CHAPTER 3: EXISTING WATER QUALITY INFORMATION AND RESULTS FOR THE GOOD HARBOR BAY WATERSHED

3.1 WATER QUALITY DATA AND REPORTS

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

- Leelanau County Inland Lakes Project: A Study of Development and Water Quality Within the Little Traverse and Lime Lake Watersheds, Leelanau County, MI, Steinburg et al, 1994
    - A study completed in partial fulfillment of the requirements for the degree of Master of Science and Master of Landscape Architecture University of Michigan School of Natural Resources and Environment
- 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 Lime and Little Traverse Lakes. 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 Lime and Little Traverse Lake. This study is over ten years old, but is the only study of the nutrient flux in these lakes.
- Michigan Department of Natural Resources, Historical Review and Management Prescription for Little Traverse Lake Fishery, (1/2002).
- Michigan Department of Natural Resources, Historical Review and Management Prescription for Lime Lake 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 Lime and Little Traverse Lakes. 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 Lime and Little Traverse.
    - 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 Lime and Little Traverse Lakes. 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.

3.2 LIME LAKE AND LITTLE TRAVERSE LAKE WATER QUALITY SUMMARY

Leelanau Conservancy Watershed Council Database – (1990-2014)

This database contains chemical and physical water sampling results of Leelanau County lakes and streams starting from 1990 through the 2014[1]. This database is available as a result of a water quality program started by Dr. Tim Keilty in 1989 and other dedicated volunteer's in 1989. The program and database is hosted and supported by the Leelanau Conservancy. Lime and Little Traverse Lakes and their tributary streams are included in the database. Parameters on the seven major lakes in Leelanau County include: TP, nitrates, nitrites, Kjeldhal nitrogen, ammonia, chlorophyll a, conductivity, oxygen reduction potential, temperature, conductivity, pH and SD. The major tributaries (streams) to each of the major lakes are also sampled for Total Phosphorus and discharge. The database provides an overview of trends over time. The stream samples include an estimate of discharge and average of phosphorous loading to Lime and Little Traverse Lakes from Shetland, Shalda and Lime Creeks. Zebra mussels were introduced to Little Traverse Lake in 1998 and showed established populations by 2002. In Lime Lake zebra mussels were introduced in 2002 (Woller-Skar 2009).

A report completed on Lime and Little Traverse Lake in partial fulfillment of the requirements for the degree of Master of Science and Master of Landscape Architecture University of Michigan School of Natural Resources and Environment in 1994 was referenced for this water quality section. It is titled: Leelanau County Inland Lakes Project: A Study of Development and Water Quality Within the Little Traverse and Lime Lake Watersheds, Leelanau County, MI, Steinburg et al, 1994. Keilty and Woller 2002 and Canale and Neilsen 1997 are also referenced.

[1] There was no data available for the Lakes in 2013.

Nutrients (Phosphorus – P and Nitrogen – N)

Total phosphorus (TP) is an essential nutrient for plant growth, but it tends to be low in northern lakes. Keilty and Woller (2002) provided information that indicated Lime and Little Traverse Lakes are oligotrophic, or high quality, clear lakes with low productivity. 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. An N:P ratio of greater than 10 typically indicates that the lake is a Phosphorus limiting system. Table 14 below shows that from 1990-2014, TP concentrations for Lime and Little Traverse Lakes fell within Wetzel's oligotrophic classification (Wetzel 2001 and Keilty and Woller 2002) 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 below show the lakes nitrogen levels also likely fall into the oligotrophic range for Lime Lake and Little Traverse Lake (Table 14).

Table 14- Lime and Little Traverse Lakes Water Quality Summary Data

Lime Lake		Little Traverse Lake	
Parameter	**Result**	**Parameter**	**Result**
TP	4.3	**TP**	5.1
N	216	**N**	125.8
N:P Ratio	50.9	**N:P Ratio**	23.6

The trophic state of lakes is indicative of their biological productivity, or the amount of living material supported within them, primarily in the form of algae. The least productive lakes are called 'oligotrophic'. These are typically cool and clear, and have relatively low nutrient concentrations. The most productive lakes are called ‘eutrophic’ and are characterized by high nutrient concentrations which result in algal growth, cloudy water, and low dissolved oxygen levels. Those lakes with a trophic status that falls along the continuum somewhere between oligotrophy and eutrophy are termed ‘mesotrophic’ (Adapted from http://www.epa.gov/greatlakes/glindicators/water/trophicb.html).

Using long term data from the water quality database, allows for monitoring the Trophic Status Index or TSI for all the lakes in Leelanau County. The Trophic Status Index (TSI) was calculated for all lakes for 2014 (Figure 16). Both Lime and Little Traverse Lake have a TSI < 35. The ratio of N/P is also an important factor in lake biology because microorganisms typically require about 10 times more nitrogen than phosphorus (Keilty and Woller 2002). Both Little Traverse Lake and Lime Lake have N/P ratios greater than 10 (see Figure 17).

Keilty and Woller (2002) also report a slight decline of TP from the water column, and attribute it to zebra mussel filtering of plankton in Little Traverse Lake, but no zebra mussels were reported in Lime Lake in 2002. 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 detergents.

Figure 16: Trophic Status Index for all Lakes in Leelanau County (2014)

