LAKE LEELANAU WATERSHED

PROTECTION PLAN

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CHAPTER 1 EXECUTIVE SUMMARY

Introduction

While the Lake Leelanau watershed is widely known for its scenic viewsheds and recreational opportunities its value as a biological resource is just as important. The Lake Leelanau watershed has pristine and sensitive wetland areas associated with its groundwater, tributaries, and riparian corridors. Recent studies have documented that the lake's pristine water quality has changed little over the past century. Lake Leelanau is among a handful of Midwestern lakes with extremely low nutrient levels. The lake maintains its high water quality because it is surrounded by nutrient-poor sandy soils, and because of the lush and diverse biological communities of these areas which help to absorb excess nutrients and runoff from adjacent land as well as support many rare and endangered plants and animals. The direct link of wetlands and groundwater recharge areas to high water quality demonstrates the influence of land use on bodies of water.

A healthy ecosystem is a major reason why people enjoy living in the Lake Leelanau area. Many people also live in this region because of the numerous forms of recreation it provides. In order to maintain the quality of this resource, local governments, concerned citizens, and numerous agencies all need to work together towards a common goal – protecting Lake Leelanau and its watershed from poor management decisions and any further degradation. Watershed protection means conscientious stewardship of all water and land within the watershed. A watershed protection plan summarizes existing water quality conditions, while also outlining and prioritizing major watershed pollutants and offering recommendations on how to reduce the impact and amount of pollution entering the system. The plan provides a description of the watershed including such topics as geologic and human history, population, land use, government jurisdictions, water quality trends and data, and recreational activities.

The Watershed Planning Process

In December 2001, the Lake Leelanau Watershed Management Plan was prepared by the Leelanau Conservancy with collaboration and input from major watershed stakeholders including the Lake Leelanau Lake Association (LLLA), Grand Traverse Band of Ottawa and Chippewa Indians (GTB) and local units of government. Much was accomplished during the first plan and is outlined in Chapter 3 (section 3.14). Eight years later, the same groups initiated new meetings to update the watershed plan to include additional information according to newly implemented Environmental Protection Association (EPA) requirements. Traditional management plans have focused on the restoration of degraded water resources. However, the Lake Leelanau watershed is blessed to have high water quality. Because of this fact, the steering committee decided to use the term Watershed Protection Plan instead of Watershed Management Plan to reflect the high water quality of the Lake Leelanau watershed and the need to preserve the high water quality. The current watershed plan provides a description of the watershed (including such topics as bodies of water, population, land use, municipalities, and recreational activities) and outlines current water quality conditions in the lakes and rivers. Water quality threats were identified and efforts to address these issues were researched, developed, and prioritized. This 2010 updated plan also includes additional information on pollutant sources and

concentrations, load reduction estimates of various Best Management Practices (BMPs), fisheries management, critical areas of the watershed, measurable milestones to guide plan implementation progress, and a set of criteria to evaluate the effectiveness of implementation efforts.

Watershed Characteristics

The Lake Leelanau watershed is located in beautiful northwest Michigan's Leelanau County and drains approximately 140 square miles of land (89,535 acres). The Lake Leelanau Watershed, formed from the combined basins of both North and South Lake Leelanau, is one of the most prominent geographical features of the interior of the Leelanau Peninsula. According to the Michigan Digital Water Atlas (Breck 2004), Lake Leelanau is 8,607 surface acres. The 5,370-acre South Lake Leelanau (SLL) is joined to the 2,950-acre North Lake Leelanau (NLL) by a mile long "Narrows" channel. The Narrows is approximately 287 acres. This lake system is about 15 miles in length and has 41 miles of shoreline. SLL is considered the largest tributary of NLL by way of the Narrows. However, limnologically the lakes are considered one body of water since they share the same surface level. The Lake Leelanau system has its outlet via the Leland River to Lake Michigan passing over the dam in Leland.

Michigan Department of Environmental Quality (MDEQ) characterizes Lake Leelanau as oligotrophic based on low nutrient concentrations and high water clarity. It is home to a large wetland complex (The Solon Swamp) which drains into Lake Leelanau, and contains high-quality hardwood forests around its ridgelines. The major tributary feeding the Lake Leelanau system is Cedar Creek, entering on the south shore of South Lake Leelanau. All other flow into Lake Leelanau comes from numerous small, groundwater fed tributaries and seeps along the shoreline of both lakes.

The Lake Leelanau watershed is comprised of portions of 11 townships within Leelanau County, Benzie County and Grand Traverse County. Rich in land and water resources, Leelanau County is home to more than 22,000 people sharing their living space with many flora and fauna including bobcats, coyotes, deer, great blue herons, lady slippers and trillium. According to the last census, Leelanau County grew at one of the fastest rates in Northwest Michigan. From 1990 to 2000 the county's population rose 28% and future projections indicate a steady growth rate for years to come. In addition, the area is one of the most popular tourist destinations in the Midwest, with growing numbers of visitors each year.

Results of monitoring in the Lake Leelanau watershed from 1992-1995 helped form a hydrological and nutrient budget that shows approximately 6,445 pounds of Total Phosphorus (lb TP) enter South Lake Leelanau (SLL) each year. Of that total, about 29% is from surface water, 20% was from direct precipitation (atmospheric deposition), 18% from subsurface groundwater, 19 % from internal loading and 14% from septic systems. The study also estimated that 327,166 Total Nitrogen (lb TN) enter SLL each year; 13 % from direct precipitation, 46 % from subsurface groundwater inputs, 33 % from surface water, and 4% each from internal loading and septic systems. These loading estimates also included storm events. Results for North Lake Leelanau (NLL) show that approximately 3,814 pounds of Total Phosphorus (lb TP) enter NLL each year. Of that total, 51% is from surface water (SLL via the Narrows), 18% was from direct

precipitation (atmospheric deposition), 9 % from internal loading and 13% from septic systems. The study also estimated that 206,439 Total Nitrogen (lb TN) enter NLL each year; 11% from direct precipitation, 7% from subsurface groundwater inputs, and 77% from surface water, of which 60% enters through the narrows.

Cedar River discharges approximately 583 lb TP and 40,565 pounds of Total Nitrogen (lb TN) to South Lake Leelanau each year and the Leland River annually carries approximately 1,555 lb TP and 458 lb TN to Lake Michigan.

Designated Uses and Their Pollutants, Sources, and Causes

Michigan water quality standards and identified designated uses for Michigan surface waters were used to assess the condition of the watershed. Each of Michigan's surface waters is protected by Water Quality Standards for specific designated uses (R323.1100 of Part 4, Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended). These standards and designated uses are designed to 1) protect the public's health and welfare, 2) to enhance and maintain the quality of water, and 3) to protect the state's natural resources. Protected designated uses as defined by Michigan's Department of Environmental Quality include: agricultural, industrial water supply, public water supply (at point of intake), navigation, warm water and/or cold water fishery, other indigenous aquatic life and wildlife support, fish consumption, and partial and total body contact recreation.

None of the designated uses for the Lake Leelanau watershed are impaired on a watershed wide scale. However, in some cases, activities and resulting pollutants in the watershed may prove to be a threat to water quality and designated uses. Threatened water bodies are defined as those that currently meet water quality standards, but may not in the foreseeable future. Currently, the designated uses of the Lake Leelanau watershed are threatened from increasing human development along with exotic species introduction and proliferation. The Lake Leelanau Watershed Protection Plan will focus on five designated uses to protect by maintaining water quality throughout North and South Lake Leelanau and its watershed. The designated uses include the warmwater/coldwater fishery, other indigenous aquatic life and wildlife, total body contact, navigation, and fish consumption. Threatened designated uses were ascertained through scientific research reports, water quality monitoring reports, steering committee members, and personal contact with watershed residents, public input and scientific experts on the Lake Leelanau watershed.

For each designated use to protect in the Lake Leelanau watershed there are a number of different pollutants and environmental stressors that can adversely affect the designated uses. The term environmental stressor is used to describe those factors that may have a negative effect on the ecosystem, but are not necessarily categorized as contaminants that change water chemistry. It is meant to address the wide range of environmental degradation experienced in the watershed. By avoiding the traditional approach of labeling a negative impact as a pollutant, the management plan hopes to engage a wider community support base. This plan will refer to classic watershed pollutants such as nutrients, sediment, and toxic substances, as well as environmental stressors such as habitat and wetland loss. The term pollutant and environmental stressor will be used interchangeably. Environmental stressors representing activities and

conditions that negatively impact the designated and/or desired uses of the Lake Leelanau watershed include invasive species, loss of habitat, excess nutrients, sediment loading, inappropriate shoreline development and more.

Overall, loss of habitat, invasive species, nutrients, and sediment are the top environmental stressors in the watershed. Other issues that threaten these designated uses include toxic substances, pathogens, and thermal pollution. All of these factors degrade water quality, destroy aquatic habitat, and reduce the number and diversity of aquatic organisms.

A Comprehensive Watershed Protection Table was developed listing sources and causes of watershed pollutants and environmental stressors to help identify water potential quality problems and provide guidance for future implementation projects to protect the quality of the watershed. This table summarizes key information necessary to begin water quality protection, provides specific targets to act upon for watershed protection, and forms the basis for all future implementation projects planned to protect the quality of the watershed. It may be used as a reference to distinguish what the major sources of pollutants are on a watershed-wide scale.

Priority and Critical Areas

Although watershed management plans address the entire watershed, there are certain areas within the Lake Leelanau watershed that warrant more extensive management or protection consideration. Areas that focus on preservation and protection are considered **Priority Areas.** Any areas that are especially sensitive and may require restoration and rehabilitation are considered **Critical Areas**. Note that critical and priority areas often overlap.

Priority areas in the Lake Leelanau watershed are defined as the portions of the watershed that are most sensitive to environmental impacts and have the greatest likelihood to affect water quality and aquatic habitat. Most often these areas require permanent protection. These are the portions of the watershed which would have a direct negative impact to the high water quality if they are degraded in the future. Please refer to Chapter 5.3 for details on how the critical and priority areas were defined.

The priority areas for the Lake Leelanau watershed cover roughly 45% of the watershed and include the following areas (Figure 11):

- **High Priority Areas -**
  - *Important Watershed Lands:* These lands are considered the highest ranking for land protection by the Leelanau Conservancy as they are high quality wetlands that are vital for maintaining the high water quality in the Lake Leelanau Watershed.
  - *Top Ranked Lands identified Natural Lands Inventory (NLI):* Areas with the highest NLI scores (lands with the highest potential for high quality natural areas) with land parcels greater than 10 acres.
- **Second Highest Priority Areas -** These areas include the second and third highest Ranked Lands identified NL with land parcels greater than 10 acres.

Any areas that are especially sensitive and may require future restoration and rehabilitation (i.e. buffers, streambank restoration, etc.) are considered Critical Areas. ***Currently the highest priority Critical Areas include the Village of Leland, the shoreline of Lake Leelanau, identified Phragmites locations, the high priority road and stream crossings closest to Lake Leelanau and any agricultural areas of concern. These are identified in YELLOW on the map (Figure 12).*** However, since protection of waterbodies (i.e. wetlands and stream corridors) are vitally important to the water quality in the Lake Leelanau watershed, a buffer of 300 feet from any stream, body of water or wetland was created to make up the critical area (Figure 12). We have identified these critical areas as riparian corridors that are vital to maintaining the high water quality in the Lake Leelanau watershed. If there is a property, wetland habitat or section of shoreline that becomes degraded within this critical area, it will be a top priority to focus on implementing Best Management Practices in these areas. Critical areas for the Lake Leelanau watershed cover roughly 43% of the watershed.

Watershed Goals, Objectives, and Recommendations

The overall mission for the Lake Leelanau Watershed Protection Plan (LLWPP) is to provide guidance for the implementation of actions that will reduce the negative impact that pollutants and environmental stressors could have on the designated watershed uses. The envisioned endpoint is to have North and South Lake Leelanau and its watershed continue to support their appropriate designated and desired uses while maintaining their distinctive environmental characteristics and aquatic biological communities.

Using stated goals from the first edition of the Lake Leelanau Watershed Management Plan, suggestions obtained from Steering Committee meetings, LLLA board, public input and examples from other watershed management plans, the project steering committee developed six broad goals for the Lake Leelanau watershed. Working to attain these goals will ensure that the threatened designated uses described in Chapter 4 are maintained or improved. Watershed goals are as follows:

Watershed Goals:

1. Protect aquatic and terrestrial ecosystems.
2. Protect and improve the quality of water resources.
3. Establish and promote management practices that conserve and protect the natural resources of the watershed.
4. Preserve the quality of recreational opportunities.
5. Establish and promote educational programs that support stewardship and watershed planning goals, activities, and programs.
6. Preserve the distinctive character and aesthetic qualities of the watershed, including viewsheds and scenic hillsides.

In an effort to successfully accomplish the goals and objectives, specific and tangible recommendations, called implementation tasks, were developed based on the prioritization of watershed pollutants, sources, and causes while also looking at the priority areas in the watershed. These implementation tasks represent an integrative approach, combining watershed

goals and covering more than one pollutant at times, to reduce existing sources of priority pollutants and prevent future contributions.

Implementation tasks were summarized by the pollutant and/or source it relates to (Table 24). In this way, organizations may work on a specific issue (i.e., invasive species, swimmers itch, stormwater or shoreline restoration) that may contribute more than one type of watershed pollutant and meet more than one watershed goal. *The categories are as follows:* Shoreline Protection and Restoration; Road Stream Crossings; Agriculture; Habitat; Fish and Wildlife; Stormwater; Wastewater and Septics; Human Health Issues; Wetlands; Invasive Species; Land Protection and Management; Development, Zoning and Land Use; Groundwater and Hydrology; Monitoring and Research; and Desired Uses.

Additionally an Information and Education Strategy was developed with specific recommendations to highlight the actions needed to successfully maintain and improve watershed education, awareness, and stewardship for the Lake Leelanau watershed. It lays the foundation for the collaborative development of natural resource programs and educational activities for target audiences, community members, and residents.

Evaluation Procedures

An evaluation strategy will be utilized to measure progress during the Lake Leelanau Watershed Protection Plan's implementation phase and to determine whether or not water quality is improving. The timeline for the evaluation is approximately every 5 years, with ongoing evaluation efforts completed as necessary. The first aspect of the evaluation strategy measures how well we are doing at actually *implementing* the watershed management plan and assesses if project milestones are being met. The second aspect is to evaluate how well we are doing at *improving water quality* in the watershed. The evaluation will be ongoing and will be conducted through the existing Steering Committee. The Steering Committee will meet two times a year to assess progress on plan implementation and to learn and share information about existing projects throughout the watershed. In addition, plan tasks, priorities, and milestones will be assessed every 5 years to ensure that the plan remains current and relevant to the region and that implementation is proceeding as scheduled and is moving in the right direction.

The evaluation will be conducted by analyzing the existing watershed plan goals and objectives, as well as the implementation tasks and 'milestones' in Sections 7.3 and 7.4 to determine progress. Key milestones include conducting necessary research and water quality monitoring, protecting priority land areas, and assisting townships with enacting ordinances to protect water quality. The proposed timeline for each task will also be reviewed to determine if it is on schedule. Other anecdotal evidence (not attached to specific plan milestones) also will be noted that indicates the protection plan is being successfully implemented, such as an increase in the amount of updated or new zoning ordinances that deal with water quality and natural resource protections in watershed townships and municipalities.

Since this watershed protection plan has an Information and Education (IE) Strategy that addresses the communication needs associated with implementing the watershed protection plan, it is important to measure and keep track of the social impacts of the Lake Leelanau Watershed

Protection Plan. The LLLA, LC, and other organizations conducting outreach must find out what types of outreach are working in the community and what types are not, along with how people's attitudes and behaviors are impacted. Key social evaluation techniques will be used to assess the implementation of the IE Strategy, as well as other watershed BMPs.

Most watershed goals outlined in Chapter 6 seek to maintain or improve the current state of water quality and habitat, as well as increase awareness of this valuable resource. Additionally, the Steering Committee will focus on land protection measures to protect the critical, high quality groundwater recharge areas that are so important to maintaining excellent water quality. In addition to conducting an evaluation every 5 years regarding protection plan implementation, the Steering Committee will evaluate whether or not water quality in Lake Leelanau and its tributaries is declining, improving, or staying the same.

Priority Tasks and Future Efforts for Implementation

The Lake Leelanau Lake Association, Leelanau Conservancy and other project partners will continue to build partnerships with various groups throughout the watershed for future projects involving the implementation of recommendations made in this watershed plan. Continued support and participation from key partner groups, along with the availability of monies for implementation of the plan is necessary to keep the momentum generated by planning efforts. Partners responsible for the implementation of the plan are encouraged to review the plan and act to stimulate progress where needed and report to the larger partnership.

Important issues facing the watershed include: increasing development and the associated pollution it brings, invasive species, and residential runoff into waterways. Priority will be given to implementation tasks (both BMPs and educational initiatives) that work to reduce the effects from these sources.

Priority tasks that should be conducted over the next 1 – 3 years are as follows, with the most important tasks listed first:

- Continue existing and begin new monitoring and research programs (i.e. water quality, *E.coli*, cladophora, microcystine).
- Begin initial outreach and education efforts outlined in the IE strategy – focusing on general watershed information, invasive species prevention, benefits of water quality protection ordinances and conservation easements, wetland preservation, and pollution stemming from residential areas
- Initiatives to preserve land and wildlife corridors (i.e. conservation easements)
- Continue Swimmer's Itch program to reduce its impact on humans and determine what snails and birds may be causing infection in South Lake Leelanau.
- Assist with developing or revising Master Plans and Zoning Ordinances to include more water quality protection (i.e., septic system point of sale ordinances, etc.)
- Wetland restoration and protection

Implementing the Information and Education strategy is perhaps the most critical and important long-term task to accomplish. It highlights actions needed to successfully maintain and improve watershed education, awareness, and stewardship for the Lake Leelanau watershed.

Additionally, it lays the foundation for the collaborative development of natural resource programs and educational activities for target audiences, community members, and residents. Environmental awareness, education, and action from the public will grow as the Education and Outreach Strategy is implemented and resident awareness of the watershed is increased.

CHAPTER 2 INTRODUCTION

The Lake Leelanau Watershed, formed from the combined basins of both North and South Lake Leelanau, is one of the most prominent geographical features of the interior of the Leelanau Peninsula. Watersheds are defined as the area of land that drains into a common water body. As water makes its way down the drainage basin following the path of least resistance, it is influenced by the landscape through which it flows. As a result, all activities within a watershed affect the quality of water as it percolates through and runs across developed landscapes.

Lake Leelanau (which includes both South and North Lake Leelanau) is the largest lake located in Leelanau County, Michigan. North and South Lake Leelanau receive the runoff of approximately 140 square miles and the watershed encompasses parts of 11 townships, three villages and three counties. South Lake Leelanau is also unique in northwest Michigan for the amount of waterfront wetland flanking its shores, much of which is in public ownership. These wetland areas provide habitat for wildlife, spawning areas for fish, and an essential nutrient-filtering capacity which helps to protect lake water quality.

The Lake Leelanau watershed is home to many streams and important wetlands, including the Solon Swamp at the southern end of South Lake Leelanau. The watershed drains via the Leland River into Lake Michigan. The overall health of the watershed is remarkably good based on water quality monitoring results, although increased development pressure threatens to degrade the function of the land necessary for high water quality. The Lake Leelanau watershed has pristine and sensitive wetland areas associated with its groundwater tributaries and riparian corridors. The lush and diverse biological communities of these areas help to absorb excess nutrients and runoff from adjacent land as well as support many rare and endangered plants and animals. The direct link of wetlands and groundwater recharge areas to high water quality demonstrates the influence of land use on bodies of water.

A healthy ecosystem is among the reason people love to live in the Lake Leelanau area. Many people also live in this region because of the numerous forms of recreation it provides. But, if environmental stressors (such as the addition of sediment, phosphorus, and nitrogen to the lake basin) is not managed and degradation of this natural resource occurs, many of the activities enjoyed by residents and visitors alike will be in jeopardy. Contamination of the lake and river from numerous sources may lead to unsafe swimming and increased blooms of aquatic plants, which are an annoyance to swimmers and boaters. Recreational fishing is also impacted by water pollution. Other forms of recreation that many people enjoy on a daily basis that could be impaired include swimming, kayaking, canoeing, wildlife observation and the scenic viewsheds.

In order to maintain the quality of this resource, local governments, concerned citizens, and numerous agencies all need to work together towards a common goal – protecting Lake Leelanau and its watershed from poor management decisions and any further degradation. Watershed protection means conscientious stewardship of all water and land within the watershed. This watershed protection plan summarizes existing water quality conditions, while also outlining and prioritizing major watershed pollutants and offering recommendations on how to reduce the impact and amount of pollution entering the system. The plan provides a description of the watershed including such topics as geologic and human history, population, land use, government jurisdictions, water quality trends and data, and recreational activities.

In December 2001, an initial Lake Leelanau Watershed Management Plan was prepared by the Leelanau Conservancy with collaboration and input from major watershed stakeholders including the Lake Leelanau Lake Association (LLLA) and local units of government. Much was accomplished during the initial watershed plan and is outlined in Chapter 3.14 in more detail. The following is a summary of what has been accomplished over the last eight years:

- Newsletter articles (quarterly) 2002-present highlighting various topics related to the watershed plan and overall watershed health
- Annual Picnics and Regular Lake Association meetings highlighting various topics
- LLLA members deeply involved with a County appointed task force reviewing septic system regulations in the county leading to a change in the regulations to permit the use of newer technologies to treat residential waste water (2002)
- A second annual fall survey was made near all boat launch sites on the lake, looking for the presence of Eurasian Milfoil (2002)
- Review the road stream inventory and prioritize sites for repair (2002)
- 70 property owners receive information on Fish shelters (2003)
- Leelanau Conservancy awarded 3/4 million dollars from the State's Clean Michigan Initiative grant to be used exclusively in the Lake Leelanau watershed to permanently protect our wetlands. (2003)
- Fish survey conducted by Fish Committee during November and December (2003)
- Lake Leelanau Lake Association website developed for educational purposes (2004)
- Dam subcommittee spent many hours monitoring issues concerning the Leland dam repair (2004)
- The association involved in proposed marina development in the narrows with the goal to reduce negative impact from marina development in the narrows and protect that fragile ecosystem. (2004-present)
- First Kids Fish Day held at Veronica Valley (2004), continues through to present
- DNR assists with Zebra mussel study (2004)
- 12 CMI projects were completed, protecting wetlands and viewsheds in the watershed
- Water Quality Committee introduces "Friends of Lake Leelanau" protecting the lake we love through good stewardship program. (2005)
- The Lake Association directs attention toward changing zoning ordinances to protect the lake (2006)
- Second CMI grant awarded to protect critical wetlands on Lake Leelanau (2006)

- Activities continue to update/upgrade township zoning ordinances that impact shoreline activities (2007)
- A survey conducted to get feedback from riparians on what they perceive as current and impending problems which may be damaging to the lake (2007)
- Continued annual survey of Eurasian Water milfoil to detect an appearance of this pest (2007)
- Water quality committee continues to review all applications for permits to do work in wetlands and work on the shoreline or below the surface of the lake, with intervention when necessary (2007)
- The Fish Committee continues to be involved in several activities that help to promote a successful fishery in LL (2007)
- LLLA successfully encouraged Leland Township to enact a 'no-wake' ordinance for the Narrows to enhance safety and minimize environmental damage (2007)
- LLLA has successfully encouraged all six townships abutting the lake to enact a keyholing restrictions in their zoning ordinances (2007)
- LLLA joins County Water Quality Task Force. Several LL board members actively participate with this diverse group to improve water quality in Leelanau County (2008)
- LLLA hires an individual to coordinate the swimmer's itch program and solicits volunteers for assistance (2009)
- Board members serve on Water Quality Task Force subcommittees: Nutrient Loading, Invasive species, and Wetlands (2009)
- First Lake Leelanau Walkabout held for residents to learn about the watershed (2009)
- E-mail questionnaire sent to members regarding swimmer's itch (2009)

Eight years later, the same groups again got together to update the watershed plan to include additional information according to newly implemented EPA requirements. Many management plans have focused on the restoration of degraded water resources. However, the Lake Leelanau watershed is blessed to have high water quality. Because of this fact, the steering committee decided to use the term Watershed Protection Plan instead of Watershed Management Plan to reflect the high water quality of the Lake Leelanau watershed and the need to preserve the high water quality. This 2009 revised plan includes additional information on pollutant sources and concentrations, load reduction estimates of various BMPs, measurable milestones to guide plan implementation progress, and a set of criteria to evaluate the effectiveness of implementation efforts.

By addressing watershed uses, the protection plan will gain a broad support base throughout the community. If we protect our land, so do we protect our water, thereby ensuring the enjoyment of future watershed residents and visitors. This watershed protection plan was written as a planning framework to be used by watershed stakeholders to maintain and improve the water quality of the Lake Leelanau watershed. The intent of the management plan is to assist the LLLA, the Leelanau Conservancy, local governments, volunteer groups, and many others in making sound decisions to help improve and protect water quality. It is important to note that the implementation of any element of this plan by a responsible party does not obligate any other party or stakeholder to participate beyond their respective organizational objectives.

Leelanau County has experienced a 26.7 % population increase from 1990-2008 (US Census, factfinder.census.gov). Since 2001, there have been 159 riparian (applicants listed Lake Leelanau as adjacent body of water) fill permit applications and only 37 of them were approved. Of the 37, three ended up being denied and eight of those issued were modified from the original application. The lake has seen an expanding walleye fishery in the last 15 years, which has attracted regional fishing tournaments and outdoor writers throughout the Midwest. The benefits accruing to the state and region from activity and development in the Lake Leelanau Watershed are dependent on preservation of its high water quality and scenic attractiveness. The Lake Leelanau Watershed contains scenic views, public parks, nature preserves, and large campgrounds, which attract thousands of visitors each day during the summer. Approximately seventeen (17) public parks and launching ramps provide access to the lake for swimming and recreational boating.

CHAPTER 3 DESCRIPTION OF THE LAKE LEELANAU WATERSHED

3.1 Location and Size

The Lake Leelanau Watershed drains 89,530 acres and is located primarily in Leelanau County but the headwaters are in Benzie and Grand Traverse Counties. The watershed covers the jurisdictions of 11 townships, three counties and contains three villages. It is approximately 140 square miles in size (23 miles long and 8 miles wide) (Figure 1).

3.2 Water Bodies

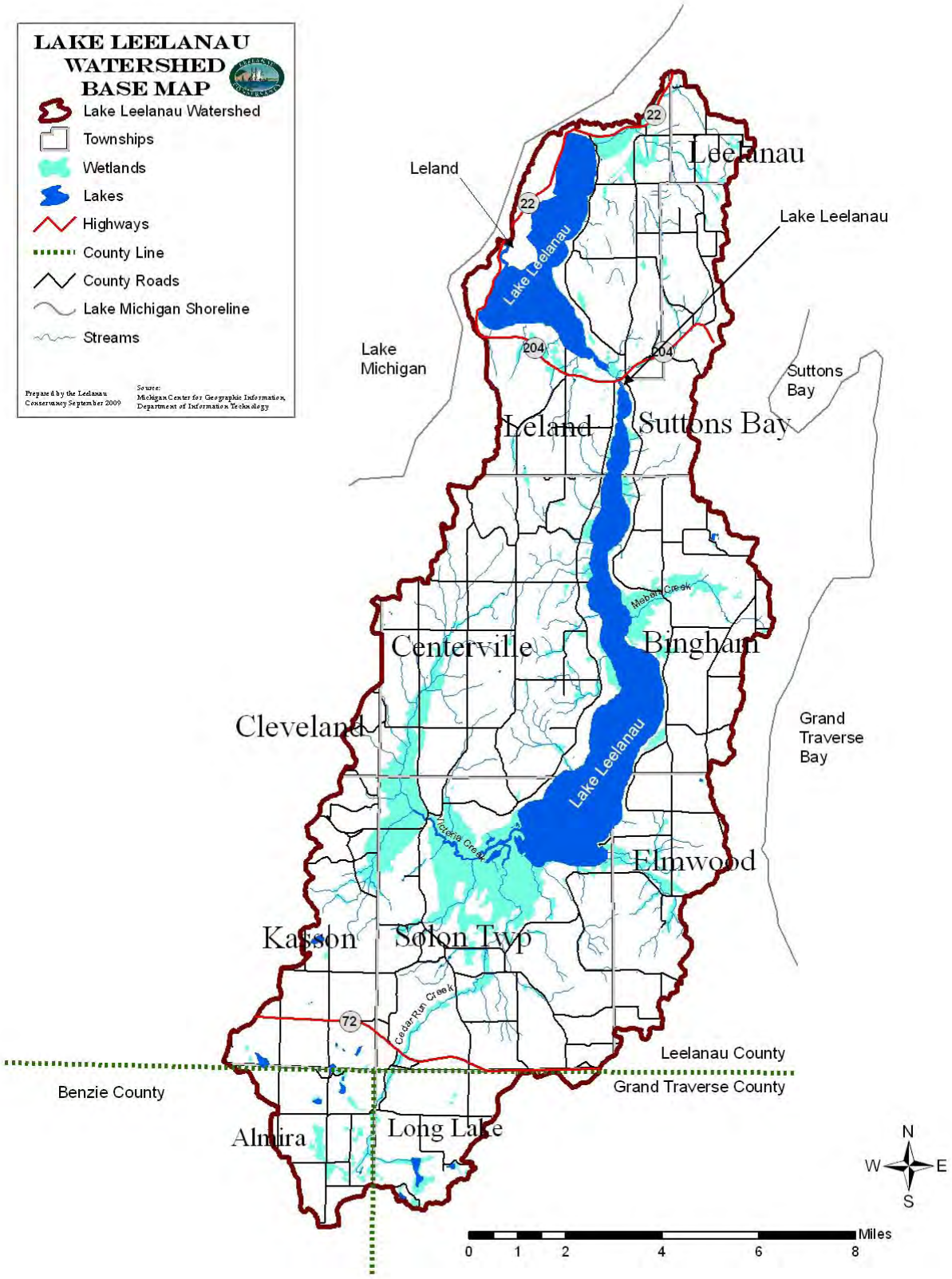
Lake Leelanau is a large recreational lake divided into two distinct basins. It is notable for its large size (13 square miles, 41 linear miles of shoreline), and its long, skinny shape. Lake Leelanau (which includes both South Lake Leelanau and North Lake Leelanau) is the largest lake located in Leelanau County, Michigan. South Lake Leelanau (SLL) is the larger body of water and is eight miles long with 26 miles of shoreline. The maximum depth of SLL is 62 feet with an average depth of 25 feet. North Lake Leelanau (NLL) reaches a maximum depth of 121 feet with an average depth of 43 feet. NLL is 4.6 square miles, with 15 miles of shoreline and covers 55 % of the surface area. NLL contains 98% as much volume as SLL. According to the Michigan Digital Water Atlas (Breck 2004), Lake Leelanau is 8,607 surface acres.

In northwest Long Lake Township in Grand Traverse County, Cedar Lake gives rise to Cedar Run Creek, which flows briefly into northwest Almira Township in Benzie County before flowing north into Leelanau County (Figure 1). Cedar Run Creek is joined by many first and second order, coldwater tributaries as it flows toward its junction with Victoria Creek in the Solon Swamp just south of Cedar on the Southern edge of SLL. The union of Cedar Run Creek and Victoria Creek form the Cedar River, which accounts for 78 % of the total surface water flow into SLL. Cedar River flows for a little less than a mile until emptying into SLL. The 5,370-acre SLL is joined to the 2,950-acre NLL by a mile long “Narrows” channel. This lake system is about 15 miles in length and has 41 miles of shoreline.

The majority of the watershed flows North. SLL is considered the largest tributary of NLL by way of the Narrows. However, limnologically the lakes are considered one body of water since they share the same surface level. The Leland Dam raised the natural water level seven feet and prevents the migration of aquatic species from Lake Michigan into Lake Leelanau. The elevation of Lake Leelanau is maintained at 589.21 feet from April 15-November 15, and lowered 12 inches from November 15-April 15 (Hanchin et al. 2007). Michigan Department of Environmental Quality (MDEQ) characterizes Lake Leelanau as oligotrophic based on low nutrient concentrations and high water clarity.

The Lake Leelanau Narrows were dredged 25 years ago to facilitate the movement of water from SLL to NLL and therefore keep the two lakes more equal in elevation. They were also dredged to allow for more uniform lake level control with the dam and to facilitate navigation between the lakes. To date there is no schedule for the Narrows to be re-dredged. It is possible they will need to be dredged within the next 10 to 15 years.

Figure 1: Lake Leelanau Watershed – Base Map



3.3 Jurisdictions

The Lake Leelanau watershed is comprised of portions of nine townships within Leelanau County (Figure 1, Table 1) and one township in Benzie and one township in Grand Traverse County. State of Michigan State Forest comprises 4 % of the watershed (Figure 2, Table 2). The Pere Marquette State Forest Land comprises the majority of public land the watershed and is primarily wetland, which comprises the Solon Swamp. The majority of the watershed is in private ownership (85%), which includes about 3300 acres or 4% in private conservation easements.

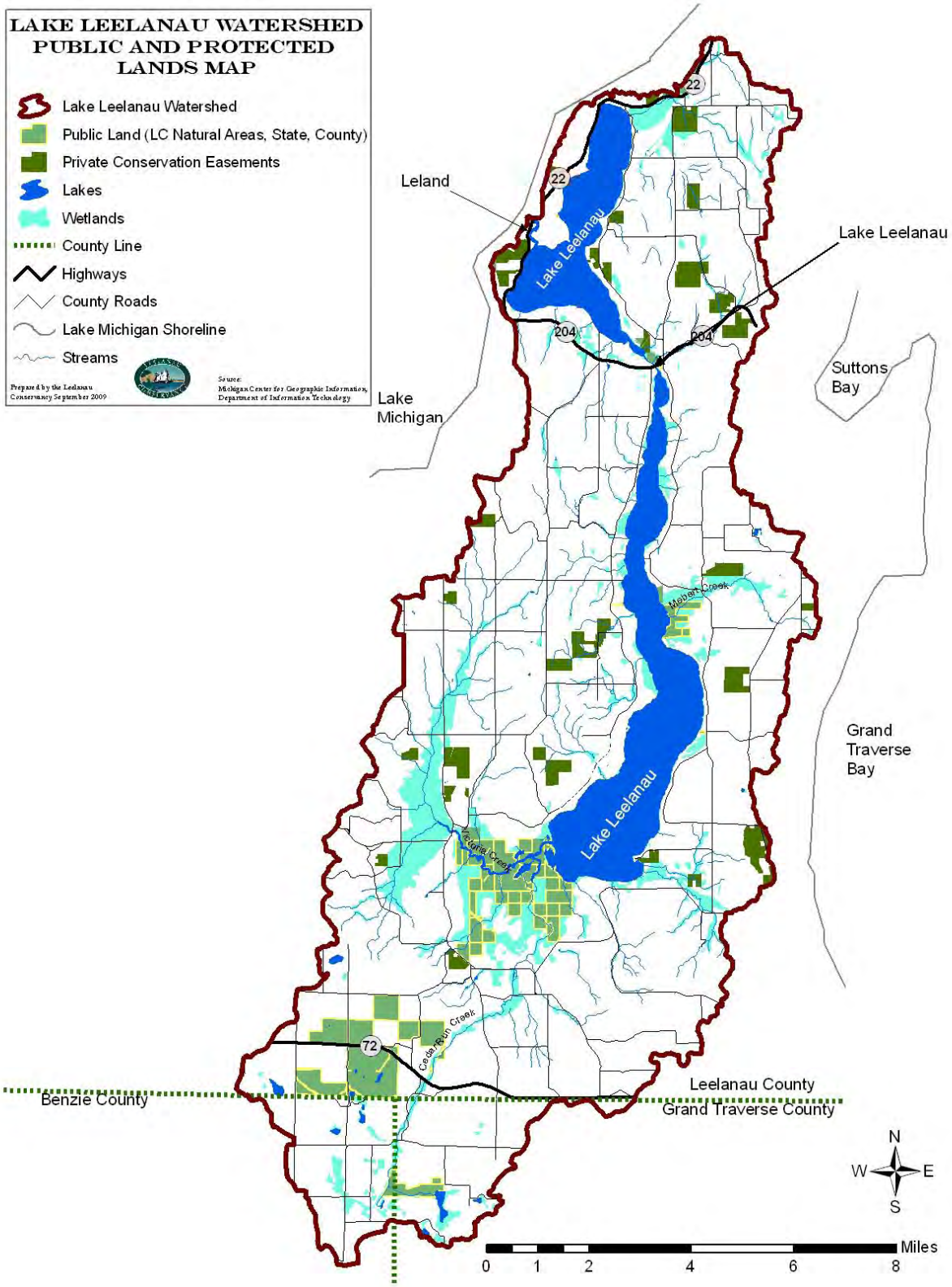
Table 1: Percent of each township within the watershed

Township	Acres in Watershed	% of Township in Watershed	% of Watershed
Bingham	10,128	61	11
Centerville	17,378	90	19
Cleveland	724	3	1
Elmwood	5,907	45	7
Kasson	6,812	29	8
Leelanau	1,633	5	2
Leland	15,009	46	17
Solon	19,031	100	21
Sutton's Bay	5,136	32	6
Grand Traverse County (Long Lake Twp)	3,977	17	4
Benzie County- Almira Township	3,786	16	4
Total	89,530		100

Table 2: Public and Private Land in the Lake Leelanau Watershed

Jurisdiction	Acres	% of Watershed
Privately Protected Land (conservation easements- CE's)	3,286	3.7
State Land	3,519	3.9
County Land	64	0.1
Private Land	73,732	82.4
Water (Lakes and Streams)	8,929	10.0
Total	89,530	100%

Figure 2: Public/Protected Lands in the Watershed



3.4 Population

Rich in land and water resources, Leelanau County is home to more than 22,000 people (US Census Bureau) sharing their living space with many plant and animal species such as bobcats, coyotes, deer, great blue herons, lady slippers and trillium.

According to the last census, Leelanau County grew at one of the fastest rates in Northwest Michigan. From 1990 to 2007 the county's population rose 28% (Table 3) and future projections indicate a steady growth rate for years to come. This means that over 10,000 additional people will be permanently residing in the county by the year 2020. They will be attracted to Lake Leelanau and the surrounding area to a great degree because of the high water quality and the recreational attractions. But, as more and more people discover how beautiful these lakes and this region are, the more difficult it will be to maintain their current outstanding water quality (Stone 2005). Since 1960, Leelanau County has experienced a 126% population increase.

The Northwest Seasonal Population Model, completed in 1996, estimates that during the summer months, Leelanau County's population almost doubles (note: study only included overnight visitation and daily visits, 'day trips', to the area were not measured) (LCPD 2004). A seasonal population study discussing residency, land values, seasonal and permanent residents, taxable value, and building permits was completed by Leelanau County in 1999 and 2000 as a working paper for the Leelanau General Plan. This study concluded that the seasonal population continues to grow at a faster rate than the year-round population.

As more and more seasonal residents are moving to the region on a permanent basis, the watershed is experiencing an increase in associated residential impacts. A prime example is a septic system operating for 12 months out of the year instead of three to six months a year. A 1995 study by the MSU Department of Parks, Recreation and Tourism suggests that more and more people are turning their seasonal homes into year-round residences. The study indicated that 40% of seasonal home owners in Leelanau County considered themselves "very likely" or "likely" to convert their seasonal homes to permanent residences (LCPD 2004, LCPD 2000). Most of the populations are centered around the lakeshore and near village centers. However, more recently the trends are showing the locations of new construction being built away from village centers and in more rural settings.

Table 3: Population and Population Change

Township	1990	2000	2008*	% Change (2000-2008)
Leelanau County				
Bingham	2,051	2,425	2,470	1.9
Centerville	836	1,095	1,171	6.9
Cleveland	783	1,040	1,110	6.7
Elmwood	3,427	4,264	4,244	-0.5
Kasson	1,135	1,577	1,736	10.1
Leelanau	1,694	2,139	2,203	3.0
Leland	1,642	2,033	2,105	3.5
Solon	1,268	1,542	1,633	5.9
Sutton's Bay	2,150	2,982	3,027	1.5
Total				**Average:**
Townships in LL Watershed	*14,203*	*19,097*	*19,699*	*3.2*

**Estimate – Population Division, U.S. Census Bureau*

3.5 Land Use/Land Cover

The land use within the watershed is dominated by 32.5% forested lands, (25.2% deciduous and 7.3 % coniferous), followed by 24% agriculture (12.4% cropland, 9.8% orchards and vineyards, and 1.7 % permanent pasture or other agriculture), 19.6% Open shrub/Grassland, 9.9 % water and 8.9 % wetlands, and Urban uses comprising 5% (Figure 3, Tables 4 & 5).

The Lake Leelanau watershed is blessed with more than 32% of its land in a forested condition (Table 4,5). Deciduous forest stands comprise the single largest land use of the watershed and, with sustainable management, provide an economic resource. At the same time, these forests have vital ecological roles. Following behind forests, agriculture (24%) and water/wetlands (18.8%) cover the majority of the remaining portions of the watershed (Table 5).

The major human land use of the watershed is agricultural (24%) along with residential homes, which comprise nearly 5% of the watershed (Table 5). Agriculture is an important part of the Lake Leelanau Watershed, especially the orchard industry. The lack of significant industry in the watershed is a legacy of the 1950's resort era that followed the crash of the resource dependant early 1900's economy. The economy of the watershed has become more reliant seasonal tourism and summer residents that are drawn to the natural scenery found few other places. The high percentage of forested land in the watershed provides scenic beauty enjoyed by thousands of tourists while simultaneously protecting wildlife habitat, groundwater recharge and important water quality functions. Shoreline habitat of Lake Leelanau was estimated at 80% upland (non-wetland) and 20% wetland (Hanchin et al. 2007).

Table 4: Land Use/Cover in the Lake Leelanau Watershed

Land Use/Cover	Acres	% Total
Commercial	102	0.11
Coniferous Forest	6643	7.41
Cropland	11,103	12.40
Emergent Wetland	524	0.59
Extractive (Sand and gravel)	319	0.36
Deciduous Forest	22,468	25.10
Herbaceous Rangeland	10,251	11.45
Industrial	54	0.06
Lakes	8,859	9.90
Open/Other	555	0.62
Orchards, Vineyards, and Ornamental	8,831	9.87
Other Agricultural Land	361	0.40
Permanent Pasture	1,184	1.32
Reservoir	6	0.01
Residential	3,939	4.40
Sand Dune	12	0.01
Scrub-Shrub Wetland	1,199	1.34
Shrub Rangeland	6,716	7.50
Streams	65	0.07
Transportation/Utilities	37	0.04
Wooded Wetland	6,304	7.04
Total	89,530	100%

Table 5: Grouped Land Use/Cover

Land Use/Cover Category*	Acres	% Total
Forested (non-wetlands)	29,111	32.50
Agriculture	21,477	24.00
Open Shrub/Grassland	17,522	19.60
Urban	4,450	4.97
Water	8,929	9.90
Wetlands (emergent and forested)	8,027	8.90
Barren (beaches, dune, rock)	12	0.01
Total	89,530	100%

Land Use Groupings:

- *Forested: coniferous, deciduous*
- *Agriculture: confined feeding, cropland, orchards/vineyards, other agriculture, permanent pasture*
- *Open Shrub/Grassland: herbaceous, open land/other, shrub*
- *Urban: commercial/services/institutional, extractive, industrial, residential*
- *Water: lake, streams/waterways*
- *Wetlands: wetlands*
- *Barren: beach/riverbanks, sand dune*

Figure 3: Land Use in the Lake Leelanau Watershed

3.6 Geology and Soils

Geology

The Lake Leelanau watershed is underlain by sedimentary bedrock of the undifferentiated Traverse Group (primarily limestone) on the west side and Antrim Shale deposits on the east side. Bedrock does not crop out anywhere within in the watershed, since it is overlain by many hundreds of feet of glacial deposits. However, bedrock rich in lime does influence the pH of Lake Leelanau and its tributary streams, causing the lake to be generally a hard water system high in mineral content. All surface features within the watershed are the product of late Pleistocene glaciation and the shoreline processes of the ancestral Great Lakes which re-shaped glacial deposits.

The final push of glacial ice into northern Michigan occurred just over 11,000 years ago. This last pulse of glaciation has been called the Great Lakian (formerly Valders), and its southern extent coincides with the southern boundary of the Lake Leelanau watershed. Lands to the south are generally outwash plains, pocked by numerous kettle holes and other ice-contact features. To the north, in the Lake Leelanau and adjacent watersheds, the advance of the glacier came in smaller lobes branching off of the main ice body that occupied the present Lake Michigan basin. As the climate cooled ice pushed up the valleys, and then retreated during warmer spells. This pulsing of the ice front, together with a generally northerly direction of flow, gave rise to the North-South trend of the valley which the lake occupies, and also the generally North-South orientation of nearby hills, primarily drumlins. The glaciers left behind vast quantities of undifferentiated sand and gravel, mixed with poor quality clay and pocked by numerous boulders.

For a period of time as the ice retreated the Lake Leelanau basin was a pro-glacial lake, dammed up between glacial ice that remained northward in the Lake Michigan basin, and the Great Lakian terminal moraine to the south. At this time, water drained westward into the Maple City area, and onward through a succession of glacial spillway channels into the Glen Lake basin. When ice finally retreated well into the Lake Michigan basin, waters stabilized in two higher lake levels: Lake Algonquin lasted for about 700 years at an elevation of between 625 and 630 feet; and Lake Nippissing lasted for about 2,000 years at an elevation of 605 feet above sea level. Today, only a few remnants of Lake Algonquin shorelines remain, such as while Nippissing age shoreline features are well represented.

