- "There are serious problems affecting the future of agriculture in Benzie County. These problems include rapid residential development; burdensome tax policies, low prices for products and limited market opportunities. The result, if these problems are not solved, may be the loss of agriculture as a viable business activity in Benzie County plus the loss of rural open space."
- "The current development trends of increased subdivisions and strip residential are both a problem and a boon to Benzie County farmers. For many farmers, the sale of large parcels of land for subdivision development or the incremental sale of individual parcels of land for future year around or vacation homes have been important income sources. However, in the future, continued, sprawling residential development will contribute to a decline in farming in general in Benzie County, even though some individual farm property owners may be able to realize financial gain."
- "Both property taxes, when farms are taxed at a residential rate, and inheritance taxes can prevent a family from keeping a farm over several generations."
- "Global markets have driven the price of important fruit products below the profitable level."
- "local growers find it difficult to market fresh produce within the region."
- "rural Benzie County will not remain rural and farming will not remain viable for the long term if current trends in where and how development occurs continue into the future."

(***Benzie County Comprehensive Plan Agriculture Report: Draft***, 1999)

Tables 47 and 48 present a selection of the agricultural data comparing Benzie and Manistee Counties in 2007 and 2012. The data come from the ***2012 Census of Agriculture*** and can be found in the Michigan portion of the report. (***2012 Census of Agriculture***, 2014)

Based on the information in the tables, conclusions can be drawn, not only about agriculture in Benzie and Manistee Counties generally, but also about agriculture in these counties over time. Both counties experienced changes between 2007 and 2012. Manistee County had more farms than did Benzie County in 2007 and 2012, but the number of farms in both counties dropped over time. Benzie County had higher average sales per farm than did Manistee County in 2007 and 2012, but average sales per farm in both counties dropped over time. Average farm production expenses per farm were higher in Benzie County than in Manistee County in 2007 and 2012, but average expenses per farm increased in both counties over time. Average net gains per farm were higher in Benzie County than in Manistee County in 2007 and 2012, but, interesting, average net gains per farm increased over time in Benzie County and decreased in Manistee County; the number of farms with net gains decreased in both counties from 2007 to 2012. Average net losses per farm were also higher in Benzie County than in Manistee County in 2007 and 2012 but increased over time in both counties; the number of farms with net losses also decreased in both counties from 2007 to 2012. Average net gains per farm were higher than average net losses in both counties in both years. Benzie County had higher average government payments per farm than did Manistee County in 2007 and 2012, and average government payments per farm increased in both counties over time but especially dramatically in Benzie County. Benzie County had a higher average gross income (before taxes and expenses) from farm-related sources per farm in 2007 and 2012, but the average gross income increased over time in

Table 47: Select Agricultural Data for Benzie County, 2007 and 2012
Source: 2012 Census of Agriculture, 2014