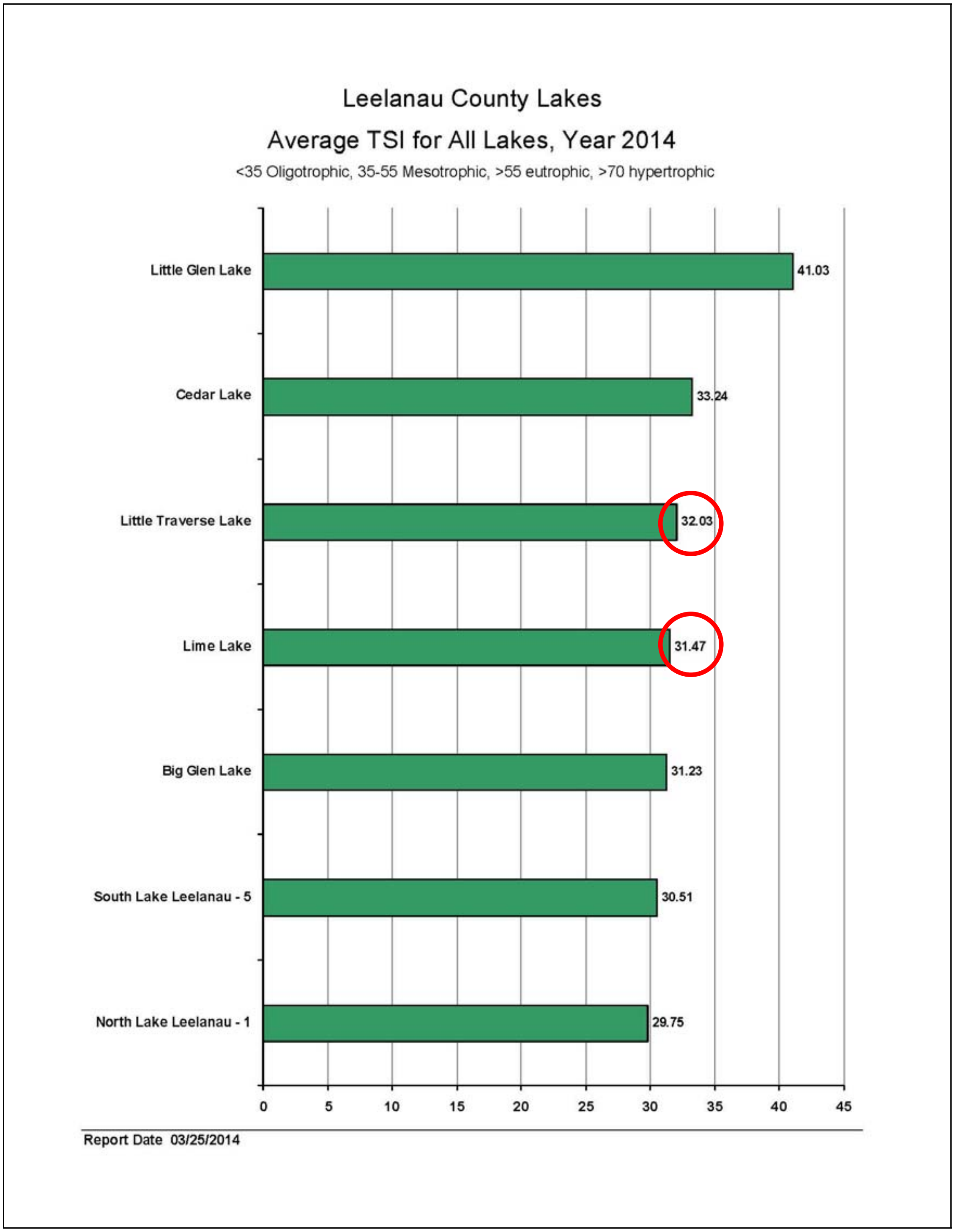
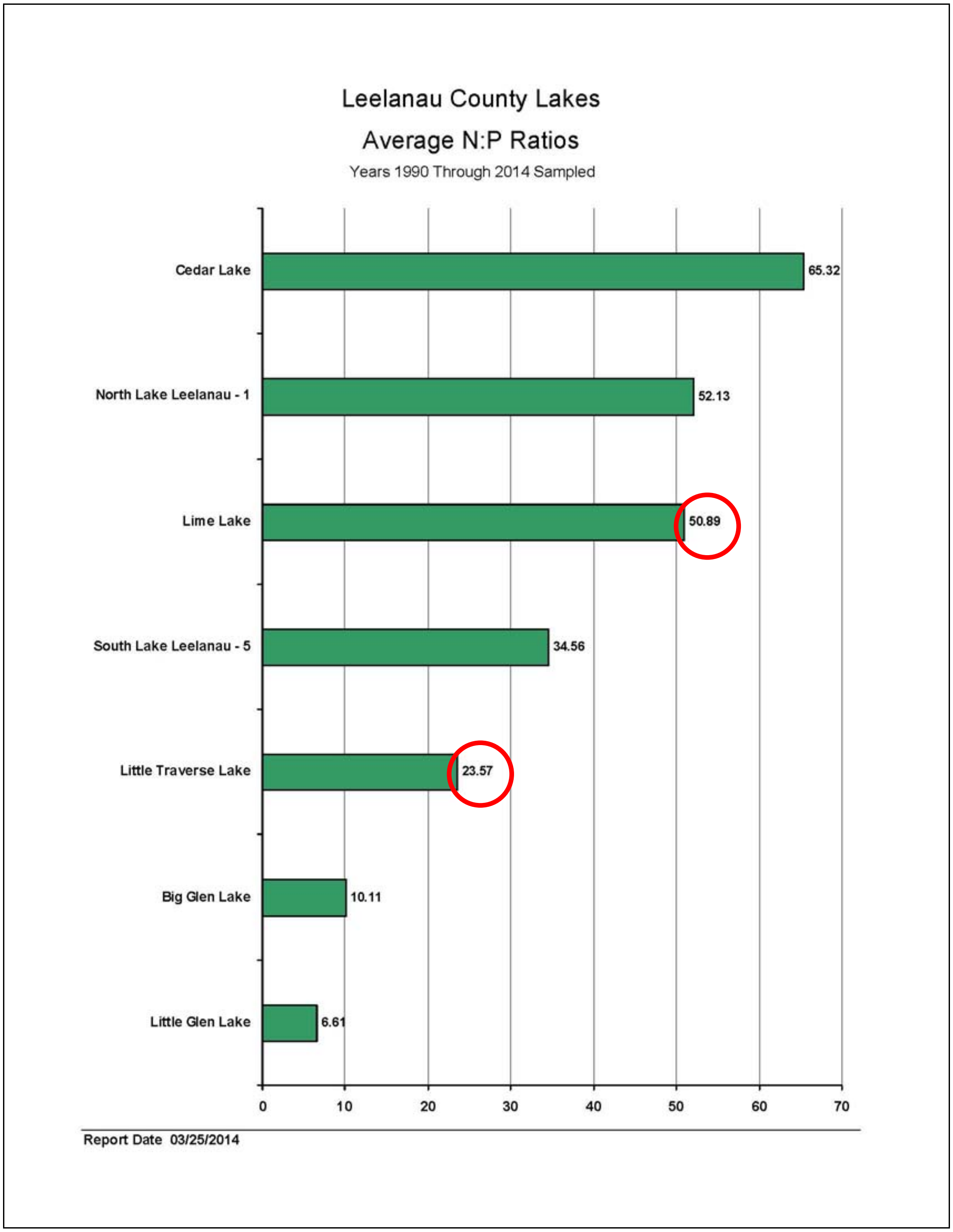


Figure 17: N:P Ratio for all Lakes in Leelanau County (1990-2014)