Soon after the glaciers retreated, Lake Leelanau was actually a long sinuous channel running from the area around Leland in the north to Greilickville near Traverse City in the south. Exposed to the open waters, sand bars formed in and around Lake Leelanau such as the hooked spit (Section 36 Leland Township) and a long sandbar which pushes southward into the Solon Swamp area at the foot of Lake Leelanau near Cedar (Section 9 Solon Twp.) Associated with erosion of the surrounding moraines, fine particles of clay and organic matter settled to the bottom of protected embayments while beach terraces were formed at levels between 605 and 630 feet. After the water levels dropped, these relatively flat terraces with fine-textured soils set the stage for development of extensive wetland areas, particularly around South Lake Leelanau.

Like similar large northern Michigan lakes, Lake Leelanau is an embayment lake. It was finally separated from the open waters in the Lake Michigan basin when sand bars formed at the northern end of the basin between higher moraines. When water levels in the Lake Michigan dropped to the present-day level of 580 feet, the sandbars formed in the higher lake emerged from the waters and cut off the waters of Lake Leelanau. Today, the Leland River runs across this sand bar and forms the outlet of the lake. Large embayment lakes tend to be linear, relatively deep, and oligotrophic. Because most of the glacial deposits surrounding the lake are low-nutrient sand and gravel, and because rainfall freely infiltrates the porous soils then runs relatively freely into small tributaries and directly into the lake, such lakes tend to be clear and cold, and in the absence of anthropogenic influences, such lakes should remain oligotrophic for a very long time. However, these porous sandy soils also allow contaminants to quickly enter the groundwater system, thereby making it even more important to protect wetlands and other natural water filtration features of the landscape, such as forests.

Soils and Topography

The topography of the Lake Leelanau watershed is gently sloping with soils that range from mucky to well drained (Hanchin et al. 2007). The Lake Leelanau watershed is bordered to the east and west by north/south running, streamlined hills formed by retreating glaciers. These hills, called drumlins, are composed of sandy and coarse loam soils that are well drained and conducive to agriculture (Figure 4).

There are six main soil associations in the Lake Leelanau watershed: Emmet-Montcalm-Kalkaska association, 45.3%, the Blue Lake-Leelanau-Montcalm association, 15.9%, Kalkaska-Leelanau-Emmet association, 12.7%, Eastport-East Lake-Deer Park association, 12.0%, Kalkaska-Rubicon-Duel association, 3.4%, and the Rubicon-East Lake-Eastport association comprising 1.8% (Figure 5). The Blue Lake association is characterized by well-drained, nearly level to strongly sloping, gravelly, loamy and sandy soils on outwash plains. The Deer Park association is made up of sandy soils that are well drained and strongly sloping to very steep. Eastport associations are well to moderately well drained, nearly level to gently sloping, sandy soils. Nearly level to strongly sloping sandy soils on outwash plains characterize the Kalkaska-Leelanau association. In contrast, the Kalkaska-Rubicon association is found on moraines. Watershed valley floors, lakeshores and wetlands are typically composed of Lupton-Markey mucks or marl with a high pH.

Figure 4: Lake Leelanau Watershed Topography

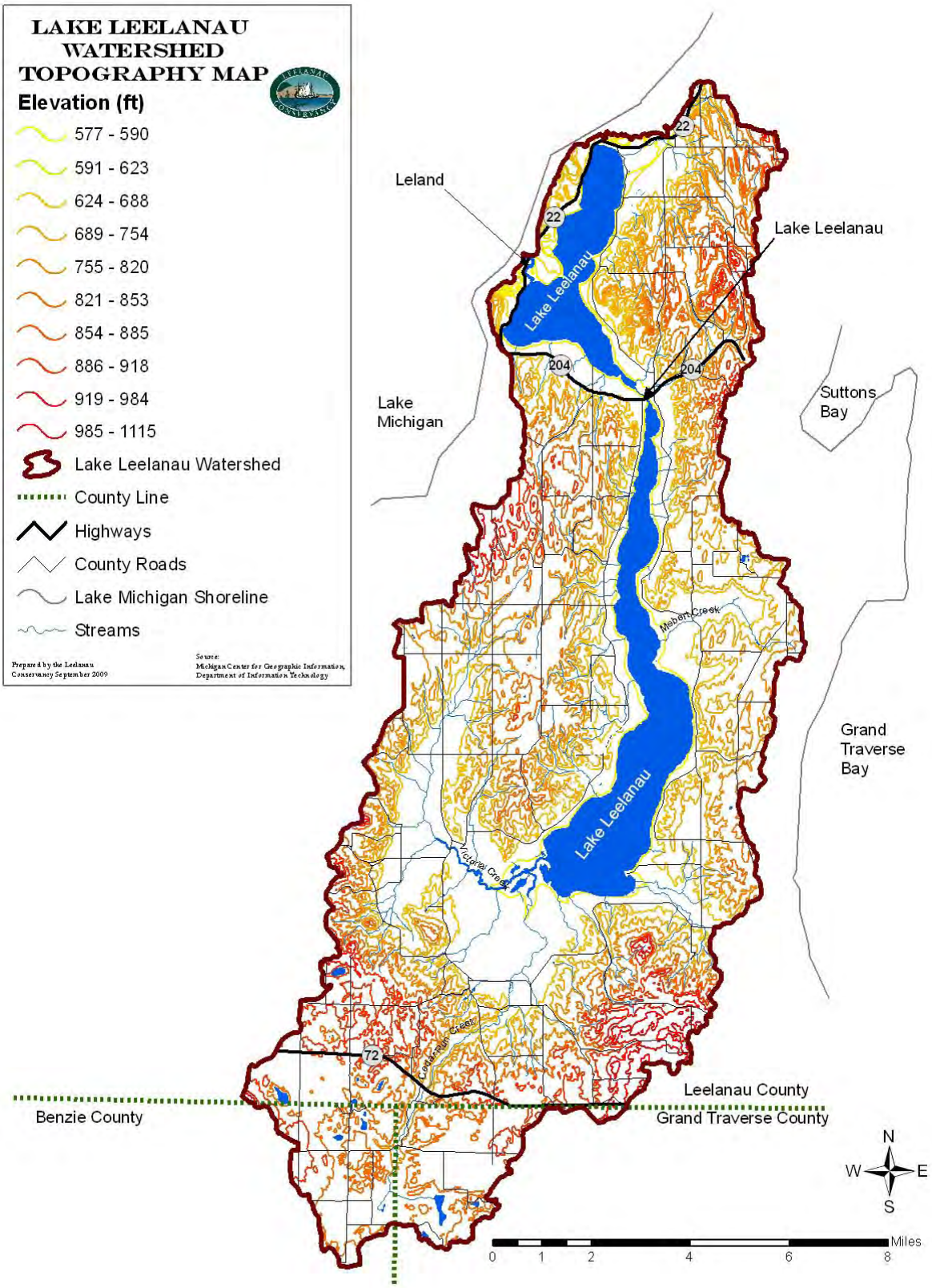
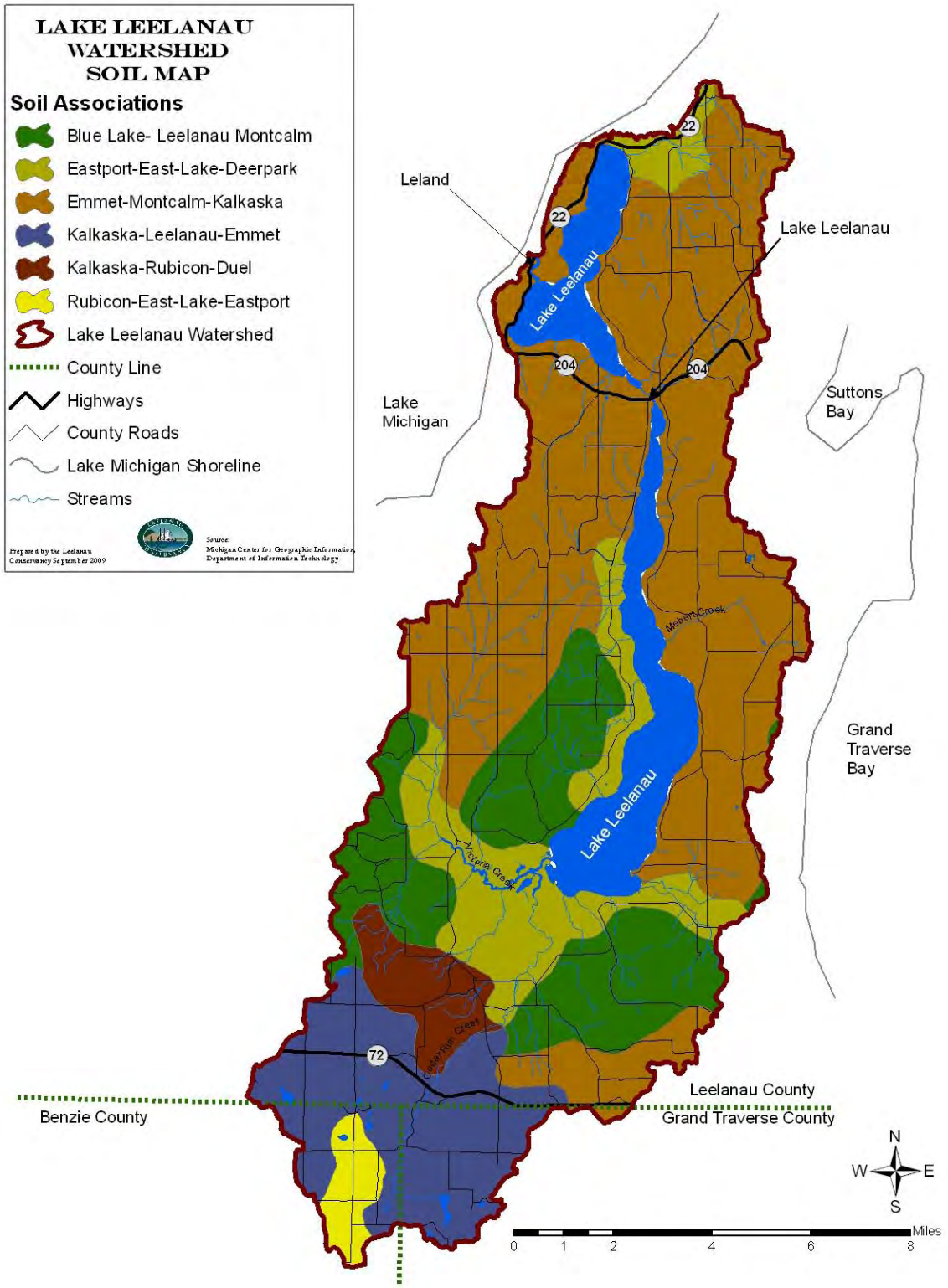


Figure 5: Soil Associations of the Lake Leelanau Watershed



3.7 Hydrology and Groundwater Recharge

North Lake Leelanau receives 2.1 % of its water supply from subsurface groundwater discharge, another 90.8% from surface flow, and the remaining 7.1% from atmospheric deposition. South Lake Leelanau receives 46.8% of its water supply from subsurface groundwater discharge, another 39.5% from surface flow, and the remaining 13.7% from atmospheric deposition. Additionally, a good portion of the measured surface flow values include groundwater seeps, which flow over the land a short distance before reaching the lake. Groundwater is an extremely important factor in the hydrological budget of NLL. Therefore it is essential that groundwater is replenished or "recharged". This underscores the importance of protecting upland areas from impervious surfaces or other development that can inhibit the percolation of precipitation through the soil into the groundwater and decrease groundwater recharge. Areas that have a low slope gradient combined with permeable soils in general have a higher potential for groundwater recharge, especially when adjacent to high slope gradient uplands.

Victoria Creek and Cedar Run Creek are the two main river systems in the Lake Leelanau watershed. The Leland River is the main outflow of water from the watershed. Direct overland runoff to the lake is insignificant, as rainwater quickly infiltrates soils and becomes integrated with the groundwater and surface spring inputs to the lake. Thus, land use practices in the entire watershed have a much greater potential to impact water quality than is the case for many other watersheds in the State with less permeable soils.

3.8 Wetlands

Wetlands comprise a vital link in the preservation of high water quality in the Lake Leelanau watershed. On their way to Lake Leelanau, the main tributaries pass through the Solon Swamp, at the Southwest corner of Lake Leelanau, which acts as a significant filter that extracts nutrients in the water before it enters the lake (Figure 6). Intact and healthy wetland communities take up excess nutrients swept from the soil and land surface by filtering storm and melt water as it flows down the landscape. Wetlands also help to minimize flooding by absorbing surface runoff and storm water and releasing it slowly into streams and groundwater. In addition to the water quality benefits of intact wetlands, the Lake Leelanau watershed contains habitat for several threatened and endangered plants and animal species that require these sensitive habitats to support their dwindling populations. The diversity of micro-habitats found within wetlands allows them to host more types of plants and animals than any other biological community.

In order to perpetuate the enjoyment and use of the Lake Leelanau watershed it is essential to protect sensitive wetland areas. Recreational interests such as birding, fishing, hunting and wildlife viewing are all enhanced by the healthy and intact wetland areas adjacent to North and South Lake Leelanau. Unfortunately, Leelanau County had the highest number of wetland fill permit applications of any county in Northwest Lower Michigan for most of the 1990's (personal communication with Mark Tonello, MDNR fisheries biologist in 2003). Since 2001, there have been 159 riparian (applicants listed Lake Leelanau as adjacent body of water) fill permit applications and only 37 of them were approved. Of the 37, three ended up being denied and eight of those issued were modified from the original application. Development in and adjacent to wetland areas threatens to degrade the aquatic resources, which are the heart of this watershed's desirability and attractiveness.

Currently the Federal Army Corps of Engineers and the State of Michigan regulate wetlands that are 5 acres or greater or connected to the Great Lakes. Additionally, the State of Michigan also protects wetlands under state law PA 451 of 1994 if they meet any of the following conditions:

- Located within 1,000 feet of one of the Great Lakes or Lake St. Clair.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river or stream.
- Not connected to one of the Great Lakes or Lake St. Clair, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the DEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

A study to identify potential wetland areas, combining different sources of wetland information using Geographic Information Systems (GIS) software, was completed in early 2000 by the Northwest Michigan Council of Governments (NWMCOG) through the Special Wetland Area Management Project (SWAMP), coordinated by the Michigan Department of Environmental Quality (DEQ). The dataset is a composite of three sources of wetland information:

1. The National Wetland Inventory (NWI), conducted by the U.S. Fish and Wildlife Service.
2. The U.S. Soil Conservation Service Soil Survey, which identifies hydric soils and soils with hydric inclusions and/or components.
3. The Michigan Resource Inventory System (MIRIS) Land Cover interpretation from aerial photographs.

Section 5.3, Priority and Critical Areas, describes the most important wetland areas in the watershed for maintaining water quality and sustaining rare plants, animals and habitats. The largest wetland areas within the watershed are found south of Lake Leelanau in the Solon Swamp (Figure 6). Cedar Run Creek, the largest surface water tributary to Lake Leelanau, meanders through an ecologically rich wetland that provides a diverse habitat for many plant and animal species, some threatened or endangered. The undisturbed wetland located there is critical to the creek’s biological diversity and its preservation is a high priority in the Lake Leelanau wetland.

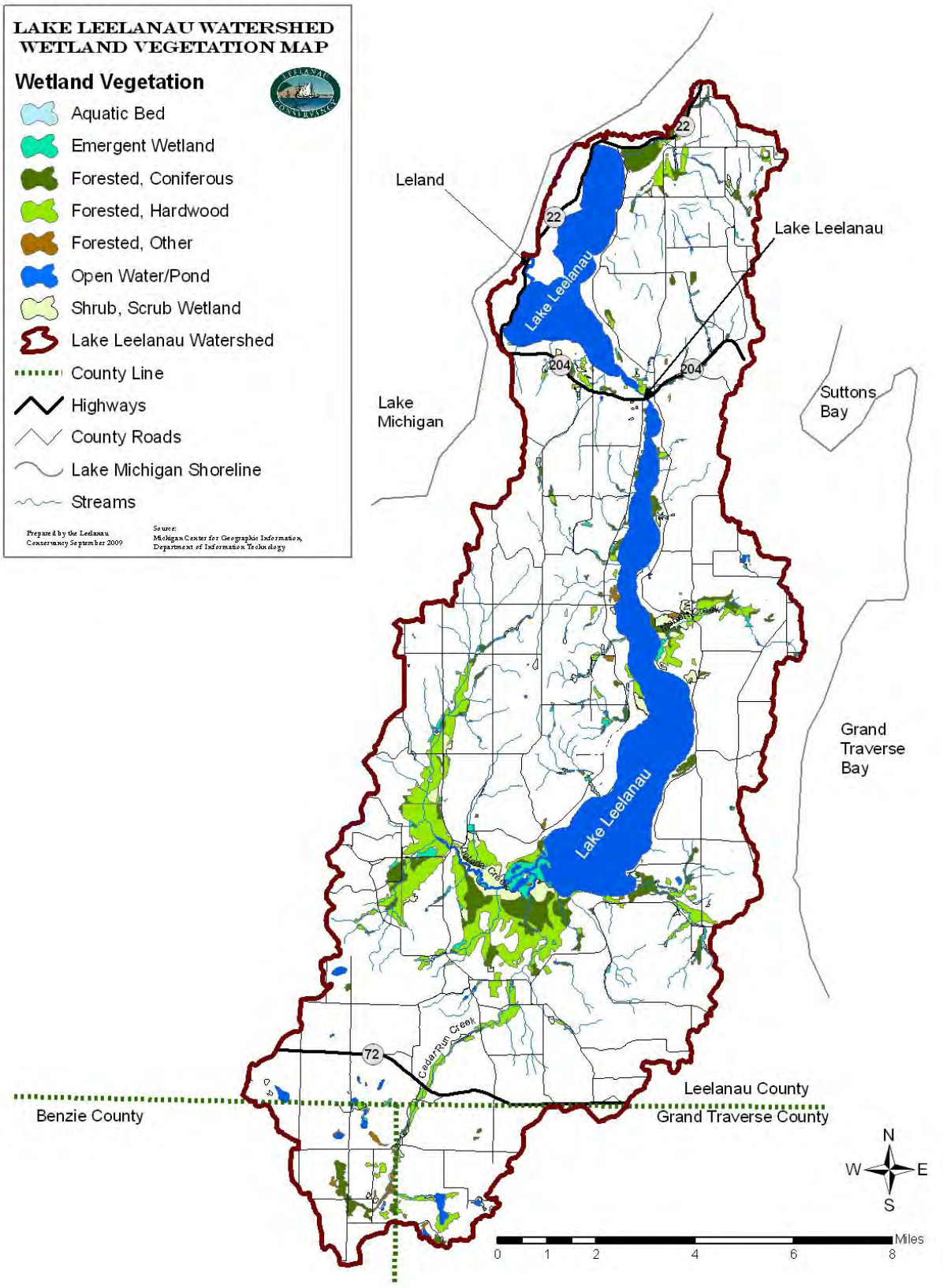
Looking at the data in Table 6, the total wetland area in the Lake Leelanau watershed is approximately 18,708 acres or 20.9 % of the total watershed area, compared to only 18.8 % using only the land use data (Tables 4 and 5, Figure 3). These data provide a useful tool in determining the location of potential wetland areas, but because the data has not been field checked, it does not guarantee the presence or absence of a wetland. It should be used only for general planning purposes.

Table 6: Composite Wetland Areas in the Lake Leelanau Watershed

Type of Wetland	Acres	% of Watershed
Emergent	1,156	1.29
Forested:		
Conifer	5,929	6.62
Dead	53	0.06
Deciduous	1,829	2.04
Unclassified	440	0.49
Open Water	8,837	9.87
Shrub Scrub	464	0.52
Total	***18,708***	***20.9***

**The wetland descriptor in the land use tables (Tables 5 and 6) do not contain all wetlands. Total wetlands are delineated in the table above, and cover 20% of the watershed. As an example of this difference, Table 6 represents cedar swamp areas as coniferous forest, as opposed to the 'forested-conifer' wetland description in the above table.*

Figure 6: Composite Wetlands of Watershed



3.9 Fisheries

Lake Leelanau, including the North and South basins, has a diverse fishery that has been documented by numerous fisheries surveys starting in 1949. The current fish community of Lake Leelanau is typical of oligotrophic lakes in the region. Cool water fish present include smallmouth bass, northern pike, suckers, sunfishes, yellow perch, and walleye. There have been 72 State of Michigan Master Angler awards taken from Lake Leelanau from 1994-2006 (Hanchin et al. 2007). From April 2002 to March 2003 a comprehensive survey of Lake Leelanau fisheries was conducted by the Michigan Department of Natural Resources (MDNR) to evaluate the fish community and fishery of Lake Leelanau, with emphasis on walleyes, northern pike and smallmouth bass (Hanchin et al. 2007).

It is likely that walleye are native to the lake because it was connected to Lake Michigan prior to construction of the Leland Dam (Hanchin et al. 2007). Management efforts prior to the 1970s centered around coldwater species, primarily lake trout, rainbow trout, and brown trout. Between 1948 and 2005, the lake was stocked with walleye, bluegill, rainbow trout, brown trout, splake and lake whitefish (Hanchin et al. 2007). Prior to 1948 smallmouth bass, largemouth bass, yellow perch and warmouth were also occasionally stocked according to MDNR records. lake trout are the only species stocked in Lake Leelanau on a regular basis. The lake trout fishery is primarily contained in the north basin. Stocking of brown trout was discontinued in 2000 due to poor survival and return to creel. Walleye stocking was suspended after 2001 after MDNR confirmed walleye were exhibiting excellent natural reproduction and above average growth (Hanchin et al. 2007).

Currently the fishery of Lake Leelanau is dominated by walleye, yellow perch and small mouth bass, which together comprised 91% of the total annual harvest, and 87% of released fish. Lake trout and lake herring were harvested, but only in the north basin. (Hanchin et al. 2007). The MDNR compared Lake Leelanau to other large lakes in Michigan and found the overall harvest of fish per acre is relatively low (1.8 fish/acre), but is most likely the result of fishing effort directed at large predators rather than more numerous pan fish (Hanchin et al. 2007). For walleyes specifically, the estimated annual harvest from Lake Leelanau was 1.09 fish per acre, and more specifically, it was 1.47 per acre in the south basin. This harvest is above average relative to other waters in Michigan. The walleye fishery in Lake Leelanau is considered one of the best in Michigan and the fishery seems to be self-sustaining. Interestingly, different population characteristics of walleye were noted between North and South Lake Leelanau despite the high degree of movement between the lakes (Hanchin et al. 2007). The northern pike fishery in Lake Leelanau is below average and the small mouth bass fishery is about average (Hanchin et al. 2007).

The Hanchin et. al (2007) survey concluded that there are significant differences in the north and south lake basins, which should be considered when managing their fisheries. South Lake Leelanau is primarily a walleye, smallmouth bass and perch fishery, while North Lake Leelanau is primarily a coldwater lake trout fishery, with some opportunity for walleye, perch and smallmouth bass.

3.10 Existing Water Quality Information and Results for the Lake Leelanau Watershed

The aging of bodies of water is a natural process that occurs over hundreds or thousands of years. As lakes age, they tend to accumulate nutrients which in turn promote the growth of aquatic vegetation and algae. Lakes progress from a very low nutrient condition (oligotrophic) to a lake overgrown by weeds (eutrophic). The primary contributors to this change are nitrogen (N) and phosphorus (P). This process is often accelerated by increases in nutrients that fertilize aquatic plants. Just 16% of Michigan's inland lakes with public access are defined as oligotrophic (DEQ 2006). Oligotrophic bodies of water are desirable because of their excellent water quality; however, they are highly susceptible to degradation as a result of increases in nutrient concentrations. As a result of these very low levels of naturally occurring nutrients, human contribution of N and P, associated with fertilizers, septic effluents, and other human activities, can have significant, and sometimes detrimental water quality impacts.

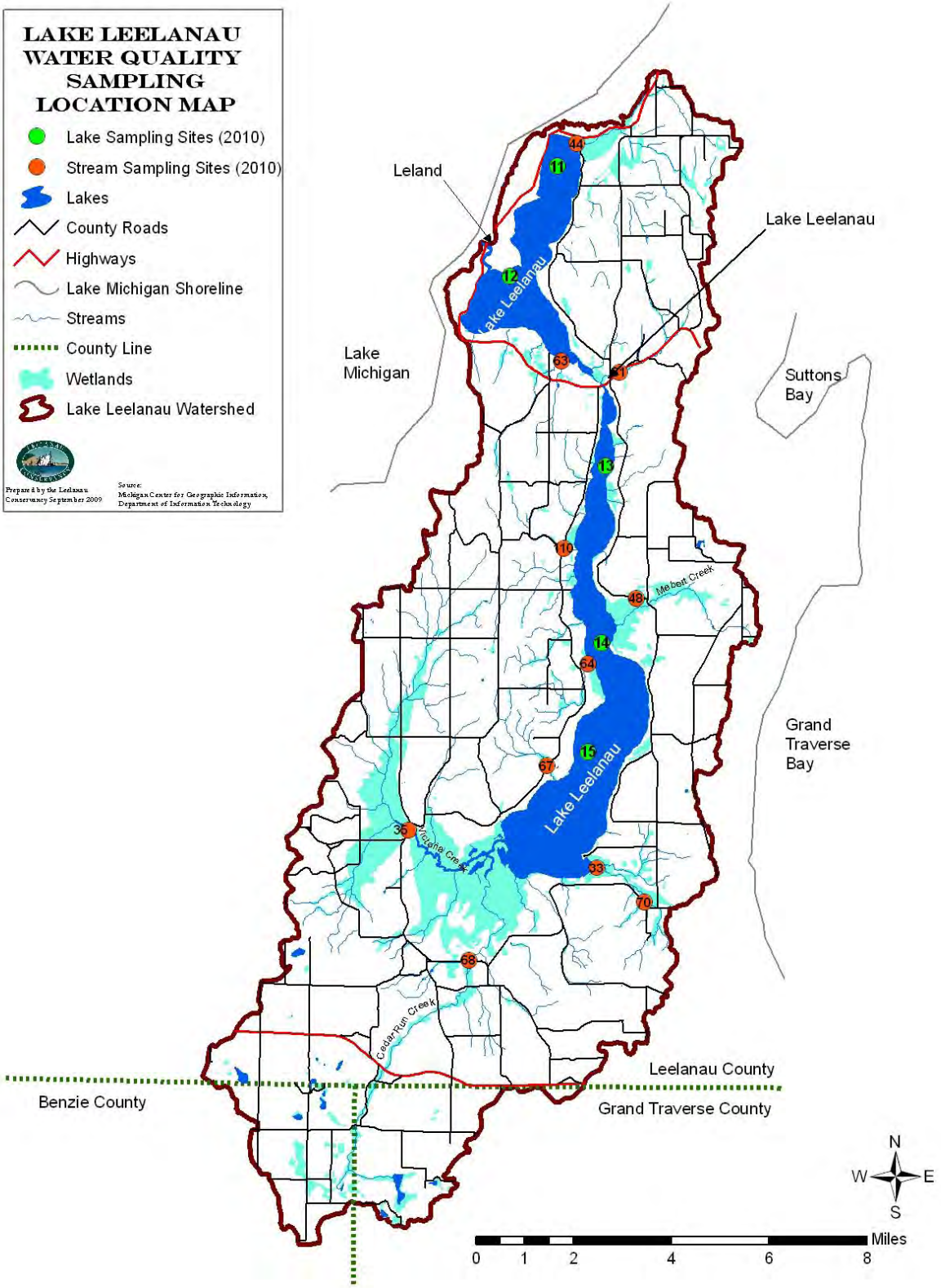
Since 1992, volunteers and members of the Leelanau Watershed Council (LWC), have been collecting water quality data on the major lakes and various streams around Leelanau County. A list of the current sampling locations is listed in the table below and a map of these locations can be found on the next page (Figure 7). Data collected by the Leelanau Watershed Council (LWC), the Lake Leelanau Lake Association (LLLA), and its volunteers indicate that the water quality in North Lake Leelanau (NLL), South Lake Leelanau (SLL), their numerous tributaries, and the Leland River is excellent. Both NLL and SLL chemical sampling data put them in a classification of oligotrophic lakes based on total N (TN), total P (TP) and Chlorophyll a concentrations along with secchi disk (SD) readings. Both lakes stratify thermally and turn over in spring and summer.

NLL is managed as a cold-water trout fishery and SLL is managed as a warm water fishery (primarily walleye) by the Michigan Department of Natural Resources (MDNR). The MDNR also lists and regulates several streams as trout streams which are tributaries to NLL and SLL: Houdek Creek, Beaudwin Creek, Mebert Creek, Belnap Creek, Weisler Creek, Solon or Cedar Run Creek, Clearbrook Creek, Rice Creek and eight unnamed creeks.

ID Number	Stream Site Name
31	Beaudwin Creek
33	Belnap Creek
35	Victoria Creek
44	Houdek Creek-Mouth
48	Mebert Creek (CR641)
63	Provemont Creek Mouth
64	Skeba Creek
67	Rice Creek
68	Cedar Run Creek
70	Mann Creek
110	Little Finger Creek (CR643)

ID Number	Lake Site Name
11	North Lake Leelanau 1
12	North Lake Leelanau 2
13	South Lake Leelanau 3
14	South Lake Leelanau 4
15	South Lake Leelanau 5

Figure 7: Water Quality Sampling Locations in the Watershed



Water Quality Information for Lake Leelanau and its tributaries

Significant data and summary reports have been produced which describe the water quality of the Lake Leelanau watershed throughout the year. Following are information sources used in the following water quality summary:

- Report of the Leelanau Watershed Council, Water Quality Monitoring Program (A synthesis of data from 1990 - 1995) – T. Keilty (7/1997)
    - A summary of water quality parameters that were sampled from 1990-1995 in several Leelanau County lakes, including NLL and SLL. Parameters included: TP, Nitrate+Nitrite Nitrogen, Chlorophyll-a, and SD.
- Report of the Leelanau Watershed Council, Nutrient Data and Budgets for Leelanau County Streams and Lakes 1990 – 1996 – R. Canale and W. Nielsen (9/1997)
    - This study summarized the nutrient budgets (inflow and outflow) of several Leelanau County lakes, including NLL and SLL. This study is over ten years old, but is the only study of the nutrient flux in Lake Leelanau.
- Michigan Department of Natural Resources, Historical Review and Management Prescription for Lake Leelanau Fishery, (1/2002).
- Report of the Leelanau Watershed Council, Water Quality Monitoring (A Synthesis of data from 1990 through 2001) - T. Keilty and M. Woller (2/2002)
    - An update (1990-2001) of a 1997 report summarizing water quality parameters sampled from several Leelanau County lakes, including NLL and SLL. Parameters included: TP, TN, Chlorophyll-*a*, and SD.
    - *While seemingly a long period of monitoring, the researchers in these studies indicate the program is just emerging from its infancy. The data have changed over this period because of the colonization of exotic zebra mussels which have affected the lake's ecology. The authors recommended more targeted studies for emerging issues*.
- Predicting Blue-Green Algal Blooms & Potential Toxin Production in Zebra Mussel Infested Oligotrophic Lakes (Leelanau Watershed Council, Leelanau Conservancy for MDEQ) – M. Woller and T. Keilty (2004)
    - A study of the influence of zebra mussels on the plankton populations of several Leelanau County lakes, including NLL and SLL. The authors cited literature sources that documented zebra mussels selectively consume green algae and reject cyanobacteria. This mechanism causes the decline in diversity of plankton and potential for cyanobacteria blooms causing a commensurate increase of microcystin (a hepatotoxin) excreted by the cyanobacteria *Microcystis aeruginosa*.

- Microcystin Production and Fate in Zebra Mussel Infested Oligotrophic Lakes, Prepared for Michigan Department of Environmental Quality, M. Woller and T. Keilty (3/2006)
    - This study report documented concentration and fate of microcystins generated by cyanobacterial blooms in several Leelanau County lakes, including NLL and SLL. The report recorded concentration of microcystin (an hepatotoxin) in the water, sediments, macroinvertebrates and fish. The authors hypothesized potential for persistence and bioaccumulation of microcystin based on literature and results of their work.

- Personal Communication, Raymond P. Canale, Ph.D. (2009). Discussions with Dr. Canale about the results and management implications of his 1997 report, "Nutrient and Data Budgets for Leelanau County Streams and Lakes".

- Leelanau Conservancy Watershed Council Database – (2008).

    - This database contains chemical and physical water sampling results of Leelanau County lakes and streams starting from 1990 through the present. NLL and SLL and their tributary streams are included in the database. Parameters include: TP, nitrates, nitrites, Kjeldhal nitrogen, ammonia, chlorophyll a, conductivity, oxygen reduction potential, temperature, conductivity, pH and SD. The database provides an overview of trends over time. The stream samples include an estimate of water flow and average of phosphorous loading to Lake Leelanau.

General Characteristics: (Depth, Temperature, Dissolved Oxygen – DO, Conductivity, pH, Secchi Disk, Oxidation/Reduction Potential)

- **Depth**
    - NLL maximum 121 feet, average 43 feet
    - SLL maximum 62 feet, average 25 feet

- **Temperature**
    - NLL
        - Surface: 52.3^{o} F – 75.9^{o} F
        - 30M – 40M: 43.7^{o} F – 48.1^{o} F
    - SLL
        - Surface: 47.9^{o} F – 64.9^{o} F
        - 18M: 32.6^{o} F – 32.6^{o} F

- **Dissolved Oxygen (DO)**
    - NLL
        - Surface: 7.5 mg/L – 12.4 mg/L
        - 30M-40M: 1.2 mg/L – 12.4 mg/L
    - SLL
        - Surface: 7.4 mg/L – 12.1 mg/L
        - 18M: 0.04 mg/L – 11.3 mg/L

Temperature and Dissolved Oxygen are intimately linked in northern temperate lakes such as NLL and SLL, because of the formation of a vertical temperature gradient during summer periods. Because cooler water is denser than warm water it settles to the bottom of the lake. As the sun continues to heat the lake surface layer, the warm/cool water density gradient becomes too great to allow mixing of surface and bottom water. The upper layer of warm water is called the epilimnion, the transition zone the thermocline, and the cooler bottom water the hypolimnion. This lack of vertical mixing creates environments where near-bottom oxygen can be reduced or depleted. Near bottom oxygen depletion occurs in both NLL and SLL. These conditions favor the release of P from the sediments. See more below.

- **Conductivity:**
  - NLL
    - 1995 – 2005: 0.27 mS/cm – 0.37 mS/cm
    - Average 1995 – 2005: 0.32 mS/cm
  - SLL
    - 1995 – 2005: 0.27 mS/cm – 0.37 mS/cm
    - Average 1995 – 2005: 0.31 mS/cm
- **pH**
  - NLL
    - 1995 – 2005: 7.45 – 8.05
    - Average 1995 – 2005: 7.8
  - SLL
    - 1995 – 2005: 7.57- 8.11
    - Average 1995 – 2005: 7.9

"Conductivity of lake water is a measure of its resistance to electrical current flow. It declines with increasing ionic content, i.e. the more pure (salt free) the water, the greater its resistance to electrical flow. The salinity of our waters is comprised primarily of the four major cations (calcium, magnesium, sodium, and potassium,) and the major anions (bicarbonate, carbonate, sulfate, and chloride)." (Keilty and Woller, 2002) Conductivity is measured in milli-Siemens/centimeter, (mS/cm). The pH of both NLL and SLL tend to stratify during the summer because of the photosynthetic activity of the plankton. The epilimnion tends to be higher, above a pH of 8.0 and the hypolimnion tends to have pH near 7.5.

Secchi Disk

- NLL
  - 1990 - 1996: 13.0 ft.(1991) – 16.3 ft (1993)
  - Average 1990 – 1996 = 13.9 ft.
  - 1997 – 2007: 13.2 ft (1997) – 22.3ft (2005)
  - Average 1997 – 2007 = 16.5ft.

- SLL
  - 1990 – 1996: 11.6 ft (1990) – 16.5 ft (1992)
  - Average 1990 – 1996 = 14.0 ft
  - 1997 – 2007: 13.0 ft (1998) – 18.0 ft (1999)
  - Average 1997 – 2007 = 15.4ft

The Secchi disk is a measure of water transparency, which is directly linked to inorganic suspended solids and plankton abundance. Transparency and secchi disk readings vary throughout year, with generally greater readings in spring and fall. Keilty (1997) reported the clouding or "whiting" appearance of water during the summertime from peak photosynthetic activity of phytoplankton. Keilty and Woller (2002) reported that the introduction of zebra mussels into NLL and SLL resulted in summer increases in the secchi readings after 1997. The following are average annual readings from NLL and SLL for two periods 1990 – 1996 and 1997 – 2007, which generally show an increase in secchi readings for the averages of the two years.

Nutrients *(Phosphorus – P and Nitrogen – N)*

North Lake Leelanau

- TP 1990-2005
  - Range: 3.27 µg/L – 6.76 µg/L
  - Average: 4.88 µg/L
- Nitrate/Nitrite 1990 -2005
  - Range: 133.75 µg/L – 747.88 µg/L
  - Average: 267.9 µg/L
- N:P Ratio
  - Range: 24.4 – 132.44
  - Average: 54.3

South Lake Leelanau

- TP 1990-2005
  - Range 3.45 µg/L – 8.09 µg/L
  - Average 5.18 µg/L
- Nitrate/Nitrite 1990 -2005
  - Range 75.56 µg/L – 315.43 µg/L
  - Average 195.03 µg/L
- N:P Ratio
  - Range 15.03 – 67.14
  - Average 36.08

Total phosphorus (TP) is an essential nutrient for plant growth, but it tends to be low in northern lakes. Keilty and Woller (2002) provide information that indicates NLL and SLL are oligotrophic, or high quality, clear lakes. Oligotrophic lakes are typified by total phosphorus (TP) concentrations ranging from 3ug/L to 17ug/L, and Total nitrogen (TN) concentrations between 307ug/L and 1630ug/L. The tables above show TP concentrations fell within Wetzel's oligotrophic classification. Keilty and Woller reported nitrate/nitrite (N) concentrations as opposed to Wetzel's classification using TN(which also includes organic and ammonia nitrogen). The ranges of the nitrate/nitrite values above show the lakes nitrogen levels also likely fall into the oligotrophic range. The ratio of N/P is also an important factor in lake biology because microorganisms typically require about 10 times more nitrogen than phosphorus. Both NLL and SLL have N/P ratios greater than 10. The authors also report a slight decline of TP from the water column, and attribute it to zebra mussel filtering of plankton. Other factors they cite as possible reasons for phosphorus reduction are education efforts to riparian owners to reduce phosphorus containing substances such as fertilizer and dish detergents. They also cite the prolonged decrease in rainfall since atmospheric input represents 18% and 20% for NLL and SLL, respectively.

Chlorophyll a

- NLL 1993 - 2007
  - Range: 1.07 μg/L(2003) – 2.07 μg/L (2006)
  - Average 1.42 μg/L
- SLL 1993 - 2007
  - Range: 1.15 μg/L(2000) – 2.3 μg/L (2006)
  - Average 1.57 μg/L;
- Both NLL and SLL are within ranges of chlorophyll a for Oligotrophic lakes (0.3-4.5 μg/L)

Both NLL and SLL are within ranges of chlorophyll a for oligotrophic lakes (0.3 – 4.5 ug/L) (Keilty and Woller, 2002). The authors show decline of chlorophyll a from the water column, and attribute it to zebra mussel filtering of plankton.

Aquatic Plant Survey and Invasive Species

Invasive Plants – Eurasian Milfoil

- Volunteers from the LLLA have inspected NLL and SLL during the fall of the year, especially near boat launches for the presence of Eurasian Milfoil. No sightings have been documented during these surveys. However, more intensive and systematic surveys should be conducted
- There was a weed survey conducted by the LLLA in 1999. With 209 surveys returned, results showed a decrease in weeds in SLL, with algae growth appearing stable. In NLL there was an increase in weeds reported as well as an increase in algal growth.
- *Phragmites* has been identified on at least 20 acres of Lake Leelanau as of December 2009. It is expected that 50 acres may be present along the entire Lake Leelanau shoreline. There is a project underway that seeks to control the detrimental invasive species, *Phragmites australis*, to maintain water quality and near-pristine habitats of Lake Leelanau and restore native vegetation to shoreline affected by *Phragmites*.(see section 5.4 Pollutants of Concern, Invasive Species for more information)

Invasive Animals – Zebra Mussel *(Dressina polymorpha)*

- The zebra mussel became established in NLL and SLL in the mid-1990's. See the discussion below on the species implications for water quality.

Threatened and Endangered Species

- To date there is has not been a detailed study on threatened or endangered species in the Lake Leelanau Watershed, however there is definitely habitat for listed species within the watershed.

Phytoplankton and Zooplankton
• Phytoplankton populations appear to be dominated by cyanobacteria (cyanobacteria algae). Keilty and Woller (2004 And 2006) indicate that selective feeding by zebra mussels on green algae give a competitive advantage to cyanobacteria algae, especially *Microcystis aeruginosa*.

Nutrient Loading for Nitrogen and Phosphorus -- *NLL and SLL*

A study of Leelanau County lakes, including NLL and SLL was completed by Canale and Nielsen (1997). The research covered the period 1992 – 1995. It quantified contributions of nitrogen and phosphorus to the lakes by atmospheric deposition, groundwater, septic systems and tributaries. Outputs included evaporation and outflows. The mass balance between inputs and outputs was assumed to remain in the sediments or ecosystem biomass.

SLL nutrient loading is summarized in Table 7. Canale and Nielsen estimated SLL received 327,166 pounds of TN and 6,445 pounds of TP annually. Twenty-one percent of TP input to SLL is contributed by its two major tributaries, Solon Creek (12%) and Cedar River (9%). Another 20% comes from atmospheric deposition, 19% from internal loading, 18% from groundwater, and 14% from septic systems. The remaining 8% comes from the remaining smaller tributaries. About 62% of the TN and 70% of TP are retained in the system. From a watershed management and BMP perspective, SLL's P load from two major tributaries, Cedar River and Solon Creek represent 21% of the total input into SLL. Septic systems represent another 14%.

Below is a table representing the total pollutant loads for Total Suspended Solids, Total Nitrogen and Total Phosphorus (Lbs /yr) per land use type for the Lake Leelanau Watershed. The numbers were calculated by multiplying the land use acreages from Table 5 and estimated pollutant loads from Table 29.

Land Use	Acres	Total Suspended Solids	Total Nitrogen	Total Phosphorus
Urban/Industrial	512	542,720	5,658	563
Residential	3,939	2,371,278	23,043	2,954
Agriculture	21,477	3,285,981	51,545	3,866
Vacant	12	480	6	1
Open Space	54,662	1,093,240	10,932	7,106
Total	**80,602**	**7,293,699**	**91,184**	**14,490**

Note: Numbers are in Pounds/year. Averages were taken from Table 29 in order to group land use categories appropriately. Water is not included in this table.

Table 7. South Lake Leelanau nutrient budget (1992-1995)

	Flow	Total Nitrogen		Total Phosphorous			N/P Ratio
INPUT:	**cfs**	**µg/L**	**Ib/yr**	**µg/L**	**Ib/yr**	**% Total**	
Belnap Creek	5.9	1110	12,877	20.0	232	4	55.5
Cedar River	18.2	1130	40,565	16.3	583	9	69.5
Mebert Creek	3.5	1,567	10,754	22.3	153	2	70.4
Rice Creek	2.2	658	2,813	17.3	74	1	38.1
Skeba Creek	1.8	1315	4,554	19.5	68	1	67.4
Solon Creek	29.0	652	37,623	13.0	743	12	50.2
Atm. Deposition	21.0		42,290		1,282	20	33.0
Septic Systems			11,664		916	14	12.7
Internal Loading			12,640		1,264	19	10.0
Groundwater	71.8	1072	151,386	8.0	1130	18	134
	153.4		327,166		6,445.0		50.8
OUTPUT;							
Narrows	132.4	478	124,505	7.5	1,954		63.7
Evaporation	21						
	153.4						
NUTRIENT RETENTION			%61.94		%69.68		

NLL nutrient loading is summarized in Table 8. Canale and Nielsen estimated NLL received 206,429 pounds of total nitrogen and 3,814 pounds of TP annually. Fifty-one percent of the TP input to NLL comes from SLL via the narrows. Another 18% comes from atmospheric deposition, 13% from septic systems, and 9% from internal loading (i.e. liberating of soluble biologically available phosphorous from decaying organic matter). This occurs in the near bottom areas in reducing, anoxic or low-oxygen conditions. Thirty-seven percent of the TN and 59% of TP are retained in the lake. From a watershed management perspective the sources that are controllable, and lend themselves to BMP development are the septic loading (13%) and the load from smaller tributary streams.

Table 8: North Lake Leelanau Nutrient Budget (1992 - 1995)

(From Canale and Nielsen, 1997)

	Flow	Total Nitrogen		Total Phosphorous			
INPUT:	**cfs**	**µg/L**	**lb/yr**	**µg/L**	**lb/yr**	**% Total**	**N/P Ratio**
Beaudwin Creek	2.9	2,294	13,272	17.8	103	3	129.2
Houdek Creek	3.8	2,018	15,140	18.8	141	4	107.6
Narrows	132.4	478	124,505	7.5	1954	51	63.7
Provemont Creek	1.3	2,628	6,865	13.5	35	1	194.7
Atm. Deposition	10.9		21,877		663	18	33
Septic Systems			6,477		509	13	12.7
Internal Loading			3,580		358	9	10
Groundwater	3.2	2,313	14,713	8	51	1	289.2
	154.5		206,429		3,814		54.1
OUTPUT							
Leland River	143.7	458	129,490	5.5	1,555		83.3
Evaporation	10.9						
	154.6						83.3
NUTRIENT RETENTION			37.3%		59.2%		

The Canale and Nielsen work is the only holistic evaluation of the nutrient budget for the Lake Leelanau watershed. Personal communication with the senior author indicated that the nutrient numbers in Tables 7 and 8 present approximations of the P loading. The author recommends a more comprehensive study of the watershed phosphorus sources be conducted to provide more reliable numbers if the information is to used for effective planning purposes.