Benzie County - Comparison of 2007 and 2012	2007	2012
Number of Farms	205	181
Average Sales per Farm ($)	$38,933	$35,339
Number of Farms with Less than $1,000 of Sales	56	56
Number of Farms with $1,000-$2,499 of Sales	27	23
Number of Farms with $2,500-$4,999 of Sales	26	18
Number of Farms with $5,000-$9,999 of Sales	34	28
Number of Farms with $10,000-$19,999 of Sales	21	17
Number of Farms with $20,000-$24,999 of Sales	2	5
Number of Farms with $25,000-$39,999 of Sales	7	6
Number of Farms with $40,000-$49,999 of Sales	7	1
Number of Farms with $50,000-$99,999 of Sales	3	11
Number of Farms with $100,000-$249,999 of Sales	11	7
Number of Farms with $250,000-$499,999 of Sales	9	7
Number of Farms with $500,000+ of Sales	2	2
Number of Farms that Sold Agricultural Products Directly to People for Consumptive Purposes	40	40
Average Farm Production Expenses per Farm ($)	$41,071	$49,512
Number of Farms that Purchased Fertilizer, Lime, and Soil Conditioners	118	96
Number of Farms that Purchased Chemicals	99	97
Number of Farms with Hired Farm Labor	45	58
Number of Farms with Contract Labor	29	23
Number of Farms with Net Gains	70	60
Average Net Gains per Farm ($)	$30,967	$33,054
Number of Farms with Net Losses	135	121
Average Net Losses per Farm ($)	$11,217	$18,098
Number of Farms Receiving Government Payments	29	37
Average Government Payments per Farm ($)	$2,540	$21,846
Average Gross Income (before Taxes and Expenses) from Farm-Related Sources per Farm ($)	$19,959	$25,004
Number of Farms with Sales of Forest Products (Except for Christmas Trees, Maple Products, and Short Rotation Woody Crops)	19	24
Number of Farms with Agritourism and Recreational Services	2	2
Acres of Land in Farms (acres)	21,069 acres	20,646 acres
Number of Farms with Harvested Cropland	156	126
Acres of Harvested Cropland (acres)	7,051 acres	7,560 acres
Number of Operators	331	284
Number of Principal Operators with Primary Occupation of Farming	99	95
Number of Principal Operators with Primary Occupation Other Than Farming	106	86
Number of Principal Operators with Days Worked Off Farm	125	102
Average Number of Years on Present Farm (years)	22.3 years	24.9 years
Number of Principal Operators Under 25 Years Old	--	--
Number of Principal Operators 25-34 Years Old	3	7
Number of Principal Operators 35-44 Years Old	25	10
Number of Principal Operators 45-54 Years Old	49	37
Number of Principal Operators 55-59 Years Old	35	27
Number of Principal Operators 60-64 Years Old	27	32
Number of Principal Operators 65-69 Years Old	28	21
Number of Principal Operators 70+ Years Old	38	47
Average Age of Principal Operators (years)	58.4 years	60.9 years

Table 48: Select Agricultural Data for Manistee County, 2007 and 2012
Source: 2012 Census of Agriculture, 2014

Manistee County - Comparison of 2007 and 2012	2007	2012
Number of Farms	358	324
Average Sales per Farm ($)	$25,732	$23,544
Number of Farms with Less than $1,000 of Sales	127	101
Number of Farms with $1,000-$2,499 of Sales	54	52
Number of Farms with $2,500-$4,999 of Sales	28	33
Number of Farms with $5,000-$9,999 of Sales	41	46
Number of Farms with $10,000-$19,999 of Sales	39	29
Number of Farms with $20,000-$24,999 of Sales	8	12
Number of Farms with $25,000-$39,999 of Sales	12	17
Number of Farms with $40,000-$49,999 of Sales	12	3
Number of Farms with $50,000-$99,999 of Sales	19	12
Number of Farms with $100,000-$249,999 of Sales	9	14
Number of Farms with $250,000-$499,999 of Sales	6	3
Number of Farms with $500,000+ of Sales	3	2
Number of Farms that Sold Agricultural Products Directly to People for Consumptive Purposes	65	52
Average Farm Production Expenses per Farm ($)	$25,730	$31,239
Number of Farms that Purchased Fertilizer, Lime, and Soil Conditioners	195	159
Number of Farms that Purchased Chemicals	120	144
Number of Farms with Hired Farm Labor	65	61
Number of Farms with Contract Labor	17	23
Number of Farms with Net Gains	121	101
Average Net Gains per Farm ($)	$26,838	$23,003
Number of Farms with Net Losses	237	223
Average Net Losses per Farm ($)	$10,656	$14,087
Number of Farms Receiving Government Payments	51	42
Average Government Payments per Farm ($)	$2,209	$5,731
Average Gross Income (before Taxes and Expenses) from Farm-Related Sources per Farm ($)	$10,677	$18,155
Number of Farms with Sales of Forest Products (Except for Christmas Trees, Maple Products, and Short Rotation Woody Crops)	19	21
Number of Farms with Agritourism and Recreational Services	1	3
Acres of Land in Farms (acres)	46,034 acres	44,298 acres
Number of Farms with Harvested Cropland	264	234
Acres of Harvested Cropland (acres)	17,090 acres	13,642 acres
Number of Operators	541	478
Number of Principal Operators with Primary Occupation of Farming	169	142
Number of Principal Operators with Primary Occupation Other Than Farming	189	182
Number of Principal Operators with Days Worked Off Farm	248	189
Average Number of Years on Present Farm (years)	23.7 years	23.8 years
Number of Principal Operators Under 25 Years Old	--	2
Number of Principal Operators 25-34 Years Old	10	16
Number of Principal Operators 35-44 Years Old	42	15
Number of Principal Operators 45-54 Years Old	82	58
Number of Principal Operators 55-59 Years Old	50	65
Number of Principal Operators 60-64 Years Old	51	51
Number of Principal Operators 65-69 Years Old	39	31
Number of Principal Operators 70+ Years Old	84	86
Average Age of Principal Operators (years)	59.8 years	60.9 years