Lime Lake

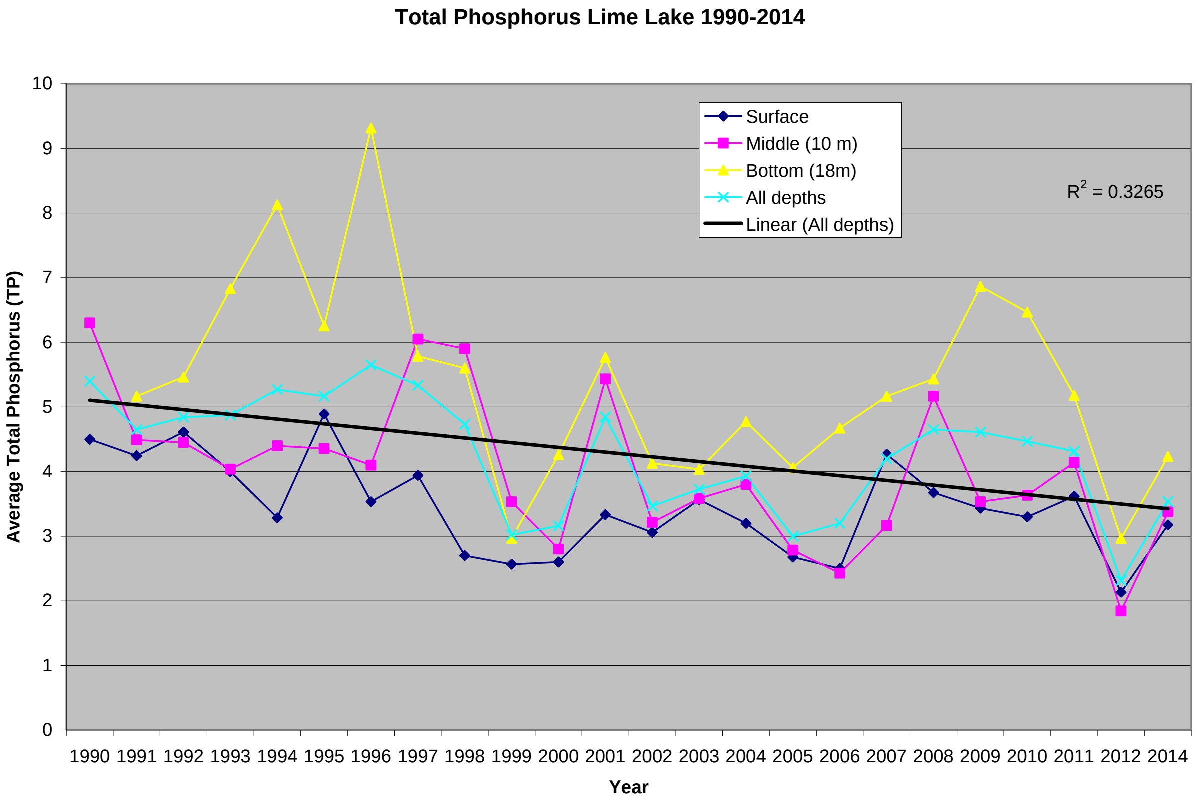
Lime lake was sampled for Total Phosphorus (TP) at three different depths 165 times for a total of 402 measurements from 1990-2014. Total Phosphorus (TP) for Lime Lake has averaged 4.3 ug/L at all depths (Table 15). This is the lowest observed average TP value for all of our lakes, placing Lime Lake in the ultra-oligotrophic range. Many who spend time in Lime Lake in the summer may notice the cloudy, lime green aspect of the water. This is due to the hard water calcareous nature of the system, and it undoubtedly results in some summertime co-precipitation of phosphorus with calcium carbonate, ultimately removing phosphorus from the system (Keilty and Woller 2002). All of the Lakes in Leelanau county experience this, but Lime Lake and nearby Glen Lake seem to be the most remarkable in this regard (Keilty and Woller 2002).

Table 15: Lime Lake Total Phosphorus (TP) and Nitrogen (NOx) results (1990-2014) at 0, 10 and the bottom (18 m), n =165

	0m	*10m*	18m	All depths
Parameter	***Result***	***Result***	***Result***	***Result***
TP (mg/L)	3.5	4.0	5.5	4.3
NOx (ug/L)	231.8	213.3	203.6	216.0

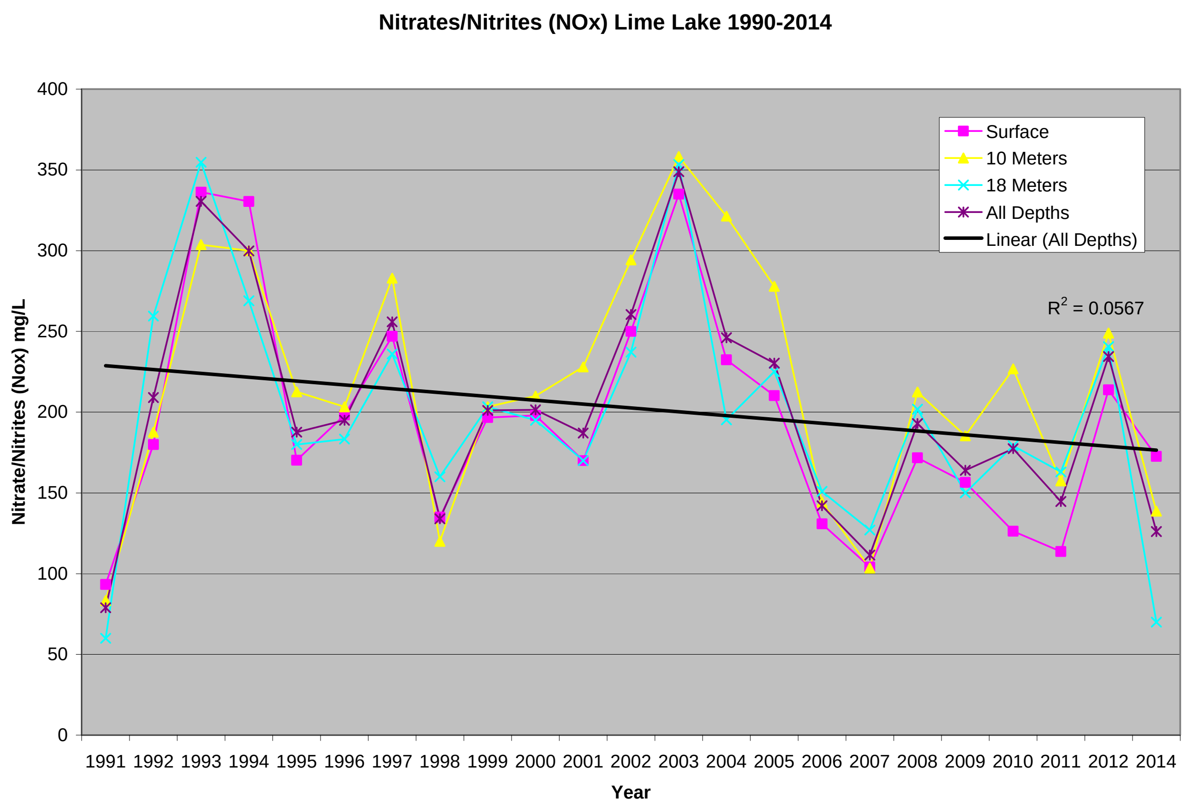
When looking at the TP values over the various depths (surface -0m, middle-10m and the bottom, 18m) from 1990-2014, there a slight decrease from 1990 (Figure 18). These levels are quite a bit higher than what was observed in Little Traverse Lake at 5.08 ug/L (Figure 20, page 90). While zebra mussel populations were observed as early as 1998 in LTL, they were not established in LTL until 2002 (Woller-Skar 2009). Efforts by riparian owners to reduce Phosphorus inputs undoubtedly have had an effect further enhanced by subsequent zebra mussel filtering.