Dr. Canale's comments bear relevance when reviewing data for years after the 1992-1995 dataset. Phosphorus loading from the above streams was monitored for several years after the 1992-1995 period. Table 9 shows quite different numbers from the 1992-1995 average loads. The reason for the differences is unclear. Keilty and Woller (2002) hypothesized that some of the TP decline seen in their data may be related to decreases in precipitation patterns. These observations do support the need for a more comprehensive study should funding sources be found. MDNRE is in the process of establishing a new approach to establish TP standards for Michigan, including Lake Leelanau and the other County lakes. Studies in LL have demonstrated that our long-term TP average will likely be below the MDNRE final number for TP in northern Michigan Lakes. However, new development, land use practices (fertilization), failing septic systems that are all part of this plan should be monitored and managed effectively to assure LL's long-term TP levels do not increase.

Table 9. Phosphorous Loading to Lake Leelanau Tributaries (lb/yr)*

	1996	1999	2000	2001	2006	2007	2008
Beaudwin Creek	78.7	46.1	40.0	33.7	34.5	39.1	37.8
Belnap Creek	151.1	170.5	153.7	95.4			63.4
Cedar River (Victoria Cr)	641.5	266.9	266.9	567.3	91.2		
Houdek Creek	95.6	25.4	43.4	40.8		13.8	
Mebert Creek	105.0	95.9	120.1	42.2		24.7	
Provemont Creek	29.1	55.0	37.7	36.4	18.3	17.6	15.7
Rice Creek	126.2	38.9	37.6	77.8			37.3
Skeba Creek	90.2	20.1	62.5	11.9			20.1
Solon Creek	616.3	822.8					
Lake Leelanau Narrows							
Leland River	1988.1	2329.1	1875.0				

*From Leelanau Watershed Council Database

In summary, the TP levels in NLL and SLL have remained within the oligotrophic range during the period of the monitoring. It would seem prudent to establish these long-term levels as a baseline level of TP. Updating and refinement of the nutrient budget previously completed would be helpful to identify the most efficient control mechanisms for TP. Since TP contributions such as atmospheric loading cannot be controlled, it would also be prudent to develop monitoring programs and BMPs for areas that could help to quantify and reduce TP. For example, shoreline *Cladophora sp*. Surveys could help identify TP contributions from septic systems or over-fertilization of lawns. Landowners can be educated about the benefits of phosphorus reductions to help support landowner initiatives. Monitoring should be continued to assure tracking of lake TP levels.

Zebra Mussel Colonization and Water Quality Impact - *NLL and SLL*

Keilty and Woller (2002) focused attention on the potential impact of zebra mussels, *(Dressina polymorpha)* on the water quality of NLL and SLL. The authors reported the first appearance of zebra mussels was near Perrins Landing on SLL in 1996.

Zebra mussels have the ability to reproduce quickly and females are capable of producing 30,000 to 1 million eggs per year. Adult zebra mussels filter about one liter of water per day to scavenge planktonic organisms for food. Their high reproductive ability coupled with high filtering capacity has a pronounced effect on water clarity where they have become established. They have reached isolated densities of 3,249/m^2 in NLL and 1,278/m^2 in SLL.

Figure 8 and Figure 9 show the average secchi disk readings in NLL and SLL by month, for years 1990-1996 (pre-zebra mussel colonization) and 1997 – 2001 (post zebra mussel colonization), Keilty and Woller (2002). The general trend in early spring and late autumn show increased water clarity, likely due to low cyanobacteria densities, which is more pronounced in

NLL. During the warmer summer months when cyanobacteria tend to dominate, they decreased water clarity. The high photosynthetic activity also raises the surface water pH and calcium carbonate precipitates causing a cloudy appearance of the water. The authors also indicate that the filtering ability of the zebra mussel tends to reduce chlorophyll a and TP in the water column.

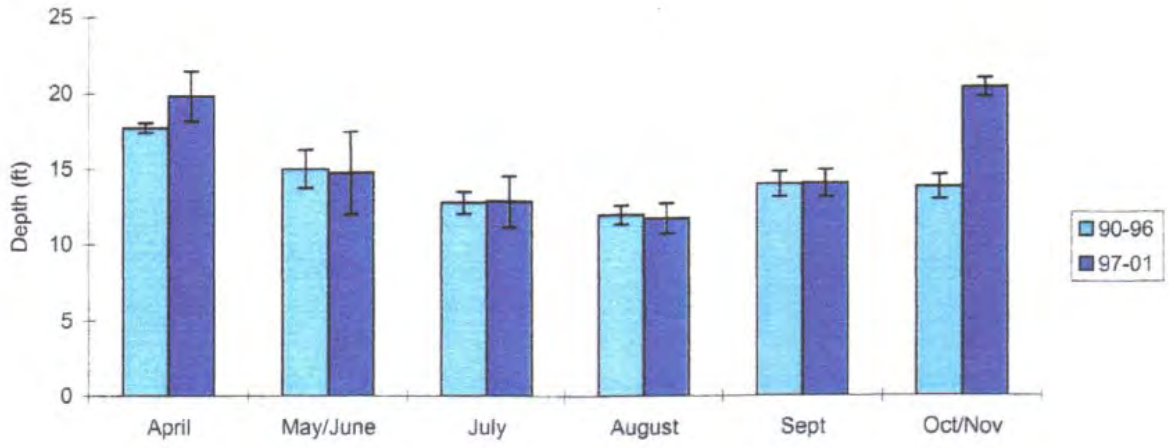


Figure 8. Mean secchi disk transparency by month in NLL. Years 1990-1996 represent pre-zebra mussel colonization and 1997-2001 represents years after zebra mussels were established in NLL.

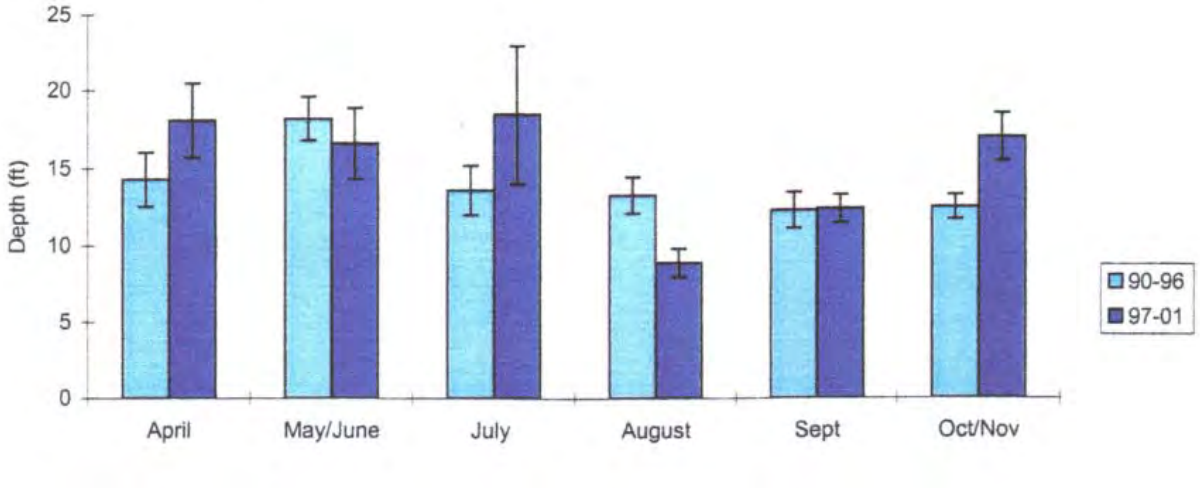


Figure 9. Mean secchi disk transparency by month in SLL. Years 1990-1996 represent pre-zebra mussel colonization and 1997-2001 represents years after zebra mussels were established in SLL.

Zebra Mussels and Mycrosistis

An emerging issue with a potential threat to Lake Leelanau is recent research by the Leelanau Watershed Council (LWC) that supports evidence linking zebra mussel densities and filtering capacities to peak, observed concentrations of *Microcystis aeruginosa*, a potentially toxic cyanobacteria, in Lake Leelanau and nearby Little Traverse Lake (Keilty and Woller 2004).

Microcystis forms small colonies that look like floating yellowish-green pollen or sand grains. At high populations, wind can push the colonies toward shore, forming a very dense blanket. Although *Microcystis* is present in most lakes, it is rarely noticeable. In recent years, though, some lakes have experienced much higher than normal concentrations.

There is much speculation in the scientific community about why this is occurring, but one of the suspected culprits is invasion by zebra mussels, a non-native pest that was introduced to the Great Lakes region in the early 1980s. These thumbnail-size mussels filter and digest large quantities of algae, but appear to "spit out" *Microcystis*. With competing algae reduced, *Microcystis* may build to greater concentrations than normal (Solomon 2009). Microcystis can produce natural toxins, called microcystins, which can be harmful to wildlife and humans.

Keilty and Woller (2002) researched additional potential impacts resulting from the colonization of zebra mussels in NLL and SLL and corresponding increase in cyanobacteria. They cite literature of zebra mussels' ability to selectively reject Cyanobacteria. The cyanobacteria are also buoyant (especially *Microcystis spp*) enabling them to avoid zebra mussel consumption. Their work established that *Microcystis aeruginosa* was the dominant cyanobacterial algae species (by volume) during late summer (2001) in NLL and SLL. *Microcystis* was only observed in very low densities before the zebra mussel colonization of the lakes.

Woller and Keilty (2004) pooled data from Lake Leelanau and nearby Little Traverse Lake and Lime Lake which indicated that *Microcystis* abundance was positively correlated with zebra mussel density. However, the authors believe *Microcystis* abundance may be more a function of zebra mussel filtering capacity in relation to lake volume.

The significance of *Microcystis* abundance relates to its ability to produce microcystine. Microcystine has many isomers and at least one (microcystine-LR) is a potent hepatoxin. The World Health Organization (WHO) established a provisional guideline of 1 ppb (parts per billion) of microcystine-LR for drinking water. WHO also established recreational guidelines for abundance of cyanobacteria (20,000 cell/mL, chlorophyll a (10 ppb), and microcystine (2-4 µg/L). Whole water samples collected in NLL and SLL were below the WHO drinking water guidelines, but the authors expressed concern of potential concentrations in foam in downwind areas of the lakes.

Further study by Woller and Keilty (2006) focused on the potential for microcystine to migrate through the food web and possibly bioconcentrate as it moves up succeeding trophic levels. Samples of water, foam, sediment, macroinvertebrates, zebra mussels, native freshwater mussels, and fish were measured for microcystine. They found microcystine levels in all these trophic levels several orders of magnitude above the WHO 1 ppb drinking water guideline. Whole fish from SLL measured 41.3 ppb microcystine. The authors expressed concern about the potential

health and recreational implications. However, their analytical methodology for microcystine was not sophisticated enough to distinguish between microcystine-LR and other microcystine isomers. They recommended continued monitoring of microcystine in the lakes and fish using high performance liquid chromatography (to positively distinguish the microcystine-LR isomer) to corroborate data.

3.11 Human History

The European settlement history of the Lake Leelanau watershed is one of initial opportunistic development, overuse and a diminishment of timber resources, and a gradual progression toward appreciation of the area as a vacation and retirement location. The first European settlers came to the watershed in the mid 1800's via steamers, all burning wood for fuel. Settlement on South Manitou Island was the beginning of Leelanau County's development. A lighthouse was erected on the island in 1839. The first European settler in the Leelanau watershed thought it would be a great place for a sawmill. In 1853, Antoine Manseau came from North Manitou island and laid claim to thirty acres of land that included the creek that drained Lake Leelanau, in the now village of Leland. The following year, Manseau brought his family to the location and along with a handful of others, installed a dam on the creek, and built the first sawmill. Dozens and then hundreds of settlers soon followed him and founded what is today Leland. The dam dramatically altered the landscape upstream and down. Prior to Manseau's dam, Lake Leelanau was a chain of three separate lakes, the first two feeding into the third, which emptied into Lake Michigan. The obstruction reportedly raised the lake level of the lowest lake by twelve feet and created one large navigable waterway with a narrow passage at what is today called the Narrows (which the settlers considered an important improvement since it facilitated the movement of saw logs from the interior to the new shipping wharves at Leland). The new backwaters of the Leland dam became known as Carp Lake. The once lively creek that connected Lake Leelanau's aquatic ecosystem with Lake Michigan was now cut off and named the Carp River.

Where the later named Carp River met Lake Michigan, a natural fish ladder formed a traditional Native American fishing ground used long before white settlements. From the 1850s on, settlers to the area began to fish the Carp River as well. Both sides of the Carp River were lined with wooden shacks, reels to dry nets and ice houses and smoke houses to preserve their catch. Pound nets and gill nets were used to catch white fish, lake trout and chub. Boats taking Leland Lumber and iron out also transported Leland fish to market. Fishing boats were locally built and were powered by gas motors in the early 1900s. Fishing peaked in 1930 and then declined due to species depletion from over fishing, introduction of exotic species and regulations favoring sports fishing. Today the settlement is known as 'Fishtown'. Two commercial fisheries remain along with active charter fishing businesses.

Early pioneers moved in to the heavily timbered wilderness of Leelanau County and began lumbering. The first settlements opened up along the shoreline and were based upon water power or harbor facilities. Farmers who came soon after took up their land a short distance away from the centers or on selected sites along the shores of interior lakes such as Lake Leelanau. Access to settlements via water was very important as all activities were based on the removal of timber. At this time many farmers made good wages clearing the land while chopping down trees and

selling the wood. Those who could not sell the wood, being too far from the market, piled the wood into great piles and burned them, anxious to get the crops in as soon as possible. The wooding business was important to the settlement of Leelanau County, and carried through until the 1890s when steamers converted to coal. Sawmills were also important to the economy, creating lumber for ship building. The lumber industry peaked in 1893 and ended in 1907 as inevitably the available timber began to dwindle and the saw mills were replaced with more modern technology.

In 1862, the first road was built in the county connecting Traverse City to Northport. The first railroad came to the county in 1892, the Manistee Northeaster, which had two stations in the county- Solon and Fouch. In 1903, a branch was constructed from Solon to Provemont (now the Village of Lake Leelanau). The county's last rail link to the outside world was severed in 1983. During the time when the railroad reached Provemont a metallic bridge was built across the Narrows.

During the late 1800s to early 1900s the main cash crop for farmers was potatoes. The sandy soil was ideal for this purpose, with as much as 200 bushels per acre being produced. Fruit growing also became a major activity, apples being an important crop for many years. Beginning in 1912, cherry trees rapidly began to replace the apples.

Eventually, the hills around Lake Leelanau were a land of plenty. The communities that occupied the watershed generated waste as communities tend to do. The outhouses and garbage dumps introduced new types of nutrients into the watershed that began to change the chemical balance of the water. Certain types of microorganisms became abundant and altered the food chain. Early on, surface water became unsafe to drink.

As shallow hand-pump wells became tainted, and outbreaks of diseases like cholera and polio become more frequent, the fragile dynamics of our water supply began to dawn on people. Deeper wells were drilled, septic tanks were introduced, and health codes established to protect people from themselves. In the wake of the lumbering activity, surface runoff on the denuded land carried huge amounts of sediment into the lake and its tributaries. The altering and damming of the Carp River had drastically changed the natural dynamics of the lake's ecosystem. In a matter of a few decades, the natural bounty of the area was exhausted-and so was the local economy. The communities around Lake Leelanau had seen several industries rise and then self-destruct by over-consumption: first the lumber industry, then the commercial fishing industry, then a charcoal industry that supplied the Leland iron foundry. Each had devastated the very resource that sustained it, and, once depleted, the industry itself wasted away.

From a peak prior to the turn of the century, Leelanau County's population gradually dwindled with the fallen fortunes of the local economy. Since the Lake Leelanau region lay far from the commercial and industrial centers of the new world, in a sense, its downfall was its salvation. The decades of modest farming and sparse population that followed the boom of exploitation allowed the environs of Lake Leelanau and the rest of Northwest Lower Michigan, for that matter, to slowly rebound. In some places carefully managed, in some places just left alone, the sparse saplings thickened into mature forests. Many of the animal species migrated back into the area as their natural habitat reestablished itself. Some species that were once relatively minor in

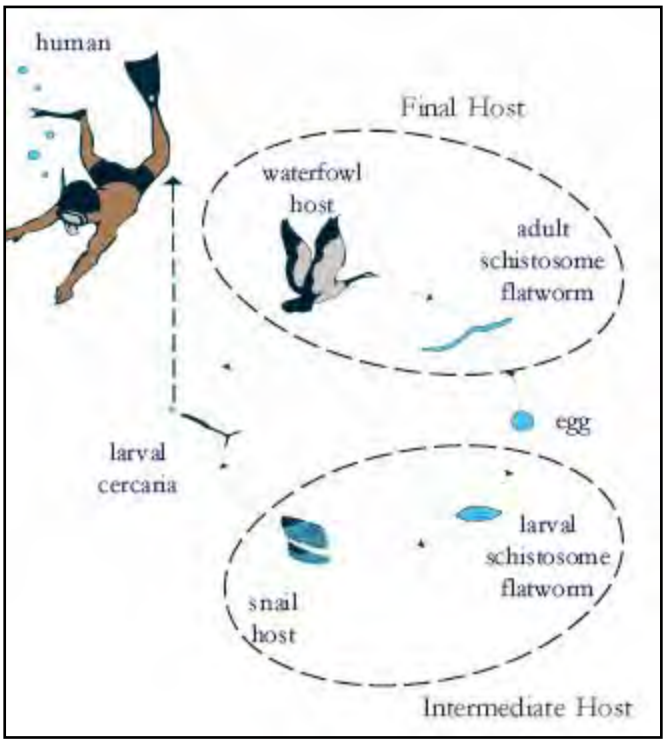
the area have seized niches once occupied by other species, such as the whitetail deer that now roam where the woodland elk once dominated. Sadly, not all of the species returned –we will never again see the huge flocks of carrier pigeons, or the schools of shimmering grayling in our streams. It was soon after the demise of the last sawmill, that the first vacationers began to make their way north.

The swelling number of tourists and seasonal residents paralleled the inexpensive and widespread availability of transportation. At first, the travelers trickled in and out by train and ferry. But the great surge of tourism accompanied the spread of the automobile. Over the last few decades, more and more seasonal visitors have sought to become permanent residents. In the 1960s, Leelanau County surpassed the population peak of the 19th Century and each summer season absorbs many times the official count.

3.12 Economy, Tourism, and Recreation

The economy of the watershed has become more reliant on seasonal tourism and summer residents that are drawn to the natural scenery found few other places. The high percentage of forested land in the watershed protects scenic beauty enjoyed by thousands of annual tourists while simultaneously providing wildlife habitat, groundwater recharge and important water quality functions. Over the last few decades, more and more seasonal visitors have become permanent residents. Although the region still relies heavily on tourism, the northwest Michigan economy is becoming increasingly diversified and stable – able to support a larger year around population.

Traditionally, visitors and local and regional residents have used Lake Leelanau for fishing, swimming, boating, and general recreation. There are only a few public beaches on Lake Leelanau, most are small parks with access for boats. The public boat launches on either lake are operated by the MDNR. They are equipped with a launch ramp, parking area, and toilets.



Special Note – Swimmer's Itch
Along with all of the other major Leelanau County lakes, Lake Leelanau has historically had a problem with swimmer's itch. Swimmer's itch is caused by the incidental penetration of a swimmer's skin by the larval form of a minute, parasitic flatworm. The larvae, called cercaria, are about 1/50 of an inch long; they are released into the water daily by snails infected with the parasite. Only about 40% of people exposed to cercaria develop swimmer's itch. In those people sensitive to swimmer's itch, a small, reddened spot appears followed by relatively intense itching that can occur for

several days. The life cycle of the flatworm requires the presence of two hosts, therefore the control of either would effectively diminish swimmer's itch.

The following measures can help reduce the likelihood of contracting swimmer's itch:

1. Towel off vigorously upon leaving the water.
2. Apply oils such as suntan or baby oil before swimming.
3. Avoid swimming at midday, since cercaria is released in response to full sunlight.
4. Avoid swimming in near shore areas exposed to prolonged onshore winds. (Wave action can congregate cercaria in these locations).
5. Do not feed or encourage waterfowl to remain in the area.
6. Implement best management practices (BMPs) for shorelines. (Waterfowl tend to exhibit a preference for mowed lawns that extend to the water's edge).

In preparation for applying for a US Fish and Wildlife Service depredation permit, LLLA conducted a survey in October 2009. The survey's purpose was to determine the potential health impact and recreational impact of the swimmers itch. The survey results appear in Table 10. LLLA received about a 30% response to the survey. A total of 89 individuals responded with 40 reporting swimmers itch as a problem, 29 from NLL and 13 from SLL. Two hundred nine (209) vacationers contacted swimmers itch which resulted in 1517 days (number of people x number of days itch lasted) that swimmers itch affected their health and certainly comfort. Two hundred twenty two (222) individuals reported that they avoided further recreation in Lake Leelanau. This totaled 1330 days that vacationers avoided swimming or water recreation in Lake Leelanau because of fear of getting the itch again. These results indicate that swimmers itch has implications for negative health impact and economic impact for the county (Table 10).

Table 10. LLLA Swimmers Itch Questionnaire Response Summary – October 2009 via email

Number Respondents	47
Number Reporting Itch	42
North Lake	29
South Lake	13

Number of People Infected

Adults	105
Children	104

Months of Occurrence

May	2
June	9
July	21
August	7
Sept	1
Total Days of Itch	1517

Treatment Cost

< $50	16
$51-$100	7
$101-$200	1
<$200	1
Doctors Visits	2

Recreation Days Avoided Because of Itch

Number of People	222
Total Days Avoided	1330

Years Swimmers Itch Has Been a Problem

1 to 5	4
6 to 10	6
11 to 20	6
< 20	7

Lake Leelanau Lake Association's Merganser Control Program

In the early 1990's, LLLA began to attempt to control swimmer's itch. Dr. Harvey Blankenspoor from Hope College, conducted extensive research to determine that common mergansers were responsible for most of the swimmers itch problems on Lake Leelanau. A program to trap mergansers was implemented, but discontinued after a couple years.

Live trapping and relocation of Merganser broods was initiated again during 2009 by Swimmers Itch Control (SICon). LLLA plans to continue to trap and relocate broods, because several years of continuous removal is required for successful control of swimmers itch. A federal depredation permit from the US Fish & Wildlife Service is required to conduct this activity.

SICon conducted a snail infection rate survey in NLL and SLL in 2009, since the snail *Stagnicola emarginata* is the secondary host associated with the common merganser. SICon determined that infection rate in NLL was the highest it has ever recorded. However, SICon could not find sufficient numbers of *S. emarginata* in SLL to perform studies. SLL riparians still experienced significant cases of swimmers itch in 2009, so another primary/secondary host combination may be at work. A study will have to be conducted to determine the primary bird/snail combination causing swimmers itch on SLL. The long-term success for control of swimmers itch is contingent on LLLA's success in obtaining a depredation permit, and identifying another trapping company, since SICon is no longer trapping birds.

Lake Leelanau Merganser Relocation Program Stats 2009

- 3 broods removed on NLL, 1 brood on SLL
- Total of 33 chicks and 2 females
- Snail infection rate NLL: 6.09% (*Stagnicola emarginata*), highest ever measured by SICon

3.13 Steering committee, Stakeholder and Partner Outreach

In December 2001, the Lake Leelanau Watershed Management Plan was prepared by the Leelanau Conservancy with collaboration and input from major watershed stakeholders including the Lake Leelanau Lake Association (LLLA), Grand Traverse Band of Ottawa and Chippewa Indians (GTB) and local units of government. Much was accomplished during the first plan and is outlined in Chapter 3 (section 3.14). Eight years later, the same groups initiated new meetings to update the watershed plan to include additional information according to newly implemented Environmental Protection Association (EPA) requirements. The steering committee began meeting about once a month starting in Fall 2009. These meetings were generally held on Thursdays at 1 p.m. in the Leelanau Conservancy conference room. During the first few meetings the group discussed watershed plan details and delegated tasks to start updating the plan. After the bulk of the plan was written the committee spent many of the meetings going over edits, suggestions and comments in order to better improve the plan.

During the course of the watershed planning process, a stakeholder survey was mailed and passed around at community events in order to gain input from all who live in the watershed and incorporate the ideas/suggestions into the plan. A stakeholder meeting was also held in December 2009 and input was gathered from this meeting and incorporated into the watershed plan. Along with stakeholder involvement, various partners were asked to read parts of the plan and offer their suggestions.

The majority of the stakeholders who filled out the survey were residents, with a total of 35 survey results gathered. The highest percentage of activities enjoyed in the Lake Leelanau watershed includes boating (23%), swimming (18%), fishing (15%) and canoeing/kayaking (11%) (Table 11). When asked what they perceive as the threats to the Lake Leelanau watershed, indicated exotic or non-native species was the highest threat (19%). Fourteen percent (14%) indicated nutrients were a threat to the watershed along with toxic substances (11%), swimmer's itch (9%) and loss of natural habitat (8%) (Table 11). A continuing theme from the stakeholder survey was the need for more education of homeowners as well as seasonal visitors. Suggestions included providing educational information in rental homes and cottages as well as displaying educational signs. It was also suggested to manage invasive species, increase research on invasive species, and increase surveillance of lakes.

Events Steering Committee Members Attended in 2009
Kids Fishing Day – 6/28 (questionnaire available)
Lake Leelanau Lake Association Annual Meeting – 7/18 (presentation and questionnaire)
Lake Leelanau Lake Association (LLLA) board meetings
LLLA newsletter (article and questionnaire)
Leelanau Conservancy Newsletter (Stakeholder meeting announcement)
Leelanau Conservation District office (questionnaire)
Lake Leelanau Walkabout (booth and questionnaire)

Photos from Kids Fishing Day (2007)

Table 11: Summary of Stakeholder Watershed Survey Questionnaire Results

What do you want the watershed to be like in 50 years?	%
Preserve in current condition or better	40
Same Water Quality	13
More Public Access	13
More people, less impact	7
Sound development	7
Better fishing management	7
Healthier than today	7
Greenbelts everywhere	7

Activities enjoyed in the Watershed	%
Boating	23
Swimming	18
Fishing	15
Canoeing/Kayaking	11
Water skiing/tubing	8
Hunting	8
Wildlife Observation	7
Scenery enjoyment	4
Hiking/biking	3
Farming/Gardening	2
Ice Fishing	1
Snowmobile	1

Threats/Problems in the Watershed	%
Exotic Species	19
Nutrients	14
Toxic Substances	11
Swimmer's Itch	9
Loss of natural habitat	8
Sediments	6
Development	5
Coliform Bacteria	5
Increased Boat traffic	5
Shoreline erosion	4
Septic Systems (old/failing)	4
Reckless/unsafe water sport users	3
None	3
Fragmentation of wildlife habitat	3
Water too shallow-dredging req'd	1
Lead sinkers	1
Filling wetlands/draining	1

Solutions to the threats/Problems	%
Continued education of homeowners	29
Increase surveillance of lakes	12
Manage invasive species	12
Educational information at all rental homes and cottages	6
Increase no wake access	6
Preserve water quality monitoring	6
Get rid of lead sinkers	6
Restrict the local sale of polluting fertilizers	6
Research on Invasives	6
More public involvement in local government	6
More awareness of watershed issues - signs/displays	6

3.14 Lake Leelanau Watershed Plan successes since 2002

The Lake Leelanau Watershed Management Plan, prepared by Walt Nielsen (LLLA) and Matt Heiman (Leelanau Conservancy) in 2002 has been used as a tool for strategic planning by the LLLA executive committee for the past eight years. The plan identified threats and impairments to the watershed and established goals to address noted concerns.

The following has been accomplished and/or initiated over the last eight years:

2002

•Fish Survey - Preliminary report received from the DNR listing the number, species and size of targeted fish (walleye, northern pike, and smallmouth bass) taken from nets placed in the north and south lakes. *This was published in the Fall 2002 LLLA newsletter*

•Summer meeting - Lake Association attracts 150 persons to hear presentations from 5 companies on septic systems, including new and alternative systems.

•Meg Woller and Tim Kielty with the Leelanau Conservancy describe and share their efforts on water quality monitoring at the LLLA 3rd annual picnic

•Fall 2002 newsletter addresses the following topics: (1) concern about Eurasian Milfoil introduction by boats; (2) notes that all applications for permits to fill or dredge shoreline wetlands are reviewed by the association's water quality committee; (3) encourages voluntary maximization of native vegetation along the shore for its aesthetic appeal as well as water quality protection; (3) patches of foam noted on the lake - most likely due to naturally occurring surfactants and algae based on description of this phenomena in limnology textbooks.

•LLLA members deeply involved with a County appointed task force reviewing septic system regulations in the county. Thus far, this has led to a change in the regulations to permit the use of newer technologies to treat residential waste water. *A proposal to require periodic inspection of all county septic systems is currently under review.*

•Winter 2002 newsletter addresses the following topics:: (1) "Before you Flush...your septic system" an article regarding how to maintain you system with dos and don'ts; (2) Zebra mussels studied in Lake Leelanau (by Meg Woller); (3) Keyholing by Hugh Farber; -

•A second annual fall survey was made near all boat launch sites on the lake, in the Leland River and in Leland Harbor looking for the presence of Eurasian Milfoil. (It was found in the Leland Harbor);

•Review the road stream inventory and prioritize sites for repair

2003

•Spring 2003 newsletter addressed: (1) alternative septic systems potential financing; (2)with the Michigan Lake and Streams Association and its sponsoring foundation grants, a 'hands-on' stewardship model program with Suttons Bay High School students and their advanced biology instructor took place collecting and sampling the waters of the lake;(3) Request for members to keep an eye out for Eurasian Water milfoil with a list of how to detect and report;(4) Efforts to seek funding to offset costs associated with shoreline stabilization denied.

•All townships have keyholing ordinances

•Fish shelters project well received - over 70 property owners requested and received the information packets which provided complete detailed instructions on how to obtain permits and materials as well as detailed instructions on how to construct the shelter and place it in the lake.

•Leelanau Conservancy awarded 3/4 million dollars from the State's Clean Michigan Initiative grant to be used exclusively in the Lake Leelanau watershed to permanently protect our wetlands. The conservancy, in partnership with the Lake Association launches a major initiative on Lake Leelanau to protect the watershed wetlands. The Lake Leelanau Watershed project has a goal of doubling this grant and raising 1.5 millions dollars. The Lake Association is an equal partner with the Conservancy to raise these funds.
•Winter 2003 newsletter addressed: (1) The Lake Association begins its opposition of a marina development in the Narrows, wetlands which are critical for safeguarding water quality; (2) Septage issues; (3) zebra mussels in Lake Leelanau - results of EPA study on Lake Leelanau; (3) DNR to discontinue walleye stocking in Lake Leelanau.
•Fish survey conducted by Fish Committee during November and December - questionnaire developed in order to obtain valuable information about the experience and attitudes of the people who fish in Lake Leelanau. Survey results were reported in the winter, 2003 survey.
•Fall 2003 newsletter addresses: (1)MLSA-LLLA grant - the LLLA will work with students to help create a stewardship program, monitoring and measuring water quality indicators on Lake Leelanau; (2) Status report from the Leland Dam Subcommittee; (3) Marine safety program report; (4) The Buffum conservation easement - fully protects critical habitat on their property; (5) keyholing update report; (6) "Sediments - the Telltale of Erosion" an excerpt from the LLLA Landowner's Handbook "Our Lake, Our Responsibility".

2004
•Lake Leelanau Lake Association website developed for educational purposes.
•Dam subcommittee spent many hours monitoring issues concerning the Leland dam repair
•Public input session hosted by the association on April 13, 2004 concerning the DEQ application for a marina development in the narrows, proposing a canal and marina basin on land adjacent to the narrows. 200 people attended the DEQ public hearing held on April 21.
•The Association hired Chris Grobbel, Ph.D. of Ball Environmental Associates to perform an ecological assessment of the wetlands involved. On 6/22/04 the DEQ denied the permit based on objections from the DNR fish and wildlife divisions.
• Summer 2004 newsletter addresses: (1) The Leland Dam Project; (2) position statement that was read at the DEA public hearing 4/21/04 re the proposed 28 slip condo/marina in the Lake Leelanau Narrows; (3) article strongly encouraging people to NOT use commercially available microbiological and enzyme additives which are promoted to reduce sludge and scum"
•First Kids Fish Day held at Veronica Valley
•DNR assists with Zebra mussel study
•Two CMI projects were completed, protecting wetlands in the watershed

2005
•Association continues to fight the marina proposed in the narrows after the developer appealed the initial denial. Lake Association retains legal counsel. Legal hearing before an Administrative Law Judge in Lansing is attended by board and experts. Main concerns are water safety, environmental impact, and impact on the aquatic and fish habitat.
•.Water Quality Committee introduces "Friends of Lake Leelanau", which focused on the first principle of stewardship: To leave the land and water in better condition than we find it. The committee encouraged lake owners to take action to protect their small part of the watershed to

help keep LL clean and healthy for generations to come. They sent pamphlets listing 17 practices and asked them to identify at least 10 that they are already doing and send to us. Respondents were listed as 'friends' in the newsletter and received a LL windsock and certificate.
•Summer 2005 newsletter addresses the following topics: (1) Good stewardship checklist; (2) three ways to clean up for summer through Leelanau County's waste management drop off and pick-up programs;
•DNR release 25,000 six long lake trout into North Lake Leelanau using an experimental method that put the fish under the ice;
•2nd annual Kids Fish Day held at Veronica Valley
•Summer meeting held regarding septic waste disposal and alternative septic systems.
•Winter newsletter addresses the following topics: (1) article entitled "Riparian Reminder - YOU make a difference with Do and Don't lists; (2) Lake Leelanau Watershed Initiative - 2004 year end summary by Matt Heiman; (3) Leland Dam repair report; (4) Landscape lighting recommendations; (5) water quality committee report; (6) keyholing report; and (7) fish committee report noting that whitefish are reproducing in North Lake Leelanau.

2006
•Summer newsletter addresses the following topics: (1) 2nd annual kids fish day; (2) Annual picnic with committee displays, including water quality; (3) "Friends of Lake Leelanau" stewardship article, addressing 17 BMP for lake stewardship.
•Continued efforts to fight marina development in the narrows and protect that fragile ecosystem.
•The Lake Association directs attention toward changing zoning ordinances to protect the lake.
•Second grant CMI grant awarded to protect critical wetlands on Lake Leelanau. The 2003 CMI grant was used to protect the lake with conservation easements on 321 acres of land around streams that flow into the lake which can impact water quality.
•Lake Association appoints a communications chairperson and committee. Responsibilities include developing the newsletter, keeping the web site up to date, updating members through e-mails, website, and letters, as well as assisting with special events and fund raising.
•Fall newsletter addresses the following topics: (1) new tax law; (2) The "Stream Team", discussing the stream sampling since 1990 in conjunction with the Leelanau Conservancy; (3) introduction of new board members;(4) introduction of the Lake Leelanau Legacy Circle - an opportunity for enhanced giving; (5) membership letter.

2007
•The association continues to fight marina development in the narrows in order to reduce negative impact from condominiums and dockage. Progress is made toward limiting number of boat slips from 22 initially requested to 8.
•Activities continue to update/upgrade township zoning ordinances that impact shoreline activities.
•3rd Annual Kids Fish Day
•Summer newsletter addresses the following topics: (1) Leland Township planning commission approves amendment to common use waterfront (keyholing) ordinance. (2) LL watershed management regulatory codes; (3) Leelanau Conservancy District overview; (4) Where to go for permits; (5) membership perks.

•Annual Lake Association business meeting addresses narrows proposal, zoning ordinance changes, update on MLSA and NOLA, as well as committee reports.
•Winter newsletter addresses the following topics: (1) narrows effort; (2) Leland PC's Master Plan release for public review; (3) continued efforts to changing zoning ordinances;(4) LLLA committee goals and accomplishments (safety, water quality, communications, fish, membership and township representatives); (5) new tax law; (6) "Friends of Lake Leelanau" notes 110 members have registered as "friends, each practicing at least ten of the good stewardship practices listed.
•A survey conducted to get feedback from riparians on what they perceive as current and impending problems which may be damaging to the lake.
•Continued annual survey of Eurasian Water milfoil to detect an appearance of this pest.
•Water quality committee continues to review all applications for permits to do work in wetlands and work on the shoreline or below the surface of the lake, with intervention when necessary.
•The Fish Committee continues to be involved in several activities that help to promote a successful fishery in LL, by conducting surveys of fishermen, sharing information with DNR biologists, persuading the DNR to place their annual lake trout planting under the ice, as well as Kids Fish day which attracts close to 500 each year.
•LLLA successfully encouraged Leland Township to enact a 'no-wake' ordinance for the Narrows to enhance safety and minimize environmental damage.
•LLLA and its members have strongly supported fund raising by the Leelanau Conservancy to purchase wetland property and conservation easements to permanently preserve wetlands in the Narrows and throughout the watershed.
•LLLA has successfully encouraged all six townships abutting the lake to enact a keyholing restrictions in their zoning ordinances.

2008
•Judge rules on narrows case, upholding a MDEQ ruling that would allow the developer to build 14 boat slips in the Narrows. (Note the Leland Township Planning Commission decision still limits the marina to just 8). After more than 3 years and $150,000 legal fees by the association.
•New goals set by president include swimmer's itch, invasive species, shoreline protection, septic system pollution and destructive development.
•LLLA joins County Water Quality Task Force. Several LL board members actively participate with this diverse group to improve water quality in Leelanau County.
•Fall newsletter includes the following topics:: (1) proposed sewer district; (2) ruling regarding the narrows; (3)new LL goals; (4) 4th annual Kids Fishing Day report; (5) 2nd annual Legacy Circle Celebration event; (6) Champion trees planted on LL shoreline; (6) LLLA joins county water quality task force;

2009
•LLLA hires an individual to coordinate the swimmer's itch program and solicits volunteers for assistance; SICon is on the lake to trap and remove merganser broods and collect snail samples to establish a baseline for parasite infection rates.
•Spring newsletter addresses the following topics: (1) war on swimmer's itch; (2) Governor's proposal for MDEQ cuts; (3) "Stem the Tide...and Cheer and All"; (3) Veronica Valley now a county park; Walkabout event; (4) boating out of season - safety issues and near tragedy account;

(5)Phragmites Australis ; (6) Buoy requirements; (7) Watershed management plan; (8) Lake gets fire and rescue boat; (9) TC hosts freshwater summit; (10) Township committee news.
•Board members serve on Water Quality Task Force subcommittees: Nutrient Loading, Invasive species, and Wetlands.
•Leelanau County Parks and Recreation Commission accepted an offer from Kid's Fishing Day committee to provide assistance in planning and facilitating recreational activities at the new Veronica Valley Park
•Summer newsletter addresses the following topics: (1) Itch control underway; (2) Earth Day, kids plant trees in the narrows; (3) Hard surface runoff; (4) president's letter addresses waterfront vegetation, disposals, fertilizers, driveways, detergents, lawn debris, septic systems and outdoor lighting; (4) How to create a shoreline buffer strip; (5) 3rd annual Legacy Circle Celebration event; 5th annual Kid's fishing day attracts over 600;
•Annual meeting holds discussions on swimmers itch abatement program and other issues facing the lake.
•First Lake Leelanau Walkabout held for residents to learn about the watershed.
•Lake Association hopes to coordinate efforts with the Conservancy to deal with Phragmites invasion in the narrows.
•E-mail questionnaire sent to members regarding swimmer's itch
•LLLA President, water quality chair, and communications chair attended the 2nd annual Freshwater Summit at NMC's Hagerty Center.
•LLLA encourages Leland Township Sewer Options Task Force
•Fall newsletter addresses the following topics: (1) Phragmites invasion; (2) swimmer's itch summer efforts and itch e-mail questionnaire summary; (3) 3rd annual Legacy Circle event held at Stonehedge; (4) Inaugural family walkabout; (5) Leland Township Planning Commission Narrows Overlay District Proposal.

CHAPTER 4 DESIGNATED AND DESIRED USES

4.1 Designated Uses in the State of Michigan

Each of Michigan's surface waters is protected by water quality standards for specific designated uses (Table 12). Designated uses as defined by the State of Michigan are recognized uses of water established by state and federal water quality laws designed to 1) protect the public's health and welfare, 2) enhance and maintain the quality of water, and 3) protect the state's natural resources.

Table 12: Designated Uses for Surface Waters in the State of Michigan

All surface waters in the state of Michigan are designated for and shall be protected for all of the following uses:
1. Agriculture
2. Industrial water supply
3. Navigation
4. Warmwater fishery
5. Other indigenous aquatic life and wildlife
6. Partial body contact recreation
7. Total body contact recreation between May 1 – October 31
8. Fish Consumption
Citation: R323.1100 of Part 4, Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended

If a body of water or stream reach is not meeting the water quality standards set for a specific designated use, then it is said to be in 'nonattainment'. An annually published listing of the bodies of water and stream reaches in the State of Michigan that are in nonattainment can be found in Appendix C of the DEQ's Integrated Water Quality Report – Water Quality and Pollution Control in Michigan (DEQ 2008). The DEQ uses a rotating watershed cycle for surface water quality monitoring where each of the 58 major watersheds in the state are scheduled for monitoring at least once every five years. The Lake Leelanau watershed was last monitored in 2008, and results show that none of the designated uses are impaired on a wide-scale basis, except for fish consumption (Table 13).

Due to widespread mercury contamination and public health fish consumption advisories, all of Michigan's inland lakes, including North and South Lake Leelanau, are not meeting water

quality standards for fish consumption. Of all the public access lakes monitored that are not meeting water quality standards, the primary cause is fish consumption advisories for PCBs or mercury (DEQ 2008). For further information on mercury sources in the environment and mercury pollution prevention strategies, please refer to publications by Sills (1992) and Mehan (1996), respectively. These two reports resulted from two specific DEQ task force investigations into mercury in the environment, sources, and prevention. The problem of mercury contamination and other related toxic contamination problems (i.e., PCB, chlordane, etc.) in the Lake Leelanau watershed will not be discussed in depth in this Protection Plan. The DEQ has taken the lead to develop pollution prevention and abatement strategies throughout the State of Michigan for mercury contamination and other related toxins.

It is important to note that an additional cold water fishery state designated use applies to 16 designated trout streams or cold water streams which are important for various aquatic and fish species. These streams are shown in figure 10 and a list of these streams in the table below. Designated trout streams require high dissolved oxygen content and year-round temperatures below 74 degrees Fahrenheit. These are high water quality systems that are fed by groundwater springs and seeps. The reliance on stable groundwater flow that is low in nutrients is what underscores the direct connection between the health of trout streams and the land use adjacent to it. The predominantly sandy loam soils of Leelanau County are very susceptible to the forces of erosion. Poor land use and development of land adjacent to stream corridors typically leads to excessive accumulation of sediment in the stream channel. This can bury large woody debris and other in-stream habitat, which effectively turns the system into an aquatic desert.