both counties. The number of operators was higher in Manistee County in 2007 and 2012 than in Benzie County, but the number of operators decreased in both counties over time. The average age of principal operators in both Manistee and Benzie Counties increased from 2007 to 2012. (*2012 Census of Agriculture*, 2014)

The ***Farm and Food System Assessment***, part of the Lakes to Land Regional Initiative, provides a comprehensive agricultural inventory of the region and overview of farming and food in the area based on interviews and analyses. It is important to recognize that the Arcadia-Pierport Watershed is only situated within a portion of the entire Lakes to Land region, which itself is situated within a portion of Benzie and Manistee Counties, so the numbers might differ if only the watershed area had been assessed; nonetheless, the report provides insightful information about the area in general. Highlights of the assessment are provided here; refer to the assessment for more information.

- "Considering the amount of agricultural land, the reported 3.5% of the L2L population with an occupation in agriculture, forestry, fishing, hunting and mining may not reflect the percentage of the population for whom farming is a secondary occupation."
- "The L2L region is home to two (2) large processors and numerous small and medium processors."
- "According to the U.S. Census 2012 County Business Patterns, food manufacturing in Benzie County constitutes 26% of total manufacturing. The six (6) total food manufacturing establishments have 247 paid employees, and are of various sizes with the three (3) smallest employing 5-9 people and the largest employing 100-249 people."
- "There is also one food manufacturer that employs 5-9 people within Manistee County's boundaries."
- "Some wholesale food products leave the producers for local processors and distributors in the greater northwest Lower Michigan region, such as Graceland Fruits or for Cherry Capital Foods, a local distributor in Traverse City. Other products travel to large processors and distributors in the state, other places in the country, and some leave the U.S. borders."
- "a food desert, or geographic area lacking means to obtain affordable, nutritious food [seems to exist] in Blaine, Joyfield, Arcadia, and Pleasanton Townships. However…these townships have the greatest density of agricultural land. Retail locations, farmers markets, and food pantries are not available in these rural locations, leaving underserved residents with growing food for themselves, shouldering the additional burden of having to travel outside of their area for assistance, or truly going without access."
- "Benzie and Manistee counties are home to seven (7) seasonal farmers markets listed in the 2013 Taste the Local Difference guide. Since they gather on varying days and times, there is a market on nearly every day of the week. Six (6) are located within the L2L region and include Elberta, Frankfort, Grow Benzie, Honor, Manistee, and Onekama markets."
- "According to the 2012 Census of Agriculture, 70% of farms in Benzie and Manistee counties are small family farms with low sales. Eighty (80) were identified as assets in the region and 19 participated in surveys and interviews. In general, the participants grew a wide variety of crops and the sales of their products offer a secondary family income. Farming may have begun as a hobby, interest, or lifestyle that became a business. The farms vary in size from 3.5 acres to 183 acres according to the 14 individuals who reported the acreage of their farm. Many are small: eight (8) of the fourteen (14) participants have farms less than 10 acres in size. Most of the farms in this category are family run by one (1) or two (2) people who may hire some sporadic paid help. The families have been in business farming for two to 67 years. Nine (9) of twelve (12) responders have been in business for less than 10 years. They operate in mostly seasonal production and report the production of fruit, vegetables, and value-added products. Ninety four (94%) percent of the respondents process and sell 100% of their products within Benzie and Manistee counties."
- "Seven (7) farms reported that between 70% and 100% of their product is sold through the direct to consumer market channel through farmers markets, private on-site farm stands, and u-pick programs. Their products can also be found at local retailers, produce stores, and grocery stores."
- "Two (2) farms reported that they sell up to 20% of product through the wholesale channel, and a few farms also reported minor sales to retail, food service, and the emergency food market."
- "Only 12% of farms in Benzie and Manistee counties have medium-sales according to the 2012 USDA Census of Agriculture. The eight (8) farmers that participated in the study represent 50% of the farms in this category identified as assets in the L2L region. Participants produce higher quantities of a smaller variety of crops including apples, cherries, peaches, blueberries, asparagus, beef, and eggs. According to participants, the families have been in business for 29 to over 100 years and the farms are larger than those in the low sales category. The six (6) farmers that reported acreage have farms that vary in size from 40 to 1350 acres depending on the product. In general, medium-sales farms have more year-round employees and hire between 8 and 16 seasonal employees."
- "The amount of product that is sold in Benzie and Manistee counties varies greatly. Some farms reported that they sell 100% of their product in the region, while numerous others reported that they sell less than 20%, and some as little as 2%."
- "Small family farms with medium sales report that 50 – 100% of their product is sold through the wholesale market, the average of the seven (7) participants that provided the information is 83%. Some farms in this category also sell to retail and food service. The six (6) participating farms that sell direct to consumer report an average of 23% of their product uses this channel, a range from 50% to as little as 1%. The small amount of food that goes right to the consumer's plate is through u-pick, farmers markets,