Figure 18: Lime Lake Total Phosphorus (1990-2014)



Nitrate levels in Lime Lake averaged 215.9 ug/L for 364 observations, sampled 165 times (Table 16 above. Figure 19) resulting in an N:P ratio of 50.9. However, groundwater comprises an estimated 53% of the water coming into Lime Lake, while groundwater only comprises 16% of water coming into Little Traverse Lake (Canale and Neilsen 1997). It is believed that there are more extensive submergent weed beds in Little Traverse Lake and that these macrophytes may be assimilating much of the nitrate during the growing season (Keilty and Woller 2002).

Figure 19: Lime Lake Nitrate/Nitrites from 1990-2014



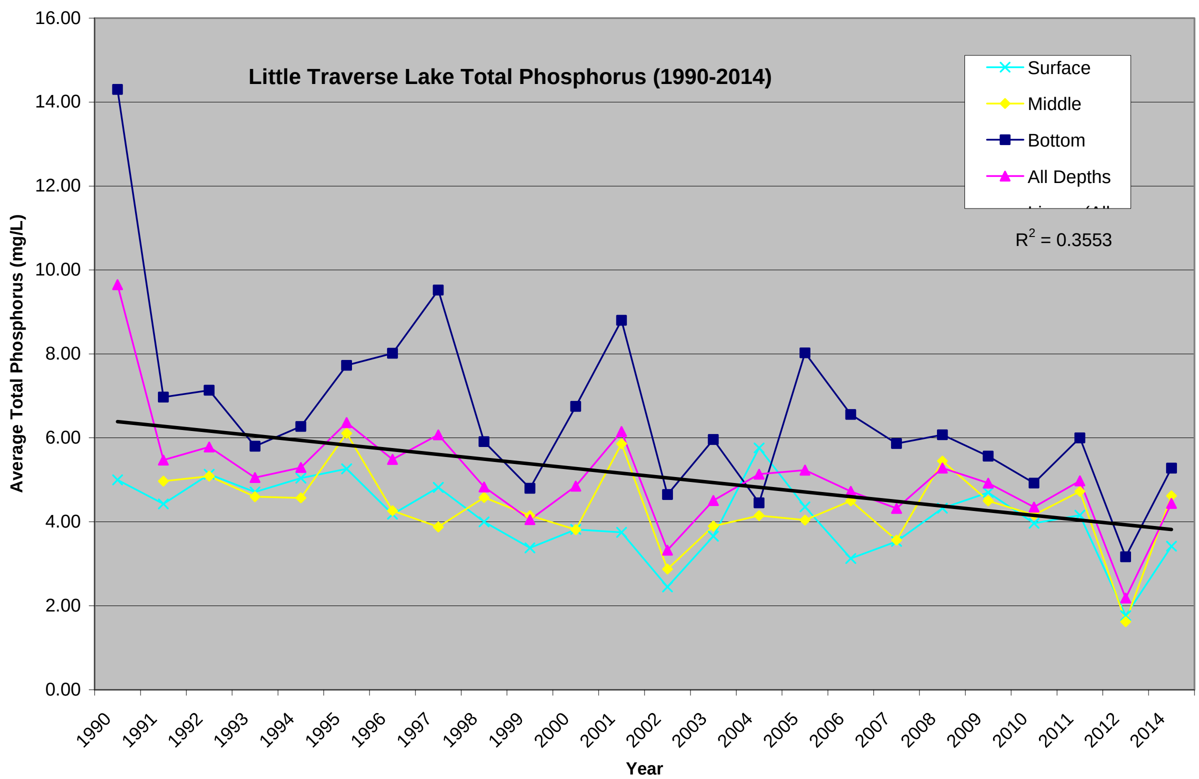
Little Traverse Lake

The Total Phosphorus (TP) in Little Traverse Lake has averaged 5.08 ug/L for 218 sampling dates for a total of 462 measurements from 1990-2014 (Table 16). By this standard, the lake would be considered oligotrophic. When looking at the average TP values over the various depths (surface -0m, middle-7m and the bottom, 12-14m) from 1990-2014, there is a slight decrease from 1990 (Figure 20).

Table 16: Little Traverse Lake TP and Nitrogen (NOx) at 0, 7 and the bottom (12-14 m) (1991-2014), n =218

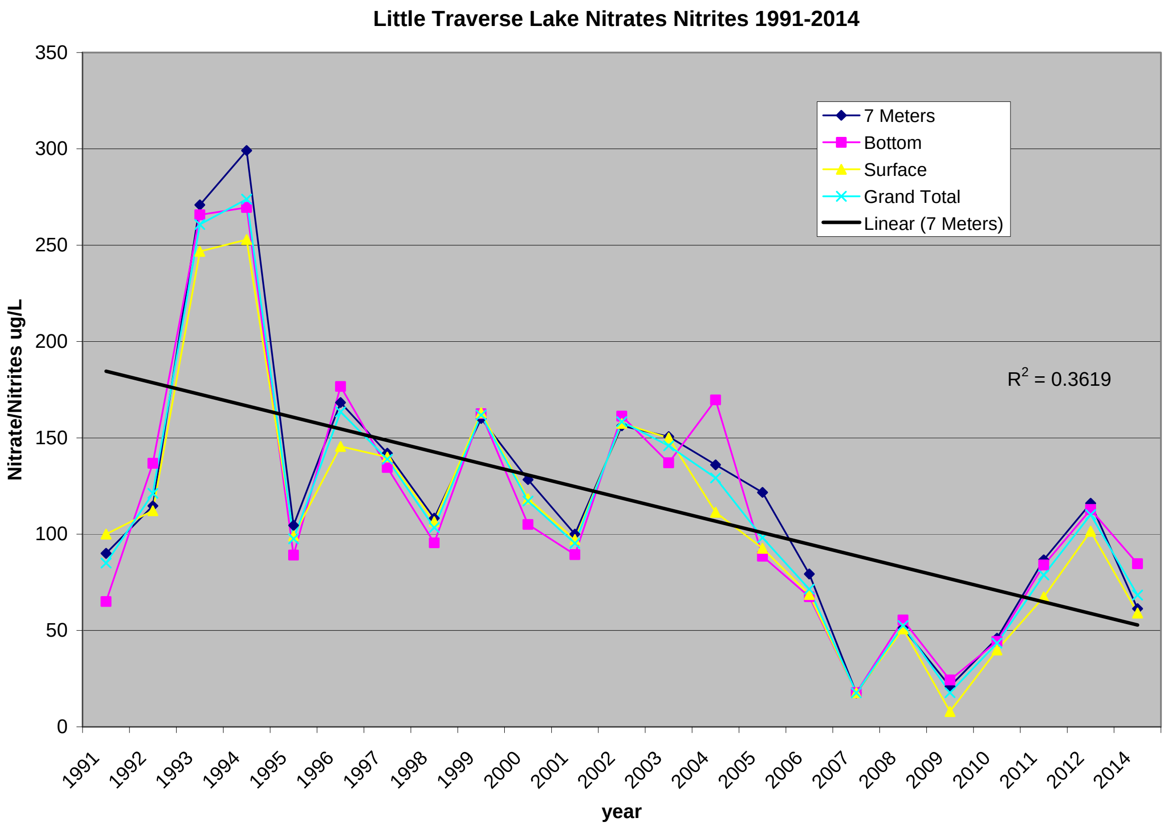
	0	7	bottom	All depths
Parameter	*Result*	*Result*	*Result*	*Result*
TP (ug/L)	6.5	4.4	4.3	5.1
NOx (ug/L)	124.7	130.0	117.6	123.8