Creek Name	**T, R, S**
Beaudwin Creek	T30N, R12W, S24
Belnap Creek	T28N, R12W, S12
Cedar Creek	T28N, R12W, S5
Clearbrook Creek	T28N, R12W, S9
Houdek Creek	T31N, R12W, S35
Mebert Creek	T29N, R12W, S13
Rice Creek	T29N, R12W, S35
Solon or Cedar Run Creek	T28N, R12W, S9
Two Unnamed Creeks	T28N, R12W, S8
Two Unnamed Creeks	T30N, R12W, S23
Unnamed Creek	T28N, R12W, S11
Unnamed Creek	T29N, R12W, S14
Unnamed Creek	T29N, R12W, S11
Weisler Creek	T28N, R12W, S10

Figure 10: Designated Trout Streams in the Lake Leelanau Watershed

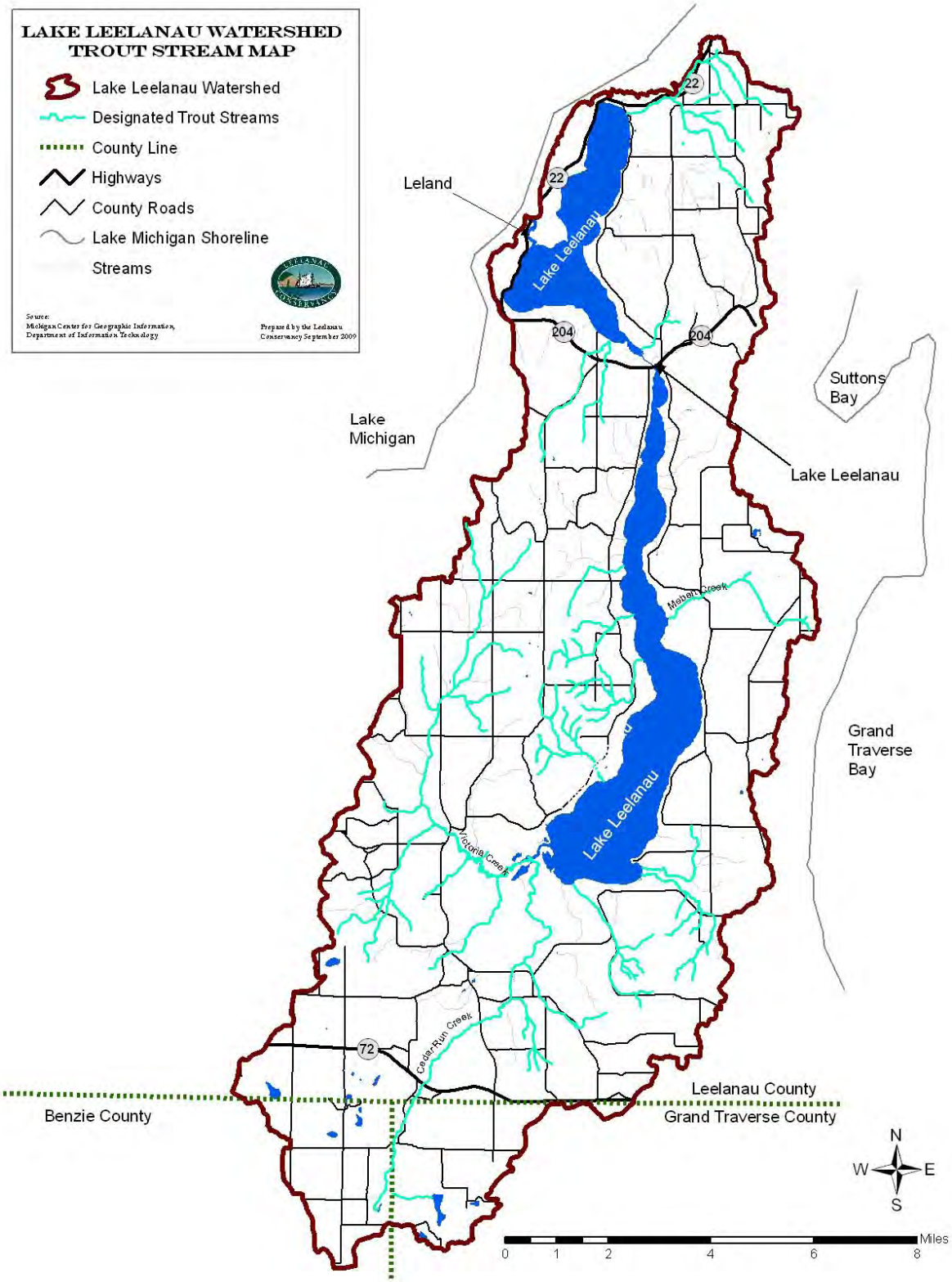


Table 13: Sections of Watershed Supporting Designated Uses*

Designated Use	***Use Support:*** *South Lake Leelanau*	***Use Support:*** *North Lake Leelanau*	***Use Support:*** *Cedar Run and Victoria Creek*	**Water quality standards****
Total body contact recreation	Not assessed	Not assessed	Not assessed	Counts of 130 or less for Escherichia coli (E. coli) per 100 ml monthly average and 300 or less for E. Coli per 100 ml at any time
Partial body contact recreation	Not assessed	Not assessed	Not assessed	Counts of 1,000 or less for E. coli counts per 100 ml
Navigation	Fully supporting	Fully supporting	Fully supporting	--
Industrial water supply	Fully supporting	Fully supporting	Fully supporting	--
Agriculture	Fully supporting	Fully supporting	Fully supporting	--
Warmwater fishery***	Not assessed	Not assessed	Not assessed	Dissolved oxygen (DO) not less than 5.0 mg/L during summer stratification in the epilimnion (uppermost layer of the lake). Not less than 5.0 mg/L for the rest of the year in entire lake area.
Other indigenous aquatic life and wildlife	Insufficient Information	Not assessed	Fully supporting	Numerous numeric chemical limits such as pH, ammonia, toxic metals, and organic compounds, as well as narrative limits such as for nutrients (nuisance algal growths) and physical properties (color, temperature, clarity, etc.)
Coldwater fishery***	Insufficient Information	Fully supporting	Not assessed	DO not less than 6.0 mg/L in any 24-hour period during summer minimum flow period and not less than 7.0 mg/L rest of the time
Fish Consumption	Not assessed	Not Supporting: **REASONS:** *Mercury in fish tissue* *PCB in fish tissue*	Not assessed	Fish Consumption Advisory trigger levels for toxic heavy metals and organic compounds

**Data from Appendix B2 of DEQ's Integrated Water Quality Report – Water Quality and Pollution Control in Michigan (DEQ 2008)*

Adapted from Exhibit 43 from Portage Lake Watershed Forever Plan (PLWFP 2008)* *** See appendix B for a listing of maximum temperatures***

Table 13: Sections of Watershed Supporting Designated Uses*

Designated Use	***Use Support:*** *Provemont Creek*	***Use Support:*** *Houdek Creek*	***Use Support:*** *Beaudwin Creek*	**Water quality standards****
Total body contact recreation	Not assessed	Not assessed	Not assessed	Counts of 130 or less for Escherichia coli (E. coli) per 100 ml monthly average and 300 or less for E. Coli per 100 ml at any time
Partial body contact recreation	Not assessed	Not assessed	Not assessed	Counts of 1,000 or less for E. coli counts per 100 ml
Navigation	Fully supporting	Fully supporting	Fully supporting	--
Industrial water supply	Fully supporting	Fully supporting	Fully supporting	--
Agriculture	Fully supporting	Fully supporting	Fully supporting	--
Warmwater fishery***	Not assessed	Not assessed	Not assessed	Dissolved oxygen (DO) not less than 5.0 mg/L during summer stratification in the epilimnion (uppermost layer of the lake). Not less than 5.0 mg/L for the rest of the year in entire lake area.
Other indigenous aquatic life and wildlife	Fully supporting	Fully supporting	Fully supporting	Numerous numeric chemical limits such as pH, ammonia, toxic metals, and organic compounds, as well as narrative limits such as for nutrients (nuisance algal growths) and physical properties (color, temperature, clarity, etc.)
Coldwater fishery***	Not assessed	Not assessed	Not assessed	DO not less than 6.0 mg/L in any 24-hour period during summer minimum flow period and not less than 7.0 mg/L rest of the time
Fish Consumption	Not assessed	Not assessed	Not assessed	Fish Consumption Advisory trigger levels for toxic heavy metals and organic compounds

**Data from Appendix B2 of DEQ's Integrated Water Quality Report – Water Quality and Pollution Control in Michigan (DEQ 2008)*

Adapted from Exhibit 43 from Portage Lake Watershed Forever Plan (PLWFP 2008)* *** See appendix B for a listing of maximum temperatures***

Table 13: Sections of Watershed Supporting Designated Uses*

Designated Use	***Use Support:*** *Cedar Lake*	***Use Support:*** *Lake Leelanau-Nedows Beach*	**Water quality standards****
Total body contact recreation	Not assessed	Insufficient Information	Counts of 130 or less for Escherichia coli (E. coli) per 100 ml monthly average and 300 or less for E. Coli per 100 ml at any time
Partial body contact recreation	Not assessed	Fully supporting	Counts of 1,000 or less for E. coli counts per 100 ml
Navigation	Fully supporting	Fully supporting	--
Industrial water supply	Fully supporting	Fully supporting	--
Agriculture	Fully supporting	Fully supporting	--
Warmwater fishery***	Not assessed	Not assessed	Dissolved oxygen (DO) not less than 5.0 mg/L during summer stratification in the epilimnion (uppermost layer of the lake). Not less than 5.0 mg/L for the rest of the year in entire lake area.
Other indigenous aquatic life and wildlife	Fully supporting	Not assessed	Numerous numeric chemical limits such as pH, ammonia, toxic metals, and organic compounds, as well as narrative limits such as for nutrients (nuisance algal growths) and physical properties (color, temperature, clarity, etc.)
Coldwater fishery***	Not assessed	Not assessed	DO not less than 6.0 mg/L in any 24-hour period during summer minimum flow period and not less than 7.0 mg/L rest of the time
Fish Consumption	Not assessed	Not assessed	Fish Consumption Advisory trigger levels for toxic heavy metals and organic compounds

**Data from Appendix B2 of DEQ's Integrated Water Quality Report – Water Quality and Pollution Control in Michigan (DEQ 2008)*

Adapted from Exhibit 43 from Portage Lake Watershed Forever Plan (PLWFP 2008)**** See appendix B for a listing of maximum temperatures***

4.2 Impacted Designated Uses in the Lake Leelanau Watershed

None of the designated uses for the Lake Leelanau watershed are impaired on a watershed-wide scale. However, in some cases, activities and resulting pollutants in the watershed may prove to be a threat to water quality and designated uses. Threatened waterbodies are defined as those that currently meet water quality standards, but may not in the near future.

Currently, the designated uses of the Lake Leelanau watershed are threatened from increasing human development along with exotic species introduction and proliferation. The LLWPP will focus on three of the four designated uses to protect in order to maintain water quality throughout Lake Leelanau and its watershed. The designated uses include the warmwater/coldwater fishery, other indigenous aquatic life and wildlife, and total body contact. (Table 14). Threatened designated uses were ascertained through scientific research reports, water quality monitoring reports, steering committee members, and personal contact with watershed residents and scientific experts on the Lake Leelanau watershed.

Table 14: Threatened or Impaired Designated Uses in the Lake Leelanau Watershed

Designated Uses	
Warmwater and Coldwater Fishery	Threatened
Other Indigenous Aquatic Life and Wildlife	Threatened
Total Body Contact Recreation (May1-Oct 31)	Threatened
Fish Consumption	Impaired

4.3 Desired Uses

In addition to designated uses, watershed residents may have uses and concerns particular to their region, which are not directly related to water quality. Such issues result in the addition of desired uses to the watershed management plan. Desired uses can be defined as the ways in which people use the watershed and think it should be protected and/or preserved for future generations. They may be very general or very specific, or somewhere in between. The desired uses are simply how watershed residents might want to use their watershed. Desired uses help to reflect community concerns such as loss of wildlife habitat or deterioration of scenic viewsheds. Desired uses for the Lake Leelanau watershed include uses for recreational, aesthetic, human health, and ecosystem preservation purposes (Table 15).

Table 15: General Desired Uses for the Lake Leelanau Watershed

Desired Use Category	Goal
Recreation	• Provide navigable waters that do not exceed responsible limits for usage. • Develop and implement an effective swimmer's itch management program.
Aesthetics	• Preserve the distinctive aesthetic character and inherent beauty of the lake and watershed. • Preserve the scenic and rural environment with emphasis on viewshed protection, riparian vegetation protection and wetland preservation. • Design and promote development that supports privacy, security, visual quality throughout the watershed. • Maintain the 'peace and quiet' usage of lake
Human Health	• Protect potable groundwater sources • Maintain whole body contact recreation May-October
Ecosystem Preservation	• Enhance fish and wildlife habitat with emphasis on protecting rare, endangered, and wetland species. • Preserve natural and intact riparian corridors with an emphasis on private landowner stewardship and conservation easements.

CHAPTER 5 WATER QUALITY PROBLEMS

5.1 Threatened Designated Uses: Pollutants, Sources, and Causes

For each designated use to protect in the Lake Leelanau watershed there are a number of different pollutants and environmental stressors that adversely affect each of the designated uses, or have the potential to (Table 16). The term environmental stressor is used to describe those factors that may have a negative effect on the ecosystem, but are not necessarily categorized as contaminants that change water chemistry. It is meant to address the wide range of environmental degradation experienced in the watershed. By avoiding the traditional approach of labeling a negative impact as a pollutant, the management plan hopes to engage a wider community support base. This plan will refer to classic watershed pollutants such as nutrients, sediment, and toxic substances, as well as environmental stressors such as habitat and wetland loss. The term pollutant and environmental stressor will be used interchangeably. Environmental stressors representing activities and conditions that negatively impact the designated and/or desired uses of the Lake Leelanau watershed include invasive species, loss of habitat, excess nutrients, and more (Table 16).

Table 16: Pollutants and Environmental Stressors Affecting Designated Uses in the Lake Leelanau Watershed

Pollutant or Environmental Stressor	Designated Uses Affected
Invasive Species	Warmwater/Coldwater Fishery Other Indigenous Aquatic Life Navigation Total Body Contact
Loss of Habitat	Warmwater/Coldwater Fishery Other Indigenous Aquatic Life
Nutrients	Warmwater/Coldwater Fishery Other Indigenous Aquatic Life Total Body Contact
Pathogens **(*E. Coli*)**	Total Body Contact
Sediment	Coldwater Fishery Other Indigenous Aquatic Life Navigation
Thermal Pollution	Coldwater Fishery Other Indigenous Aquatic Life
Toxins **(Pesticides, Herbicides, Oils, Gas, Grease, Salt/Chlorides, Copper Sulfate, Microcystis)**	Warmwater/Coldwater Fishery Other Indigenous Aquatic Life Fish Consumption

Note: This is a general list that encompasses pollutants for the entire Lake Leelanau watershed. Not all reaches in the watershed are impacted by all of the pollutants listed above.

Sources and Causes of Pollutants

A Comprehensive Watershed Protection Table was developed listing sources and causes of watershed pollutants and environmental stressors (Table 17). This table summarizes key information necessary to continue to focus on water quality protection, provides specific targets to act upon for watershed management, and forms the basis for all future implementation projects to protect the quality of the watershed. Sources and causes were identified using a wide variety of methods including: road stream crossing inventories, scientific research reports, water quality monitoring reports, steering committee members, and personal contact with watershed residents and scientific experts on the Lake Leelanau watershed.

Table 17: Pollutants, Sources, and Causes of Water Quality Degradation in the Lake Leelanau Watershed

(COMPREHENSIVE WATERSHED PROTECTION TABLE)

Environmental Stressor or Pollutant	Impaired or Threatened Use	Sources K = known, S = suspected, P = potential	Causes K = known, S = suspected, P = potential
Nutrients	*Warm/ Coldwater Fishery *Other Indigenous Aquatic Life *Total Body Contact	Residential, Agricultural or Commercial Fertilizer Use (k)	Improper application (amount, timing, frequency, location, method, P content) (k)
		Septic Systems (s)	Poorly designed, sited, sized, maintained (s) High density/age of systems (k) Lack of required inspections (k)
		Runoff from urban or developed areas (k)	Poor storm water management practices (k)
		Loss of runoff filtering capacity (k)	Development and filling (k) Clearing by landowner (k) Lack of adequate shoreline setbacks and appropriate native species and deep rooted vegetation (p) Reduction of Wetlands (k)
		Atmospheric Deposition (k)	Industrial emissions (k)
		Animal Waste (k)	Geese/ducks along shore & beach areas (k) Inappropriate livestock waste management (k)
Sediment	*Coldwater fishery *Other indigenous Aquatic Life *Navigation	Road Stream Crossings (k)	Poor design/construction/maintenance (k) Lack of erosion/surface runoff controls (k) Steep approaches (k) Culverts not aligned to streambed (k) Undersized culverts (k) Failing/eroding culverts/bridges (k)
		Bank/Shoreline Erosion (k)	Removal of riparian vegetation (k) Boat traffic/wakes (k) Recreational activities (k) Sandy soils (k)
		Residential and Road Construction (k)	Poor soil erosion practices (k) Permitted wetland filling (k)
		Runoff from urban and developed areas (k)	Poor storm water management practices (k)
		Lack of Riparian Buffer (k)	Clearing by landowner (k) Lack of adequate shoreline setbacks & native species & deep rooted vegetation (p)
		Loss of runoff filtering capacity (k)	Poor storm water management practices (k) Non-compliance with permits (k) Development and filling (k)
		Forestry Practices (k) Lake Leelanau Narrows Dredging (p)	Poor road design, management (k) Poor timber harvest practices (k) Improper methods (p) Re-suspension of particles in water column (p) Non-compliance with dredging permit restrictions (p)

Table 17: Pollutants, Sources, and Causes of Water Quality ….. Continued			
Environmental Stressor or Pollutant	**Impaired or Threatened Use**	**Sources** K = known, S = suspected, P = potential	**Causes** K = known, S = suspected, P = potential
Invasive Species	*Warm/Coldwater Fishery *Other Aquatic Life *Navigation *Total Body Contact	Landscaping practices (k)	Lack of awareness (s)
		Introduction of Invasive Species from Boat Hulls, Personal Watercraft, Live Wells, Bilges, Trailers, Etc. (k)	Lack of restrictions on boat travel (k) Lack of awareness (k) Don't Care (s)
		Other Biota (i.e. birds, frogs) (k)	'Hitching' a ride (k)
Loss of Habitat	*Warm/ Coldwater Fishery *Other Indigenous Aquatic Life	Development (k)	Poor development & design practices (k) Lack of knowledge on impact (k) Increasing population (k) Potential demand for vacation/seasonal homes (p)
		Permitted and Un-permitted Wetland Filling (k)	Increasing demand for shoreline homes (k)
Thermal Pollution	*Coldwater Fishery *Other Indigenous Aquatic Life	Runoff from urban/developed areas (k)	Poor storm water management practices (k)
		Impervious Surfaces (k)	More roads, roofs, and parking lots due to development (k)
		Lack of Streamside or Shoreline Canopy and Riparian Buffer (k)	Development (k) Clearing by landowner (k)
		Ponds, impoundments, & other water-control devices (p)	Top draw structures (p) Poorly maintained ponds & other water control devices (p)
		Sedimentation in stream channel (k)	*See Section on Sediment*
Toxins (Pesticides, Herbicides, Oils, Gas, Grease, Microcystin, Etc.)	*Warm/ Coldwater Fishery *Other Indigenous Aquatic Life *Total Body Contact *Fish Consumption	Abandoned Wells (leaking, uncapped) (p)	Improper disposal of chemicals (p) Poor adjacent land use (p)
		Atmospheric Deposition (k)	Industrial emissions (k)
		Contaminated Sediments (s)	Historical spills, disposals, discharges (s)
		Oil, Gas, Hydrocarbon, & Underground Injection Wells (p)	Maintenance (p), Accidents (p), Brine Storage (p) Abandoned Wells (leaking, uncapped) (p)
		Underground Storage Tanks (p)	Leaking tanks (p)
		Automobiles (k)	Oil, gas, and other leaks from cars, farm equipment, etc. (k)
		Storm Water (k)	Poor storm water management practices (k) Lack of riparian buffer
		Motor Boats (k)	Inefficient (2cycle) or poorly maintained watercraft motors (k) Fuel spills (p)
		Introduction of Mycrosystis (k)	S*ee section on invasive species*
		Improper Chemical Use & Disposal (s)	Lack of disposal facilities and/or limited hours of operation (s)
		Road Salt in Winter (k)	Runoff from roads (k)

Table 17: Pollutants, Sources, and Causes of Water Quality ….. Continued			
Environmental Stressor or Pollutant	**Impaired or Threatened Use**	**Sources** K = known, S = suspected, P = potential	**Causes** K = known, S = suspected, P = potential
Pathogens (*E. coli* and Fecal Coliform indicators)	*Total Body Contact	Animal Waste (k)	Geese/ducks/pets along shore, beach areas (k) Riparian Grazing (p) Manure piles (s)
		Septic Systems (s)	Poorly designed, sited, sized, maintained (s) High density/age of systems (p) Uninspected systems (p)

The Comprehensive Watershed Protection Table (Table 17) may be used as a reference to distinguish what the major sources of pollutants and environmental stressors are on a watershed-wide scale. However, they do not distinguish between pollutants and their sources and causes at specific locations. And, as stated earlier, not all of the pollutants listed are a problem everywhere in the watershed.

5.2 Priority Pollutant Ranking

It is extremely difficult to rank and prioritize all the pollutants and environmental stressors in the watershed because all of them are important and should be priorities for maintaining the health of the Lake Leelanau watershed. The series of environmental stressors shown in Table 16 are an interdependent web, with each pollutant potentially having some effect on the other, and each causing degradation in its own way.

Almost always, pollutants and stressors are interconnected with each other and changes in one causes changes to the others. Overall, loss of habitat, invasive species, nutrients, and toxins are the top environmental stressors in the watershed, in no particular order (Table 16). Maintaining the excellent water quality and low productivity (oligotrophic status) for North and South Lake Leelanau will require minimizing the amount of nutrient pollution that enter the lakes from adjacent properties, through stormwater runoff, erosion, or the lack of a riparian buffer (or greenbelt), poorly managed fertilization practices, or failing septic systems.

Habitat loss is an increasing concern as development in Leelanau County is moving further into the upland recharge areas and wetlands are being filled. This increases the amount of nutrients and other substances entering water bodies. Nutrients often attach to soil particles, thereby linking sediment and nutrient pollution. Even though Lake Leelanau is oligotrophic and low in nutrients overall, the increasing pressure form sources identified in Table 17 will continue to add nutrients to the lakes. Increases in nutrients can lead to increases in algal blooms and increases in aquatic plant growth.

Additionally, the impact invasive species may have on the Lake Leelanau ecosystem (both currently and in the future) is of great concern. While currently not a primary concern throughout portions of the watershed, invasive species are beginning to drastically change the ecosystem and habitat dynamics in surrounding watersheds and Lake Michigan. The diversity and quality of water-based recreational activities enjoyed throughout the watershed could change drastically from an increase in invasive species.

Table 18: Pollutant Priorities for the Lake Leelanau Watershed

Pollutant	Priority in Watershed
Loss of Habitat	High
Invasive Species	High
Nutrients	High
Sediment	Medium
Pathogens (*E. Coli*)	Low
Thermal Pollution	Low
Toxins (Pesticides/Herbicides, Oils, Gas, Grease, Salt/Chlorides, Copper Sulfate, Mycrosystin)	Low

The project steering committee has decided that the specific sources for each pollutant and stressor are the most important items to rank and prioritize in this protection plan because that is where one can actually stop pollution from entering waterways (Table 19). Additionally, as noted above, because most of the pollutants and stressors are interconnected, dealing with one source and its causes could actually reduce a number of different pollutants and stressors from affecting a stream or water body. This concept is discussed more in-depth in Chapter 7.

Table 19: Pollutant Source Priority Ranking

Environmental Stressor or Pollutant	Sources: K = known, S = suspected, P = potential	Priority
Nutrients	Residential, Agricultural or Commercial Fertilizer Use (k)	High
	Loss of runoff filtering capacity (k)	High
	Septic Systems (s)	Medium
	Runoff from urban or developed areas (k)	Medium
	Atmospheric Deposition (k)	Low
	Animal Waste (k)	Low
Sediment	Road Stream Crossings (k)	High
	Bank/Shoreline Erosion (k)	High
	Residential and Road Construction (k)	High
	Runoff from urban or developed areas (k)	High
	Loss of runoff filtering capacity	Medium
	Lack of Riparian Buffer (k)	Medium
	Poor Forestry Practices (k)	Medium
	Lake Leelanau Narrows Dredging (p)	Low
Invasive Species	Introduction of Invasive Species from Boat Hulls, Live Wells, Bilges, Trailers, Etc. (k)	High
	Landscaping practices (k)	High
	Other Biota (i.e. birds, frogs) (k)	Low
Loss of Habitat	Development (commercial and residential) (k)	High
	Permitted and Unpermitted Wetland Filling (k)	High
Thermal Pollution	Runoff from urban or developed areas (k)	Medium
	Lack of Streamside or Shoreline Canopy and Riparian Buffer (k)	Medium
	Ponds, impoundments, (k)	Medium
	Dredging (p)	Low
Toxins **(Pesticides, Herbicides, Oils, Gas, Grease, Etc.)**	Runoff from urban or developed areas (k)	High
	Introduction of Mycrosystis	High
	Motor Boats (k)	Medium
	Road Salt in Winter (k)	Medium
	Automobiles (k)	Medium
	Atmospheric Deposition (k)	Low
	Contaminated Sediments (s)	Low
	Oil, Gas, Hydrocarbon,& Underground Injection Wells (p)	Low
	Improper Chemical Use and Disposal (s)	Low
	Underground Storage Tanks (p)	Low
	Abandoned Wells (leaking, uncapped) (p)	Low
Pathogens (***E. Coli*** **and Fecal Coliform indicators)**	Animal Waste (k)	Medium
	Septic Systems (s)	Medium

5.3 Priority and Critical Areas

Although watershed management plans address the entire watershed, there are certain areas within the Lake Leelanau watershed that warrant more extensive management or protection consideration. Areas that focus on preservation and protection are considered **Priority Areas.** Any areas that are especially sensitive and may require restoration and rehabilitation are considered **Critical Areas**. Note that critical and priority areas often overlap.

Priority Areas

Priority areas in the Lake Leelanau watershed are defined as the portions of the watershed that are most sensitive to environmental impacts and have the greatest likelihood to affect water quality and aquatic habitat. Most often these areas require permanent protection. These are the portions of the watershed which would have a direct negative impact to the high water quality if they are degraded in the future.

The priority areas were identified by analyzing the Tables 17-19, which deal with sources, causes, and prioritization of watershed pollutants, and identifying the major areas where most of the threats to water quality exist. Other resources used to identify the critical areas include; scientific research reports, the Michigan Natural Features Inventory, water quality monitoring reports and personal contact with scientific consultants of the Lake Leelanau Steering Committee.

Additionally results from the Leelanau County Natural Lands Inventory (NLI) were utilized to determine priority areas as well. The NLI was conducted in 2007 as part of a strategic planning process by the Leelanau Conservancy and identifies and ranks the remaining natural lands in Leelanau County. Natural lands are identified as places on the landscape dominated by native vegetation that have various levels of potential for harboring high quality natural areas and unique natural features. These areas may provide critical ecological services such as maintaining water quality and ground water recharge. The results of this inventory were published in a report along with GIS layers and maps and distributed to local units of government in Leelanau County. The top three categories identified in the NLI are considered as having potential for being high quality natural areas. They are also considered the mostly ecologically rich wetlands and important stream corridors.

The priority areas for the Lake Leelanau watershed cover roughly 45% of the watershed and include the following areas (Figure 11):

- **High Priority Areas -**
  - *Important Watershed Lands:* These lands are considered the highest ranking for land protection by the Leelanau Conservancy as they are high quality wetlands that are vital for maintaining the high water quality in the Lake Leelanau Watershed.
  - *Top Ranked Lands identified NLI:* Areas with the highest NLI scores (lands with the highest potential for high quality natural areas) with land parcels greater than 10 acres.
- **Second Highest Priority Areas -** These areas include the second and third highest Ranked Lands identified NL with land parcels greater than 10 acres.

Critical Areas

Any areas that are especially sensitive and may require future restoration and rehabilitation (i.e. buffers, streambank restoration, etc.) are considered Critical Areas. ***Currently the highest priority Critical Areas include the Village of Leland, the shoreline of Lake Leelanau, identified Phragmites locations, the high priority road and stream crossings closest to Lake Leelanau and any agricultural areas of concern. These are identified in YELLOW on the map (Figure 12).*** However, since protection of waterbodies (i.e. wetlands and stream corridors) are vitally important to the water quality in the Lake Leelanau watershed, a buffer of 300 feet from any stream, body of water or wetland was created to make up the critical area (Figure 12). We have identified these critical areas as riparian corridors that are vital to maintaining the high water quality in the Lake Leelanau watershed. If there is a property, wetland habitat or section of shoreline that becomes degraded within this critical area, it will be a top priority to focus on implementing Best Management Practices in these areas. Critical areas for the Lake Leelanau watershed cover roughly 43% of the watershed.

Figure 11: Priority Areas in the Lake Leelanau Watershed

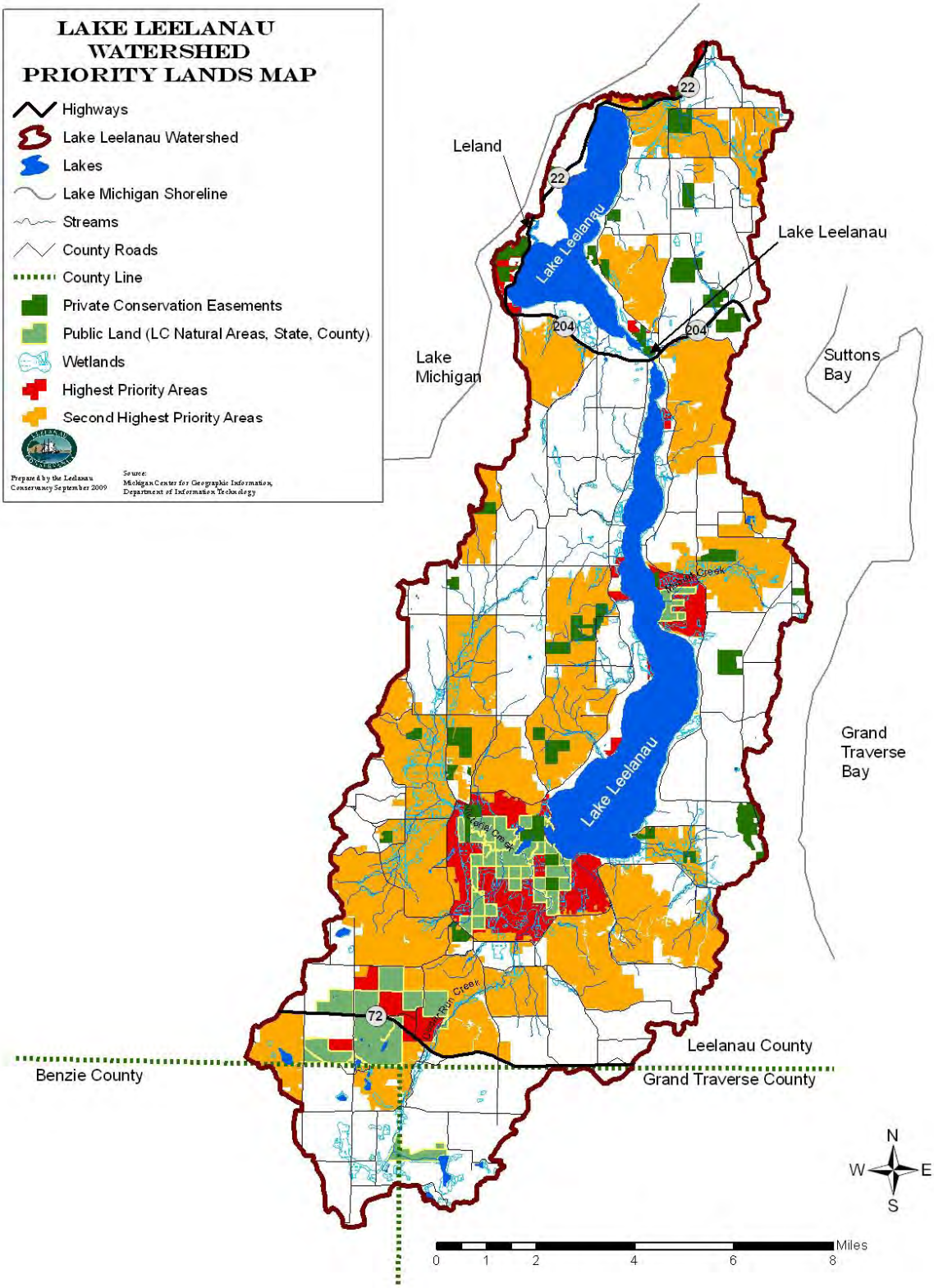
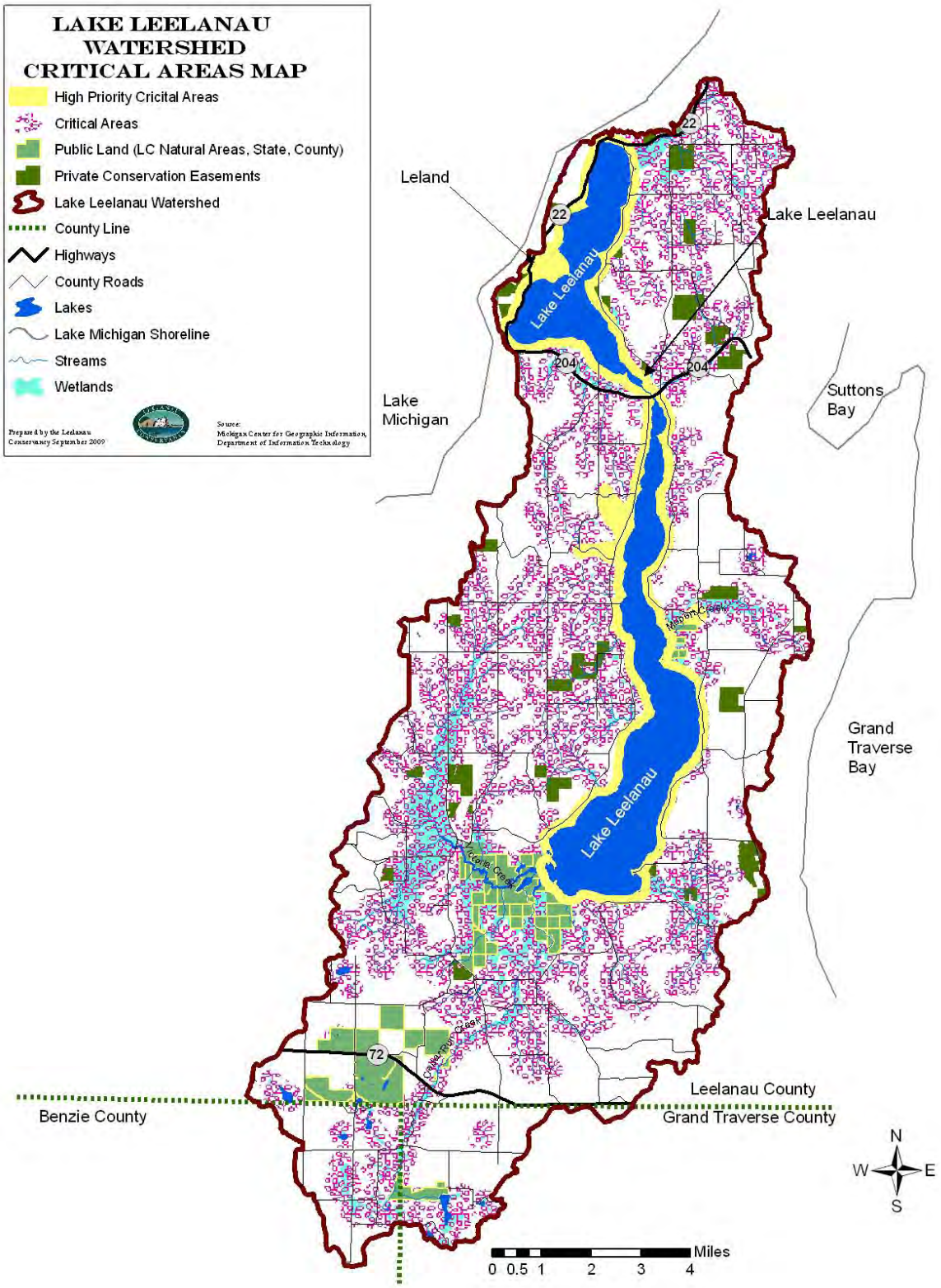


Figure 12: Critical Areas in the Lake Leelanau Watershed



5.4 Pollutants of Concern

Loss of Habitat

All plants and animals require specific environmental conditions, or habitat, to live and reproduce. Healthy biological communities are diverse, containing numerous kinds of habitat that support various species of plants, animals, fungi, etc. This diversity makes them stable, and flexible, thereby allowing the community to adapt when the environment changes. As habitat is lost, so are the species that require it.

The population of Leelanau County ballooned by 28% from 1990 to 2000 (U.S. Census). Residential development fragments the panoramic views of forested ridgelines and pristine river corridor that traditionally have enchanted visitors and residents alike. Incremental development causes loss of habitat. In addition to the development of the few remaining vacant parcels, three other trends have altered wildlife habitat and the surrounding viewshed: conversion of seasonal to year-round homes; replacement of smaller, aging cottages with larger homes; and development of view lots on the ridges overlooking the watershed.

Typical Impacts from Habitat Loss

Impact #1: Extinction and extirpation of native species.

Impact # 2: Habitat fragmentation, increase of edge effect

Impact #3: Loss of overall biological community stability and function.

Impact #4: Reducing the scenic magnitude of the Lake Leelanau Watershed which is the heart of the region's attraction and draw for over a million annual tourists and residents.

Invasive and Nuisance Species

Invasive species (also called exotic or non-native species) have threatened the Great Lakes ever since Europeans settled in the region. Exotic species are organisms that are introduced into areas where they are not native. While many exotic species are introduced accidentally, others are intentionally released, often to enhance recreational opportunities such as sport fishing. The Pacific salmon, which was purposely stocked in the Great Lakes, is an exotic species, but they are not a "nuisance" species. Species are considered a nuisance when they disrupt native species populations and threaten the ecology of an ecosystem as well as causing damage to local industry and commerce. Without pressure from the competitors, parasites, and pathogens that normally keep their numbers in check, invasive species may undergo large population increases.

Stowing away on boat hulls and in bilges is the primary way many invasive species are introduced into the ecosystem. Other ways of introduction include landscaping practices and lack of awareness by homeowners of the threat (this is how purple loosestrife was introduced to Michigan) and hitching a ride on other biota like frogs and birds.

Invasive species are becoming problematic throughout many of Michigan's inland lakes. Many of these species exhibit vast increases in numbers following their introduction, or following changes in the environment. Exotic species can affect the watershed in many ways. Zebra mussels and Eurasian watermilfoil influence the overall water quality and stability along with recreational use. Zebra mussels also alter the amount of available P by concentrating it on lake bottoms. As shown in both Lake Leelanau and Little Traverse Lake (another nearby lake), this increase in P may subsequently result in toxic cyanobacterial (blue-green algae) blooms at the height of the recreational season (Keilty and Woller 2004).

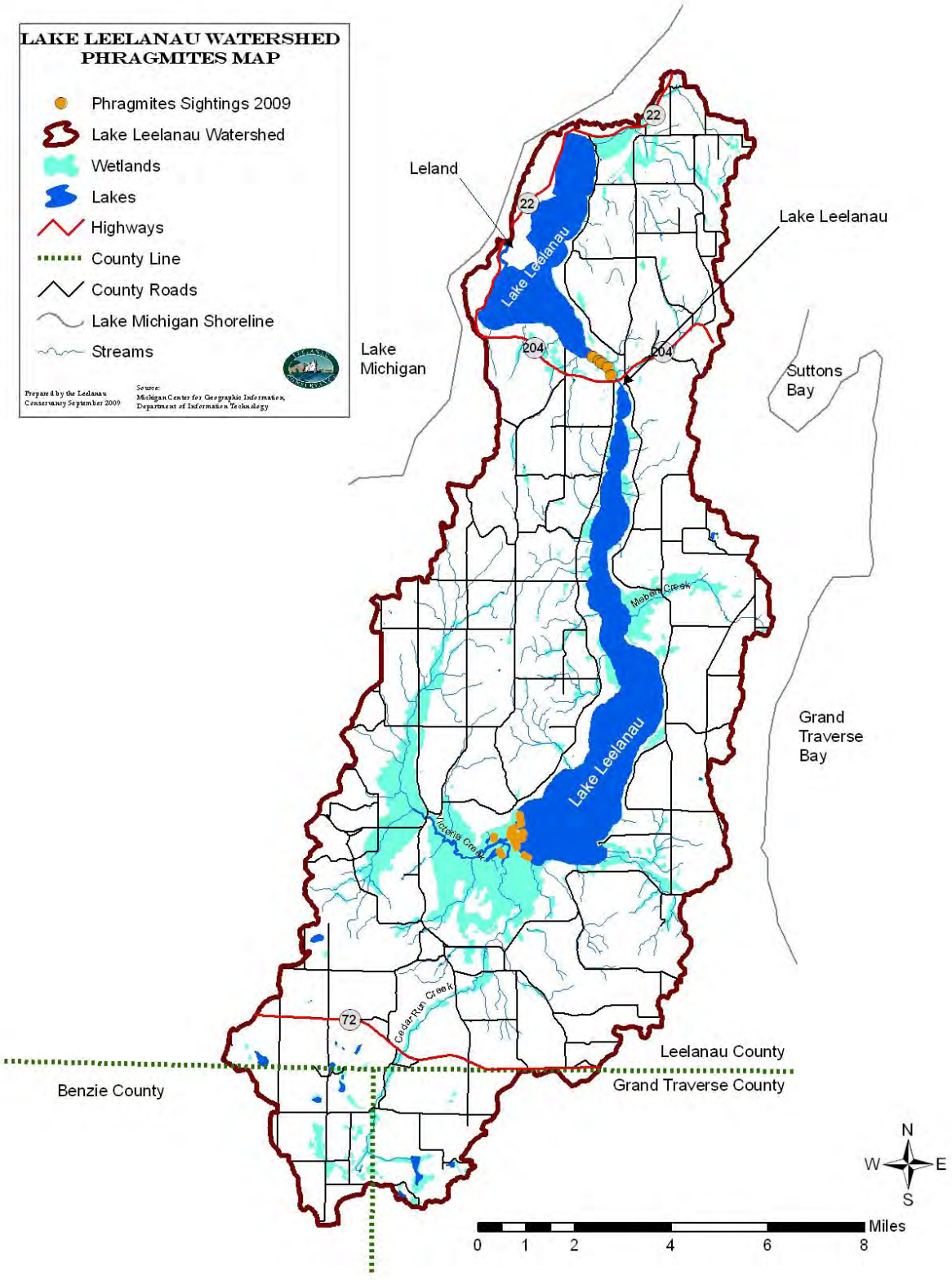
The only current documented aquatic invasive species in the Lake Leelanau watershed are the zebra mussel and curly leaf pondweed. In the 2008 LLLA newsletter, the survey results of a weed survey of LLLA members were presented. The results demonstrated that except for the Narrows, zebra mussel infestations were encountered the same frequency in 2008 as in past years.

In addition, *Phragmites australis*, an emergent wetland invasive species, has been spotted on the shores of both North and South Lake Leelanau and has been documented on Leelanau Conservancy Natural Areas and Preserves. (Figure12). Although *Phragmites* is a native to Michigan, an invasive variety was introduced from Europe early in the 20th century. This invasive variety quickly out-competes the native flora, creating tall monocultures in coastal wetlands, wet areas and many other community types. The result is a degradation of wildlife habitat, loss of recreation associated with wetlands including hunting and fishing, and loss of scenic views. Volunteer-led surveys in 2009 documented several thousand *Phragmites* infestations in Leelanau County and Grand Traverse Bay, paving the way for eradication. Unlike some other areas of the Great Lakes, populations in this region are still relatively small and can be eliminated.

There is a project underway that seeks to control the detrimental invasive species, *Phragmites australis*, to maintain water quality and near-pristine habitats of Lake Leelanau and restore native vegetation to shoreline affected by *phragmites*. *Phragmites* control has been implemented on the Lake Michigan/Grand Traverse Bay shoreline, but Leelanau County also contains many interior lakes and wetlands where *phragmites* is invading. Lake Leelanau has a total shoreline of about 41 miles with over 1,200 shoreline property owners, including Michigan Department of Natural Resources (MDNR) land, The Leelanau Conservancy land, township properties, and private landowners. Six townships border Lake Leelanau, including Bingham, Centerville, Elmwood, Leland, Solon, and Suttons Bay. Four of these townships, also border Lake Michigan/Grand Traverse Bay where restoration is also proposed, including Bingham, Elmwood, Leland, and Suttons Bay.

Objectives for this project include identification and reduction of *Phragmites australis* along the shoreline and adjacent wetlands of Lake Leelanau and Grand Traverse Bay and the restoration of native species to these areas. On-the-ground restoration for invasive *Phragmites* requires multiple steps as outlined by the MDNR. First, a physical shoreline survey and adjacent wetland survey will be completed. A full winter survey is being conducted by the Lake Leelanau Lake Association and the Leelanau Conservation District. *Phragmites* has been identified on at least 20 acres of Lake Leelanau as of December 2009. It is expected that 50 acres may be present along the entire Lake Leelanau shoreline. With a completed survey, a permit can be obtained from the MDNR to conduct herbicide treatment. With issue of this permit, approved chemical will be sprayed utilizing a private

Figure 12: Known *Phragmites* locations in the Lake Leelanau Watershed



licensed contractor for the initial control efforts. Herbicide treatment is expected to occur in August and September 2010 to effectively carry the herbicide into the extensive root system. Results are noticeable in the spring re-growth after treatment (2011). There is a need for continued surveys, treatment, outreach and education along with landowner permissions, and permit management.

Reed canary grass is another invasive species which is on the top 20 list for Leelanau County (August 2008) and has potential to become established in Lake Leelanau Watershed. Other invasive species like the quagga mussel, rusty crayfish, round goby, ruffe, fishhook water flea, spiny water flea, Eurasian watermilfoil, and Hydrilla have not yet been spotted in Lake Leelanau or its watershed. The LLLA conducts annual inspections at boat ramps for invasive species. This activity should be increased with a more thorough plan and volunteers to provide better early warning of invasive species.

Zebra mussels out-compete many native species in Lake Leelanau. For example, the native clams of Lake Leelanau are one of the principal contributors to high water quality and face near to complete mortality in the presence of zebra mussels. Because of the serious impacts of zebra mussels and the threat they present to the water quality of Lake Leelanau, LLLA encourages watershed users to use recognized and effective boat/motor washing techniques before launching boats into Lake Leelanau that have come from other water bodies.

Native species may cause nuisance problems for inland lakes as well. They may be native to the region, but, in the presence of certain types of water conditions grow at extremely high rates and cause problems. A prime example of a nuisance species is *Cladophora*, a branching, bushy-like alga that has recently become problematic in Lake Michigan.

Typical Impacts from Invasive Species

Impact #1: *Invasive species often have no natural predators and can out-compete native species for food and habitat.*

Impact #2: *Introduction of a single key species can cause a sudden and dramatic shift in the entire ecosystem's structure. New species can significantly change the interactions between existing species, creating ecosystems that are unstable and unpredictable. (Example: Established populations of zebra mussels can promote toxic blue-green algal blooms.)*

Impact #3: *In some instances invasive species can interfere with recreation in the watershed For example, rows of zebra mussel shells washed up on shore can cut beach walkers' feet, and Eurasian watermilfoil can get tangled up in boat propellers.*

Toxins

Toxic substances such as pesticides, herbicides, oils, gas, grease, salt, and metals often enter waterways unnoticed via stormwater runoff. These types of toxins are perhaps the most threatening of all the watershed pollutants because of their potential to affect human and aquatic health. Every time it rains, these toxic pollutants are washed from the roads, parking lots, driveways, and lawns into the nearest storm drain or road ditch, eventually reaching nearby lakes and streams. Additionally, farms, businesses, and homes throughout the watershed are potential sites of groundwater contamination from improperly disposed and stored pesticides, solvents,

oils, and chemicals. Stormwater runoff from impervious surfaces can also carry oils directly into surface waters or wash them into groundwater recharge basins.

Traditionally speaking, toxic substances such as mercury and other heavy metals have been regarded as the most serious due to their human health impacts. As fossil fuels burn, chemicals are released into the atmosphere. When rain falls through the clouds, it carries these suspended chemicals to the surface water, via runoff that eventually flows into receiving lakes and streams. In addition to transporting airborne pollutants, surface runoff can also leach these toxic compounds that have accumulated in soil or on impervious surfaces, such as roads, into streams and lakes. The toxins bioaccumulate through the food web, and therefore the oldest higher vertebrates, in this case fish, contain the greatest concentrations. The Michigan Department of Health has issued a consumption warning for fish in North and South Lake Leelanau to protect human health as a result of high chlordane, mercury and PCB (polychlorinated biphenyl) concentrations.