and online business."

- "According to the 2012 U.S. Census of Agriculture, the average age of farm principal operators is 60.9 years in both Benzie and Manistee counties, 3.3 years older than the Michigan statewide average, and 2.6 years above the national average."
- "Large-scale family farms are those with sales greater than $250,000; of which four (4) are identified as assets in the L2L region. Within all of Benzie and Manistee counties, 17% of farms have sales greater than $250,000."
- "The three (3) large-scale family farms that participated in this study produce apples, cherries, peaches, wine grapes, strawberries, and asparagus on between 325 and 1000 acres. On average, the farms have been in business 47 years and hire about 45 or 50 seasonal employees. The respondents reported that some of their product is processed locally but the percentage amount locally sold varies greatly depending on the farm and product, from 60% sold in Benzie and Manistee counties to only 70% sold in the entire state of Michigan."
- "Of the farms that reported market channel use, 85 – 99.75% of their product is sold wholesale."

(*Farm and Food System Assessment*, 2014)

Forestry

Though it is from 1998, and the situation may have changed since, the ***Benzie County Comprehensive Plan Forestry & Mineral Resources Report*** provides an insightful overview of forests and forestry in the county and a detailed inventory. Highlights of the report are provided here; refer to the report for more information.

- "Wildlife is an important feature of Benzie County that should be retained and improved for ecological benefits, quality of life experience of residents, recreation and tourism values."
- "Forestland is defined as land that is at least 10% occupied by trees of any size. Timberland is defined as forest land that is producing, or capable of producing, in excess of 20 cubic feet per acre per year of industrial roundwood products under natural conditions, is not withdrawn from timber utilization by statute or administrative regulation and is not associated with urban or rural development."
- "Forest is the largest land cover category in Benzie County."
- "According to the US Forest Service, in 1993 there were 137,000 acres of timberland in Benzie County, or 67% of the County land area."
- "There are both publicly and privately owned forestlands in Benzie County. According to the US Forest Service, 48.6% of forestland is state-owned. The remaining 51.4% is in private corporate or miscellaneous private ownership. Thus, 32.6% of the County is state-owned forestland. Nearly 6% of the County is federally owned, Sleeping Bear Dunes National Lakeshore and a portion of those lands are likely to be classified as timberland."
- "Benzie County timberland is fairly well stocked. About 62% are moderately to fully stocked, which means the trees are making full use of available growing space, thus will increase in diameter and height becoming more valuable with time. However, nearly 38% is either poorly stocked or over stocked. These areas could improve, with professional management to increase stocks of marketable trees or professional management to thin timber stands to a more healthy stand."
- "The primary forest vegetation type in Benzie County is beech-maple. There were 93,000 acres of this timber land type in 1993, or 68% of all timberland in the County…this was the predominate vegetation type in Benzie County during pre-settlement times. Other current vegetation types include red pine (10%), elm-ash-soft maple (8.9%), aspen (6.6%) and others of lesser percentage cover."
- "It is the sandy soil that is a great determiner of Benzie County's land cover. The forests are one of Benzie County's few renewable resources and, over centuries, one for which the soil has been and still is ideally suited. It is that same sandy soil in which it is difficult, even with fertilization, to support any extensive growth of vegetable crops in the short growing season, but which can sustain a continuous growth of trees."
- "Small areas of Benzie County contain prime timberlands…Prime forestlands are those lands that are capable of producing sustained high yields of wood products. According to the U.S. Department of Agriculture, prime timberlands are lands that are capable of producing 85 cubic feet (about one standard cord) per acre per year in fully stocked natural stands. These lands are nationally significant."