Figure 20: Total Phosphorus Results (1990-2014) Little Traverse Lake



Nitrate nitrogen in Little Traverse Lake has average 123.8 ug/L for 218 sample dates for a total of 430 measurements from 1990-2014, resulting in an overall N:P ratio of 23.58. Levels of nitrate nitrogen have decreased with respect to time as demonstrated with the negative slope associated with the regression line (Figure 21).

Figure 21: Nitrate/Nitrites from 1990-2014 in Little Traverse Lake



Chlorophyll a

Both Lime and Little Traverse Lake are within ranges of chlorophyll a for oligotrophic lakes (0.3 – 4.5 ug/L) (Keilty and Woller, 2002) (Figures 22 & 23). The authors show decline of chlorophyll a from the water column, and attribute it to zebra mussel filtering of plankton in Little Traverse Lake, however in 2000 there was no evidence of zebra mussels in Lime Lake. By 2002 zebra mussels were noticed in Lime Lake (Woller Skar 2009).

Chlorophyll a in Lime Lake averaged 1.7 ug/L for 116 measurements from 1993-2014 (Figure 21). This is lower than the average from Keilty and Woller's data from 1990-2000 (2.58 ug/L). Chlorophyll a in Little Traverse Lake averaged 2.25 ug/L for 163 measurements from 1993-2014 (Figure 23).

Figure 22: Average Chlorophyll a for Lime Lake (1990-2014)

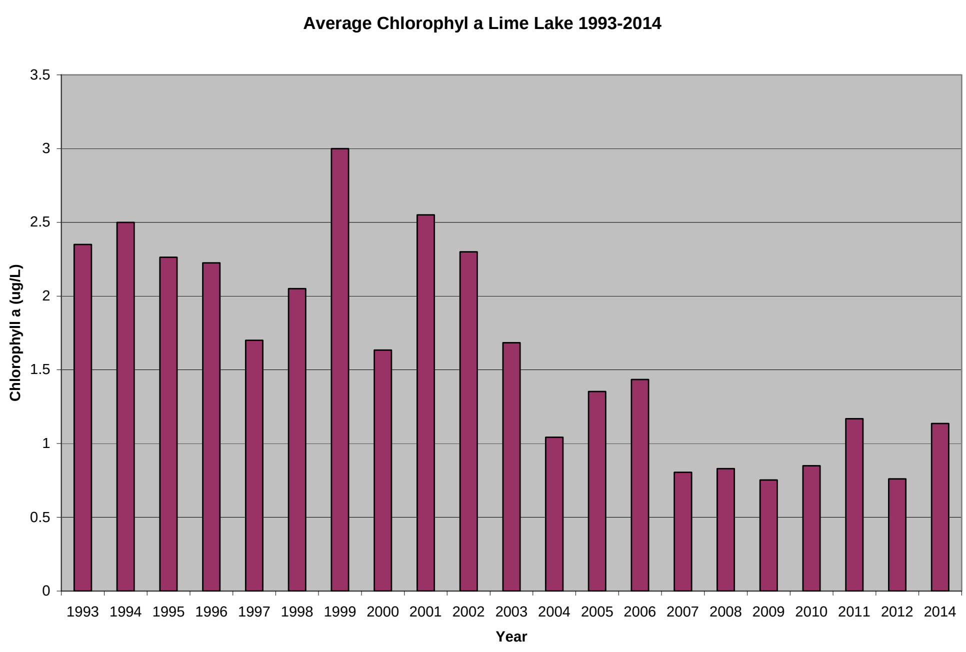
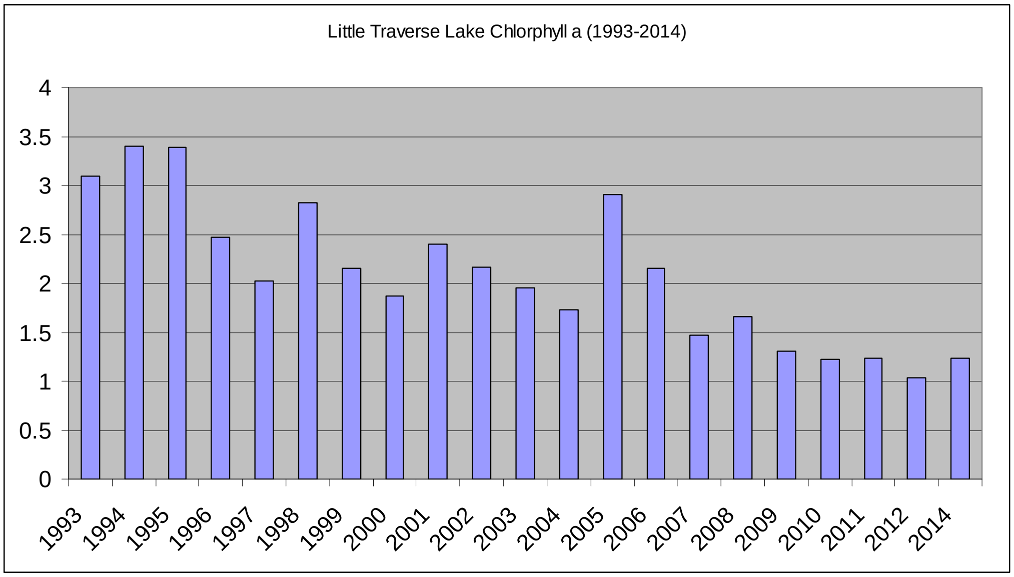