In addition to the substances noted above, other potentially toxic substances in the Lake Leelanau watershed include copper and sodium chloride. Copper sulfate has historically been used as a treatment method for swimmer's itch, and can accumulate in sediments and lead to mutations and even death in aquatic animals. High concentrations of copper can pose serious human heath risks. Sodium chloride enters the watershed primarily as a result of road salt application in the winter and subsequent runoff in the winter and spring. Higher levels of sodium chloride in streams and lakes can kill fish species.

Water quality reports on Lake Leelanau have shown that the colonization of Zebra mussels has lead to a decrease in normal green algae and an increase in bluegreen algae *Microcystis aeruginosa*. This organism produces an organic compound microcystine, some forms of which are powerful liver toxins.

Typical Impacts from Toxins

Impact #1: *Toxic chemicals entering waterbodies harm stream life, potentially causing entire reaches of a stream to be killed off if the concentrations of contaminants are high enough. Additionally, reproductive processes may be harmed.*

Impact #2: *Persistent toxic pollution in a stream may put human health and recreation at risk. Serious human health risks may include liver failure, kidney disease, and cancer.*

Impact #3: *Contaminated groundwater may pose a problem for homes and businesses throughout the watershed that rely upon groundwater wells for their drinking water. This poses a risk to human health and often requires difficult and costly cleanup measures.*

Nutrients

Nutrients are elements such as nitrogen, phosphorus, carbon, sulfur, calcium, potassium, iron, manganese, boron, and cobalt that are essential to the growth of living things. Nitrogen and

phosphorus are critical nutrients for all types of plants, including aquatic species. Phosphorus has shown to contribute to excessive algae growth.

Ordinarily, however, as the amount of P in the water column increases, rooted plant and algal growth increase as well. Generally speaking, total P concentrations greater than 10μg/L may contribute to increased aquatic plant growth and are indicative of impaired water quality. Since 1990, P concentrations in North Lake Leelanau averaged around 4.88 μg/L and 5.18μg/L for South Lake Leelanau. Average levels for N in both lakes from 1990-2005 are 268 μg/L for North Lake Leelanau, and 195 μg/L for South Lake Leelanau. These are over the 30:1 ratio, for both lakes, therefore it is important to control sources of both N and P into South and North Lake Leelanau. See Section 3.10 for nutrient pollutant load estimated for the watershed.

When elevated levels of nutrients occur in the water column, rooted plant and algae growth can be quite excessive, resulting in nuisance conditions. Blooms of algae resulting from nutrient enrichment eventually die and decompose, removing oxygen from the water and potentially leading to levels of dissolved oxygen that are insufficient to sustain aquatic life (Allan 1995). In terms of water quality, nutrients have a negative impact on the system when their concentrations exceed natural background levels. This condition can effectively reduce the recreational value of the waters by making the water unpleasant and undesirable for swimming, fishing, or boating due to increased algae and aquatic plant growth.

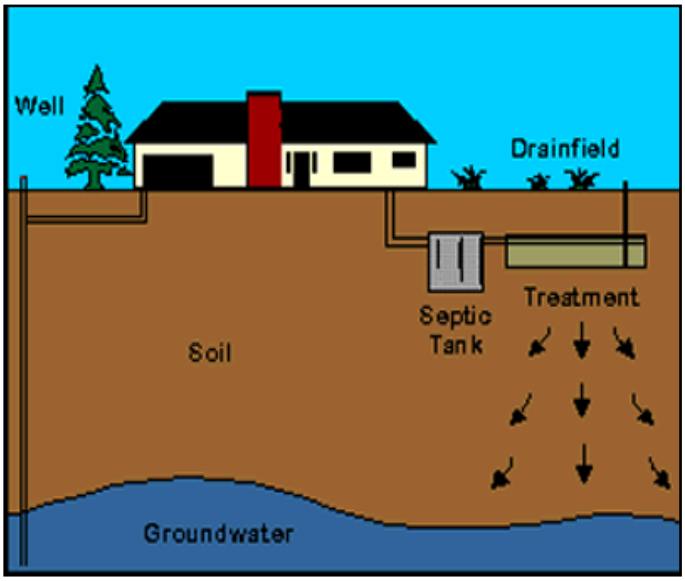
Nutrients speed up the natural aging process of lakes and ponds. This process is called eutrophication. The signs of an aging water body are deeper bottom sediments and heavy weed growth. This aging process would normally be measured in hundreds of thousands of years if not for the added sediments, fertilizers, and other organic wastes supplied by runoff from a developed watershed or from the atmosphere.

Sources of increased nutrients to the Lake Leelanau watershed resulting from human activities include residential and commercial fertilizer use, stormwater runoff from residential areas and roads (see Section 5.5 for a discussion on stormwater), septic system effluent, lack of riparian buffers, and reduction of wetlands.

Fertilizers

Fertilizers are a large source of nutrient input to the watershed. Since P is most often the limiting nutrient in aquatic systems, P concentrations in fertilizers have a dramatic impact in the watershed. While no detailed studies involving nutrient runoff from lawns are available for the Lake Leelanau watershed, information from lawn studies done in Wisconsin indicate a large amount of P in the water stemming from fertilizer use. One study conducted in an urban area reported that lawns accounted for 24% of runoff volume, but 56-70% of P exports (Waschbusch et al. 1999). Another study conducted on a lake with 70% of its shoreline developed with lawns mowed to the water's edge reported that lakeshore lawn drainage area provided just 4% of the water inflow to the lake, but comprised 51% of the total P input (Garn 2002). The same study measured total P concentrations in runoff for different fertilizer categories (no fertilizer, no-P fertilizer, and regular fertilizer) and found that total P concentrations in runoff from lawn sites with the no-P fertilizer applications were similar to that of unfertilized sites (Garn 2002). This indicates that no-P fertilizer use is an effective, low-cost practice for reducing P in runoff.

Septic Systems



A septic system consists of two basic parts: a septic tank and a soil absorption field or drainfield. Wastes flow from the house into the septic tank where most solids are separated to the bottom and are partially decomposed by bacteria to form sludge. Some solids float and form a scum mat on top of the water. The liquid effluent from the septic tank, carrying disease-causing organisms and liquid waste products, is discharged into the soil absorption field. In the absorption field, the water is further purified by filtration and decomposition by microorganisms in the soil. The semi-purified wastewater then percolates to the groundwater system.

Image and information courtesy of MSU Institute for Water Research:
www.iwr.msu.edu/edmodule/water/septic

Another potential source of nutrient enrichment in the Lake Leelanau watershed is from failing septic systems. Septic systems are used to treat wastewater from toilets, wash basins, bathtubs, washing machines, and other water-consumptive items, many of which can be a source of high pollutant loads. They are particularly common in rural or large lot settings, where centralized wastewater treatment systems are not economical. Nationally, one out of every four homes uses some form of septic system, with a combined discharge of over one trillion gallons of waste each year to subsurface and surface waters (NSFC 1995). There is a small municipal sewer system around the Leland area, but the majority of houses along Lake Leelanau and the rest of the watershed are serviced by individual septic systems. In areas where the soil does not percolate, many residents are on holding tanks, which required frequent pumping (often every 1-2 months).

The Benzie-Leelanau District Health Department has rules and permit for septic systems (Environmental Health Regulations, Chapter II). These rules require that “all flush toilets, lavatories, bathtubs, showers, laundry drains, sinks and any other similar fixtures or devices to be used to conduct or receive water carried sewage shall be connected to a septic tank of some other device in compliance with the minimum standards and the Michigan Department of Public Health regulations and finally disposed of in a manner in compliance with these minimum standards and the Michigan Department of Public Health regulations and any other applicable law, ordinance or regulation.” (Environmental Health Regulations, Chapter II) The rules require a percolation test (via an application), and require specific setbacks of septic tanks and subsurface disposal system (or drainfield) from wells, property lines, lakes/wells/springs/streams.

A failing septic system occurs when a septic system is no longer functioning properly, and the sewage water from the septic tank begins to pond on the ground surface over one or more components of the system. Some factors that may cause a septic system to fail include: the age of the septic system; excessive water use; damage to the disposal field area; broken pump; crushed crossover pipe; and broken tight line (US Inspect 2010). Failure rates for septic systems

typically range between one and five percent each year (De Walle 1981) but can be much higher in some regions (Schueler and Holland 2000, Article 123). According to information from the National Environmental Service Center's 1992 and 1998 summary of the status of onsite wastewater treatment systems in the United States, the septic system failure rate in Leelanau County is estimated to be near 1.14%. Using this theoretical estimate, a total of 5393 housing units in the nine townships having portions in the watershed (2000 data, LC working paper 11), approximately 61.5 have septic systems that are currently failing. Identifying and eliminating these possible failing septic systems, especially ones located along North and South Lake Leelanau will help control contamination of ground and surface water supplies in the watershed and potential impact on Lake Leelanau from untreated wastewater discharges.

The best way to prevent septic system failure is to ensure that the system is sited and sized properly and to employ appropriate treatment technology and maintenance. Design requirements will vary according to local site factors such as soil percolation rate, soil composition, grain size, and depth to water table.

The effectiveness of septic systems at removing pollutants from wastewater varies depending on the type of system used and the conditions at the site. The fact is, even a properly operating septic system can release more than 10 pounds of N per year to the groundwater for each person using it (Ohrel 2000). The average pollutant removal effectiveness for a conventional septic system is as follows: total suspended solids – 72%, biological oxygen demand – 45%, total nitrogen – 28%, and total phosphorus – 57% (USEPA 1993). This shows that even properly operating conventional septic systems have relatively low nutrient removal capability, and can be a cause of an increased rate of eutrophication in lakes and coastal areas.

A study of Leelanau County Lakes, including North and South Lake Leelanau estimated approximately 13-14% of the total P load to Lake Leelanau each year was attributed to septic systems effluent (Canale and Nielsen 1997) (Table 8). While the bulk of P entering South Lake Leelanau watershed is from atmospheric deposition (Table 9), which cannot be impacted by local change, reducing the amount of P and N entering from cultural sources (i.e., surface and subsurface groundwater inputs) can only help the watershed to stay in its current low-nutrient status. There has been significant development along lakeshore areas of the watershed since the 1997 study, increasing potential P loading from other sources in addition to septic systems. Septic system effluent still remains a concern for the entire watershed area.

Typical Impacts from Excessive Nutrients

Impact #1: Increased weed and algae growth impact water recreation and navigation.

Impact #2: Decomposition of algae and weeds removes oxygen from lakes, harming aquatic life and reducing the recreational and commercial fishery.

Impact #3: Exotic plant species like Eurasian Watermilfoil and Purple Loosestrife can better compete with native plants when nutrients are abundant.

Impact #4: Some algae (i.e., blue-green algae) are toxic to animals and humans and may cause taste and odor problems in drinking water.

Impact #5: High nitrate levels in drinking water are a known human health risk.

Sediment

Sediment is fine inorganic soil or sand particles and sedimentation is the process whereby sediment is deposited in a stream or lake bottom. It occurs naturally in all stream and lake environments due to land erosion by wind and water. However, excessive sedimentation can severely degrade an entire riparian system (Waters 1995) and has been identified as a major cause of degradation to aquatic life in many Michigan streams and rivers (DEQ 1998). Excessive sediment deposition in many of Michigan's streams also severely impacts the amount of suitable habitat needed to support healthy and diverse communities of fish and fish food organisms. When sediment enters a stream it covers gravel, rocky, and woody habitat areas, thereby leading to decreases in habitat diversity and aquatic plant production. Sedimentation caused by streambank erosion may increase channel widening. The increased width and resulting shallower depth increases the overall water temperature of the river. Because fish and aquatic insects are sensitive to temperature changes, this sedimentation results in further degradation of habitat and animal populations.

Sediment is identified as a medium priority pollutant in the Lake Leelanau watershed, particularly on small streams in Leelanau and Suttons Bay townships, based on field inspections and inventories conducted throughout the watershed. Significant sources of sediment to Lake Leelanau tributaries include activities that cause streambank erosion such as road/stream crossings, increased flow levels (rapidly changing stream levels), boat traffic in shallow areas such as the Leland River and the Narrows, removing streamside vegetation, and heavy recreational use at poorly designed access sites (Table 19).

Another source of sediment in the Lake Leelanau watershed is the clearing of land for construction, development, or other purposes. This creates a host of other erosion related problems including flooding, polluted runoff, loss of topsoil from surface runoff, and a reduction in fisheries and channel depth. Any kind of excavation, earth moving, drainage, bridging, tunneling, or other activity in which soil is disturbed can result in sediment transport to nearby streams. Alexander and Hansen (1988) report that increases in sediment erosion from development are detrimental to aquatic communities. Increased sediment loads also will continue past the development construction phase due to the resulting increase in stormwater runoff from the newly created impervious surfaces. Roads, rooftops, and parking lots are examples of impervious surfaces that replace rural and forestland during development. Development results in decreased water-retention capacities, increased flood frequencies, and rapid filling of stormwater detention systems.

Specific sites that could be contributing to sedimentation of Lake Leelanau tributaries are designated in the Lake Leelanau Watershed Road/Stream Crossing Inventory Report by the Grand Traverse Band of Ottawa and Chippewa Indians (Appendix B). Details on nutrient data and budgets for North and South Lake Leelanau can be found in Canale and Nielsen (1997) and Keilty (1997), published by the Leelanau Conservancy.
A 2001 road/stream crossing survey conducted by the Grand Traverse Band of Ottawa and Chippewa Indians (GTBOCI) shows that there are 18 road stream crossings in the Lake Leelanau

watershed identified as having a severe rating for erosion (GTB, 2001). These are shown in Figure 14. Most of these are on small tributaries to creeks that feed into Lake Leelanau (Table 20). There are 24 road stream crossings in the Lake Leelanau Watershed identified as having a moderate rating for erosion. Most problems at road crossings in the watershed stem from erosion around the culvert openings and failing/eroding retaining walls. Of the 18 severely ranked sites, the top concerns are replacing culverts, paving curb and gutters, putting in diversions, and revegetating the banks. Estimated total costs by GTBOCI to fix the severe sites are $161,038, and the costs to fix all of the moderately ranked sites is $349,200. Currently work is planned to begin at the high priority site #67 as part of the Environmental Stewardship Program through the GTB (refer to Figure 14). The GTB is working with the NRCS to complete this work. See appendix C for an article announcing the project on site #67.

Depending on the severity and number of erosion sites and road stream crossings, a significant amount of sediment, and, subsequently, phosphorus (P) and nitrogen (N) may be released into river systems. Sediment erosion estimates for road crossings in the Lake Leelanau watershed were not readily available. However, if we use estimates from the Grand Traverse Bay Watershed Protection Plan for portions of its watershed in Leelanau County, we can estimate that sediment loss from severely ranked sites is 10 yd^3/yr (14.2 ton/yr) and moderate sites is 3 yd^3/yr (4.3 ton/yr) (TWC 2005). These numbers show that more than 350 tons of sediment is eroded from severe and moderate road stream crossings each year (255 tons – severe, 103 tons – moderate). Using the MDEQ Pollutants Controlled Manual (DEQ 1999) discussed in Section 7.2, we can calculate that the average amount of phosphorus entering the watershed from erosion at these road stream crossings is 304 lbs, with Nitrogen at 608 lbs. (NOTE: These equations were made using the assumption that soils at road crossings are sandy loam.)

Typical Impacts from Sedimentation

Impact #1: *Sand and sediment harm aquatic life by covering natural stream and lake substrate, which fish and prey species rely upon for spawning and feeding.*

Impact #2: *Sediment also increases turbidity, decreasing visibility and clogging fish and insect gills. Turbid stream flow also dislodges fish eggs and insect prey.*

Impact #3: *When more sand and sediment is deposited than can be moved by stream flow, water levels are raised, causing streambank erosion and potential flooding. Excessive sedimentation may also fill lakes, ponds, and wetlands.*

Impact #4: *Nutrients, heavy metals, and other pollutants can attach to finer sediment particles and enter the water when suspended.*

Impact #5: *Excess sedimentation can potentially impair navigation by making the water too shallow for boats and boat access.*

Impact #6: *Sediment accumulation decreases stream depth, and increases stream width, thereby causing the water temperature to rise.*

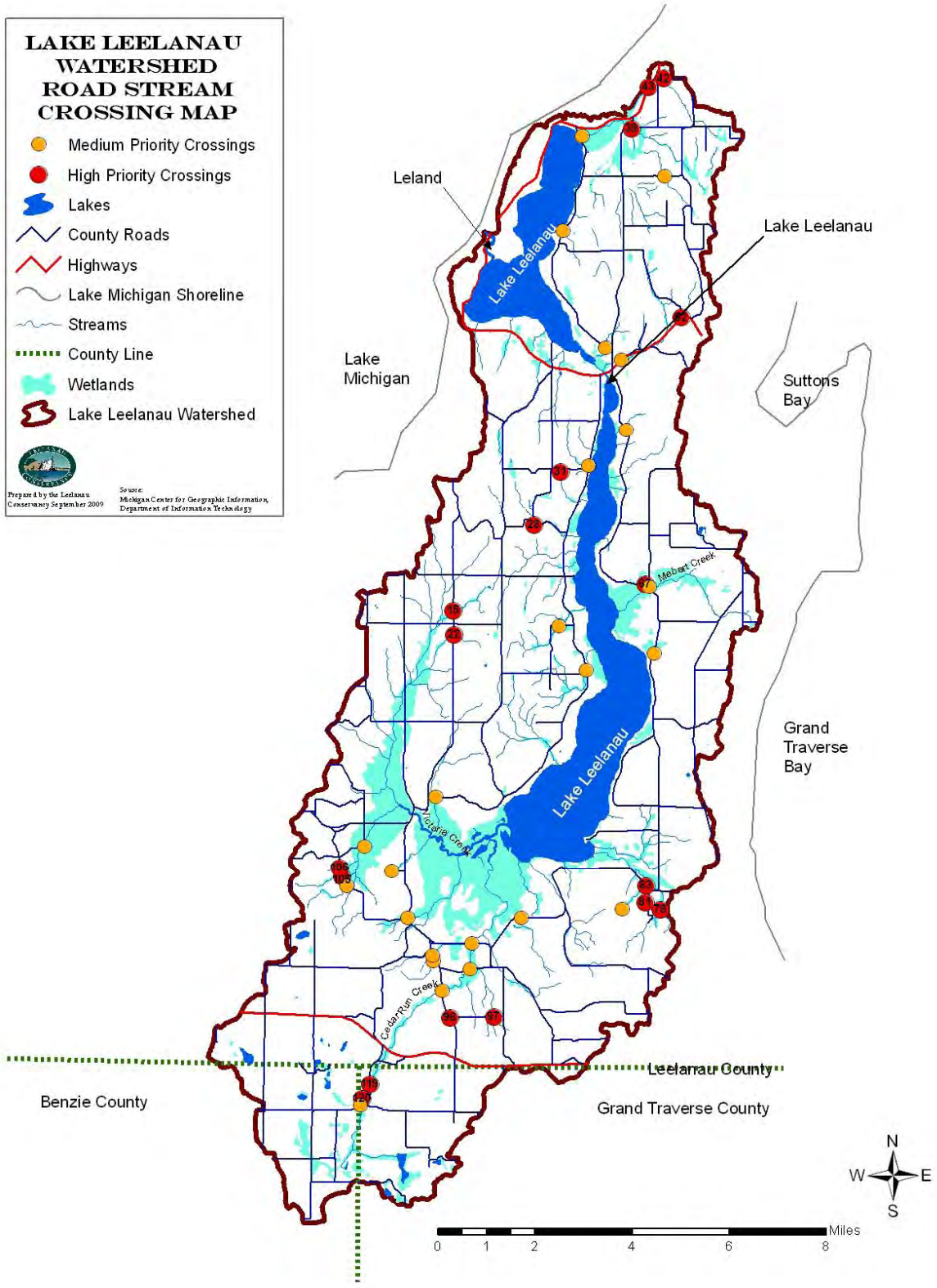
Table 20: Road Stream Crossing HIGH Priority Locations in the Lake Leelanau Watershed

Site #	*Stream Name*	*Road Name*	*Township*	*Erosion Extent*	*Severity Rating*	*Estimated Cost*	*Repair Type*
15	Victoria Creek	Schomberg	Centerville	Severe	Severe	$51,444	pave curb & gutter, 2 diversion outlets, increase fill, replace 1 culvert, extend 1 culvert
22	Victoria Creek	Schomberg	Centerville	Severe	Severe	$0	Contact Landowners about fencing cattle away from stream
28	unnamed	Amore	Centerville	Severe	Minor	$4,500	Replace 1 culvert
31	unnamed	Lavassar	Centerville	Severe	Severe	$8,550	Diversion outlets, fill, culvert replacement
39	Houdek Creek	Eagle Hwy	Leland	Severe	Severe	$19,200	Pave curb & gutter, Diversion, extend culvert
42	unnamed	Kovarik	Leelanau	Severe	Severe	$31,000	2 diversion outlets, replace &extend culvert
43	unnamed	M22	Leland	Severe	Severe	$14,000	pave curb & gutter, erosion control structure, culvert extension
52	Beaudwin	Duck Lake-M204	Suttons Bay	Severe	Severe		fence off inlet
67	Mebert	S. Lake Leelanau	Bingham	Severe	Severe	$15,500	Replace with 4 x 6 box
78	Mann Tributary	Bugai	Elmwood	Severe	Severe	$12,875	replace 1 culvert, extend 1 culvert
81	Mann Tributary	Orchard Way	Elmwood	Severe	Severe	$14,670	pavement
83	Mann Tributary	Fouch	Elmwood	Severe	Severe	$13,125	replace 1 culvert with 4 x 6 box
96	Cedar Run Tributary	Rudolph	Solon	Severe	Severe	$25,222	Pave curb & gutter, 4 diversion outlets
97	Cedar Run Tributary	Rudolph	Solon	Severe	Severe	$2,620	Diversion, culvert replacement, debris removal
105	Victoria Creek Tributary	Kasben	Kasson	Severe	Severe	$14,400	Extend 1 culvert, fence stream
106	Victoria Creek Tributary	Kasben	Kasson	Severe	Severe	$5,000	Replace 1 culvert
119	Cedar Run Creek	Cedar Valley	Long Lake	Severe	Severe	$35,166	Pave curb & gutter, replace 4 culverts with 4 x 6 box
120	Cedar Run Creek	Clay	Long Lake	Severe	Severe	$22,460	Pavement, pave curb & gutter, Diversion outlets, replace 1 culvert with 4 x 6 box
					Total Cost	**$161,038**	

Table 21: Road Stream Crossing Medium Priority Locations in the Lake Leelanau Watershed

Site #	*Stream Name*	*Road Name*	*Township*	*Erosion Extent*	*Severity Rating*	*Estimated Cost*	*Repair Type*
11	unnamed	Sharnowski	Centerville	Moderate	Moderate	$600	extend 1 culvert
14	Cedar Lake Trib.	Grandview	Elmwood	Moderate	Moderate	$0	Diversion outlet
32	unnamed	S. Lakeshore Drive	Leland	Moderate	Moderate	$9,680	extend 1 culvert @ inlet, vegetate shoulder
38	Houdek Creek	N. Lake Leelanau Drive	Leland	Moderate	Moderate	$12,500	Replace culvert w
46	unnamed	N. Lake Leelanau Drive	Leland	Moderate	Moderate	$10,000	Replace 1 culvert w
47	Houdek Creek	Alpers Road	Leelanau	Moderate	Moderate	$4,000	Replace 1 Culvert
59	Beaudwin	Duck Lake, M 204	Leland	Moderate	Moderate	$39,000	Erosion control structure, replace culvert, vegetate bank
61	unnamed	N. Lake Leelanau	Leland	Moderate	Moderate	$15,500	pave curb & gutter, erosion control structures, replace culvert
62	Unnamed	S. Lake Leelanau Drive	Suttons Bay	Moderate	Moderate	$3,760	Replace 1 Culvert
66	Mebert Creek	Maple Valley	Bingham	Moderate	Moderate	$19,000	Replace 1 culvert
71	unnamed	S. Lake Leelanau Drive	Bingham	Moderate	Moderate	$4,500	Replace 1 culvert
87	Cedar Creek	Cherry Bend Road	Elmwood	Moderate	Moderate	$5,750	Extend Culvert
93	Cedar Run Creek	Alpine	Solon	Moderate	Moderate	$40,375	Pave curb & gutter, replace culvert
94	Cedar Run Creek	White	Solon	Moderate	Moderate	$59,500	Pavement, replace culvert
95	Cedar Run Creek	Cedar	Solon	Moderate	Moderate	$47,500	Pave curb & gutter, replace with 1 culvert
98	Tager Creek	Vlack Park	Solon	Moderate	Moderate	$4,360	Pave curb & gutter, increase fill, extend culvert
99	Tager Creek	Cedar	Solon	Moderate	Moderate	$1,200	2 diversion outlets, vegetate upstream bank
102	Clearbrook	Cedar	Solon	Moderate	Moderate	$18,750	replace 1 culvert
104	Victoria Tributary	Kasben	Kasson	Moderate	Moderate	$12,500	replace 1 culvert
107	Victoria Creek Tributary	Valley	Kasson	Moderate	Moderate	$12,750	replace 1 culvert
111	Victoria Creek Tributary	S. Lake Leelanau Drive	Solon	Moderate	Moderate	$200	vegetate banks & shoulder
116	Victoria Creek Tributary	Popa	Solon	Moderate	Moderate	$3,375	replace 1 culvert
121	Cedar Run Creek	Cedar Run	Almira	Moderate	Moderate	$20,000	replace 1 culvert
835	Mann Tributary	Slope	Elmwood	Moderate	Moderate	$4,400	increase fill, replace culvert
				Total Costs		**$349,200**	

Figure 14: High and Medium Priority Road Stream Crossings in the Lake Leelanau Watershed



Pathogens

Pathogens are organisms that cause disease and include a variety of bacteria, viruses, protozoa and small worms. These pathogens can be present in water and may pose a hazard to human health. The US Environmental Protection Agency (EPA) recommends that freshwater recreational water quality be measured by the abundance of *Escherichia coli* (*E. coli*) or by a group of bacteria called *Enterococci*. Michigan has adopted the EPA's *E. coli* water quality standards. *E. coli* is a common intestinal organism, so the presence of *E. coli* in water indicates that fecal pollution has occurred. However, the kinds of *E. coli* measured in recreational water do not generally cause disease; rather, they are an indicator for the potential presence of other disease causing pathogens. EPA studies indicate that when the numbers of *E. coli* in fresh water exceed water quality standards, swimmers are at increased risk of developing gastroenteritis (stomach upsets) from pathogens carried in fecal material. The presence of *E. coli* in water does not indicate what kinds of pathogens may be present, if any. If more than 130 *E. coli* are present in 100mL of water in 5 samples over 30 days, or if more than 300 *E. coli* per 100mL of water are present in a single sample, the water is considered unsafe for swimming.

Fecal pollution entering the Lake Leelanau watershed may come from stormwater runoff, animals on the land or in the water, illegal sewage discharge from boats, or leaking septic systems. Different sources of fecal pollution may carry different pathogens. Peak *E. coli* concentrations often occur during high flow periods when floodwater is washing away possible contaminants along streambanks and shorelines from waterfowl like ducks and geese.

There was some *E. coli* data collected in Summer 2004 by The Watershed Center at Nedows Beach, a public swimming area on North Lake Leelanau. Results did not indicate a threat to human health from *E. coli* at that time. However, it is recommended that E. coli monitoring be conducted on both North and South Lake Leelanau, as well as major tributaries such as Cedar Run Creek and Victoria Creek.

Typical Impacts from Pathogens

Impact #1: High levels of pathogens in the water pose a threat to human health and reduce the recreational value of the lake, thereby degrading use and enjoyment of the watershed.

Thermal Pollution

Not normally thought of as a pollutant, increased water temperatures can potentially detrimentally affect water quality and aquatic life in a watershed system. Thermal pollution increases the temperature of a body of water, and even small increases in temperature can dramatically alter natural processes. Water's ability to hold dissolved oxygen decreases as temperature increases; thereby reducing the available amount of oxygen in the water to fish and other aquatic life. Temperature also influences the rate of physical and physiological reactions such as enzyme activity, mobility of gases, diffusion, and osmosis in aquatic organisms. For most fish, body temperature will be almost precisely the temperature of the water. Fish will seek water that is in their preferred temperature ranges so as to avoid stress from elevated water temperature. If unable to avoid the higher temperatures a fish's body temperature increases, and this then changes their metabolic rate and other physical or chemical processes as well. When thermal stress occurs, fish cannot efficiently meet their energetic demands (Diana

1995). Optimal water temperatures for trout are in the 60°F range(15-20°C) or below. Lethal maximum temperatures vary with different trout species, but temperatures above 76°F (24.4°C) can be lethal.

Other sources of thermal pollution in the Lake Leelanau watershed are heated stormwater runoff from paved surfaces, the removal of shade vegetation along streambanks and shorelines, and undersized culverts at road stream crossings that create warm pools of retained water upstream, coupled with low flows and shallow pool depth below. Excessive inputs of sediment into streams and lakes may also contribute to thermal pollution. Sediment inputs can fill stream pools and lakes, making them shallower and wider and, consequently, more susceptible to warming from solar radiation. Thermal pollution also occurs in the watershed through solar warming of stagnant pond water.

Changes in climate due to global activities also may enhance the degree of thermal pollution in a watershed. Average global surface temperatures are projected to increase by 1.5°C to 5.8°C by the year 2100 (Houghton et al. 2001). Increases in surface temperatures may increase stream water temperatures as well, although impacts will vary by region. Overall, increases in stream water temperature will negatively affect cold-water aquatic species. For example, cold-water fish, such as trout and salmon, are projected to disappear from large portions of their current geographic range in the continental United States due to an increased warming of surface waters (Poff et al. 2002). While climate change has the potential to increase inland water temperatures, it is beyond the scope of the LLWPP.

Typical Impacts from Thermal Pollution

Impact #1: *Surges of heated water during rainstorms can shock and stress aquatic life, which have adapted to cold water environments. Aquatic diversity is ultimately reduced. Constant heating of rivers and lakes ultimately changes the biological character and thus the fishery value.*

Impact #2: *Thermal pollution decreases the amount of oxygen available to organisms in the water, potential suffocating them.*

Impact #3: *Warm water increases the metabolism of toxins in aquatic animals.*

Impact #4: *Algae and weeds thrive in warmer waters.*

Impact #5: *Human made impoundments increase stream temperatures creating lethal conditions for cold water species such as brook trout.*

5.5 Special Sources of Concern: Stormwater, Lack of Riparian Buffer, and Master Plans and Zoning Ordinances

Stormwater

Road and roof runoff are two sources of stormwater. Photo Copyright 1999, Center for Watershed Protection

One of the major pathways by which many types of pollutants get to lakes and streams is through stormwater runoff. Stormwater runoff results from rain or snow melt, and the resulting water that does not infiltrate into the ground flows over the surface of the land. This stormwater flow often dislodges and carries soil or sediment particles (causing streambank erosion in some places) to which many pollutants are attached. The stormwater flow may also directly move the pollutant itself (i.e., garbage, oils, grease, gas, pesticides, fertilizer, etc.). The amount of stormwater runoff that occurs is dependent upon a variety of conditions including storm intensity and duration, topography, time of year, soil moisture levels, soil permeability, vegetative cover types, the extent of vegetated cover, and the amount of impervious surfaces.

Residential subdivisions in the watershed produce greater amounts of stormwater flow due to the increased amount of impervious surfaces relative to more rural settings within the watershed. Impervious surfaces are those areas on land that cannot effectively absorb or infiltrate rainfall. Areas such as these may include: roads, streets, sidewalks, parking lots, driveways, and rooftops. Research suggests that there is a threshold to the amount of impervious cover that can occur within a watershed at which the degradation of aquatic systems occurs. Findings reveal that stream and lake degradation consistently occurs when impervious surface levels in a watershed reach between 10-20% (CWP 1994). Due to its large amount of forested and wetland areas, impervious surface levels in the Lake Leelanau watershed as a whole are nowhere near this threshold. There is a significant amount of shoreline development along the shores of both NLL and SLL. However, there are some instances of localized degradation from stormwater in residential subdivisions throughout the watershed along riparian areas, including the village of Leland which most likely contributes some storm water runoff to the Leland River. However there are some instances of localized degradation from stormwater in residential subdivisions throughout the watershed along riparian areas including the village of Leland, which most likely contributes some in storm water runoff to the Leland River. Another instance of local impact is the routing of stormwater from the Village of Cedar into the Cedar River. By far, the biggest stormwater problems in the watershed are runoff from residential lawns, driveways, rooftops, and roads, none of which go through a traditional stormwater conveyance system with a pipe outlet.

When added up, all these small inputs of stormwater can result in a significant amount of pollution entering the Lake Leelanau watershed. Most often the pollution coming from

stormwater runoff is at its worst during heavy rain and snowmelt events. Data from the Rouge River National Wet Weather Demonstration Project (Cave et al. 1994) in Southeast Michigan present the typical pollutant concentration in stormwater from various land uses (Table 20). As expected, developed land uses (such as residential and commercial) and impervious surfaces have noticeably higher concentrations of pollutants compared to forest and open spaces.

Table 21: Typical Stormwater Pollutant Concentrations from Land Uses in Southeast Michigan

Land Use	Pollutant (mg/L)			
	Total Phosphorus	***Total Nitrogen***	***Total Suspended Sediment***	***Lead***
Road	0.43	1.82	141	0.014
Commercial	0.33	1.74	77	0.049
Industrial	0.32	2.08	149	0.072
Low Density Residential	0.52	3.32	70	0.057
High Density Residential	0.24	1.17	97	0.041
Forest	0.11	0.94	51	0.000
Urban Open Space	0.11	0.94	51	0.014
Pasture, Agriculture	0.37	1.92	145	0.000

(Source for data in table: Cave et al., 1994)

Stormwater also contributes directly to thermal pollution. As stormwater runs over the land, it can be warmed by the land surface and may cause increases in water temperatures when it is deposited into a stream or other body of water. Spikes of warm temperatures in streams can be fatal to fish and other aquatic life (see earlier section on Thermal Pollution).

Any reductions to stormwater flow, as well as better management of stormwater, will decrease the amount of sediment, nutrients, thermal pollution, toxins, and pathogens that enter area waterbodies.

Stormwater can increase stream velocities and carry pollutants (like sediment) downstream.

Lack of Riparian Buffer

Riparian buffers are widely considered one of the best ways to control and reduce the amount of non-point source pollution entering a water body. Also called vegetated stream buffers, filter

strips, or greenbelts, these buffers consist of strips of trees, shrubs, and other vegetation lining a stream corridor or lakefront. These linear strips of vegetation serve as a stream or lakes last line of defense against human activities such as lawns, septic systems, erosion and development.

Riparian buffers help to reduce the impact of almost all of the pollutants that currently threaten the Lake Leelanau watershed: sediment, nutrients, toxins, thermal pollution, pathogens, changes to hydrology, and loss of habitat.

There was a shoreline study conducted of Lake Leelanau in 1998 (LLLA, CRA). The results showed about 20% of the shoreline on both NLL and SLL to be protected with stone, with only 22% protected by lawn or sand in SLL and 40% in NLL. The results also indicate the greenbelt around the lake is mostly made up of trees and shrubs (45% for NLL and 49% for SLL) as well as lawn (36% NLL and 43% in SLL). It is recommended to have an updated stream bank erosion and shoreline erosion study conducted within the next five years.

Benefits of Riparian Buffers:

Stabilization of Streambanks – The deep rooted vegetation binds the soil along stream and lake banks, which prevents bank erosion during periods of high runoff or strong winds on Lake Leelanau.

Improved Water Quality – Trees, shrubs, and deep rooted grasses along the waterfront remove sediment, nutrients, pesticides, pathogens, and other potential pollutants before they enter surface water. Fertilizers and other pollutants that originate on the land are taken up by tree roots and stored in leaves, limbs and roots of the vegetation instead of reaching the water. Studies have shown dramatic reductions of 30% to 98% in nutrients (nitrogen and phosphorus), sediment, pesticides, and other pollutants in surface and groundwater after passing through a riparian forest buffer (Chesapeake Bay Program 1997).

Reduced Flooding and Sedimentation – Trees and shrubs help to retain runoff longer, improve infiltration, and filter out sediment that might otherwise be delivered to the water during floods.

Reduction of Thermal Pollution (Stream Warming) – The canopy provided by the leaves of the vegetation provide shading to the stream, which moderates water temperatures and protects against rapid fluctuations that can harm stream health and reduce fish spawning and survival. Cool stream temperatures maintained by riparian vegetation are essential to the health of aquatic species. Elevated temperatures also accelerate algae growth and reduce the amount of dissolved oxygen the water can hold, further degrading water quality. In a small stream, temperatures may rise 1.5 degrees in just 100 feet of exposure without a leaf canopy. The leaf canopy also improves air quality by filtering dust from wind erosion and construction.

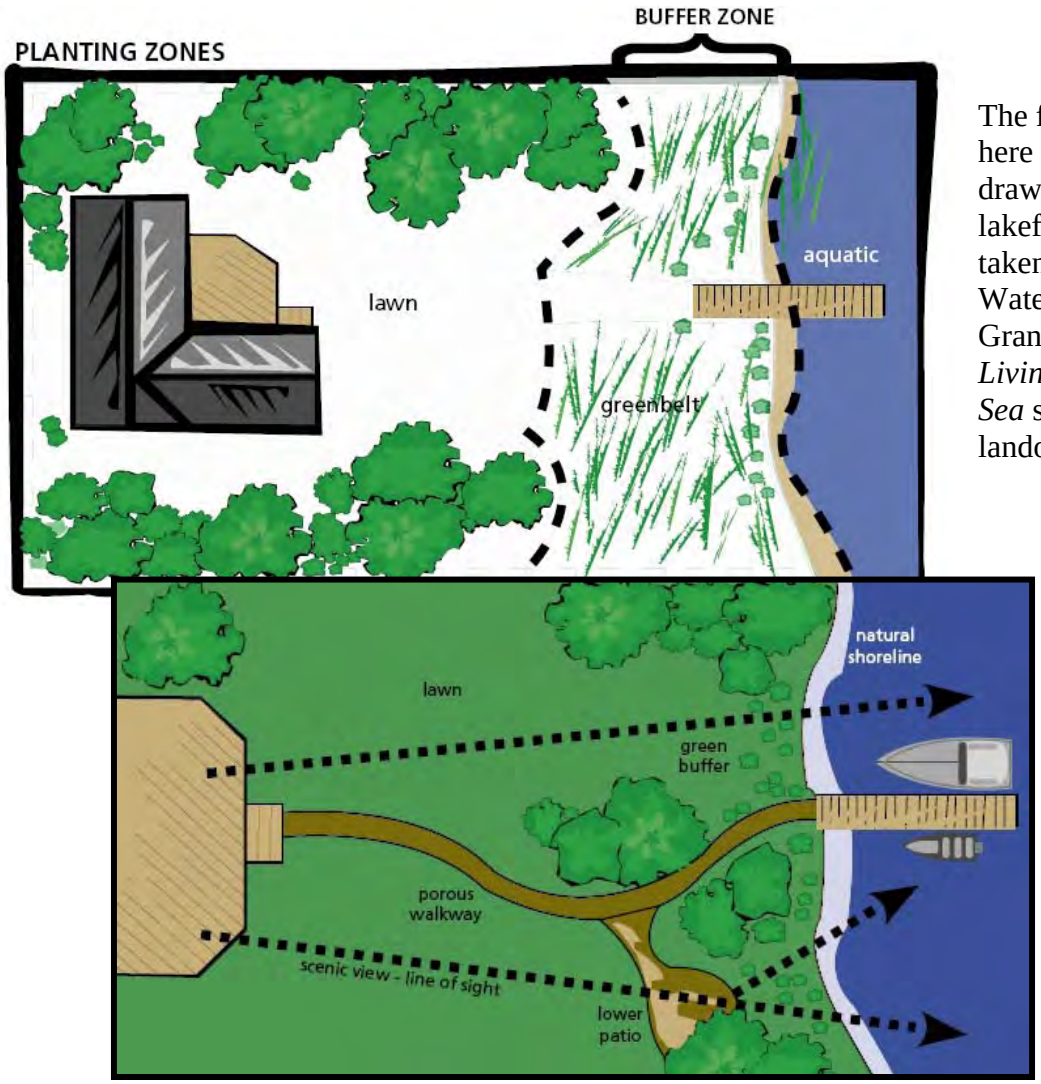
Enhanced Wildlife Habitat – The trees and shrubs contained in a riparian buffer supply a tremendous diversity of habitat and travel corridors for many wildlife species in both the aquatic and upland areas. Travel corridors are particularly important where habitat is limited. In addition, woody debris (fallen trees and limbs) in the stream and along the lakeshore provides both habitat and cover for fish and other macroinvertebrate species. Leaves that fall into a stream are trapped on woody debris and rocks where they provide food and habitat for small

bottom-dwelling creatures (i.e. crustaceans, amphibians, insects and small fish), which are critical to the aquatic food chain.

Improved Scenery (Desired Uses) – Strips of trees and shrubs along waterfront add diversity and beauty to the landscape.

Riparian buffers vary in character, effectiveness, and size based on the environmental setting, proposed management, level of protection desired and landowner objectives. To protect water quality, a buffer at least 55 – 100 feet wide should be preserved or created around all bodies of water and wetlands, with strip widths increasing with increasing slope. Research shows that when the buffer is less than 100 feet, stream quality can begin to diminish (DEQ 2001).

Streamside and lakeshore areas lacking a riparian buffer have a reduced filtering capacity and do not effectively filter out watershed pollutants. While the lack of a riparian buffer along a stream or lakefront does not *add* any pollutants to the watershed and is technically not a *source* of pollution, the lack of a buffer significantly increases the possibility of pollutants reaching a body of water. The actual sources of the pollution are coming from another place and the buffer only reduces their effects on the watershed. For the purposes of this management plan, the lack of a riparian buffer (and streamside canopy) is referred to as a source of pollution and environmental stress in the watershed, with the general understanding that increases in the amounts of riparian buffers will decrease the amount of various pollutants entering the watershed.



The figures shown here are conceptual drawings of a lakefront buffer zone taken from The Watershed Center Grand Traverse Bay's *Living on an Inland Sea* shoreline landowner's guide.

Most riparian buffers are composed of three zones, the width of each determined by site conditions and landowner objectives. This three-zone concept provides a conceptual framework in which water quality, habitat, and landowner objectives can be accomplished. The picture and accompanying text below describes the components of each zone.

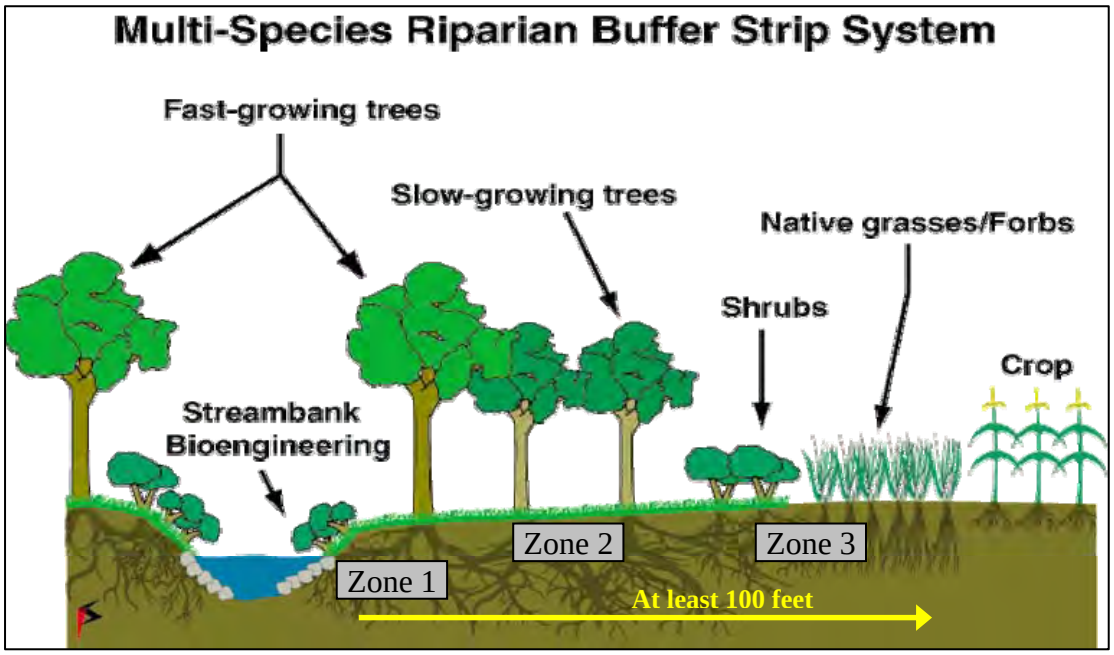


Illustration courtesy of the ISU Forestry Extension Website

Zone Description from the DEQ's Guidebook of Best Management Practices for Michigan Watersheds & the USDA – NRCS website (www.mi.nrcs.usda.gov):

Zone 1 – The Streamside Zone: This zone is usually made up of mature trees and shrubs that provide shade, leaf litter, and woody debris to the stream, as well as erosion protections. The minimum width of this zone is 15 – 25 feet. Land uses in this zone should be limited to footpaths and well-designed watercourse crossings (for utilities, roads, etc.). The mature forest along the edge of the water maintains habitat, food, and water temperature and helps to stabilize streambanks, reduce flood impact, and remove nutrients.

Zone 2 – The Middle Zone: This zone extends from the outer edge of the streamside zone and protects the stream's ecosystem by providing a larger protective area between the stream and upland development. Ideally, this zone will also be composed of mature trees and shrubs and will be between 20 – 50 feet, with widths increasing to ensure the 100-year floodplain. A primary function of Zone 2 is to filter runoff by removing sediment, nutrients and other pollutants from surface and groundwater.

Zone 3 – The Outer Zone: The outer zone extends from Zone 2 to the nearest permanent structure and is composed of grass and other herbaceous cover. This is the main filtering part of

the riparian buffer strip. The vegetation included in this zone is useful in spreading and filtering runoff that may be transporting sediment, nutrients, or pesticides.