- "Most of Benzie County contains timberlands of regional importance, which are not quite as productive…"
- "Benzie County forests are managed by private landowners, with or without professional guidance, and public land managers on the Pere Marquette State Forest (PMSF)."
- "Private landowners are highly interested in the forests, but timber harvesting is not always the biggest concern. Most of the requests for advice from the Conservation District Forester concerns optimizing the forest for wildlife and insuring the 'health' of the forest. Timber harvesting is also an interest of landowners, frequently after being approached by a timber buyer. In the late 1990s, timber prices were high, making timber on scattered, smaller properties economical to harvest. Landowners with as little as five acres sought assistance from the Conservation District, with at least half of the requests coming from persons with parcels of 40 acres or less."
- "Each year only a few landowners plant trees. These are usually red pine plantings of about 10 acres. Red pine is the most reliable species to plant. It has the highest survival rate and is highly marketable…Red pine is used for pulpwood, utility poles, landscape timbers, flooring and structural lumber."
- "There are many private parcels on which Scotch pine grows. These were mainly planted for Christmas trees. Those that were not cut remain. There was a many-year period when there was a glut of Scotch pine and sales were low. The trees kept on growing and became too large for Christmas trees. The stands became too dense making them a fire hazard and prone to insect and disease attack. Unfortunately, Scotch pine is not generally useful for other commercial purposes. These stands do provide some wildlife cover."
- "In 1998 there are four small sawmills in Benzie County…A larger operation in Manistee County handles both aspen and red pine."

- "One of the parties responsible for forest management in Benzie County is the Department of Natural Resources (DNR). The Forest Management Division of the DNR is responsible for managing over 50,000 acres of State Forest in Benzie County (3.8 million acres statewide)."
- "Sustainable forestry will, for the foreseeable future, require parcels of land of a minimum size (40 acres). There were 885 parcels of land in Benzie County in 1996, that were 40 acres or larger. This is about one third of the private land. There were 171 parcels 100 acres or larger...It will be increasingly difficult for private forestry to remain a viable part of the Benzie economy if division of much of that land continues...In 1996, there were 94 parcels of privately owned land."
- "It will be increasingly difficult for private forestry to remain a viable part of the Benzie economy if division of much of that land continues…Note the subdivision of many large parcels of 60 to 240 acres into 3, 4, 5, and mostly 10 acre parcels. In these four sections, there were 18 parcels of privately owned land in 1957. In 1996, there were 94 parcels of privately owned land. And in the same time period, the state acquired one 120 acre parcel in section 18."
- "A large portion of private land in a large block, about 5,000 acres spanning both Benzie County (Blaine Township) and Manistee County, is owned by Consumers Energy…This land was intended for development of a reservoir power generating facility. It will not be used for that purpose. Consumers believes the highest use of the land is for development. While not actively seeking a buyer, it will consider a sale. [Its] ideal example is a 'Bay Harbor' (near Petoskey) type development. Such a development would mean the loss of several thousand acres of potential forestland… Some of the land is currently leased for agriculture, but various forest uses are possible for that property."
- "Forests are important to Benzie County for economic benefit, scenic value, wildlife habitat and protection of water quality."

(***Benzie County Comprehensive Plan Forestry & Mineral Resources Report***, 1998)

Figure 62: Agricultural Fields

Reference List

2012 Census of Agriculture. (2014, May). United States Department of Agriculture. http://www.agcensus.usda.gov/Publications/2012/#full_report.

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