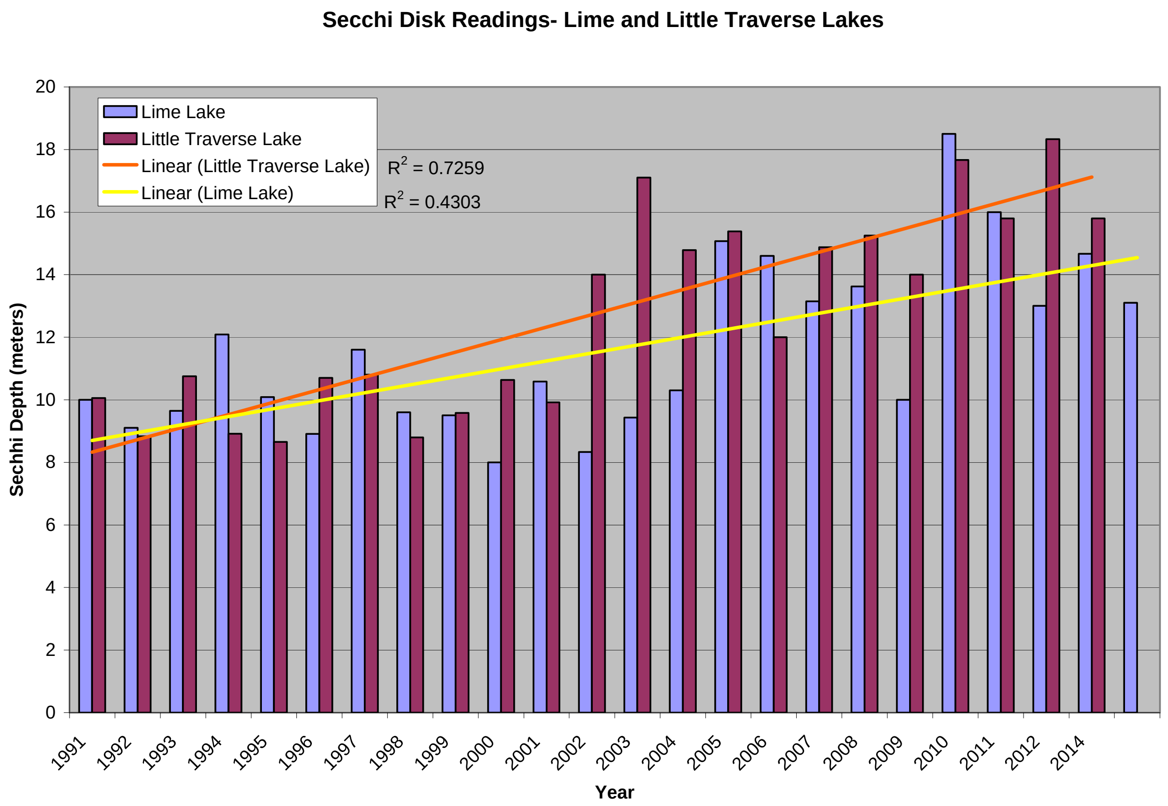
Figure 23: Average Chlorophyll a for Little Traverse Lake (1990-2014)



Secchi Disk

The Secchi disk is a measure of water transparency, which is directly linked to inorganic suspended solids and plankton abundance. Transparency and secchi disk depth measurements vary throughout year, with generally greater depths observed in spring and fall. The figure below shows average annual measurements from Lime and Little Traverse Lake from 1990-2014 which generally show an increase in secchi readings (or higher water clarity) for the averages of the two periods (Figure 24). This is mostly likely directly related to zebra mussel colonization. For example, in the spring of 2002, the secchi disc reading in Little Traverse Lake was 10m.

Figure 24: Average Secchi Disk Readings for Lime and Little Traverse Lakes (1990-2014)

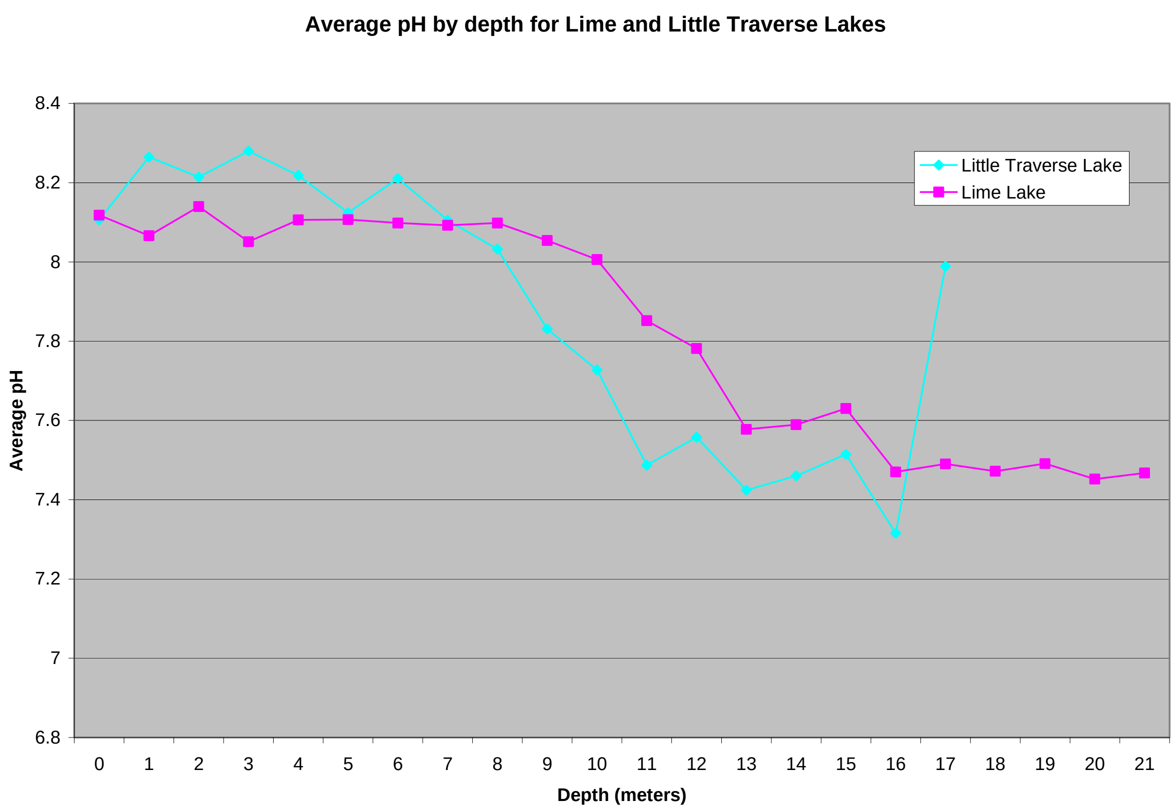


<u>General Characteristics: (Depth, Temperature, Dissolved Oxygen – DO, Conductivity, pH, Secchi Disk, Oxidation/Reduction Potential)</u>

Temperature and Dissolved Oxygen are intimately linked in northern temperate lakes such as Lime and Little Traverse Lake, because of the formation of a vertical temperature gradient during summer periods. Because cooler water is denser than warmwater 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 warmwater 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 Lime and Little Traverse Lake. These conditions favor the release of Phosphorus from the sediments, consistent with observed data.

The pH was sampled for each of the lakes at various depths from the surface to the bottom. The pH of both Lime and Little Traverse Lake 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 (Figure 25).