Master Plans and Zoning Ordinances

How communities manage their land use has a direct impact on the community's water resources. Zoning, master plans, and special regulations are a few of the more commonly used land management tools. Zoning ordinances, if enforced, establish the pattern of development, protect the environment and public health, and determine the character of communities. In 2006, PA 110, The Michigan Zoning Enabling Act was signed into law. This act codified the laws regarding local units of government regulating the development and use of land. It also provides for the adoption of zoning ordinances; to provide for the establishment in counties, townships, cities, and villages of zoning districts; prescribes the powers and duties of certain officials; to provide for the assessment and collection of fees; authorizes the issuance of bonds and notes; and prescribes penalties and provide remedies. In 2008, PA 33, titled Michigan Planning and Enabling Act, was signed into law. This law consolidated previous planning acts under one statute, creating a standard structure for all local planning commissions and one set of requirements that will apply to the preparation of all master plans. Since protecting water quality requires looking at what happens on land, zoning is an important watershed management tool.

Planners should recognize that stream quality is directly impacted by adjacent land use with the amount of impervious surfaces being particularly paramount. Land use planning techniques should be applied that preserve sensitive areas, redirect development to those areas that can support it, maintain or reduce impervious surface cover, (such as roads, driveways and parking lots) and reduce or eliminate nonpoint sources of pollution.

Zoning's effectiveness depends on many factors, such as the restrictions in the language, the enforcement, and public support. Many people assume existing laws protect sensitive areas, only to find otherwise when development is proposed. Zoning can be used very effectively for managing land uses in a way that is compatible with watershed management goals. A wide variety of zoning and planning techniques can be used to manage land use and impervious cover in the watershed. Some of these techniques include: watershed based zoning, overlay zoning, impervious overlay zoning, floating zones, incentive zoning, performance zoning, urban growth boundaries, large lot zoning, infill/community redevelopment, transfer of development rights (TDRs), and limiting infrastructure extensions. Some benefits of zoning include: increased local control/autonomy over land use decision-making; communicating clear expectations with developers based on community needs; and, an opportunity for the residents of the area to design the type of community they want to live in - one that respects their unique cultural, historic, and natural resource values.

Local officials face hard choices when deciding which land use planning techniques are the most appropriate to modify current zoning. Table 22, adapted from the Center for Watershed Protection's Rapid Watershed Planning Handbook, provides further details on land use planning techniques and their utility for watershed protection (CWP 1998). While most of these techniques are for watersheds much bigger than the Lake Leelanau watershed, it still presents a good picture of available land use planning techniques. In addition, the DEQ has published a book titled *Filling the Gaps: Environmental Protection Options for Local Governments* that

equips local officials with important information to consider when making local land use plans, adopting new environmentally focused regulations, or reviewing proposed development (Ardizone, Wyckoff, and MCMP 2003). An overview of Federal, State, and local roles in environmental protection is provided, as well as information regarding current environmental laws and regulations including wetlands, soil erosion, inland lakes and streams, natural rivers, floodplains, and more. The book also outlines regulatory options for better natural resources and environmental protection at the local level. A copy of this guidebook is available via the DEQ website: www.michigan.gov/deq → Water → Surface Water → Nonpoint Source Pollution (look under Information/Education heading).

Local governance can be a complicated issue. Generally, local governments may enact zoning laws that are more stringent than the next highest ranking form of government, but not less. In any case, all applicable State laws must be followed. All townships located in the Lake Leelanau watershed have both a Master Plan and Zoning Ordinances, while Leelanau County does not have a county-wide zoning ordinance (Table 23). Assisting local governments in updating and enacting strong zoning ordinances to protect water quality and secure natural areas is extremely important in the Lake Leelanau watershed and is a high priority for implementation efforts (Sections 7.3 and 8.1). While the State of Michigan has laws to protect clean water, much more can be done at the local level because townships know their land resources better than the State does.

While not necessarily a direct source of pollution, local governments' master plans and zoning ordinances have great potential to affect water quality. Zoning ordinances primarily affect land development in a region and are related to site design and access. They are used to regulate permitted uses of the land, for example, setting minimum/maximum lot sizes and setback requirements (from neighbors, roads, water bodies). Overall, zoning ordinances are enacted to protect the use of a property and ensure the public's safety, health, and welfare. As stated in Section 3.3, how communities manage their land use has a direct impact on the community's water resources. Since protecting water quality requires looking at what happens on land, zoning can be an extremely important watershed management tool.

Examples of ways to utilize zoning to protect water quality include requiring vegetative buffer zones along bodies of water (see earlier section on Lack of Riparian Buffer), requiring greenbelt areas, protecting the integrity of soil by having filtered views along stream corridors (protects banks from erosion), or protecting wetlands. Both Garfield and East Bay Townships located in nearby Grand Traverse County have recently passed ordinances requiring riparian buffers along their waterways.

Table 22: Land Use Planning Techniques

Land Use Planning Technique	Description	Utility as a Watershed Protection Tool
Watershed-Based Zoning	Watershed and subwatershed boundaries are the foundation for land use planning.	Can be used to protect receiving water quality on the subwatershed scale by locating development out of particular subwatersheds.
Overlay Zoning	Superimposes additional regulations for specific development criteria within specific mapped districts.	Can require development restrictions or allow alternative site design techniques in specific areas.
Impervious Overlay Zoning	Specific overlay zoning that limits total impervious cover within mapped districts.	Can be used to protect receiving water quality at both the subwatershed and site level.
Floating Zones	Applies a special zoning district without identifying the exact location until land owner specifically requests the zone.	May be used to obtain proffers or other watershed protective measures that accompany specific land uses within the district.
Incentive Zoning	Applies bonuses or incentives to encourage creation of amenities or environmental protection.	Can be used to encourage development within a particular subwatershed or to obtain open space in exchange for a density bonus at the site level.
Performance Zoning	Specifies a performance requirement that accompanies a zoning district.	Can be used to require additional levels of performance within a subwatershed or at the site level.
Urban Growth Boundaries	Establishes a dividing line that defines where a growth limit is to occur and where agricultural or rural land is to be preserved.	Can be used in conjunction with natural watershed or subwatershed boundaries to protect specific water bodies.
Large Lot Zoning	Zones land at very low densities.	May be used to decrease impervious cover at the site or subwatershed level, but may have an adverse impact on regional or watershed imperviousness.
Infill/ Community Redevelopment	Encourage new development and redevelopment within existing developed areas.	May be used in conjunction with watershed based zoning or other zoning tools to restrict development in sensitive areas and foster development in areas with existing infrastructure.
Transfer of Development Rights (TDRs)	Transfers potential development from a designated "sending area" to a designated "receiving area".	May be used in conjunction with watershed based zoning to restrict development in sensitive areas and encourage development in areas capable of accommodating increased densities.
Limiting Infrastructure Extensions	A conscious decision is made to limit or deny extending infrastructure (such as public sewer, water, or roads) to designated areas to avoid increased development in these areas.	May be used as a temporary method to control growth in a targeted watershed or subwatershed. Usually delays development until the economic or political climate changes.

Table adapted from Center for Watershed Protection's Rapid Watershed Planning Handbook – page 2.4-5 (CWP 2001)

Table 23: Master Plan and Zoning Ordinance Status Summary for Local Governments in Watershed

Township	Master Plan	Zoning
Bingham	Y (2005)	Y (revisions thru 2005)
Centerville	Y (2005)	Y, 2007
Cleveland	Y (2009)	Y (1997, amendments thru 2007)
Elmwood	Y (1998)	Y (updating in 2006)
Kasson	Y (2004)	Y, 1997, updates 2006-09?
Leelanau	Y (2010) in process of updating	Y, 5/2009
Leland	Y (7/2008)	Y, 1996 & updates to 5/09
Solon	Y, (2010)	Y, 1971 with updates
Sutton's Bay	Y (2010) in process of updating	Y, 1994 with amendments to 2007
Leelanau County	Y, with updates in 2000 and 2005	N (Rely on individual Townships)

During the process of updating the LLWPP a review and summary of master plans and zoning ordinances was conducted (Tables 24 and 25). For the most part, community master plans usually have good intentions when it comes to protecting natural resources. The natural resources of this area are why most people choose to live in the Lake Leelanau region. In general however, townships and communities often lack the knowledge on how to draft and enact effective, yet enforceable, zoning requirements. The validity of a zoning ordinance, particularly those that are more restrictive is often challenged by developers, among others. Local governments may have trouble obtaining information to back up their ordinances that will stand up in court. Additionally, it is often an argument of property rights vs. the public good, with local governments trying to show and prove that a certain ordinance is important to protect water quality.

Soil Erosion and Stormwater Ordinances

It is important to note that, in addition to zoning ordinance, counties may have separate soil erosion and/or stormwater ordinances. These ordinances come under different state enabling acts than local zoning ordinances. So, even if a township or municipality in the County does not have zoning, they still have to follow the State's soil erosion regulations enforced by Leelanau County. Stormwater ordinances can be extremely valuable tools in protecting water quality. It is also important to note that there are existing State and Federal statutes regarding soil erosion and stormwater runoff that must be followed as well.

TABLE 24: LAKE LEELANAU WATERSHED 2010 MASTER PLAN ASSESSMENTS

	MASTER PLAN ASSESSMENT								
UNIT OF GOVERNMENT	*PLAN REVIEWED ("NA" INDICATES NO PLAN AND "NP" INDICATES PLAN NOT PROVIDED BY PROJECT DEADLINE)*	*MASTER PLAN GOALS/ NARRATIVE ADDRESS:*							
		MAINTAINING/ PROMOTING COMMUNITY CHARACTER	LAND USE LIMITATIONS BASED ON ENVIRON-MENTAL CONSTRAINTS	PROTECTING SHORELINE/ LAKE LEELANAU	PROTECTING WETLANDS	PRESERVING AND PROTECTING STREAMS/ SURFACE WATER/ GROUNDWATER	SOIL EROSION/ STORMWATER MEASURES	PROTECTING DUNES/ HILLS/ SLOPES	PROTECTING FORESTS/ AGRICULTURE/ OPEN SPACE
LEELANAU COUNTY	X	X	X	X	X	X	X	X	X
BINGHAM TOWNSHIP	X	X	X	X	X	X	X	X	X
CENTERVILLE TOWNSHIP	X	X		X		X		X (Soils)	X
CLEVELAND TOWNSHIP	X	X	X?	X	X	X	X	X	X
ELMWOOD TOWNSHIP	X	X	X		X	X	X	X	X
KASSON TOWNSHIP	X	X	X	NA		X	X		X
LEELANAU TOWNSHIP	X	X	X	X	X	X		X?	X
LELAND TOWNSHIP	X	X	X	X		X	X	X	X
SOLON TOWNSHIP	X	X		X	X				X
SUTTONS BAY TOWNSHIP	X	X	X	X	X	X	X	X	X

TABLE 24: LAKE LEELANAU WATERSHED 2010 MASTER PLAN ASSESSMENTS (CONT'D)

	MASTER PLAN ASSESSMENT								
UNIT OF GOVERNMENT	*PLAN REVIEWED ("NA" INDICATES NO PLAN AND "NP" INDICATES PLAN NOT PROVIDED BY PROJECT DEADLINE)*	*MASTER PLAN GOALS/ NARRATIVE ADDRESS:*							
		MAINTAINING/ PROMOTING COMMUNITY CHARACTER	LAND USE LIMITATIONS BASED ON ENVIRON-MENTAL CONSTRAINTS	PROTECTING SHORELINE/ LAKE LEELANAU	PROTECTING WETLANDS	PRESERVING AND PROTECTING STREAMS/ SURFACE WATER/ GROUNDWATER	SOIL EROSION/ STORMWATER MEASURES	PROTECTING DUNES/ HILLS/ SLOPES	PROTECTING FORESTS/ AGRICULTURE/ OPEN SPACE
VILLAGE OF SUTTONS BAY	X	X	X	X	X	X	X	X	X
Grand Traverse County	Did not have to review	X	X	X	X	X	X	X	X
Long Lake Township	X	X	X		X	X		X	X
Benzie County	X	X	X	X	X	X	X	X	X
ALMIRA TOWNSHIP	Plan being updated								

TABLE 25: LAKE LEELANAU WATERSHED 2010 ZONING ORDINANCE ASSESSMENTS

	ZONING ORDINANCE ASSESSMENT									
UNIT OF GOVERNMENT	*ORDINANCE REVIEWED* *("NA" INDICATES NO PLAN AND "NP" INDICATES PLAN NOT PROVIDED BY PROJECT DEADLINE)*	*ORDINANCE REGULATIONS INCLUDE:*								
		SPECIAL DISTRICTS FOR ENVIRON-MENTALLY SENSITIVE AREAS	SPECIAL APPROVAL OR PERMITS FOR ENVIRON-MENTALLY SENSITIVE AREAS OR USES	SPECIAL REQUIREMENTS FOR SHORELINE/ LAKE LEELANAU	SPECIAL REQUIREMENTS FOR WETLAND AREAS (SUCH AS FOR AREAS NOT REGULATED BY DEQ OR US ARMY CORP. OF ENGINEERS)	SPECIAL PROVISIONS TO PROTECT STREAMS/ SURFACE WATER/ GROUNDWATER	SOIL EROSION/ STORMWATER PROVISIONS	SEWER/ WATER PROVISIONS	OPEN SPACE REQUIREMENTS
LEELANAU COUNTY	No Zoning	---	---	---	---	---	---	---	---
BINGHAM TOWNSHIP	X			X		X	X	X?	X
CENTERVILLE TOWNSHIP	X			X?				X	X
CLEVELAND TOWNSHIP	X		X?			X			
ELMWOOD TOWNSHIP	X		X		X	X	X	X	
LEELANAU TOWNSHIP	X			X	X?	X	X		X
LELAND TOWNSHIP	X	X?	X	X	X	X	X	X?	X
SOLON TOWNSHIP	X	X	X	X	X	X	X		
SUTTONS BAY TOWNSHIP	X	X		X		X	X	X	X

TABLE 25: LAKE LEELANAU WATERSHED 2010 ZONING ORDINANCE ASSESSMENTS (CONT'D)

	ZONING ORDINANCE ASSESSMENT									
UNIT OF GOVERNMENT	*ORDINANCE REVIEWED* *("NA" INDICATES NO PLAN AND "NP" INDICATES PLAN NOT PROVIDED BY PROJECT DEADLINE)*	*ORDINANCE REGULATIONS INCLUDE:*								
		SPECIAL DISTRICTS FOR ENVIRON-MENTALLY SENSITIVE AREAS	SPECIAL APPROVAL OR PERMITS FOR ENVIRON-MENTALLY SENSITIVE AREAS OR USES	SPECIAL REQUIREMENTS FOR SHORELINE/ GRAND TRAVERSE BAY	SPECIAL REQUIREMENTS FOR WETLAND AREAS (SUCH AS FOR AREAS NOT REGULATED BY DEQ OR US ARMY CORP. OF ENGINEERS)	SPECIAL PROVISIONS TO PROTECT STREAMS/ SURFACE WATER/ GROUNDWATER	SOIL EROSION/ STORMWATER PROVISIONS	SEWER/ WATER PROVISIONS	OPEN SPACE REQUIREMENTS
VILLAGE OF SUTTONS BAY	X			X		X		X	X
Grand Traverse County	Did not have to review	X	X	X	X	X	X	X	X
Long Lake Township	X	X	X		X	X		X	X
Benzie County	Did not have to review								
ALMIRA TOWNSHIP	Plan being updated								

5.6 Understanding Conservation Easements

Land trusts are organizations that help to permanently protect land for the benefit of the public. There are more than 1,600 land trusts in the United States. These community-based institutions have protected more than 37 million acres of land. Land trusts may protect land through donation and purchase, by working with landowners who wish to donate or sell conservation easements (permanent deed restrictions that prevent harmful land uses), or by acquiring land outright to maintain working farms, forests, wilderness, or for other conservation reasons (LTA 2009).

The Leelanau Conservancy is a small non-profit accredited land trust serving Leelanau County. ***Our mission is to conserve the land, water and scenic character of Leelanau County.*** The Conservancy believes in working together with like-minded individuals and families to find conservation solutions. The Conservancy operates with the philosophy that a good conservation transaction must be good for both the land and the people involved. The Conservancy works with private landowners, farmers, communities, businesses and all levels of government to preserve Leelanau's environmentally sensitive areas in an economically sustainable fashion.

Since their formation in 1988, the Conservancy has preserved 7279 acres and 27 miles of shoreline/stream and river frontage. They've launched a farmland preservation program, established a renowned water-quality monitoring program and created 20 Natural Areas and Preserves. Some of the best views, most sensitive wetlands, and biggest working farms have been forever protected because of the Leelanau Conservancy. With nearly 2,800 members backing us up, the Conservancy is making a very real difference in what Leelanau County is to become. In the Lake Leelanau watershed, the Conservancy has protected approximately 3,711 acres through land conservation practices (2,909 acres of natural land/open space and 802 acres of farmland).

A conservation easement is a legal agreement between a landowner and a land trust that permanently limits a property's uses in order to protect its conservation values. These agreements are not a new concept in property law, as similar agreements have been in force in parts of the United States since the late 1800's. However, conservation easements were a rarity in Michigan before 1990. They are not a rarity any longer, and the Leelanau Conservancy has established over 130 conservation easements since its founding in 1988.

<u>How Conservation Easements Work</u>

When a person owns land, they also "own" many rights associated with it. These property rights include the right to harvest timber, build structures, grow crops, and so on (subject to zoning or other land use restrictions). When they grant a conservation easement to a land conservancy, they permanently restrict or eliminate some of those rights and retain others. For example, a landowner may restrict the ability to develop more than 1 home site in the future, but retain the right to manage the forest for sustainable timber harvest according to an approved forest management plan and maintain trails and two-track roads. Importantly, all future owners are bound by the conservation easement's terms since they are attached to the deed of the property.

Conservation easements can be used to protect a wide variety of land including farms, forests, wildlife habitat, and properties with scenic views. They are drafted in a detailed legal format that

spells out the rights and restrictions on the owner's uses of the property as well as the rights and responsibilities of the land conservancy.

The Leelanau Conservancy works with each interested landowner to determine if their land qualifies for permanent protection and helps them determine the most appropriate conservation easement terms to protect the land's conservation values. Thus, each conservation easement is a unique and personalized document. Generally, limitations are made on the number and location of structures and types of land use activities that can take place. A conservation easement can serve as a flexible tool in a family's financial planning as well. Conservation easements may cover all or just a portion of the entire property and they often allow some future construction within an approved area, if that is compatible with the easement's conservation objectives.

Key Advantages of Conservation Easements

- Leave the property in private ownership, and owners may continue to live on it, sell it, lease it or pass it on to heirs
- They are flexible and can be written to meet the particular needs of the landowner while protecting the property's conservation values
- They are permanent, remaining in force when the land changes hands
- Can provide significant income, property, and estate tax benefits – often making the difference between a family being able to retain land or being forced to divide and sell because of high property and/or estate taxes

Conservation Easement Donations

Conservation easements customarily are donated by landowners who are motivated to protect land for its intrinsic value, and sometimes because they want future generations to enjoy the land and its wildlife as the donor has. Once a landowner has indicated an interest in conveying a conservation easement to the Leelanau Conservancy, a number of steps are required to complete the transaction (i.e. property tour to determine if a conservation easement is appropriate, consultation with legal and tax counsel, negotiation of restrictions to easement, draft documentation and finalize). In addition to recently expanded Federal Income tax incentives for conservation easement donations, the passage of PA 446 late in 2006 gives Michigan property owners the ability to prevent property taxes from skyrocketing when land is passed down in the family by donating a conservation easement over qualifying land before it transfers.

Purchase of Conservation Easements:

Watershed protection with permanent conservation easements is a land protection option with great community benefits. Priority protection parcels can qualify for the purchase of a conservation easement when funds are available. In the recent past, the Leelanau Conservancy has had great success utilizing grant funds (awarded by the MDEQ) in combination with private donations to purchase conservation easements over important watershed parcels. Conservation easements most often are purchased for less than full market value – producing what is known as a bargain sale to a charity. For tax purposes a bargain sale is treated as a "part sale/ part donation." When a conservation easement is purchased at less than full market value it can combine the income producing benefit of a sale with the tax-reducing benefit of a donation. The difference between the conservation easement's values as established by an appraisal and its sale price is considered a charitable donation and can be claimed as a Federal income tax deduction as well. The charitable donation component of a bargain sales of a conservation easement is treated exactly the same as an outright gift under federal income tax rules. Additionally, land

restricted by a conservation easement, whether the easement was donated or purchased, is not subject to the "pop-up tax" when it is sold or transferred.

More information on establishing conservation easements with the Leelanau Conservancy and the benefits associated with them can be found on their website at: www.theconservancy.com or by calling 231-256-9665. Ask to speak with a Land Protection Specialist.

CHAPTER 6 WATERSHED GOALS AND OBJECTIVES

The Lake Leelanau watershed is a uniquely beautiful, high water quality area that residents and visitor's alike treasure and it should be protected and maintained as such. The overall mission for the Lake Leelanau Watershed Protection Plan is to provide guidance for the implementation of actions that will reduce the potential negative impact that pollutants and environmental stressors could have on the designated watershed uses. The envisioned endpoint is to have Lake Leelanau and its watershed continue to support appropriate designated and desired uses while maintaining its distinctive environmental characteristics and aquatic biological communities.

Using stated goals from the first edition of the Lake Leelanau Watershed Management Plan, suggestions obtained from Steering Committee meetings, and examples from other watershed management plans, the project steering committee developed six broad goals for the Lake Leelanau watershed (Table 26). Working to attain these goals will ensure that the threatened designated uses described in Chapter 4 are maintained or improved.

Watershed Goals:

1. Protect aquatic and terrestrial ecosystems.
2. Protect and improve the quality of water resources.
3. Establish and promote management practices that conserve and protect the natural resources of the watershed.
4. Preserve the quality of recreational opportunities.
5. Establish and promote educational programs that support stewardship and watershed planning goals, activities, and programs.
6. Preserve the distinctive character and aesthetic qualities of the watershed, including viewsheds and scenic hillsides.

Table 26: Lake Leelanau Watershed Goals

Goal	Designated or Desired Use Addressed	Pollutant/Environmental Stressor Addressed
1. Protect aquatic and terrestrial ecosystems.	Warm/Coldwater Fishery Other Aquatic Life Desired Use: *Ecosystem Preservation*	Invasive Species Loss of Habitat Nutrients Sediment Thermal Pollution
2. Protect and improve the quality of water resources.	Warm/Coldwater Fishery Other Aquatic Life Total Body Contact Desired Use: *Human Health*	Nutrients Pathogens Sediment Thermal Pollution Toxins
3. Establish and promote management practices that conserve and protect the natural resources of the watershed.	Warm/Coldwater Fishery Other Aquatic Life Navigation Desired Use: *Aesthetics and Ecosystem Preservation*	All
4. Preserve the quality of recreational opportunities.	Warm/Coldwater Fishery Total Body Contact Navigation Desired Use: *Recreation*	All
5. Establish and promote educational programs that support stewardship and watershed planning goals, activities, and programs.	All	All
6. Preserve the distinctive character and aesthetic qualities of the watershed, including viewsheds and scenic hillsides.	Desired Use: *Aesthetics*	Invasive Species Loss of Habitat Nutrients Sediment

Goal #1
Protect aquatic and terrestrial ecosystems.

Designated Uses: Warm/Coldwater Fishery, Other Aquatic Life
Desired Uses: Ecosystem Preservation
Pollutants or Stressors Addressed: Invasive Species, Loss of Habitat, Nutrients, Sediment, Thermal Pollution

Objective 1.1 Protect and restore critical habitat areas for aquatic insects and fish

Objective 1.2 Preserve the biodiversity of populations and communities of aquatic and terrestrial organisms.

Objective 1.3 Work to stop wetland and other types of lowland filling.

Objective 1.4 Establish wildlife corridors and protect their habitat in priority areas.

Objective 1.5 Protect shoreline habitats by minimizing shoreline alteration and development.

Objective 1.6 Prevent the spread of existing invasive species and the introduction of new ones.

Goal #2
Protect and improve the quality of water resources.

Designated Uses: Warm/Coldwater Fishery, Other Aquatic Life, Total Body Contact
Desired Use: Human Health
Pollutants or Stressors Addressed: Nutrients, Pathogens, Sediment, Thermal Pollution, Toxins

Objective 2.1 Prevent increases of levels of phosphorus and nitrogen in Lake Leelanau and its tributaries.

Objective 2.2 Control and/or minimize the input of pathogens and toxic compounds (herbicides, pesticides, heavy metals, etc.) into surface water and groundwater.

Objective 2.3 Control and reduce the amount of stormwater runoff entering surface waterbodies; control and reduce the amount of pollutants in stormwater as well.

Objective 2.4 Identify, map, and work to protect groundwater recharge areas for watershed.

Objective 2.5 Continue implementing appropriate swimmer's itch management program in Lake Leelanau.

Objective 2.6 Maintain and manage existing long term water quality testing program/procedures and system of data storage/retrieval.

Goal #3
Establish and promote management practices that conserve and protect the natural resources of the watershed.

Designated Uses: Warm/Coldwater Fishery, Other Aquatic Life, Navigation
Desired Uses: Aesthetics and Ecosystem Preservation
Pollutants or Stressors Addressed: All

Objective 3.1 Protect and restore priority areas as outlined in Protection Plan (see Figure 9).

Objective 3.2 Establish voluntary conservation easements to help prevent degradation of natural resources.

Objective 3.3 Work with landowners to protect critical habitat and wildlife corridors.

Objective 3.4 Assist townships in adopting and developing ordinances to protect water quality and natural resources (e.g., adequate setbacks for buildings, minimizing development clearings by landowners, establishing riparian buffers, and protecting wetlands). Ideally, all townships would adopt the same water quality ordinances in for uniformity throughout the watershed (perhaps utilizing overlay districts).

Objective 3.5 Improve stormwater management throughout the watershed by establishing management practices that reduce the amount of stormwater directly entering waterways.

Objective 3.6 When new or redevelopment of existing property takes place along shoreline and residential areas, encourage appropriate provisions during or before site plan review for water quality and natural resources in the approval process.

Goal #4
Preserve the quality of recreational opportunities.

Designated Uses: Warm/Coldwater Fishery, Total Body Contact, Navigation
Desired Use: Recreation
Pollutants or Stressors Addressed: All

Objective 4.1 Support desired recreational uses while maintaining distinctive environmental characteristics and aquatic biological communities throughout the watershed.

Objective 4.2 Maintain desirable sport fishing quality in Lake Leelanau and its tributaries.

Objective 4.3 Maintain and promote high water quality to ensure safe and clean areas for public swimming and other types of water recreation.

Objective 4.4 Preserve un-fragmented large tracts of wetland and forested habitat in identified

Objective 4.5 Ensure sufficient public access to beaches, lakes, and river for public use that does not jeopardize the integrity of the resource.

Goal #5
Establish and promote educational programs that support stewardship and watershed planning goals, activities, and programs.

Public I/E Campaign
Designated Uses: All
Desired Uses: All
Pollutants or Stressors Addressed: All

Objective 5.1 Implement Information and Education Strategy outlined in Chapter 7.4.

Objective 5.2 Develop a set of consistent messages that can be used by partners in a variety of communications.

Objective 5.3 Increase watershed community awareness and concern for water quality by educating watershed users and the general public about the value of the Lake Leelanau watershed to the community, their responsibility to be stewards of this community asset, and the role that an individual's day-to-day activities can play in protecting the resource.

Objective 5.4 Involve the citizens, public agencies, user groups and landowners in implementation of the watershed plan through meetings and workshops with individuals or groups.

Objective 5.5 Regularly inform stakeholders about the watershed, implementation activities and successes and opportunities to participate.

Objective 5.6 Motivate target audiences to adopt behaviors and implement practices that result in water quality improvements.

Objective 5.7 Integrate monitoring and research findings into IE strategy as they become available.

Objective 5.8 Evaluate effectiveness of outreach efforts.

Goal #6
Preserve the distinctive character and aesthetic qualities of the watershed, including viewsheds and scenic hillsides.

Desired Use: Aesthetics
Pollutants or Stressors Addressed: Invasive Species, Loss of Habitat, Nutrients, Sediment

Objective 6.1 Establish voluntary conservation easements to protect scenic hillsides, riparian corridors, and significant viewsheds.

Objective 6.2 Maintain open space, parks, riparian buffers, and natural areas to allow for aesthetic enjoyment and the high quality of life that brings people to the area.

Objective 6.3 Assist townships in developing and adopting ordinances to protect scenic, cultural and historical viewsheds and the designated Leelanau Scenic Heritage Route on M-22 and M-204.

Objective 6.4 Preserve sites of particular historical and/or cultural importance (e.g., the Narrows and Fishtown).

CHAPTER 7 IMPLEMENTATION TASKS

7.1 Summary of Implementation Tasks

In an effort to successfully accomplish the goals and objectives listed in Chapter 6, specific recommendations were developed based on the prioritization of watershed pollutants, sources, and causes while also looking at the priority and critical areas in the watershed (Tables 18 and 19, Figures 9 and 10). These implementation tasks are listed in Section 7.3 and represent an integrative approach, combining watershed goals and covering more than one pollutant at times, to reduce existing sources of priority pollutants and prevent future contributions. The project Steering Committee found it helpful to summarize the implementation tasks by categories. In this way, organizations may work on a specific issue they may be more involved with as an organization (i.e., land conservation or shoreline restoration). It is intended that these tasks be implemented in priority and critical areas in the watershed (Figures 9 and 10).

The categories and goal(s) they address are as follows:

Category	Goal(s) Addressed
1. Shoreline Protection and Restoration	1, 2, 3
2. Road Stream Crossings	1, 2
3. Agriculture	1, 2
4. Habitat, Fish and Wildlife	1, 2, 3, 6
5. Stormwater	1, 2, 3, 6
6. Wastewater and Septics	1, 2, 3
7. Human Health Issues	2
8. Wetlands	1, 2, 3
9. Invasive Species	1, 4
10. Land Protection and Management	1, 2, 3
11. Development	1, 2, 3
12. Zoning and Land Use	3
13. Groundwater and Hydrology	1, 2, 3
14. Monitoring and Research	All
15. Desired Uses	4, 6

For each action step, the organization(s) best suited to help implement the task along with estimated costs to implement each item has been identified where possible. A timeframe of 10 years was used to determine the scope of activities and the estimated costs for implementing the tasks. Tasks that should be done in the short term were given a timeframe of 1-3 years. Tasks that should be undertaken annually were given a timeframe of "ongoing." Funding for most short-term tasks will come from State and Federal grant sources (DEQ: CMI, CWA Sec. 319, MiCorps), private foundations, fundraising dollars from the Lake Leelanau Lake Association and Leelanau Conservancy, and volunteer time. Funding for long-term tasks will be discussed as implementation of the plan begins.

7.2 Best Management Practices

Best Management Practices (BMPs) are any structural, vegetative, or managerial practices used to protect and improve surface water and groundwater (DEQ 2001). It is important to note that 1) no BMP can be used at every site, and 2) no BMP can include so many specifications that all possible uses and all possible conditions are included. Each site must be evaluated independently, and specific BMPs can be selected which will perform under given site conditions. For BMPs to be effective, the correct method, installation, and maintenance need to be considered for each site. Addressing each of these factors will result in a practice that can successfully prevent or reduce pollution.

Structural BMPs are physical systems that are constructed for pollutant removal and/or reduction. This can include rip-rap along a stream bank, rock check dams along a steep roadway or biodetention basins, oil/grit separators, and porous asphalt for stormwater control.

Non-structural BMPs include managerial, educational, and vegetative practices designed to prevent or reduce pollutants from entering a watershed. These BMPs include riparian buffers and filter strips, but also include education, land use planning, natural resource protection, regulations, operation and maintenance, or any other initiative that does not involve designing and building a physical structure. Although most non-structural BMPs are difficult to measure quantitatively in terms of overall pollutant reduction and other parameters, research demonstrates that these BMPs have a large impact on changing policy, enforcing protection standards, improving operating procedures and changing public awareness and behaviors to improve water quality in a watershed over the long term. Moreover, they target source control which has been shown to be more cost effective than end-of-the-pipe solutions (like the old saying, "An ounce of prevention is worth a pound of cure"). Therefore, these BMPs should not be overlooked, and in some cases, should be the emphasis of a water quality management program.

It is important to note that installing a single BMP has the potential to reduce more than one type of pollutant. For example, installing a riparian buffer will reduce a number of different pollutants (sediment, nutrients, toxins, etc.), as well as reduce impacts from fertilizer use and stream bank erosion. Also, installing more than one BMP at a single site will increase the likelihood of pollutant reduction, but the effects will not be *cumulative*.

Table 25 lists potential systems of commonly used BMPs that deal with various types of pollutant sources, as well as where to find more information about each type of BMP. The table also notes if a potential load reduction estimate is available for a specific BMP. Some of this information was not available due to the timeframe and scope of this project. In addition, some of the research found was not relevant because it was either conducted in a vastly different region (i.e. southern United States) or done on a much smaller scale.

Table 27: BMP Examples by Source

Major Source or Cause	Affected Pollutant	Potential Actions to Address Pollution Source/Cause	Potential Load Reduction	Information Source
Bank/Shoreline Erosion	Sediment Habitat Loss	*Stream bank stabilization: bank slope reduction, riprap, tree revetments, vegetative plantings, bank terracing, etc.	Varies *(see milestones in Section 7.3)*	-Guidebook of BMPs for Michigan Watersheds -MI Low Impact Development Manual -Green Infrastructure Manual -Michigan Ag BMP Manual
Lack of Streamside Canopy and Riparian Buffer	Sediment Nutrients	*Improving riparian buffers: reshaping banks, planting vegetation, stop mowing, etc.	See Table 26	-Guidebook of BMPs for Michigan Watersheds -MI Low Impact Development Manual -Green Infrastructure Manual -Natural Resources Protection Strategy for Michigan Golf Courses
Stormwater and Impervious Surfaces	Sediment Nutrients Toxins Pathogens	*Numerous – See Table 28 *Develop stormwater management plans	See Table 26	-The Watershed Center's Stormwater Management Guidebook -Guidebook of BMPs for Michigan Watersheds -MI Low Impact Development Manual -Green Infrastructure Manual -Center for Watershed Protection – Stormcenter website
Road Crossings - eroding, failing, outdated	Sediment Nutrients	*Road Crossing BMPs (vary widely – See Road Stream Crossings in Section 7.3)	Varies *(see milestones in Section 7.3)*	-Guidebook of BMPs for Michigan Watersheds -MI Low Impact Development Manual -Green Infrastructure Manual
Residential/Commercial Fertilizer Use	Nutrients	*Enact local ordinances to limit fertilizers containing P *Education on proper use of fertilizers including: workshops, brochures, flyers, videos, etc.	Not available	-Public Information and Education Strategy (Section 7.4)
Reduction of Wetlands	Sediment Nutrients	*Restoration of wetlands – reshaping banks, planting vegetation, altering flow *Track/intervene in wetland permit cases as appropriate	See Table 26	-Guidebook of BMPs for Michigan Watersheds -Center for Watershed Protection

Table 27: BMP Examples by Source Cont'd

Major Source or Cause	Affected Pollutant	Potential Actions to Address Pollution Source/Cause	Potential Load Reduction	BMP Manual or Agency Contact*
Septic Systems (Leaking)	Nutrients Pathogens	*Conduct education on proper septic system maintenance including: workshops, brochures, flyers, videos, etc. *Septic system inspections *Ensure proper septic system design *Demo projects for alternative wastewater treatment systems	Varies/ Not available	-Leelanau/Benzie Health Department -Public Information and Education Strategy (Section 7.4)
Development and Construction	Sediment Habitat Loss	*Initiatives to promote open space and land preservation and protection *Encourage 'watershed friendly design' *Implement soil erosion control measures *Utilize proper construction BMPs like barriers, staging and scheduling, access roads, and grading)	Varies/ Not available	-Guidebook of BMPs for Michigan Watersheds -MI Low Impact Development Manual -Green Infrastructure Manual -Public Information and Education Strategy (Section 7.4)
Purposeful or Accidental Introduction of Invasive Species	Invasive Species	*Boat washing stations *Workshops, Brochures, Flyers, Videos, Etc. *Educational Programs	Not available	-Public Information and Education Strategy (Section 7.4)

* Green Infrastructure Manual: www.newdesignsforgrowth.com --> NDFG Programs
MI Low Impact Development Manual --> www.semcog.org/lowimpactdevelopmentreference.aspx
Natural Resources Protection Strategy for Michigan Golf Courses --> www.michigan.gov/documents/deq/ess-nps-golf-course-manual_209682_7.pdf

Pollutant Reduction Estimates for Stormwater BMPs

The Center for Watershed Protection (Ellicott City, MD) has compiled a considerable amount of information regarding the effectiveness of selected stormwater BMPs. The biggest stormwater problems in the Lake Leelanau watershed are runoff from residential lawns, driveways, rooftops, and roads, none of which go through a traditional stormwater conveyance system with a pipe outlet. The Village of Leland is the biggest source of 'end of pipe' stormwater issues as there some drainage pipes in downtown area. The village of Cedar also have a 12-16 inch stormwater outfall that discharges stormwater into the ground about five feed from the bank of the Cedar River. Table 26 lists the total percent removal of phosphorus, nitrogen, sediment (total suspended solids), and metals and bacteria for selected stormwater BMPs that could be used for stormwater pollution particular to this watershed.

Listing BMP effectiveness by percentage is a much more useful way of displaying the data rather than using specific values, which can be deceiving depending on the size of BMP implemented or installed. This is because specific values for pollutant removal depend on the size of BMP implemented (feet of riparian buffer installed or acres of stormwater detention ponds) and how much pollution was initially coming from the source.

It should be noted that it is assumed that the percent removal values in Table 26 are comparative numbers that state how much pollutant was removed **compared to no BMP implementation at the site**. For example, it is assumed that Porous Pavement values state the percentage of pollutant removed compared to if regular pavement were there instead; or that Riparian Buffer values state the percentage of pollutant removed compared to if no buffer was there and it was landscaped lawn instead. For more specific information on these stormwater BMPs, please see the Center for Watershed Protection's Stormwater Center website at www.stormwatercenter.net.

Additionally, keep in mind that not every BMP may be the best selection for every site. Some places are better suited for specific kinds of BMPs. There are other factors to consider besides pollutant removal efficiency when deciding which BMP to use at a site. Other factors include the size of site, money available for implementation, and the purpose of the land (i.e., what the site will be used for).

Table 28: Pollutant Removal Effectiveness of Selected Potential Stormwater BMPs

Management Practice	Total % Phosphorus Removal	Total % Nitrogen Removal	Total % Suspended Solids Removal	% Metal and Bacteria Removal	Other Considerations
Riparian Buffer*	Grass: 39-88 Forest: 23-42	Grass: 17-87 Forest: 85	Grass: 63-89 Forest: N/A	n/a	- Increase in property value - Public education necessary
Porous Pavement	65	82	95	Metals: 98%	$2-3/ft^2 (traditional, non-porous asphalt is $0.50-1.00/ft^2)
Infiltration Basin	60-70	55-60	75	Metals: 85-90 Bacteria: 90	$2/ft^3 of storage for a ¼-acre basin - Maintenance is essential for proper function
Infiltration Trench	100	42.3	n/a	n/a	$5/ft^3 (expensive compared to other options)
Bioretention (Rain Gardens, etc.)	29	49	81	Metals: 51-71 Bacteria: -58	$6.80/ft^3 of water treated - Landscaped area anyway - Low maintenance cost - Note possible export of bacteria
Grassed Filter Strip (150 ft)	40	20	84	n/a	- Cost of seed or sod
Sand and Organic Filter Strip	Sand: 59 +/-38 Organic: 61 +/-61	Sand: 38 +/-16 Organic: 41	Sand: 86 +/-23 Organic: 88 +/-18	Sand: Metals: 49-88 Bacteria: 37 +/-61 Organic: Metals: 53-85	Not much information, but typical costs ranged from $2.50 - $7.50/ft of treated stormwater
Grassed Channel/Swale	34 +/-33	31 +/-49	81 +/-14	Metals: 42-71 Bacteria: -25	$0.25/ft^2 + design costs - Poorer removal rates than wet and dry swales - Note the export of bacteria
Constructed Wetlands** **1) Shallow Marsh** **2) Extended Detention Wetland** **3) Pond/Wetland** **4) Submerged Gravel Wetland**	1) 43 +/-40 2) 39 3) 56 +/-35 4) 64	1) 26 +/-49 2) 56 3) 19 +/-29 4) 19	1) 83 +/-51 2) 69 3) 71 +/-35 4) 83	1) Metals: 36-85 Bacteria: 76 2) Metals: (-80)-63 3) Metals: 0-57 4) Metals: 21-83 Bacteria: 78	- Relatively inexpensive; $57,100 for a 1 acre-foot facility - Data for 1 and 2 based on fewer than five data points

*Pollutant removal efficiencies will increase as buffer width increases. Grasses in this case mean native grasses -not regular lawn or turf grass.

** Wetlands are among the most effective stormwater practices in terms of pollutant removal, and also offer aesthetic value. While natural wetlands can sometimes be used to treat stormwater runoff that has been properly pretreated, stormwater wetlands are designed specifically for the purpose of treating stormwater runoff, and typically have less biodiversity than natural wetlands. There are several design variations of the stormwater wetland, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland.

Values obtained from Center for Watershed Protection's Stormwater Center website (www.stormwatercenter.net) and Practice of Watershed Protection Manual (Schueler and Holland 2000).

It should be noted that information regarding the pollutant removal efficiency, costs, and designs of structural stormwater BMPs is constantly evolving and improving. As a result, information contained in Tables 25 and 26 is dynamic and subject to change.

Pollutant Reduction Calculations for Stream bank and Shoreline Erosion

Erosion from stream banks and shorelines can vary widely. In general, one can calculate the sediment and nutrients saved from entering a stream by eliminating the source of erosion using the MDEQ Pollutants Controlled Manual and the Channel Erosion Equation (DEQ 1999):

Sediment Reduced (T/yr) = Length (ft.) x Height (ft.) x LRR (ft./yr.) x Soil weight (ton/ft^3)

LRR: Lateral Recession Rate
Soil weight: Values obtained in MDEQ Pollutants Controlled Manual, Exhibit 1 (DEQ 1999)

Dry Density Soil Weights	
Soil Textural Class	**Dry Density (tons/ft^3)**
Sands, loamy sands	0.055
Sandy loam	0.0525
Fine sandy loam	0.05
Loam, sandy clay loams, sandy clay	0.045
Silt loam	0.0425
Silty clay loam, silty clay	0.04
Clay loam	0.0375
Clay	0.035
Organic	0.011

In turn, phosphorus and nitrogen attached to soil particles will be saved from entering the stream. The following calculations may be used to estimate the amount of phosphorus and nitrogen reduced by repairing an erosion source.

Phosphorus Reduced (lb/yr) =
Sediment reduced (T/yr) x 2000 lb/T x 0.0005 lb P/lb of soil x correction factor

Nitrogen Reduced (lb/yr) =
Sediment reduced (T/yr) x 2000 lb/T x 0.001 lb N/lb of soil x correction factor

Correction factor: Soil texture correction factors available in MDEQ Pollutants Controlled Manual, Exhibit 2(DEQ 1999)

Correction Factors for Soil Texture	
Soil Texture	**Correction Factor**
Clay	1.15
Silt	1.00
Sand	0.85
Peat	1.50

Pollutant Reduction Estimates for Land Conservation Practices

In order to maintain the high quality resources of the Lake Leelanau watershed, it is essential to address known sources of pollution while at the same time working towards the reduction of future sources of pollution and watershed disturbance. Protecting critical areas in the Lake Leelanau watershed through conservation easements or the purchase or donation of land are excellent strategies to meet this objective. The Leelanau Conservancy is a local land conservancy using these strategies to protect high quality land in the Lake Leelanau watershed, in addition to the rest of Leelanau County.

Land conservation BMPs are excellent ways to preserve water quality. When dealing with pollutant reduction from these specific types of BMPs we look at the amount of pollution prevented from entering the watershed by keeping the land in its natural state. The load reduction is essentially the difference between the loading from the current land use and the loading from future land use.

Conservation Easement Establishment Load Pollutant Reduction (lb/yr) =

$$L_{developed} - L_{existing}$$

L = Annual Load (lb)

To determine the annual load for each type of land use the following equation may be used:

Annual Load (lb) =

$$0.226 \times R \times C \times A$$

0.226 = Conversion Factor
R = Annual runoff (inches)
C = Pollutant Concentration (mg/L)
A = Area (acres)

Annual runoff (R) is calculated by:

Annual runoff (in) = $P \times P_j \times Rv$

P = annual rainfall (in)
P_j = fraction of annual rainfall events that produce runoff (usually 0.9)
*R_v = runoff coefficient (R_v = 0.05 + 0.9 * la [where la = Impervious surface fraction])*

In most cases the actual pollutant concentrations on portions of land are not known, in that case it is possible to use estimated/average pollutant loads for differing land uses from other sources like those listed in Table 29.

Table 29: Average Pollutant Loads by Land Use (Lbs/acre/yr)

Land Use	Total Suspended Solids	Total Nitrogen	Total Phosphorus
Commercial	1,040	18	1.2
Industrial	1,080	12	1.3
Institutional	790	6.5	0.8
Transportation	1,330	7.7	1.1
Multi-Family	1,050	8.6	1.1
Residential	154	3.1	0.4
Agriculture	153	2.4	0.18
Vacant	40	0.5	0.09
Open Space	20	0.2	0.13

Values obtained from EPA's Region 5 Pollutant Loading Model

Over the past 20 years the Leelanau Conservancy has worked to permanently protect 3,711 acres in the Lake Leelanau watershed through land conservation practices (2,909 acres of natural land/open space and 802 acres of farmland). Their goal over the next 10 years is to protect an additional 2,300 acres in the watershed (See Land Protection and Management Goals in Section 7.3). Using average pollutant loads for residential, open space, and agriculture land uses in Table 29 we can estimate that the Leelanau Conservancy has prevented 54 tons of sediment, 9,000 lbs N, and 962 lbs P from entering the Lake Leelanau watershed each year. If conservation goals are reached, an additional 154 tons sediment, 6,670 lbs N, 621 lb P will be stopped from entering the watershed (using open space as the before land use).

Over the past 20 years the Leelanau Conservancy has worked to permanently protect 3,711 acres in the Lake Leelanau watershed through land conservation practices (2,909 acres of natural land/open space and 802 acres of farmland). Using average pollutant loads for residential, open space, and agriculture land uses in Table 29 we can estimate that the Leelanau Conservancy has prevented 54 tons of sediment, 9,000 lbs N, and 962 lbs P from entering the Lake Leelanau watershed each year ($L_{2909\ \text{acres residential}} - L_{2909\ \text{acres open space}} + L_{802\ \text{acres residential}} - L_{802\ \text{acres farmland}}$).

Their goal over the next 10 years is to protect an additional 2,300 acres in the watershed (See Land Protection and Management Goals in Section 7.3). If conservation goals are reached, an additional 154 tons sediment, 6,670 lbs N, 621 lb P will be stopped from entering the watershed (assuming the developed land use is residential and the existing land use is open space: $L_{2300\ \text{acres residential}} - L_{2300\ \text{acres open space}}$).

IMPLEMENTATION TASKS

7.3 List of Implementation Tasks by Category

Categories:

1. Shoreline Protection and Restoration
2. Road Stream Crossings
3. Agriculture
4. Habitat, Fish and Wildlife
5. Stormwater
6. Wastewater and Septics
7. Human Health Issues
8. Wetlands
9. Invasive Species
10. Land Protection and Management
11. Development
12. Zoning and Land Use
13. Groundwater and Hydrology
14. Monitoring & Research
15. Desired Uses

Organization Acronyms:

BLHD – Benzie-Leelanau Health Department
CRA – Conservation Resource Alliance
CRGC -Cedar Rod & Gun Club
EPA – Environmental Protection Agency
GTBOCI - Grand Traverse Band of Ottawa and Chippewa Indians
GTCNC- Grand Traverse County Nature Center
ISEA – Inland Seas Education Association
LeeCty – Leelanau County
LC – Leelanau Conservancy
L-CD – Leelanau Conservation District
LCRC – Leelanau County Road Commission
LCW - Leelanau Clean Water
LCHR-Leelanau Scenic Heritage Route
LGOV – Local Governments
LLLA – Lake Leelanau Lake Association
LCPRC-Leelanau Co. Parks & Recreation Commission
MDNRE – Michigan Department of Natural Resources and Environment*
M-DOT – Michigan Department of Transportation
MSU-E – Michigan State University Extension
NRCS – USDA Natural Resources Conservation Service
NWMCOG – Northwest Michigan Council of Governments
NWMSBF-Northwest Michigan Sustainable Business Forum
OWTTF – Onsite Wastewater Treatment Task Force
USFWS - United States Fish & Wildlife Service

Others:

Leelanau County Chamber of Commerce
Local Realtors, Businesses
Solid waste management entities
Schools
Area Libraries
Boat/Marine Retailers
Garden Centers and Nurseries
Landscaping Companies
Architects and Engineers

In January, 2010, the Michigan Department of Environmental Quality (MDEQ) merged with the Michigan Department of Natural Resources (MDNR). They are now known as the Michigan Department of Natural Resources and Environment (DNRE). For the purposes of this report, most often they are still referred to separately.

Estimated Costs, Timeframes, and Milestones:
For costs associated with salaries, an average watershed technician rate of $35/hour was applied. For tasks to be completed by a specialized consultant, a rate of $50/hour was used. Tasks that will be done on a yearly or site by site basis are noted as such ($X/yr or $X/site). Appendix A lists average rates for costs associated with purchasing materials for and installing standard BMPs. Further details are noted where applicable. In general, funding for short-term tasks (1-5 years) will be attained through state and/or Federal grants, other non-profit grant programs, partner organizations' budgets, fundraising efforts, and private foundations. Funding for long-term tasks will be addressed as needed. Project milestones for specific tasks were established where feasible. They are meant to guide implementation priorities and measure progress.

The LLLA is a lead project partner in many tasks. The General Category G.1. specifies a part-time watershed coordinator be hired. The LLLA will need to obtain a grant to fund this position. All such tasks which will involve this individual are predicated on an initial and continuing grant for this position.

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 1 – SHORELINE PROTECTION **(Goals addressed: 1, 2, 3)**																
1.1	Summarize 1998 shoreline buffer study and identify priority areas where riparian vegetated stream and lakeshore buffers should be installed. Resurvey portions of lake as necessary and conduct new riparian survey for tributaries.	H 6	$6,000 (using interns)	• Lakeshore by 2011 • Tributaries by 2013	X	-	-	X							LLLA LC L-CD	1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 4.3, 6.2
1.2	Work with municipalities and other government organizations to install riparian buffers on publicly owned property in the watershed.	H 6	$5000/yr	• 1 site by 2016 • 2 more sites by 2019					X	-	-	-	-	X	CRA L-CD LGOV LLLA	1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 4.3, 6.2
1.3	Work with interested landowners to install riparian buffers in priority areas.	H 6	$5000/yr	• 10% by 2016 • 20% by 2018 • 30% by 2019					X	-	-	-	-	X	CRA L-CD LGOV LLLA	1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 4.3, 6.2
1.4	Research and develop incentive program that financially rewards the installation or presence of buffers along waterways in the watershed.	M 3	$5000	• Pilot program by 2014, full program if viable by 2015				X	-	X					LGOV LLLA	1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 4.3, 6.2
1.5	Conduct stream bank and shoreline **erosion/sedimentation** survey to determine sites where bank stabilization and restoration is needed. Compile list of priority areas.	H 2	$6000 (using interns)	• Complete by 2012	X	-	X								LLLA CRA GTBOCI L-CD	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 4.3, 6.2

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 1 – SHORELINE PROTECTION (CONT'D **(Goals addressed: 1, 2, 3)**																
1.6	Stabilize stream banks and lakeshore at priority sites and use biotechnical and soft stabilization methods where possible.	H 8	Lake ~$80/ft *Estimate: 1000ft = $8,000* Stream ~ $3,000/ea *Estimate: 3 sites = $9,000*	• 10% per year of needed area			X	-	-	-	-	-	-	X	LLLA L-CD CRA LGOV Riparian Landowners	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 4.3, 6.2
1.7	Install barriers, signage, or stairs where needed to manage human access to shorelines, especially at steep banks.	M 6	$3000/yr (Estimated 10 sites)	• 50% by Y3 • 100% by Y6					X	-	-	-	-	X	LLLA L-CD CRA LGOV Riparian Landowners	1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 4.1, 4.3, 4.7, 6.2
See also: Zoning & Land Use																
CATEGORY 2 – ROAD STREAM CROSSINGS **(Goals addressed: 1, 2)**																
2.1	Update road stream crossing inventory conducted in 2001 by GTBOCI, including an evaluation of the prioritized road stream crossings needing remediation. Obtain any new data regarding completed improvement projects.	H 1	$2,500 (using intern)	• Complete by 2012			X								LLLA GTBOCI CRA	1.1, 1.2, 2.1, 2.2, 2.3, 3.5, 4.3, 6.3

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 2 – ROAD STREAM CROSSINGS *(CONT'D)*																
2.2	Where priority road stream crossings have been identified, improve, repair, or replace outdated, failing, or eroding road stream crossings by implementing appropriate BMPs from the following: 1. Road Crossings Remove obstructions that restrict flow through the culvert; Replace undersized (too small or too short) culverts; Remove and replace perched or misaligned culverts to avoid erosion and provide for fish passage; Install bottomless culverts and bridges where possible; Replace culverts with a length that allows for ≥ 3:1 slope on embankments; Re-vegetate all disturbed or bare soils on embankments 2. Road Approaches Create diversion outlets and spillways to direct road runoff and stormwater away streams; Pave steep, sandy approaches where feasible; Dig or maintain ditches where needed and construct check dams if required 3. Road Maintenance Encourage Road Commissions to look at the long-term savings of crossing improvements over cumulative maintenance costs	M Ongoing	$161,000	• 2012: begin discussions w/ LCRC, seek funding sources • 2014: begin restoration work • Complete 1 sites/yr until finished *There are currently 18 severely ranked road stream crossing sites			X	-	-	-	-	-	-	X	LLLA L-CD GTBOCI LCRC MDOT	1.1, 1.2, 2.1, 2.2, 2.3, 3.5, 4.3, 6.3

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 3 – AGRICULTURE **Goals addressed: 1, 2**																
3.1	Develop Conservation Plans, Resource Management Plans, or Progressive Plans for all farms in the watershed that do not currently have one. Information should be included on: crop nutrient management, weed and pest management, grassed waterways, sod centers in orchard rows, conservation buffers, proper manure management, conservation tillage, fencing off stream access to livestock, installing watercourse crossings, planting cover crops, and crop rotation. In addition, Conservation Plans more than 3 years old should be reviewed & updated to keep them eligible for USDA cost-share programs.	M Ongoing	$4,000/yr (NRCS staff salary portion)	• One plan/yr	X	-	-	-	-	-	-	-	-	X	NRCS MSU-E L-CD	1.2, 1.4, 2.1, 2.2, 2.3, 2.4, 3.1, 3.3, 3.5, 4.4
3.2	Work with agricultural producers with an approved Conservation Plan to implement USDA-NRCS cost-share programs that provide cost incentives and/or rental payments to farmers who implement eligible conservation practices on their land. Examples of these types of programs include: Environmental Quality Incentives Program (EQIP), Conservation Security Program (CSP) and the Conservation Reserve Program (CRP).	M Ongoing	$7,000/year	• Implement 1 plan/yr	X	-	-	-	-	-	-	-	-	X	NRCS MSU-E L-CD	1.2, 1.4, 2.1, 2.2, 2.3, 2.4, 3.1, 3.3, 3.5, 4.4

CATEGORY 3 – AGRICULTURE CONT'D

Goals addressed: 1, 2

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
3.3	Fence livestock and other animals out of streams and wetlands and establish riparian buffers where needed in agricultural areas. Identify locations where livestock manure is entering watershed (i.e. cattle crossings) and work to remediate any existing problem.	M Ongoing, as necessary	$2.15/ft^2-$3.90/ft^2, depending on soil type, length of fence/buffer and type of crossing		X	-	-	-	-	-	-	-	-	X	NRCS MSU-E L-CD	1.1, 1.5, 2.1, 2.2, 4.3

CATEGORY 4 – HABITAT, FISH AND WILDLIFE

Goals addressed: 1, 2, 3, 6

4.1	Develop Veronica Valley Park into a resource to promote environmental education, sustainable, and annual kids fishing event and eventually a perpetual "kids" fishing resource.	H On going	*$200,000 for pavilion *$75,000: perpetual kids fishing place; habitat enhncmnt; interpretive trails; Ed field days; hunting days	• Pavilion 2010-11 • Kids fishing days 2010-2019	X	-	-	-	-	-	-	-	-	X	LLLA GTBOCI MDRNE CRGC GTCNC LCPRC	1.1, 1.2, 3.1, 4.1, 4.2, 4.7,5.1-5.4,
4.2	Conduct initial inventory of aquatic conditions and update every 5 years	M Once every 5 years	$10,000 ($5,000/ update)	• Initial by 2013 • Update 2018	X	-	-	-	-	-	-	-	-	X	LC LLLA CRA MDNRE L-CD	1.1, 1.2, 4.2, 4.3
4.3	Install lake & stream habitat improvements according to inventory in Task 1 (lunker structures, large woody debris, submerged fish structures, removing sediment)	M 6	$30,000	• Install 50% of improvements by 2016 • 75% by 2019	X	-	-	-	-	-	-	-	-	X	LLLA CRA MDNRE L-CD	1.1, 1.2, 4.2, 4.3

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 4 – HABITAT, FISH AND WILDLIFE CONT'D **Goals addressed: 1, 2, 3, 6**																
4.4	Implement Conservation Resource Alliance's Wild-Link program to identify, protect and enhance fish and wildlife habitat on private property within ecological corridors throughout the watershed.	H Ongoing	$25,000 - $50,000/ year	• Establish 1 project by 2014 • 3 by 2017 • 5 by 2019	X	-	-	-	-	-	-	-	-	X	CRA	1.2, 1.4, 3.1, 3.3, 4.4, 6.2
4.5	Educate public on the develop Veronica Valley Park as a resource for environmental education, sustainable, and annual kids fishing event and eventually a perpetual "kids" fishing resource.	H On going	Newsletter-Cost in General Category	2 newsletter articles per year Newsletter, LLLA website, Leelanau Enterprise	X	-	-	-	-	-	-	-	-	X	LLLA GTBOCI MDRNE CRGC GTCNC LCPRC	1.1, 1.2, 1.4, 4.1,4.2, 6.2
See also: Land Protection and Management																

Categories/Tasks		**Priority:** ***High (H), Med (M), Low (L)*** **Duration (yrs)**	**Estimated Cost**	**Milestone**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Potential Project Partners**	**Objective(s) Addressed**
CATEGORY 5 – STORMWATER **Goals Addressed: 1, 2, 3**																
5.1	Map and count number of culverts/storm drain outlets that drain to Lake Leelanau and Leland River.	M 1	$2,500	• Finish by 2012		X	X								LGOV L-CD LLLA LCRC NWMCOG	1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6, 4.2, 4.3
5.2	Work with local governments, area businesses, and property owners to install stormwater BMPs where appropriate. See Section 7.2 for stormwater BMP ideas and their pollutant removal effectiveness. BMPs may include: • Vegetative Filter Strips • Stormwater Filtering Systems • Infiltration Practices: Infiltration Trench/Basin, Porous Pavement • Other Low Impact Design (LID) Elements: Rain/Roof Gardens, Native Plantings, Riparian Buffers	M 9	$5,000/yr Salary cost $60,000 ($20,000/ BMP)	• 2012: Identify 3 highest problem drains <u>Installation:</u> • 2015 Have 1st drain improved • 2017 Have 2nd drain improved • 2019 Have 3rd drain improved		X	X	X	-	-	-	-	-	X	LGOV L-CD LLLA NWMCOG Local Businesses	1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6, 4.2, 4.3

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 6 – WASTEWATER & SEPTICS **Goals Addressed: 1, 2, 3**																
6.1	Develop plan for evaluating, prioritizing, and addressing potential pollution from septic systems.	H 2	$5,000	• Develop plan by 2012		X	X								LLLA BLHD LGOV NWMCOG	2.1, 2.2, 3.1, 3.4, 4.3
6.2	Complete shoreline cladophora survey to determine potential sites where there may be improperly working septic systems. Work with landowners to conduct dye testing to determine which septic systems are leaking, if any, in potential sited areas.	H 4	$10,000	• Complete by 2013	X	-	-	X							LLLA	2.1, 2.2, 3.1, 4.3
6.3	Work with local governments and BLHD to establish mandatory septic system inspections on property transfer.	M 4	$2,500/yr	• Create and adopt county ordinance by 2013	X	-	-	X							LLLA BLHD MDNRE OWTTF LCW	2.1, 2.2, 3.1, 3.4, 4.3
6.4	Work with BLHD officials who issue permits for new septic systems to ensure property owners implement proper septic system design for the site conditions and consider their proximity to Lake Leelanau and other tributaries prior to installation.	L Ongoing	$1,500/yr	• Establish an annual meeting with BLHD by 2010	X	-	-	-	-	-	-	-	-	X	BLHD OWTTF LLLA	2.1, 2.2, 3.1, 3.4, 4.3
6.5	Work with MDNRE and BLHD to address improper land application of septage from pumped septic tanks or holding tanks.	L Ongoing	$1,500/yr		X	-	-	-	-	-	-	-	-	X	BLHD OWTTF LLLA	2.1, 2.2, 3.1, 3.4, 4.3

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 7 – HUMAN HEALTH ISSUES **Goals addressed: 2**																
7.1	Monitor/track effectiveness of current Swimmers' Itch Merganser Relocation program. Tasks include: • Find & apply for grant funds • Apply & obtain USF&W depredation permit • Initiate merganser spotter program • Explore feasibility of USF&W involvement • Hire contractor for trapping • Track number of birds successfully removed *(Costs based on LLLA's 2009 expense trapping of mergansers. Last 5 years should reduce assuming birds decline in numbers.)*	H Ongoing	$100,000 Breakdown: $15 K/yr for 5 yrs $5K/yr for next 5 yrs		X	-	-	-	-	-	-	-	-	X	LLLA GTBOCI USFWS	2.5, 4.3, 2.5
7.2	Research primary/secondary host combination for swimmers' itch for South Lake Leelanau (high itch levels but no snails found). Tasks include: • Find & apply for grant funds • Find contractor or school to conduct research • Approve & approve study plan • Review study results & recommend next steps	H 5	$78,000 Yearly est. costs: Professor- $50/hr @ 100hr Technician- $35/hr @ 600hr	• 2012: Secure grant funds • 2013: Begin research		X	-	-	-	X					LLLA Universities, Colleges	2.5, 4.3
7.3	Investigate feasibility of swimmers' itch repellant remedies. Tasks include: Identify potential products • Explore funding grants from suppliers to conduct trials • Conduct trials	H 4	$28,000	• 2012 begin trials		X	-	-	X						LLLA Various consumer product companies	2.5, 4.3

Categories/Tasks	Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 7 – HUMAN HEALTH ISSUES CONT'D **Goals addressed: 2**															
7.4 Start an *E. coli* monitoring program at the following locations on Lake Leelanau. Ideally, monitoring will be weekly during swimming season at heavily used bathing beaches. 1. Nedows Beach 2. M-22 S. of Leland (aka Fudgie Beach) 3. John Suelzer's Memorial Park 4. Solon Twp Park 5. French Rd Beach 6. Centerville Twp Park 7. Bingham Twp Park	H Ongoing	$6,000/yr	• Funding for program in place by 2011 • Monitor annually		X	-	-	-	-	-	-	-	X	LLLA BLHD	2.2, 2.6, 4.3, 4.5, 6.2
7.5 Monitor other potential/suspected locations for *E. coli* pollution as necessary (i.e. Houdek Creek potential failing septic, cattle issues on unnamed creek at south end of South Lake Leelanau).	H Ongoing	$500/yr		X	-	-	-	-	-	-	-	-	X	LLLA BLHD	2.2, 2.6, 4.3, 4.5, 6.2
See also: Wastewater and Septics, Monitoring															
CATEGORY 8 – WETLANDS **Goals addressed: 1, 2, 3**															
8.1 Work with local governments, landowners, Leelanau Conservancy, and other organizations to restore wetlands and establish at least 1 demonstration site. Help enroll eligible landowners in the NRCS Wetland Reserve Program.	M 3	$25,000	• Establish Demo site by 2015				X	-	X					NRCS CRA L-CD LC	1.1, 1.2, 1.3, 2.31, 2.2, 2.3, 3.3, 3.4, 3.5, 4.4
8.2 Monitor enforcement of possible wetland filling violations and educate or intervene as appropriate.	L Ongoing	$25,000 ($2,500/yr)	• Annually	X	-	-	-	-	-	-	-	-	X	LLLA LGOV LC	1.1, 1.2, 1.3, 2.31, 2.2, 2.3, 3.3, 3.4, 3.5, 4.4
See also: Land Protection and Management; Development, Zoning and Land Use															

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 9 – INVASIVE SPECIES **Goals addressed: 1, 4**																
9.1	Monitor spread of aquatic and terrestrial invasive species in watershed- includes a shoreline survey for terrestrial invasive plants such as phragmites, and an aquatic plant and animal survey (every three years, rotating schedule).	H Ongoing	$2,000/yr (using interns for surveying)	• 2010, 2013, 2016, 2019: terrestrial exotics • 2011, 2014, 2017: aquatic plant survey • 2012, 2015, 2018: aquatic animals	X	-	-	-	-	-	-	-	-	X	LLLA LC L-CD LCHR	1.1, 1.2, 1.6, 3.1, 3.4, 4.2, 4.3, 1.6
9.2	Develop invasive species eradication program. Primary focus on prevention of introduction. Follow National Park Service or MSU-E strategies for terrestrial exotic plant eradication and partner with nearby lake associations if possible.	H 6	$15,000						X	-	-	-	-	X	LLLA LC MDNRE LGOV	1.1, 1.2, 1.6, 3.1, 3.4, 4.2, 4.3, 1.6
CATEGORY 10 – LAND PROTECTION AND MANAGEMENT **Goals addressed: 1, 2, 3**																
10.1	Establish permanent conservation easements with private landowners to protect identified Priority and Critical Areas.	H Ongoing	$1,500,000	• 10 CEs protecting an average of 50 acres each by 2012 • An additional 5 CE projects by 2015 • Complete by 2019 (2300 acres total)	X	-	-	-	-	-	-	-	-	X	LC DNRE LGOV	1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.3, 4.3, 4.4, 6.1, 6.4
10.2	Work with landowners to assure forest management practices are in compliance with current BMPs, as outlined in "Water Quality Management Practices on Forest Land," (1994) MDNR	H Ongoing	$15,000	• Introduce forestry BMPs to 5 landowners by 2014 • Work with 10 total by 2019	X	-	-	-	-	-	-	-	-	X	CRA L-CD LC	1.2, 2.1, 2.2, 2.3, 3.1, 4.3
See also: Habitat, Fish & Wildlife																

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 11 – DEVELOPMENT **Goals addressed: 1, 2, 3**																
11.1	Work with homebuilders associations, contractors, realtors, or developers to encourage 'watershed friendly' design, construction and maintenance of new and existing developments in the watershed and work to establish demonstration sites.	H 5	$2,500/yr	• 2011: Identify 1 builder to work with on model construction. • 2015: Establish showcase site for other builders and prospective new homeowners.		X	-	-	-	X					LLLA LGOV L-CD Local Businesses NWMCOG NWMSBF	1.3, 1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6
11.2	Work with appropriate local government agencies (i.e., County Drain Commission) to recommend BMP's for developers on construction sites and to ensure compliance with those BMP's (i.e. low impact development or green infrastructure planning).	H Ongoing	$2,500/yr	• 2012: Establish connection with township planning offices to be alerted of new development plans	X	-	-	-	-	-	-	-	-	X	LLLA LGOV L-CD MDNRE NWMCOG NWMSBF	1.3, 1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6
11.3	Work with Leelanau County Drain Commissioner and other appropriate local government entities to implement proper soil erosion control measures at construction sites. Should be coordinated with 8.2	M Ongoing	$12,000/yr (Drain Comm salary)		X	-	-	-	-	-	-	-	-	X	LGOV Lee Cty L-CD LLLA NWMCOG NWMSBF	1.1, 1.2, 1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6, 4.3,
11.4	Monitor Soil Erosion and Sedimentation construction permits to determine the amount and location of new developments throughout the watershed	L Ongoing	$5,000		X	-	-	-	-	-	-	-	-	X	LGOV Lee Cty L-CD NWMSBF NWMCOG	1.1, 1.2, 1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6, 4.3,

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 12 – ZONING AND LAND USE **Goals addressed: 3**																
12.1	Advocate for zoning, master plans and ordinances that protect water quality and natural resources: setbacks and buffers along lakes and river, clearing of shoreline, ridgeline, wooded hillsides, green infrastructure planning (provide financial assistance when possible).	H Ongoing	$15,000/yr Salary $28,000 To local gov't	• by 2015: pass at least one new water quality protection ordinance	X	-	-	-	-	-	-	-	-	X	LGOV LLLA Lee Cty NWMCOG	1.3, 1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6
12.2	Work with townships to develop and adopt possible special overlay districts designed to protect water quality.	L 7	$10,000	• 2013: Initial feasibility investigations • 2019: If feasible, establish overlay district by 2019				X	-	-	-	-	-	X	LGOV Lee Cty LLLA NWMCOG	1.3, 1.5, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6
12.3	Work with Leelanau County Road Commission, MDOT, and Leelanau Scenic Heritage Route on sustainable/green roads planning which would include road salt and sand runoff; stormwater issues; road crossings	M Ongoing	$1,500		X	-	-	-	-	-	-	-	-	X	LSHR, NWMCOG, DOT, RC	1.1, 1.2, 1.3, 2.1, 2.3, 2.3, 3.1, 3.4, 3.5, 4.2, 4.3

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 13 – GROUNDWATER AND HYDROLOGY **Goals addressed: 1, 2, 3**																
13.1	Inventory and summarize the status of wellhead protection plans.	L 3	$5,000				X	-	X						LLLA LGOV Lee Cty	2.1, 2.2, 2.4, 4.3
13.2	Inventory abandoned and poorly capped wells and correct properly to prevent contaminants from moving into and among groundwater aquifers via this route. Tasks will be to 1) inventory existing abandoned and poorly capped wells through surveys, well logs, and landowner interviews and 2) properly plug the abandoned wells.3) Work with area businesses and property owners to encourage proper maintenance and monitoring of underground fuel storage tanks and improperly stored vehicles (e.g., junkyards)	L 7	$15,000 (Consultant to assist in interviews, location and prioritizing) $10,000/yr thereafter	• 2013 Begin inventory • 2014 prioritize biggest offenders • 2015 Initialize plugging • 2013 Begin locating sites • 2014 Begin working with responsible parties to remediate				X	-	-	-	-	-	X	MSU-E MDNRE L-CD Lee Cty LLLA MDNRE	2.1, 2.2, 2.4, 4.3
13.3	Assess need for dredging in The Narrows area to maintain navigation from North to South Lake Leelanau. When dredging is necessary, conduct responsibly.	M Ongoing	$20,000 (Consultant rate)	• 2016 complete assessment			X	-	-	-	X				LGOV Lee Cty LLLA MDNRE	1.1, 1.2, 2.1, 2.2, 4.3, 6.4

Categories/Tasks		**Priority:** ***High (H), Med (M), Low (L)*** **Duration (yrs)**	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 14 – MONITORING AND RESEARCH **Goals addressed: All**																
14.1	Centralize all water quality data for watershed in one common location and format (database). Update water quality monitoring results in database annually.	H Ongoing	$4,000-initial centralization $1,000/yr thereafter	• 2010 Have data in LC office • Maintain annually	X	-	-	-	-	-	-	-	-	X	LLLA LC CLMP MDNRE	2.6, 5.7
14.2	Every two years summarize and analyze water quality data for long-term trends.	H Ongoing	$5,000	• Summarize 2012, 2014, 2016, 2018			X		X		X		X		LLLA LC CLMP MDNRE	2.6, 5.7
14.3	Maintain current MDNR monitoring program of fish surveys and angler creel counts to track changes in watershed.	M Ongoing	$100,000	• Evaluate trends every 5 years					X					X	MDNRE	1.2, 2.6
14.4	Conduct water quality and other types of parameter monitoring in Lake Leelanau and select tributaries. *(refer to Figure 7 for current sampling locations)* **Current/Proposed Monitoring** • Total Phosphorus sampling (Monthly, May – Oct) • Vertical profiles: DO, %DO, Temp, Conductivity, pH, transparency (Monthly, May-Oct) • Chlorophyll a samples: 2x/mth June, July, Aug; 1x/mth May, Sept, Oct • Vertical phytoplankton and zooplankton tows (ID and relative abundance): 2x/mth June, July, Aug; 1x/mth	H Ongoing	$150,000/yr	Current/Proposed Monitoring- 2010-2019- seasonal and annual monitoring Proposed Future Monitoring • 2011: Find grant organization(s) and obtain funding. • 2012: Design and conduct field monitoring and studies. • 2015: Complete data analyses and develop computer model(s).	X	-	-	-	-	-	-	-	-	X	LLLA MDNRE LCW LLLA	2.1, 2.6, 5.7

	May, Sept, Oct • Ponar dredge sampling 1x/year: Michigan 10 metals, and invertebrates (ID & relative abundance) **Proposed Future Monitoring:** • Total Phosphorus sampling of select tributaries on rotating 3-yr basis • Monitoring after Storm Events • Water Flow measurements • Conduct a nutrient budget project to develop data and nutrient budget models that are needed to assess impact of potential nutrient additions to Lake Leelanau. • Conduct research into the type and level of microcystine in Lake Leelanau caused from the impact of zebra and quagga musssels. •			• 2016: Present findings • 2016: Implement model for decision making											

Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Milestone	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners	Objective(s) Addressed
CATEGORY 15 – DESIRED USES **Goals addressed: 4, 6**																
15.1	Choose or develop recreational carrying capacity model for Lake Leelanau	M 3	$100,000	• Complete study developed by 2019								X	-	X	LLLA LC MDNRE	2.6, 4.1, 4.5, 5.7
15.2	Prevent congested and reckless boating by: 1) Optimizing the number of boat moorings on lake by critiquing new marina or launch site proposals and encouraging keyhole limitations. 2) Supporting and encouraging Marine Patrols on Lake Leelanau by inviting the Sheriff to LLLA meeting and supporting Marine Patrol at Leelanau County budget meetings.	M Ongoing	$2,500/yr		X	-	-	-	-	-	-	-	-	X	LLLA LCW LGOV Lee Cty MDNRE	4.1, 4.5, 6.2

Category Costs
The total cost for implementation efforts for all categories was determined (Table 28). The total cost for implementation of the Lake Leelanau Watershed Plan (excluding outreach activities) is **$4,816,500.**

Table 28: Summary of Implementation Task Costs by Category

Category	Cost
Shoreline Protection and Restoration	$112,000
Road Stream Crossings	$163,500
Agriculture	$110,000
Habitat, Fish, and Wildlife	$370,000
Stormwater	$112,500
Wastewater and Septics	$70,000
Human Health Issues	$219,000
Wetlands	$50,000
Invasive Species	$35,000
Land Protection and Management	$1,515,000
Development	$175,500
Zoning and Land Use	$189,000
Groundwater and Hydrology	$140,000
Monitoring	$1,619,000
Desired Uses	$125,000
Grand Total	**$4,816,500**

7.4 Information and Education Strategy

One of the most important tools to use when implementing watershed protection is an effective outreach and education campaign. Watershed residents, businesses local leaders, seasonal residents, and tourists alike are often under-educated when it comes to watershed issues. This Information and Education (IE) Strategy addresses the communication needs associated with implementing the Lake Leelanau Watershed Protection Plan.

A variety of means have already been used by the Lake Leelanau Lake Association (LLLA), Leelanau Conservancy and other organizations to inform the public regarding water quality issues for both Lake Leelanau and it tributaries. Both the LLLA and Leelanau Conservancy have effective outreach strategies and philosophies. In 1996 the LLLA produced the Lake Leelanau Landowner's Handbook (Stone and Taylor 1996), which explains a multitude of watershed concepts and outlines existing and potential threats to the watershed. It also discusses BMPs and actions landowners and residents can take to reduce pollution impacts to the watershed. However, this handbook needs to be updated with new information from this protection plan, as well as a more refined layout.

Local Research Findings

The Lake Leelanau watershed is unique in character. Many riparian landowners are not permanent residents, which provides a dilemma on how best to educate this important segment of watershed residents that are only here part time.

There has not been any local research regarding public knowledge of watersheds and water quality issues, but a survey completed in nearby Grand Traverse Bay watershed by The Watershed Center Grand Traverse Bay in 2002 identified a major gap in knowledge amongst watershed residents. 60% of the respondents answered "don't know" when asked which watershed they lived in (TWC 2005). This basic fact indicates that watershed organizations have a long way to go in informing and engaging the public in watershed issues.

The same study pointed out that though many area residents routinely express concern about environmental issues, there is a lack of understanding of the key issues that face the watershed. Residents in the Grand Traverse Bay watershed perceive that business and industry (17%) and sewage treatment plants (16%) are the main causes of water pollution to the bay. In truth, the Grand Traverse Region is dominated by non-smokestack industries and comparatively few discharge permit holders. Additionally, when asked what they believe to be the least cause of water pollution in the Bay, and area lakes, streams and rivers, respondents indicated the "day to day actions of individuals" as the second least likely pollutant. These two findings would seem to indicate that the general public sees sources outside their individual control to be more responsible for existing and potential water quality problems (TWC 2005)

Information Source	Percent
Newspaper	46.6%
TV News	13.7%
Environmental organization newsletters	7.3%
Friends, neighbors, coworkers	5.2%
Other organizations (churches, clubs, etc)	2.6
Magazines	2.3
Radio	1.6
Schools	1.3

Other key findings relevant from the Grand Traverse survey point out that most people get their information about the environment and water quality from newspapers and television. When this question was cross-tabulated with the respondents' age, more detail was revealed about where specific age demographic groups obtain their information about the environment (TWC 2005). It is worthy to note that since 2002, we have seen a boom in the use of the internet as a source of information, especially for the younger generation (specifically on social networking sites).

Age Range	Preferred Source		Education Level	Preferred Source
18-25	Schools		**Graduate Degree**	Environmental newsletters or friends, neighbors and relatives
26-35	TV News		**Some post grad**	Environmental newsletters, newspapers
36-55	Newspapers		**College degree**	Environmental newsletters, newspapers
56-65	Environmental Newsletters		**Some college, high school or some high school**	Television news
66+	Newspapers			

Summary of Regional Environmental Education and Outreach Research

Note: *The following is an excerpt from the IE Strategy outlined in Chapter 7.3 in the Grand Traverse Bay Watershed Protection Plan (TWC 2005). Even though the two watersheds differ immensely in size, the summary of research findings is relevant to the Lake Leelanau watershed and will be helpful when implementing the outreach plan. When it comes to watershed education in Northern Michigan, most of the issues and attitudes are the same across watershed and municipal boundaries.*

Recent regional and national research surveys regarding the environment confirm the basic findings of the Grand Traverse Bay surveys. A recent Roper study (Roper 2001) indicates that while there is increasing public concern about the environment, the majority of the public still does not know the leading causes of such problems as water pollution, air pollution and solid waste. This finding was also confirmed in work done by The Biodiversity Project (2003) as part of their Great Lakes Public Education Initiative. Their research involved both a public opinion poll and a survey of organizations, agencies and institutions engaged in public education efforts on Great Lakes topics. An excerpt follows:

> "...organizations are making a concerted effort to provide reliable information to people who can make a difference when it comes to

improving the environmental conditions in the Great Lakes Basin. However, the public opinion poll shows that, for the most part, people are just not grasping the importance of the issues facing the Great Lakes in three important ways: the seriousness of the threats, the need for urgency in taking action to address the threats, and ways that individuals can make a difference. This led us to examine the discrepancy between the level and focus of current communications and public education efforts and the gaps in public awareness. Because of this discrepancy, we concluded that the public knowledge gaps are likely to be attributed to other factors besides the content and volume of materials. Likely factors include the following three points.

- Limited use of targeting (tailoring messages and delivery strategies to specific audiences).
- Heavy reliance on printed materials and the Web – reaching already interested knowledge seekers; limited use of television and other communication tools that reach broader audiences.
- Multiple, complex, detailed information as opposed to broad, consistent unifying themes."

The report goes on to conclude that educators need "to pay attention to a full spectrum of factors that act as barriers to the success and impact of public outreach." Factors to be considered include:

- **Targeting** – Avoid the one-size-fits-all approach.
- **Delivery** – As resources allow, use the mediums and venues that best reach the target audience. Brochures are easy, the web is cheap, but television is the most used source of information about the environment.
- **Content** – Facts and figures are important to validate a point, but it is important to address the emotional connection needed to address why people should care, why the issue is relevant, effective solutions and what your audience can do about it.
- **Context** – Many environmental threats are viewed by the public as long term issues. Issues need to be communicated in a way that makes them more tangible. Beach closings, toxic pollution, sewage spills and water exports tend to feel more immediate than loss of habitat, land use planning and other big picture issues that citizens feel more disconnected from.

The study identified a list of educational needs and actions that should be incorporated consistently in educational efforts:

- Promote understanding of the system.
- Make the connection to individuals.
- Be local and specific.
- Include a reality check on "real threats." (For example, industrial pollution was a hot topic ten years ago but, many organizations have shifted their education focus to other current and emerging threats, such as stormwater runoff, biodiversity, etc, but the public has not caught up with this shift.)
- Emphasis on "why is this important to you" messages.
- Make the connection to policy.

Both local and regional research indicates that there are considerable gaps in the public's knowledge and understanding of current environmental issues. But, this knowledge gap is tempered by keen public interest and concern for the environment. Watershed organizations need to do a better job of making issues of concern relevant to their audiences. There is a need for ongoing, consistent and coordinated education efforts targeted at specific groups, addressing specific threats.

The Lake Leelanau watershed IE strategy addresses some of these concerns. Both local and regional opinion research findings should be considered carefully when developing messages and delivery mechanisms for IE strategy implementation.

Goals and Objectives

The goal of the IE strategy is to ***"Establish and promote educational programs that support effective watershed preservation and increase stewardship."*** Fixing an erosion problem at a road stream crossing does not involve a high degree of public involvement. But, developing and carrying out a regional vision for stewardship of water resources will require the public and community leaders to become more knowledgeable about the issues and solutions, more engaged and active in implementing solutions and committed to both individual and societal behavior changes.

The objectives of this plan focus on building awareness, educating target audiences, and inspiring action. Five major objectives have been identified:

- To raise community awareness and knowledge about Lake Leelanau, its tributaries, and the rest of the watershed, including the interconnectedness of the system and the role that an individual's day-to-day activities can play in protecting the resource.
- To develop a set of consistent messages that can be used by partners in a variety of communications.
- To involve citizens, public agencies, user groups and landowners in the implementation of the watershed management plan.
- To regularly inform stakeholders about the watershed, implementation activities and successes and opportunities to participate.
- Motivate target audiences to adopt behaviors and implement practices that result in water quality improvements.
- Integrate monitoring and research findings into IE strategy as they become available.

Target Audiences

A number of diverse regional audiences have been identified as key targets for IE strategy implementation. The targets are divided into user groups and decision-making groups.

User Groups

Households – The general public throughout the watershed.

Riparian Landowners – Due to their proximity to a specific waterbody, the education needs of riparian landowners are different.

Tourists – This area is known for its scenic beauty and recreational opportunities. This seasonal influx of people puts a noticeable strain on area infrastructure and often the environment. There is a growing concern that this important economic segment could eventually destroy the very reason why it exists, and that the region's tourism "carrying capacity" may soon be reached. There is clearly a growing need to educate tourists about their role in protecting the Lake Leelanau environment.

Builders/Developers/Real Estate – This region is one of the fasting growing areas in Michigan in terms of population and land use. Increasingly, homes around and near Lake Leelanau are being converted from small seasonal cottages to larger year round homes. Additionally, new developments are popping up all over the watershed. Members of the development industry segment play a crucial role in this growth and providing ongoing education opportunities about their role in protecting water quality and environmental health is critical.

Agriculture - Certain streams and wetland in the Lake Leelanau watershed are still prone to less than adequate agriculture practices, especially cattle wading in streams. Educating farmers using this practice would benefit the watershed by reducing erosion, protecting wetlands, and reducing nutrients and pathogens entering streams.

Education – Area educators and students, primarily K-12.

Special Target Audiences – In addition to the above, certain user groups such as recreational boaters, other sports enthusiasts, garden clubs, churches, or smaller audience segments may be targeted for specific issues.

Local Government Decision Makers

Elected/Appointed Officials – Township, village, city, and county commissioners; planning commissions; zoning board of appeals; road and drain commissioners; etc.

Staff – Planners, managers, township supervisors, zoning administrators, etc.

Message Development

General message outlines have been established for each target audience. These messages will be refined as implementation moves forward. They may also be modified or customized depending on the message vehicle.

Target Audience	Messages
Households	• Watershed awareness, the water cycle, key pollutant sources, how individual behaviors impact the watershed • Water quality-friendly lawn and garden practices • Housekeeping practices and the disposal of toxic substances • Septic maintenance • Managing stormwater on your property
Riparian Landowners	• Watershed awareness, the water cycle, key pollutant sources, how individual behaviors impact the watershed • Riparian land management including the importance of riparian buffers • Water quality-friendly lawn and garden practices • Septic system maintenance • Housekeeping practices and the disposal of toxic substances • Clean boating practices
Tourists	• Watershed awareness, the water cycle, key pollutant sources, how individual behaviors impact the watershed • Help us protect the beauty that you enjoy when you are a guest • Clean boating practices • Role in controlling the spread of aquatic invasive species
Builders, Developers, Real Estate	• Monetary advantages of and opportunities for Low Impact Development • Identification and protection of key habitats and natural features: aquatic buffers, woodlands, wetlands, steep slopes, etc. • Advantages of and opportunities for open space protection and financial incentives for conservation • Minimize the cutting of trees and vegetation • Impact of earthmoving activities, importance of soil erosion and sedimentation control practices, construction BMPs • Watershed awareness, the water cycle, key pollutant sources, how individual behaviors impact the watershed • Educate about and encourage wetland mitigation where landowners will cooperate
Agriculture	• Watershed awareness, the water cycle, key pollutant sources, how individual behaviors impact the watershed • Riparian land management including the importance of riparian buffers and BMPs • Water quality friendly types of agricultural practices • Disposal of toxic substances and pesticides should be done responsibly
Education	• Adoption and promotion of a state-approved watershed curriculum in K-12 schools. • Watershed awareness, the water cycle, key pollutant sources, how individual behaviors impact the watershed • Connection between watershed organizations' programs and school activities • Active participation in watershed protection activities and stewardship
Local Government Decision Makers	• Watershed awareness, the water cycle, key pollutant sources, how individual behaviors impact the watershed • The leadership role that local governments must play in protecting the watershed • The importance of establishing sound, enforceable natural resource protection ordinances • Economic impact and advantages of environmental protection

**Table adapted from Grand Traverse Bay Watershed Protection Plan (TWC 2005)*

Action Plan to Implement Strategies

A complete list of tasks by category follows this narrative; the categories are the same as those used to outline the implementation tasks in Section 7.3. Several priority areas for the Lake Leelanau watershed have been identified and the plan for rolling out the IE Strategy will correspond to these priority areas (Section 5.3, Tables 18 and 19, Figures 9 and 10). Additionally, the IE Strategy will support other implementation efforts to control nutrient loading, loss of habitat, input of harmful toxins, and the impacts of invasive species in the watershed, and other pollutants outlined in Section 7.3.

The IE Strategy tasks use a diverse set of methods and delivery mechanisms. Workshops, presentations, demonstration projects, brochures, public and media relations, web sites and other communications tools will be used for the different tasks and target audiences. Broadcast media, most importantly television, is beyond the reach of most area partner organizations – at least at a level of reach, frequency and timing that can be expected to have any impact on awareness and behavior. This is a barrier to utilizing this effective medium, but effort should be placed on building coalitions that can pool resources to address larger picture issues through broader-based, more long-term communications efforts. Additionally, the use of social networking websites such as Facebook and Twitter have increased exponentially over the past few years. These sites offer advantages to reaching out to a broader segment of individuals that might not be reached via other means.

Partnerships

A relatively newly formed group in Leelanau County that can assist with portions of the outreach strategy is Leelanau Clean Water. This is a group formed by Leelanau County consisting of members/representatives from various environmental groups that cover all or some portions of the county. Their mission is as follows:

> *"To protect, restore and sustain water resources, promote public awareness of environmental and economic importance, and provide accurate information to assist public participation in water resource decisions."*

The group meets once a month and discuss various initiatives and topics of concern to water quality in the County. Members include representatives from local lake associations, GT Band of Ottawa and Chippewa Indians, National Park Service, The Watershed Center Grand Traverse Bay, Leelanau Conservancy, Inland Seas Educational Association, Leelanau Conservation District, and other Leelanau County Departments. They receive a small amount of funding through the County's budget that is used to assist in funding outreach initiatives. Members from the LLLA sit on the Leelanau Clean Water committee and can convey key ideas on priorities from the outreach plan to see where there may be overlap between proposed ideas.

Since watershed outreach topics can be broad at times and not watershed-specific based (i.e. lawn care, benefits of wetlands, stormwater management, etc.) it will be beneficial to partner with as many other groups in the area as possible, with Leelanau Clean Water being a key group.

INFORMATION AND EDUCATION STRATEGY IMPLEMENTATION TASKS

GOAL 6: Promote and establish educational programs that support watershed planning goals, objectives and tasks, and increase stewardship.

Pollutants Addressed: All

Categories:

G. General
1. Shoreline Protection and Restoration
2. Road Stream Crossings
3. Agriculture
4. Habitat, Fish and Wildlife
5. Stormwater
6. Wastewater and Septics
7. Human Health Issues
8. Wetlands
9. Invasive Species
10. Land Protection and Management
11. Development
12. Zoning and Land Use
13. Groundwater and Hydrology
14. Monitoring & Research
15. Desired Uses

Note: The Monitoring and Desired Uses categories from the previous section are not included in the IE plan.

Organization Acronyms:

BLHD – Benzie-Leelanau Health Department
CRA – Conservation Resource Alliance
CRGC -Cedar Rod & Gun Club
EPA – Environmental Protection Agency
GTBOCI - Grand Traverse Band of Ottawa and Chippewa Indians
GTCNC- Grand Traverse County Nature Center
ISEA – Inland Seas Education Association
LeeCty – Leelanau County
LC – Leelanau Conservancy
L-CD – Leelanau Conservation District
LCRC – Leelanau County Road Commission
LCW - Leelanau Clean Water
LCHR-Leelanau Scenic Heritage Route
LGOV – Local Governments
LLLA – Lake Leelanau Lake Association
LCPRC-Leelanau Co. Parks & Recreation Commission
MDNRE – Michigan Department of Natural Resources and Environment*
M-DOT – Michigan Department of Transportation
MSU-E – Michigan State University Extension
NRCS – USDA Natural Resources Conservation Service
NWMCOG – Northwest Michigan Council of Governments
NWMSBF-Northwest Michigan Sustainable Business Forum
OWTTF – Onsite Wastewater Treatment Task Force
USFWS - United States Fish & Wildlife Service

Others:

Leelanau County Chamber of Commerce
Local Realtors, Businesses
Solid waste management entities
Schools
Area Libraries
Boat/Marine Retailers
Garden Centers and Nurseries
Landscaping Companies
Architects and Engineers

Target Audiences Include:

Builder/Developer/Realtor
Education
Households
Local Governments
Riparian Landowners
Tourists
General

**In January, 2010, the Michigan Department of Environmental Quality (MDEQ) merged with the Michigan Department of Natural Resources (MDNR). They are now known as the Michigan Department of Natural Resources and Environment (DNRE). For the purposes of this report, most often they are still referred to separately.*

Estimated Costs, Timeframes, and Milestones:
For costs associated with salaries, an average watershed technician rate of $35/hour was applied. For tasks to be completed by a specialized consultant, a rate of $50/hour was used. Tasks that will be done on a yearly or site by site basis are noted as such ($X/yr or $X/site). Appendix B lists average rates for costs associated with educational materials. Further details are noted where applicable. In general, funding for short-term tasks (1-5 years) will be attained through state and/or Federal grants, other non-profit grant programs, partner organizations' budgets, fundraising efforts, and private foundations. Funding for long-term tasks will be addressed as needed.