Figure 25: Average pH by depth (meters) for Lime and Little Traverse Lakes



Hydrolab profile data, secchi disk transparency data, and water samples have been collected 3-6 times per year on Lime Lake between 1990-2014, Water samples were collected at the surface, 10, and 18 meters, while 50 ml Chlorophyll a samples have been collected at 1 meter since 1993. Profile and water chemistry data indicate that the water quality of Lime Lake is also good and stable characteristic of a northern dimietic oligotrophic lake (Table 17) (Keilty 1997). Although consistently exhibiting oxygen depletion prior to fall overturn, the internal phosphorus input is probably small. Concentrations in the hypolimnion are elevated relative to the overlying water, particularly in the early and late summer periods and it is unlikely that a significant amount of Phosphorus precipitates when O_2 returns (Keilty 1997). The data from 1990-2014 appear as expected, normal, while higher concentrations in the early summer are more difficult to interpret.

Hydrolab profile data, secchi disk transparency data, and water samples have been collected 3-6 times per year on Little Traverse Lake between 1990-2014, Water samples were collected at the surface, 7, and 14 meters, 50 mI Chlorophyll a samples have been collected since 1993. Profile and water chemistry data indicate that the water quality of Little Traverse Lake is also good and very different from other lakes (Keilty 1997) (Table 17). Although consistently exhibiting oxygen depletion prior to fall overturn, the numbers suggest there is some internal phosphorus input from the oxygen depleted hypolimnion each summer (Keilty 1997).

Table 17: Hydrolab profile data for Little Traverse Lake and Lime Lake (1990-2012)

Lime Lake		*Little Traverse Lake*	
Parameter	**Result**	**Parameter**	**Result**
Depth ft (maximum)	67	Depth ft (maximum)	54
Depth ft (mean)	17.8	Depth ft (mean)	9.6
Temperature (F) Surface	63.9	Temperature (F) Surface	65.1
Temperature (F) Bottom	49.9	Temperature (F) bottom	55.4
Dissolved Oxygen (surface)	9.3	Dissolved Oxygen (surface)	9.29
Dissolved Oxygen (bottom)	5.5	Dissolved Oxygen (bottom)	4.4
Conductivity (surface)	0.289	Conductivity (surface)	0.318
Conductivity (deepest)	0.302	Conductivity (deepest)	0.359
pH (surface)	8.11	pH (surface)	8.10
pH (deepest)	7.46	pH (deepest)	7.4
Secchi Disc (range)	8m-18.5m	Secchi Disc (range)	8.7m-18.3m
Secchi Disc (average)	11.6m	Secchi Disc (average)	12.7m

Nutrient Loading for Nitrogen and Phosphorus --

A study of Leelanau County lakes, including Lime and Little Traverse Lake 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. Another report by Dr. Tim Keilty and Meg Woller was written in 2002 and summarizes the water quality data for all Leelanau County Lakes from 1990-2000 (Keilty and Woller 2002). Since 2000, water quality sampling in the major lakes and tributaries has continued and a database was created in 2008. However, this data was not formally summarized in an updated report, specifically for Lime or Little Traverse Lake until the GHB watershed planning process started.

Lime Lake Nutrient Budget

Lime Lake nutrient loading is summarized in Table 18 using data from 1992-1997 (Canale and Nielsen 1997). It is estimated Lime Lake received 38,587 pounds of TN and 579 pounds of TP annually. Fourteen percent of TP input to Lime Lake is contributed by its major tributary, Lime Creek. Another 25% comes from atmospheric deposition, 18% from internal loading, 20% from groundwater, and 23% from septic systems. About 60.4% of the TN and 70% of TP are retained in the system.

Algae require about 10 times more nitrogen compared to phosphorus for growth and reproduction. The N:P ratios of both the inputs and outputs from Lime Lake are well above ten, therefore phosphorus is the limiting nutrient in Lime Lake (Neilson 1997). Approximately 70% of the phosphorus input to Lime Lake is retained in the sediments. This value is consistent with observations from other lakes with similar water quality. Approximately 74% of the phosphorus input to the lake is from either streams, groundwater, septic systems, or lake sediments. This suggests that improvements or possible future degradations in lake water quality are strongly linked to local watershed activities.

Table 18: Lime Lake Nutrient Budget

	Flow	Total Nitrogen		Total Phosphorus			N:P Ratio
	(cfs)	(ug/L)	Lb/yr	(ug/L)	Lb/yr	% Total	N:P
Lime Creek	5.31	1099	11,484	7.8	82	14	140.9
Atm Deposition	2.47		4,971		151	25	33
Septic Systems			1,670		131	23	12.7
Internal Loading			1,040		104	18	10
Groundwater	8.79	1,124	19,22	6.4	111	20	175.6
TOTAL	**16.57**		**35,587**		**579**		**66.6**
OUTPUT							
Shetland Creek	23.79	550	14,925	6.3	171		87.3
Evaporation	2.47						
Groundwater	0.31	550	336	3.6	2		152.8
TOTAL	**16.57**		**15,261**		**173**		**88.1**
NUTRIENT RETENTION			**60.4%**		**70.1%**		

Little Traverse Lake Nutrient Budget

Little Traverse Lake nutrient loading is summarized in Table 19 (Canale and Nielsen 1997). It is estimated that Little Traverse Lake received 21,024 pounds of TN and 236 pounds of TP annually. Thirty percent of TP input to Little Traverse Lake is contributed by its major tributary, Shetland Creek. Another 22% comes from atmospheric deposition, 6% from internal loading, 10% from groundwater, and 32% from septic systems.

Algae require about 10 times more nitrogen compared to phosphorus for growth and reproduction. The N:P rations of both the inputs and outputs from Little Traverse Lake are well above ten, therefore phosphorus is the limiting nutrient in Little Traverse Lake (Canale and Neilson 1997). Approximately 64% of the input to Little Traverse Lake is retained in the sediments. This value is consistent with observations from other lakes with similar water quality. Approximately 78% of the phosphorus input to the lake is from either streams, groundwater, septic systems, or lake sediments. Note that almost 1/3 of the phosphorus loading is expected from septic drain fields. This suggests that improvements or possible future degradations in lake water quality are strongly linked to local watershed activities.

Table 19: Little Traverse Lake Nutrient Budget

	Flow	Total Nitrogen		Total Phosphorus			N:P Ratio
INPUT	(cfs)	(ug/L)	Lb/yr	(ug/L)	Lb/yr	% Total	N:P
Shetland Creek	15.87	550	17,176	6.2	194	30	88.7
Atm Deposition	2.36		4,748		144	22	33
Septic Systems			2,649		208	32	12.7
Internal Loading			410		41	6	10
Groundwater	3.52	1573	10,896	10	69	10	157.3
TOTAL	**21.75**		**35,879**		**656**		**54.7**
OUTPUT							
Shalda Creek	19.13	551	20,743	6.2	233		88.9
Evaporation	2.36						
Groundwater	.26	551	282	6.2	3		88.9
TOTAL	**21.75**		**21,024**		**236**		**88.9**
NUTRIENT RETENTION			**41.4%**		**64.0%**		

(Canale and Neilsen 1997 report)

3.3 LIME LAKE AND LITTLE TRAVERSE LAKE SHORELINE SURVEY SUMMARY

Lime Lake Shoreline Greenbelt Survey Summary Report

Purpose

The purpose of the Lime Lake shoreline and greenbelt survey was to evaluate the current condition of the existing shoreline and to establish a baseline of shoreline conditions for future evaluations.