Milestones for the IE Strategy were harder to define because many of the tasks are ongoing. Additionally, the best way to conduct outreach activities is continually evolving and depends on the audience one is trying to reach. This is why many of the IE tasks are general and only outline the audience to reach and the message to convey, but don't include specifically how to convey that message. All of the tasks in the following pages outline the target audience reached for each task, as well as what frequency the task should be performed and the method or medium that should be used to reach the audience (i.e., newsletter, website, workshop, etc.). The most important things listed for each category are the general messages or educational topics that should be focused on.

The most important task to completing effective outreach in the region is for the LLLA to acquire funds to hire a part- to full-time Watershed Coordinator. At present the LLA does not have the capacity to carry out or organize implementation of the watershed plan, especially the IE Strategy. The Watershed Coordinator will complete most of the outlined tasks in the IE strategy. The LLLA has no formal employees and is a volunteer based organization. Without a dedicated staff person to concentrate on the outreach tasks, the entire effort may stall and have no leadership. Most of the educational tasks outlined in the following pages are simple (i.e. write articles for newsletters, update website, consultations with homeowners, distribute handbooks), but do require time and coordination. Once the LLLA can obtain funding to hire an Outreach Coordinator a majority of the tasks in the IE Strategy may start.

The LLLA is a lead project partner in many tasks. The General Category G.1. specifies a part-time watershed coordinator be hired. The LLLA will need to obtain a grant to fund this position. All such tasks which will involve this individual are predicated on an initial and continuing grant for this position.

IE Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Target Audiences	Frequency/ Milestones	Medium or Method	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners
IE CATEGORY G - GENERAL																	
G.1	LLLA hire Watershed Coordinator (WC) to complete the bulk of task in IE Plan and coordinate LLLA's roles in Implementation Tasks 7.3 Evaluate need to expand to full time as needed and resources become available	H Ongoing	$210,000 (6yr@$15K; 4yr@$30K)	NA	• 2010-2015: part time • 2016-2019 full time	NA	X	-	-	-	-	-	-	-	-	X	LLLA
G.2	Publish LLLA newsletter - every 4 months - one issue each year sent to all Lake Leelanau riparians	H Ongoing	$3,500/yr	Households	-3 times a year	Newsletter	X	-	-	-	-	-	-	-	-	X	LLLA
G.3	Update current Lake Leelanau Watershed Landowners Handbook and begin distribution throughout watershed.	H 4	$10,000 -$2K design, $8K printing	Riparians Households General LGov Agriculture	• 2012: update • 2013: distribute	Handbook	X	-	-	X							LLLA, LCW
G.4	Condense information found in watershed protection plan into shorter version (i.e. brochure or small booklet).	H 3	$7,000 -$2K design, $5K printing	All	• 2012: Complete		X	-	X								LLLA, LC, LCW, LGov
G.5	Give presentations to general public and other community groups about Watershed Protection Plan	H Ongoing	WC, Volunteers	General	-4x/year	Presentation w/ handouts	X	-	-	-	-	-	-	-	-	X	LLLA, LCW, L-CD, LC
G.6	Provide watershed information and news to local and regional media on regular basis	M Ongoing	WC, Volunteers	General	-4x/year	-LE/TCRE articles -releases to local news stations	X	-	-	-	-	-	-	-	-	X	LLLA, LC, LCW

G.7	Maintain and promote current LLLA Website with info about watershed (some information will also be included on Leelanau Conservancy's website).	H Ongoing	WC, Volunteers	Riparians General LGov Agencies Agriculture	-update as needed	-Website	X	-	-	-	-	-	-	-	-	X	LLLA, LC
IE Categories/Tasks		**Priority:** ***High (H), Med (M), Low (L)*** **Duration (yrs)**	**Estimated Cost**	**Target Audiences**	**Frequency/ Milestones**	**Medium or Method**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Potential Project Partners**
G.8	Develop public attitude survey (as well as follow up surveys) to determine and monitor the public's awareness regarding watershed and water quality issues.	H Ongoing	$15,000 each survey (consultant)	Households	-Every 5 years • 2012: first survey	-phone calls or mailed survey			X					X			LLLA, LGov, LCW, MSU
G.9	Install general watershed education signs throughout watershed at parks, boat launches, downtown Leland.	M 10	$3,000 (3 signs @ $1000/ea)	General Tourists	• 2012: complete plan, begin funding search • 2015 install 1 sign • 2019 install 2 more signs	-Develop -Post -Updates	X	-	-	-	-	-	-	-	-	X	LLLA, DNRE, LC, LGov, L-CD, LeeCty, LCW, LSHR
G.10	Work with Leelanau County schools to develop Lake Leelanau watershed based curriculum and field trips for kids to get them more involved in local environment	L Ongoing	$2,000 stipend per teacher for participation	Education	As possible		X	-	-	-	-	-	-	-	-	X	LLLA, ISEA, L-CD, MSU-E
G.11	Host annual events where people are given opportunity to learn about watershed issues (i.e. LLLA Annual Meeting, Kids Fishing Day, Walk-About).	M Ongoing	$2,000/yr (planning, materials, etc.)	General	-2 events/yr	Workshop-general event	X	-	-	-	-	-	-	-	-	X	LLLA, L-CD, LC, MSU-E, GTBOCI, LeeCty, LGOV, ISEA

G.12	Develop LLLA Watershed steward awards	L Ongoing	$300/yr (staff costs)	Riparians LGov Agencies Education Households	-1x/year	-Awards in Newsletter -Presented at Annual Meetings	X	-	-	-	-	-	-	-	-	X	LLLA, LC, L-CD
G.13	Distribute watershed maps for landowners, government and others	L Ongoing	$2,000	Riparians Agencies LGov	As requested	-Ongoing distribution	X	-	-	-	-	-	-	-	-	X	LLLA, LC

	IE Categories/Tasks	Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Target Audiences	Frequency/ Milestones	Medium or Method	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners
IE CATEGORY 1 – SHORELINE PROTECTION AND RESTORATION																	
1.1	Educate the public, new home owners, contractors, builders, landscapers, garden centers, and farmers about: 1. The need for soil testing prior to fertilizer application, and the proper use of residential and commercial fertilizers, pesticides, herbicides. 2. Environmentally-friendly lawn care contractors, availability of non-phosphorus fertilizers, alternative pest management 3. Greenscaping, natural shorelines, and naturalization	H Ongoing	LLLA-WC	Riparians B/D/R Lawn care providers	-1 article on each topic per year -LLLA-WC visits and follow up as requested	-Incorporate to LLLA website -Newsletter articles -Handbook -Distribution of existing brochures -Home Visits by LLLA-WC as requested	X	-	-	-	-	-	-	-	-	X	LLLA, MSU-E, L-CD, LCW
1.2	Increase awareness of boaters and personal watercraft users on the impact of turbulence on natural resources and biological communities in the narrows and Leland River.	H Ongoing	LLLA-WC	Riparians Tourists	-Articles in newsletter -Annual Letter to the Editor in local papers	-Incorporate to LLLA website -Newsletter articles -Handbook	X	-	-	-	-	-	-	-	-	X	LLLA
IE CATEGORY 2 – ROAD STREAM CROSSINGS																	
2.1	Work with the Leelanau County Road Commissioners and Drain Commissioner regarding implementing BMPs at road crossings to reduce harmful sedimentation and stormwater runoff	L Ongoing	$18,000 (Drain Comm:$45/ hr x 40hr/yr x 10yr)	Leelanau Road & Drain Comm.	As needed	-Meetings with department heads	X	-	-	-	-	-	-	-	-	X	LGov, L-CD, MDNRE, GTBOCI

	IE Categories/Tasks	Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Target Audiences	Frequency/ Milestones	Medium or Method	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners
IE CATEGORY 3 – AGRICULTURE																	
3.1	Identify existing farms with conservation practices to serve as a demonstration site. Invite the public for tours and workshops.	M 7	$5,000	Agriculture Households	-Annual tours	2013: ID demo farm(s)				X	-	-	-	-	-	X	MSU-E, CDs, NRCS
See also: Wetlands and Land Protection and Management																	
IE CATEGORY 4 – HABITAT, FISH, AND WILDLIFE																	
4.1	Educate public re the harmful effects of herbicides/pesticides and copper sulfate (formerly used for swimmers' itch control) on fish and wildlife	H Ongoing	Newsletter cost in General Category	General Households	-1 newsletter article/yr	-Newsletter Article	X	-	-	-	-	-	-	-	-	X	LLLA, MSU-E, LC, L-CD, LCW
4.2	Educate public re the importance of maintaining diverse wildlife habitats and wildlife corridors on their property	M Ongoing	Newsletter cost in General Category	General Households	-1 newsletter article/yr	-Newsletter Article	X	-	-	-	-	-	-	-	-	X	LLLA, CRA, LC, L-CD
IE CATEGORY 5 – STORMWATER																	
- No current tasks ***See also: Road Stream Crossings, Development, and Zoning & Land Use***																	
IE CATEGORY 6 – WASTEWATER AND SEPTIC																	
6.1	Provide public education regarding using proper septic system design for site conditions, new technology, and maintaining existing systems (make page on website, distribute handbook and other existing brochures, newsletter articles, homeowner visits as requested w/ LLLA-WC).	H Ongoing	Newsletter, website cost in General Category	General Households	-1 article/yr -LLLA-WC visits and follow up as requested	-Newsletter articles -Handbook -Distribution of existing brochures -Home Visits by LLLA-WC as requested	X	-	-	-	-	-	-	-	-	X	LLLA, BLHD, LCW

6.2	Develop information that shows riparians how to conduct Cladophora surveys to self-assess potential septic leaks.	H 3	$2,500 (brochure)	Riparians Households		-Brochure -Handbook -Include info on website	X	-	X									LLLA
IE CATEGORY 7 – HUMAN HEALTH ISSUES																		
	<u>Provide public education regarding:</u>	H	LLLA-WC	General Riparians Households LGov	-1 newsletter article on each topic per year	-Newsletter -Handbook -Website	X	-	-	-	-	-	-	-	-	X		LLLA, BLHD, MSU-E, LCW
7.1	Feeding waterfowl and birds																	
7.2	Use of pesticides/herbicides	Ongoing	Newsletter, website cost in General Category															
7.3	Results of *E.coli* and microcystis monitoring																	
7.4	Improper disposal of hazardous wastes including electronics and drugs																	
7.5	Results of microcystine research																	
	(For all: provide info on website, distribute handbook, newsletter articles)																	
IE CATEGORY 8 - WETLANDS																		
8.1	Educate public, local governments, developers, contractors, and farmers regarding the benefits of existing wetlands and restoring them.	M Ongoing	LLLA-WC Newsletter cost in General Category	Riparians LGov B-D-R	As needed	-Website -Newsletter -Brochures -Site visits, as requested, by LLLA-WC	X	-	-	-	-	-	-	-	-	X		LLLA, L-CD, DNRE, LC
IE CATEGORY 9 – INVASIVE SPECIES																		
9.1	Educate local residents, visitors, garden centers regarding the negative impacts of and appropriate control/eradication measures for both aquatic and terrestrial invasive species (milfoil, zebra mussels, phragmites, etc.).	H Ongoing	LLLA-WC Newsletter cost in General Category	Riparians Tourists	-1 article/yr • 2013: web update	-Newsletter -Website -Handbook	X	-	-	-	-	-	-	-	-	X		LLLA, L-CD, LC, LCW, DNRE

9.2	Educate local residents, visitors, garden centers regarding create and maintain signs or displays on invasive species prevention at @ all boat launches and access points to Lake Leelanau.	M 6	$5,000 5 signs @ $1,000/sign	Riparians General Tourists	• 2014: plan signs • 2015 secure funding • 2016:installation	-Signs					X	-	-	-	-	X	LLLA, L-CD, LCRC, LCW DNRE, LSHR
IE CATEGORY 10 – LAND PROTECTION AND MANAGEMENT																		
10.1	Educate landowners regarding voluntary conservation easements and other available land protection measures	H Ongoing	LLLA-WC	Watershed Riparians	Ongoing	-Handbook -Newsletter -Website -Site visits, as requested, by LLLA-WC	X	-	-	-	-	-	-	-	-	X	LLLA, LC
10.2	Educate landowners regarding ecologically sound riparian shoreline and wetland management practices.	H Ongoing	LLLA-WC	Watershed Riparians	Ongoing	-Handbook -Newsletter -Website -Site visits, as requested, by LLLA-WC											LLLA, DNRE, L-CD, LGOV, LCW
IE CATEGORY 11 - DEVELOPMENT																		
11.1	Educate realtors, developers, contractors, and homeowners regarding stormwater and sediment management	H Ongoing	$12,000/yr (Drain Comm. salary) LLLA-WC	Developers Contractors	-Every year	-Visit by Drain Commissioner at blding sites	X	-	-	-	-	-	-	-	-	X	L-CD, LLLA
11.2	Educate realtors, developers, contractors, and homeowners on using BMPs to improve and protect water quality when planning construction or development on hilltops, hillsides, and water bodies.	M 8	$3,000 (printing costs)	Developers Contractors Realtors	Every three years	-Workshop -Brochure distribution to local builders			X			X			X		LLLA, L-CD

IE Categories/Tasks		Priority: *High (H), Med (M), Low (L)* Duration (yrs)	Estimated Cost	Target Audiences	Frequency/ Milestones	Medium or Method	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Potential Project Partners
IE CATEGORY 12 – ZONING AND LAND USE																	
12.1	Educate planning commissioners and township boards regarding the watershed protection plan via presentations to township/county board and planning commissions (must be ongoing due to turnover) and distribution of summary booklet produced in Task G4.	H Ongoing	LLLA-WC Volunteers	Local Gov't	4 mtg/yr	-Meetings -Booklet	X	-	-	-	-	-	-	-	-	X	LLLA, LC
12.2	Educate planning commissioners and township boards regarding information on planning, zoning, and design to protect water quality	M Ongoing	LLLA-WC Volunteers	Local Gov't Rd Com-mission	1mtg/year	-Meetings	X	-	-	-	-	-	-	-	-	X	LLLA, LGOV
12.3	Educate planning commissioners and township boards regarding sharing by townships of model ordinances to protect water/natural resources	M Ongoing	LLLA-WC Volunteers	Local Gov't	As needed	-Meetings	X	-	-	-	-	-	-	-	-	X	LLLA, LGOV
IE CATEGORY 13 – GROUNDWATER AND HYDROLOGY																	
- No current tasks																	

The total cost for implementation efforts for all categories detailed in the Information and Education Strategy for the Lake Leelanau Watershed Protection Plan is $475,000.

Table 31: Summary of Information and Education Task Costs by Category

Category	Cost
General	$352,000
Shoreline Protection and Restoration	$0 *(costs included in General Category)*
Road Stream Crossings	$18,000
Agriculture	$5,000
Habitat, Fish, and Wildlife	$0 *(costs included in General Category)*
Stormwater	$0
Wastewater and Septics	$2,500 *(additional costs included in General Category)*
Human Health Issues	$0 *(costs included in General Category)*
Wetlands	$0 *(costs included in General Category)*
Invasive Species	$5,000 *(additional costs included in General Category)*
Land Protection and Management	$0 *(costs included in General Category)*
Development	$123,000
Zoning and Land Use	$0 *(costs included in General Category)*
Groundwater	$0
Grand Total	**$475,000**

7.5 Evaluation Procedures

An evaluation strategy will be utilized to measure progress during the Lake Leelanau Watershed Protection Plan's implementation phase and to determine whether or not water quality is improving. The timeline for the evaluation is approximately every 5 years, with ongoing evaluation efforts completed as necessary. The first aspect of the evaluation strategy measures how well we are doing at actually *implementing* the watershed management plan and assesses if project milestones are being met. The second aspect is to evaluate how well we are doing at *improving water quality* in the watershed. The following sections address each of these issues.

Evaluation Strategy for Plan Implementation

This aspect of the evaluation strategy was developed to measure progress during the implementation phase of the watershed management plan and to provide feedback during implementation. The evaluation will be ongoing and will be conducted through the existing Steering Committee. The Steering Committee will meet two times a year to assess progress on plan implementation and to learn and share information about existing projects throughout the watershed. In addition, plan tasks, priorities, and milestones will be assessed every 5 years to ensure that the plan remains current and relevant to the region and that implementation is proceeding as scheduled and is moving in the right direction.

The evaluation will be conducted by analyzing the existing watershed plan goals and objectives, as well as the implementation tasks and 'milestones' in Sections 7.3 and 7.4 to determine progress. Key milestones include conducting necessary research and water quality monitoring, protecting priority land areas, and assisting townships with enacting ordinances to protect water quality. The proposed timeline for each task will also be reviewed to determine if it is on schedule. Other anecdotal evidence (not attached to specific plan milestones) also will be noted that indicates the protection plan is being successfully implemented, such as an increase in the amount of updated or new zoning ordinances that deal with water quality and natural resource protections in watershed townships and municipalities.

Additionally, a number of other evaluation tasks will be completed due to the variety of tasks involved in the watershed plan. They will include but are not limited to the following:

- Utilize Steering Committee to evaluate specific projects throughout plan implementation as needed.
- Conduct targeted surveys of project partners by direct mail, phone or by website to assist in information gathering.
- Maintain a current list of future target projects, the status of ongoing projects, and completed projects, along with their accomplishments. Keep track of the number of grants received and the dollars committed in the watershed region to implement aspects of the plan.
- Document the effectiveness of BMP implementation by taking photographs, completing site data sheets and gathering physical, chemical and/or biological site data.

The purpose of the evaluation strategy is to provide a mechanism to the Steering Committee to track how well the plan is being implemented and what can be done to improve the implementation process. Additional development of the strategy will occur as the implementation phase unwinds.

Measuring and Evaluating Social Milestones

Section 7.4 outlines an Information and Education Strategy that addresses the communication needs associated with implementing the watershed protection plan. The strategy is important because developing and carrying out a vision for stewardship of the region's water resources will require the public and community leaders to become more knowledgeable about the issues and solutions, more engaged and active in implementing solutions and committed to both individual and societal behavior changes. Residents, local officials, homeowners, and the like must be educated and motivated to adopt behaviors and implement practices that result in water quality improvements.

In this respect, it is important to measure and keep track of the social impacts of the Lake Leelanau Watershed Protection Plan. The LLLA, LC, and other organizations conducting outreach must find out what types of outreach are working in the community and what types are not, along with how people's attitudes and behaviors are impacted. Just how much is social behavior changing because of the plan implementation? To answer this question, social impacts must be included when evaluating the progress of plan implementation.

Key social evaluation techniques that will be used to assess the implementation of the IE Strategy, as well as other watershed BMPs, include:

- Continued cooperation between area organizations submitting proposals to implement aspects of management plan.
- Social surveys (and follow up surveys) for homeowners, local officials, etc. to determine watershed and water quality awareness.
- Determining any increases in 'watershed friendly' design and construction (anecdotal evidence will be used).
- Increased awareness (from both the general public and local government officials) regarding the necessity of water quality protection.
- Increase in the number of townships implementing water quality protection related ordinances.
- Incorporating feedback forms into educational and public events and posting them on he Lake Leelanau Lake Association's website www.lakeleelanau.org.
- Maintaining a list of ongoing and completed projects protecting water quality, along with their accomplishments and who is completing/completed the project. (This task is also found in next section relating to evaluating the water quality improvements.)

Evaluation Strategy for Determining Water Quality Improvement

The EPA dictates that watershed management plans must outline a set of criteria to determine whether proposed load reductions in the watershed are being achieved over time and that substantial progress is being made towards attaining water quality standards. Instead, the project Steering Committee made a broad goal to maintain current levels of phosphorus and nitrogen in North and South Lake Leelanau (Chapter 6: Goal 2, Objective 2.1). However, since the watershed area itself has threats and problem areas, it is stressed that improvements and protections must be made now in order to maintain the current water quality and protect it into the future. Most watershed goals outlined in Chapter 6 seek to maintain or improve the current state of water quality and habitat, as well as increase awareness of this valuable resource. Additionally, the Steering Committee will focus on land protection measures to protect the critical, high quality groundwater recharge areas that are so important to maintaining excellent water quality.

In the case of the Lake Leelanau watershed, overall water quality is excellent (Section 3.11) with some pollutant threats; therefore no specific watershed goals were made regarding load reductions.

In addition to conducting an evaluation every 5 years regarding protection plan implementation, the Steering Committee will evaluate whether or not water quality in Lake Leelanau and its tributaries is declining, improving, or staying the same. In addition to the State's quality criteria in Table 13, current nutrient criteria to be used to evaluate changes are outlined in Table 30:

Table 32: Criteria To Evaluate Water Quality Goals in Lake Leelanau Watershed

Criteria Used	Current Conditions *(For more details see Section 3.10)*	Source
No statistically significant increases in averages of Phosphorus or Nitrogen concentrations in Lake Leelanau	**Phosphorus** North Lake Leelanau: TP 1990-2005 average – 4.88 µg/L (Range: 3.27 µg/L – 6.76 µg/L) South Lake Leelanau: TP 1990-2005 average – 5.18 µg/L (Range 3.45 µg/L – 8.09 µg/L)	Lake Leelanau Lake Association Leelanau Conservancy
	Nitrogen North Lake Leelanau: NO_3/NO_2 1990 -2005 average – 267.9 µg/L (Range: 133.75 µg/L – 747.88 µg/L) South Lake Leelanau: NO_3/NO_2 1990 -2005 average – 195.03 µg/L (Range: 75.56 µg/L – 315.43 µg/L)	
	N:P Ratio North Lake Leelanau: Average: 54.3 (Range: 24.4 - 132.44) South Lake Leelanau: Average: 36.08 (Range: 15.03 - 67.14)	

**for a list of applicable temperature ranges for lakes and streams please see Appendix B*

The following will also be used to evaluate water quality changes:

- Monitoring results that indicate no harmful changes to water quality or biological indicators measured throughout the watershed.

Determine number of environmental efforts/projects in the watershed and how many organizations are currently working to protect water quality in the area. Maintain a list of ongoing projects and completed projects, along with their accomplishments. (This task is also found in previous section relating to evaluating the plan implementation.)

CHAPTER 8 FUTURE EFFORTS

The Lake Leelanau Lake Association, Leelanau Conservancy and other project partners will continue to build partnerships with various groups throughout the watershed for future projects involving the implementation of recommendations made in this watershed protection plan. Continued support and participation from key partner groups, along with the availability of monies for implementation of the plan is necessary to keep the momentum generated by planning efforts. Partners responsible for the implementation of the plan are encouraged to review the plan and act to stimulate progress where needed and report to the larger partnership.

In order to monitor the water quality in the watershed the Leelanau Conservancy and Lake Leelanau Lake Association plan to continue and expands portions of their monitoring and research programs. Any noted increases in nutrient and other water quality parameters will be noted. Additional research components are important to conduct, such as further investigation into the causes of swimmer's itch in the lake, and the potential impact from blooms of microcystis.

The Leelanau Conservancy will continue to evaluate the extent of development on parcels in priority areas deemed important to protecting high water quality and fish and wildlife habitat, along with the region's scenic and natural character. Conservation easements established with interested landowners will help to reduce the development rate of such parcels, as well as prevent additional pollutants from entering the watershed. Over the next 10 years, the Leelanau Conservancy has a goal of protecting 2,300 acres of watershed lands, preventing 154 tons of sediment, 6670 lbs Nitrogen, and 621 lbs of Phosphorus from entering the watershed.

Important issues facing the watershed include: increasing development and the associated pollution it brings, invasive species, swimmer's itch, aging septic systems. Priority will be given to implementation tasks (both BMPs and educational initiatives) that work to reduce the effects from these sources.

It is expected that the implementation phase will last more than 10 years, with some efforts expected to be conducted on a yearly basis indefinitely (i.e., monitoring). Grant funds and other financial sources will be used to implement tasks outlined in Chapter 7, including the continuation of water quality assessment and monitoring, installation and adoption of various Best Management Practices (Section 7.3), and educational tasks outlined in the IE Strategy (Section 7.4). In general, funding for short-term tasks (1-5 years) will be attained through state and/or Federal grants, other non-profit grant programs, partner organizations' budgets, fundraising efforts, and private foundations. Funding for long-term tasks will be addressed as needed. The Lake Leelanau Watershed Steering Committee should continue to meet two times a year during the implementation period.

Priority tasks that should be conducted over the next 1 – 3 years are as follows, with the most important tasks listed first:

- Continue existing and begin new monitoring and research programs (i.e. water quality, *E.coli,* cladophora, microcystine).
- Begin initial outreach and education efforts outlined in the IE strategy – focusing on general watershed information, invasive species prevention, benefits of water quality protection ordinances and conservation easements, wetland preservation, and pollution stemming from residential areas
- Initiatives to preserve land and wildlife corridors (i.e. conservation easements)
- Continue Swimmer's Itch program to reduce its impact on humans and determine what snails and birds may be causing infection in South Lake Leelanau.
- Assist with developing or revising Master Plans and Zoning Ordinances to include more water quality protection (i.e., septic system point of sale ordinances, etc.)
- Wetland restoration and protection

However, perhaps the most important initial task will be for the LLLA to acquire funds to hire a part- to full-time Watershed Coordinator. At present, the LLLA does not have the capacity to carry out and organize implementation of the watershed plan. LLLA will need to acquire a grant to hire a Watershed Coordinator. In the meantime, some aspects of the plan implementation will move forward by the project Steering Committee, LLLA, and LC.

Public Outreach

The Information and Education Strategy (Section 7.4) highlights the actions needed to successfully maintain and improve watershed education, awareness, and stewardship for the Lake Leelanau watershed. It lays the foundation for the collaborative development of natural resource programs and educational activities for target audiences, community members, and residents. Environmental awareness, education, and action from the public will grow as the IE Strategy is implemented and resident awareness of the watershed is increased. Implementing the IE Strategy is a critical and important long-term task to accomplish.

Initial IE efforts began a long time ago by the LLLA. They produced a Stewardship Guidebook, mentioned previously, and intend to revise this and distribute it widely throughout the watershed. Additionally, LLLA and LC publish newsletters and host educational events, as well as operate informative websites that seek to educate watershed residents. These outreach activities should be continued and paired with additional ones outlined in this management plan. Considerable time and effort should also continue to be put into introducing stakeholders to the watershed protection plan and its various findings and conclusions, as well as providing general information about the Lake Leelanau watershed and its beautiful and unique qualities. The LLLA has education and communication committees within their board structure, but implementing the entire IE Strategy will benefit greatly from hiring a Watershed Coordinator, as mentioned above.

During the implementation phase of the IE Strategy, the critical first steps are to build awareness of basic watershed issues and sources of pollution, as well as how individual behaviors impact the health of the watershed. It will also be necessary to continue to introduce stakeholders to results and information provided in the revised management plan and show them how they can use the plan to protect water quality in the region.

CHAPTER 9 CONCLUSIONS

The Lake Leelanau Watershed Protection Plan was developed to help guide efforts to protect water quality of North and South Lake Leelanau and its surrounding watershed. The initial planning phase of the plan (culminating in December 2002), allowed key decision-makers, organizations, agencies, and the public to learn about the watershed in which they live. The original plan was prepared by the Leelanau Conservancy with collaboration and input from major watershed stakeholders including the Lake Leelanau Lake Association, Leelanau Conservation District, and local units of government.

Years later, the same groups again got together to update the watershed plan, aided by The Watershed Center Grand Traverse Bay, to include additional information according to newly implemented EPA requirements. This 2010 revised plan includes additional information on pollutant sources and concentrations, load reduction estimates of various BMPs, measurable milestones to guide plan implementation progress, and a set of criteria to evaluate the effectiveness of implementation efforts. The recommendations outlined in Chapter 7 of this plan will provide guidelines to all types of organizations for taking action during the implementation phase of the project and will be a useful tool in addressing current and future water quality threats to the watershed. The Lake Leelanau Watershed Protection Plan is meant to assist decision-makers, landowners, residents, and others in the watershed in making sound decisions to help improve and protect water quality in their area.

The Lake Leelanau watershed is a uniquely beautiful, high water quality area that residents and visitor's alike treasure and it should be protected and maintained as such. Important issues facing the watershed include: increasing development and the associated pollution it brings, invasive species, swimmer's itch, aging septic systems. Priority will be given to implementation tasks (both BMPs and educational initiatives) that work to reduce the effects from these sources. The plan also delineates priority and critical areas to identify specific places in the watershed that are most sensitive to environmental impacts and have the greatest likelihood to affect water quality and aquatic habitat (Figures 9 and 10). It is in these areas that the bulk of implementation efforts mentioned above should be focused.

The success of the Lake Leelanau Watershed Protection Plan will depend on continued support and participation from key partner groups, along with the availability of monies for implementation of the plan. Partners responsible for the implementation of the plan are encouraged to review the plan and act to stimulate progress where needed and report to the larger partnership.

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APPENDIX A:

AVERAGE RATES FOR COSTS OF INSTALLING STANDARD BMPS

[AS FOUND IN GRAND TRAVERSE BAY WATERSHED PROTECTION PLAN (TWC 2005) & COMPILED BY: FISHBECK, THOMPSON, CARR & HUBER, INC. – 2002]

Average Rates for Costs of Installing Standard BMPs –
As compiled by Fishbeck, Thompson, Carr & Huber, INC. 2002

Best Management Practices Cost Estimates*

Task	Costs	Units	Output	Notes	Source
Agriculture					
Conservation Tillage	$ 10.00	acre			NRCS
Fertility Testing	$ 2.75	acre		Lab testing done to MSU standards	MDA Conservation Service 1992 adjusted for inflation
IPM	$ 5.75	acre			MDA Conservation Service 1992 adjusted for inflation
Windbreaks	$ 2.00	foot		4200 feet needed for a square 40 acre field. Protects ten times as trees are high	NRCS
Cover Crop	$ 14.00	acre		sweet clover if using forage for harvest results in gain of $125/acre	NRCS
Critical Area Planting	$ 1,300.00	acre		Includes: grading, planting, herbicides, mulch, and labor.	NRCS
Livestock Exclusion	$ 3.50	foot			NRCS
Agriculture Crossing	$ 1,200.00	crossing	2/day		NRCS
Watering site	$ 5,100.00	site	.5/day	Well, pump, pipe and water facility	NRCS
Rental Rate	$ 58.00	acre		10 year lease $150/acre with grants	NRCS
Riparian Forested Buffer	$ 900.00	acre		Use of herbicides and establishment and maintenance	NRCS

Riparian Herbaceous Buffer	$ 225.00	acre		On tilled land includes establishment and maintenance	NRCS
Filter Strip	$ 190.00	acre		establishment, herbicides, fertilizer, and lease	NRCS
Zebra Mussel Control	$ 440.00	acre		Irrigation system to control Zebra Mussels for a 1800 acre establishment	American Water Works Association, 1990 adjusted for inflation
Solar Irrigation Pump	$ 2,500.00	unit	3/day	Pump, controller, pipe, and collector	www.solarelectric.com
Waste Storage Lagoon	$ 45,000.00	unit			NRCS
Stream Erosion					
Live crib wall	$ 25.00	square foot	25 ft/day	see habitat restoration	Rogue River National Wet Weather Demonstration Project
Live staking	$ 2.50	stake		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Vegetated geogrid	$ 20.00	square yard		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Live fascine	$ 9.00	foot		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Brush layer	$ 13.00	foot		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Branch packing	$ 25.00	foot		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project
Coconut roll	$ 15.00	foot		with 3 crew and foreman	Gull Lake Shoreline Project
Joint Planting	$ 9.00	stake		with 3 crew and foreman	Rogue River National Wet Weather Demonstration Project 4 member crew with foreman
Riprap	$ 60.00	square yard		includes geotextile fabric: 2 member crew and foreman using heavy equipment	Means 1996 and adjusted for inflation: Includes heavy equipment rental

Tree revetments	$ 12.00	foot	with 3 crew and foreman	Means 1996 and adjusted for inflation
Bank Shaping	$ 15.00	cubic yard	With Heavy Equipment	NRCS
Average Bio-Engineering	$ 22.00	foot	Using soft methods only	NRCS
Average Streambank Restoration	$ 32.00	foot	Using hard methods and bioengineering	NRCS
Hydroseeding and Mulch	$ 2,200.00	acre		NRCS
Tile Outlet				
Riprap	$ 75.00	square yard	includes geotextile fabric: 2 member crew and foreman using heavy equipment	Means 1996 and adjusted for inflation
Vegetated geogrid	$ 20.00	square yard	includes geotextile fabric: 2 member crew and foreman	Means 1996 and adjusted for inflation
Pipe	$ 30.00	linear foot	10" pipe steel: 3 member crew, foreman, backhoe	Means 1996 and adjusted for inflation
Inlet/outlet structure	$3,500	each	concrete with riprap splash pool and vegetated geogrid slopes	Means 1996 and adjusted for inflation
Soil Stabilization/Repair	$2.50	square yard	2 member crew and foreman with heavy equipment	Means 1996 and adjusted for inflation
Trash and Debris				
Volunteer Mobilization	$ 60.00	day	Includes flyers, meetings, and memberagement	
Tree removal	$ 325.00	hour	includes crew, equipment, and removal fees	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Waste hauling fees	$ 75.00	load	should include a $2 tip fee for each tire	

Heavy Obstructions	$ 890.00	each		includes, crew, equipment, and removal fees	Means 1996 and adjusted for inflation: Includes heavy equipment rental
Rill and Gully					
Berm and Tube	$ 1,500.00	each		with 3 crew, foreman, heavy equipment and materials	NRCS
Water Bars	$ 300.00	each			NRCS Nebraska Cost Estimator
Grassed Waterway	$ 690.00	acre		Best case Scenario with loose soil, no brush, and already tilled ($2245 ave.)	Means 1996 and Rogue River National Wet Weather Demonstration Project
Grassed Waterway	$ 3,800.00	acre		Worst Case Scenario in hard soil, with brush and dense vegetation ($2245 ave.)	Means 1996 and Rogue River National Wet Weather Demonstration Project
Stone Spillway	$ 9.50	square yard		3 member crew, foreman, heavy equipment and material	Means 1996 and adjusted for inflation
Diversions	$ 3.75	linear foot		grassed terrace to divert flow from tilled earth	NRCS and Means 1996
Habitat restoration					
Wetland Restoration	$ 2,350.00	acre		average of $500/acre and up	NRCS and Zbiciak
Channel block	$ 340.00	log structure	3-4/day	single log	Rogue River National Wet Weather Demonstration Project
Channel block	$ 480.00	log structure	2-3/day	triple height log	Rogue River National Wet Weather Demonstration Project
Channel block	$ 1,600.00	log structure	.5-1/day	crib wall: requires heavy equipment	Rogue River National Wet Weather Demonstration Project
Boulder Cluster	$ 59.20	cluster	25/day	varies depending on distance moved: requires heavy equipment	Rogue River National Wet Weather Demonstration Project
Cover logs	$ 290.00	log structure	5-10/day	3 member crew (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project

Root wads	$ 300.00	wad	6-8/day	4 member crew (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Tree Covers	$ 172.00	tree	8-12/day	If dropped in place or already in stream (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Tree Covers	$ 215.00	tree	4-8/day	If they must me moved to site (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Crib wall	$ 9.50	square foot	120+ feet/day	If done with heavy equipment	Rogue River National Wet Weather Demonstration Project
Crib wall	$ 36.50	square foot	20-30 feet/day	If done by hand	Rogue River National Wet Weather Demonstration Project
Log or Bank Shelter	$ 1,080.00	log structure	2/day	use in small streams with a low gradient (requires heavy equipment)	Rogue River National Wet Weather Demonstration Project
Deflectors	$ 390.00	log structure	2 pairs/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Channel Constrictors	$ 2,520.00	structure	1 pair/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Cross log	$ 680.00	structure	1-2/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Wedge and "K" dams	$ 1,360.00	dam	1/day	requires highly experienced foreman to correctly size and place the structure	Rogue River National Wet Weather Demonstration Project
Soil Stabilization					
Mulch	$ 500.00	acre		Using farm equipment	NRCS
Geotextile Fabric	$ 4.50	square yard		3 member crew, foreman, and material	Means 1996 adjusted for inflation
Seeding	$ 450.00	acre		includes site preparation using heavy equipment and 3 member crew	Means 1996 adjusted for inflation

Sodding	$ 13,068.00	acre	includes site preparation using heavy equipment and 3 member crew	Means 1996 adjusted for inflation
Check Dams	$ 15.00	linear foot	includes site preparation using heavy equipment and 3 member crew	Rogue River National Wet Weather Demonstration Project
Silt fence	$ 1.75	linear foot	Done with 3 member crew	Rogue River National Wet Weather Demonstration Project
Sediment Trap	$ 175.00	each	Done with 3 member crew	Rogue River National Wet Weather Demonstration Project
Road Crossing				
Box Culvert	$ 382.00	linear foot	36" culvert: excavation, crew, foreman, transportation, and installation	NPC Inc.
Bridge	$ 1,125.00	linear foot	72" culvert: excavation, crew, foreman, transportation, and installation	Bark River Culvert and Equipment
Cleaning	$ 8.50	cubic yard	Backhoe excavation of sediment	Rogue River National Wet Weather Demonstration Project
Equipment and Operator Rental				
Loader	$ 150.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Excavator (backhoe)	$ 175.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Dozer	$ 150.00	hour	includes operator	Rogue River National Wet Weather Demonstration Project
Crew	$ 30.00	hour		Rogue River National Wet Weather Demonstration Project
foreman	$ 50.00	hour		Rogue River National Wet Weather Demonstration Project
Design & legal			typically 25% to 30% of construction costs	Rogue River National Wet Weather Demonstration Project

Mobilization			3 to 5% of construction costs	Rogue River National Wet Weather Demonstration Project
Land Clearing	$ 300.00	acre	clearing and grading smooth	NRCS
Excavation	$ 3.50	cubic yard		Means 1996 and NRCS
Backfill	$ 12.00	cubic yard		Means 1996 and NRCS
Grade and Compact	$ 2.00	square yard		Means 1996 and NRCS

*** Prices are in 2002 dollars**

Information and Education Cost Estimates

Task	Costs	Units	Notes	Source
Promotional				
Flyer	$ 0.28	each	black and white	Grand Valley Community Survey
T-shirts	$ 12.50	each	Three color m,l, and XL	Grand Valley Community Survey
Video Production	$ 6,000.00	each		Grand Valley Community Survey
Telephone book inserts standard	$ 0.07	each	min order of $2500	Verizon Super Pages
Telephone book inserts new resident	$ 0.20	each	min order of $2500	Verizon Super Pages
Bathroom Advertising	$ 75.00	each/month	monthly rate for 11"x 17" plus $95 design and $2 reproduction	Johnny Advertising
Bathroom Advertising	$ 35.00	each/month	monthly rate for 8.5" x 11" plus $95 design and $2 reproduction	
Newspaper Ad	$ 32.00	square inch	Sunday paper full page ad about $4000	Muskegon Chronicle
Newspaper insert	$ 0.05	each	Cost of service only, reproduction is not included (1 sheet max)	Berrien County Drain Commission
Utility bill inserts	$ 0.50	each	Reproduction and distribution	Grand Valley Community Survey
Yellow Pages Ad	$ 5,000.00	each/year	Half Page Add in Yellow Pages	Verizon Super Pages

Watershed Logo Signs	$ 90.00	each	11x17" sign	Grand Valley Community Survey
Operational				
Project Manager/year	$ 29,120.00	$15/hour		Bear Creek Watershed Project
Intern/year	$ 20,800.00	$10/hour		Bear Creek Watershed Project
Vehicle/year	$ 15,000.00	each	does not include maintenance or insurance	Bear Creek Watershed Project
Mileage	$ 3,840.00	$0.32/mile		MDEQ
Fringes (20%)	$ 13,752.00		20 percent of total	MDEQ
Community Development				
Ordinance Development	$ 8,000.00		lawyer fees and meetings	Grand Valley Community Survey
Education				
School Presentation	$ 250.00	each	plus 20 hours preparation	Grand Valley Community Survey
4H Program	$ 39,000.00	annually	Management, Staff, and programs	Bear Creek Watershed Project
Demonstration Sites				
Agriculture	$ 1,350.00	each		Grand Valley Community Survey
demonstration booth	$ 200.00	each		Grand Valley Community Survey
Outreach				
Riparian Club	$ 8,000.00	annually		Grand Valley Community Survey
field trips	$ 16.00	each student		Grand Valley Community Survey
phone hotline	$ 1,142.00		first year startup	Bell South
Oil recycling container	$ 2.79	each	min order of 300 and $750 delivery	GEOPlastics
Adopt-a-Stream Program	$ 3,200.00	annually		Grand Valley Community Survey
Evaluation				
Water Quality Monitoring	$ 180,000.00	annually		Bear Creek Watershed Project
Stream Monitoring	$ 25,000.00	annually		Bear Creek Watershed Project
Fieldwork				
Canoe trip	$ 250.00	each		Grand Valley Community Survey

Watershed tours	$	200.00	each		Grand Valley Community Survey
Public Relations					
Public Meetings	$	250.00	each		Grand Valley Community Survey
Workshop	$	500.00	each	plus 40 hours preparation	Grand Valley Community Survey
Committee Meeting	$	25.00	each		Grand Valley Community Survey
Newsletters					
Mailing	$	0.30	each	bulk non-sorted	USPS
	$	0.12	each	presorted bulk mail rate	USPS
	$	600.00	year	application and accounting fees for bulk mailing	USPS
Color glossy	$	2.30	each		Allegan Conservation District
Inserts	$	0.12	each	black and white	Berrien County Drain Commission
Envelopes	$	0.03	each	business envelopes box of 500	Staples.com
Letter	$	0.27	each	envelop, postage, and form letter	

Appendix B: Temperature ranges for inland lakes and rivers, streams and impoundments

Temperature: Inland lakes, general standards
R323:1072 (Rule 72 Section Subset (c)-DEQ Chapter 4 Water Quality Standards)

Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
45	45	50	60	70	75	80	85	80	70	60	50

Temperature: Rivers, streams, and impoundments naturally capable of supporting coldwater fish R323:1075 (Rule 75 Section Subset 1(b)-DEQ Chapter 4 Water Quality Standards, Section Subset 3a)

Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
38	38	43	54	65	68	68	68	63	56	48	40

Temperature: Rivers, streams, and impoundments naturally capable of supporting warmwater fish R323:1075 (Rule 75 Section Subset 3 (a)-DEQ Chapter 4 Water Quality Standards)

Jan.	Feb.	March	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.
38	38	41	56	70	80	83	81	74	64	49	39

Appendix C: Road and Stream Crossing Article

Leelanau Enterprise
4/22/2010

every day," said Browning, who lives the Benzie County line north to the be completed before the end of May.

County, tribe approve stream plan

By Chris Olson
Of the Enterprise staff

The county Road Commission unanimously approved an agreement with the Grand Traverse Band of Ottawa and Chippewa Indians to improve three stream crossings on Co. Rd. 641.

At its meeting Tuesday, the Road Commission reviewed a memorandum of agreement with tribal government in which the two will jointly agree on the scope and limits of the repair to the crossings. Also, the agreement states that the Road Commission will only be reimbursed by the Grand Traverse Band when the projects are completed to the standards the federal government's Natural Resources Conservation Service.

Commission engineer James C. Johnson said Brett Fessell, the tribe's fish and wildlife coordinator, finished his research on how the stream crossings, two involving Mebert Creek by Veronica Valley County Park and a third on Co. Rd. 641 on the north end of Lake Leelanau, can be improved for fish habitat. He said the estimated cost for improving the crossings is $130,000 and the work would be paid for by a grant from the tribe's Environmental Quality Incentive Program.

The board unanimously approved the agreement, which also authorized manager/supervisor Herb Cradduck to sign the agreement. Johnson did not have any estimate of when this work might begin.

In other business, the commission unanimously:

• Authorized management to review and award bids received on equipment for two snowplow dump trucks. Two bids were opened and reviewed at the meeting Tuesday. Heights Machinery of Williamsburg bid $38,995 for each truck; Truck and Trailer Specialities of Boyne Falls bid $45,284.96 for the first truck, and $46,830.71 for the second.

• Authorized Cradduck and management to advertise for bids to sell used equipment and vehicles, including posting a list of the equipment on the Craig's List website. Three vehicles are included in the used equipment sale: a 1990 half-ton two-wheel drive Dodge pick up truck, a 1990 Ford L9000 dump truck with wood chip enclosure, and a 1992 Ford L9000 dump truck with an underbody scraper and front plow hitch. Sealed bids will be accepted through 1:05 p.m. on May 4, at which time they will be opened. Other equipment included in the sale are three hydraulic-powered sweeper brooms that attach to front-end loaders and a 1951 four-wheel drive self-propelled snowblower.

• Heard a report from commission member John Popa about areas in which he thinks the Road Commission should do more long-range planning and goal setting. Popa cited the need for better planning in areas that included budget, labor, crack sealing, commissioner benefits, plowing, shut downs, volunteer layoffs, gravel extraction, employee meetings, grass/bush cutting, charging for public hearings and lack of written policies. The commission thanked Popa for his review but declined to hold a special meeting to further discuss the matters. Chairman Lee A. Bowen asked Popa to summarize all of his points into a written document so it could be revisited at a later date.