Background

The Good Harbor Bay Watershed plan is a work in progress. The shoreline greenbelt survey will serve as a point of information in determining recommendations and actions as part of water quality protection planning. Other watershed plans have established that major threats to high water quality are sediments from erosion and storm water runoff and nutrients from fertilizers, storm water runoff, and leaking septic systems.

Survey Method

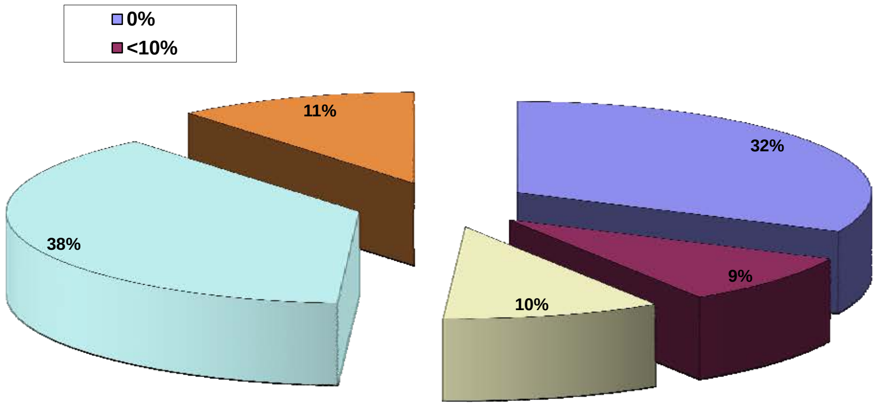
The shoreline survey of the entire Lime Lake coastline was conducted during the summer of 2013. Lime Lake is located within Cleveland Township, Leelanau County, Michigan.

All properties were surveyed with data recorded on survey sheets, including GPS readings and photos taken. Funding was provided by the Lime Lake Association.

Summary of Data

Looking at the data gathered from the Lime Lake Shoreline and Greenbelt survey, 42% of the shoreline of Lime Lake is natural and 58% is landscaped. About 66% of the shoreline of Lime Lake is developed, and only 34 % is natural. Vegetation coverage was also documented and the results show about 32% of the shoreline had no vegetation coverage (Figure 26). This could be an area of concern and where educational efforts could be focused.

Figure 26: Vegetation Coverage for Lime Lake



Little Traverse Lake Shoreline Greenbelt Survey Summary Report

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Background

The Good Harbor Bay Watershed plan is a work in progress. The shoreline greenbelt survey will serve as a point of information in determining recommendations and actions as part of water quality protection planning. Other watershed plans have established that major threats to high water quality are sediments from erosion and storm water runoff and nutrients from fertilizers, storm water runoff, and leaking septic systems.

Survey Method

The shoreline survey of the entire Little Traverse Lake coastline was conducted during the summer of 2013. Little Traverse Lake is located within Cleveland Township, Leelanau County, Michigan.

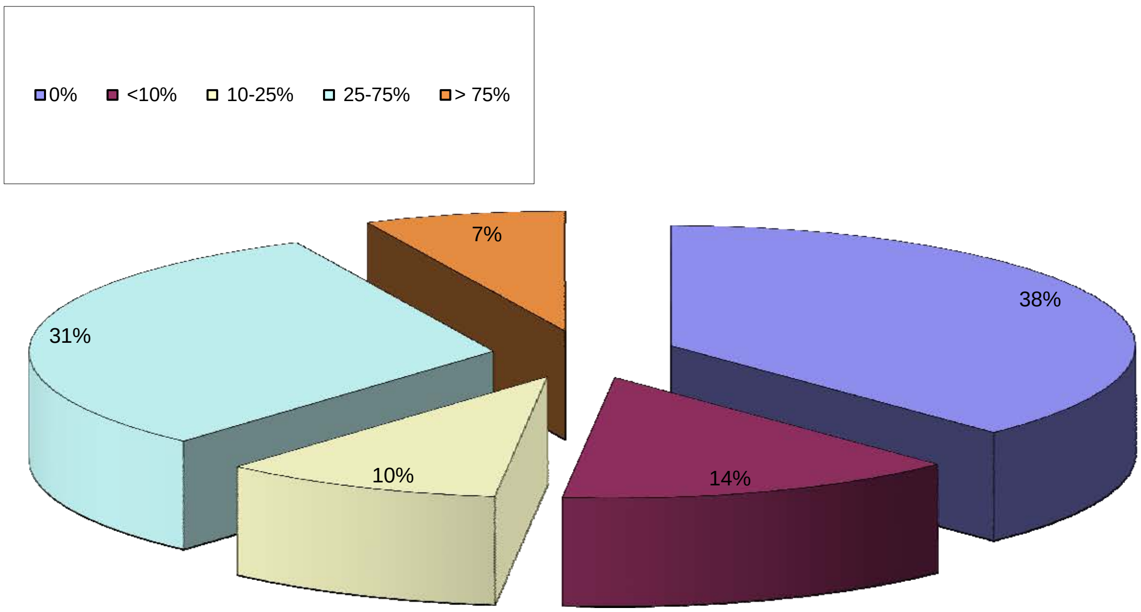
All properties were surveyed with data recorded on survey sheets, including GPS readings and photos taken. Funding was provided by the Little Traverse Lake Property Owners Association.

Summary of Data

Looking at the data gathered from the Little Traverse Lake Shoreline and Greenbelt survey, below is the summary of the study:

A) 54.5% of the shoreline of Little Traverse Lake is natural and 45.5% is landscaped
B) 51.7% of the shoreline of Little Traverse Lake is developed and 48.3% is undeveloped
C) Vegetation coverage of the shoreline of Little Traverse Lake are shown in Figure 27.

Figure 27: VEGETATION Coverage for Little Traverse Lake



3.4 SLEEPING BEAR DUNES NATIONAL LAKESHORE WATER QUALITY SUMMARY

Water resources at Sleeping Bear Dunes National Lakeshore (SLBDLNS) are abundant, diverse, and of high quality. They include 27 named inland lakes, five rivers and streams, 65 miles of Lake Michigan shoreline and nearshore waters, as well as an abundance of bogs, springs, and interdunal wetlands (see Figure 14, Page 53 for the SLDNLS boundaries within the Good Harbor Bay Watershed). Although studies of these waters precede 1940, for the purpose of this watershed management plan only the current water quality monitoring program is included. The following is a brief overview of the water quality monitoring program at SLBE.

The water quality monitoring program at SLBE is part of a larger initiative to establish consistent, scientifically sound water quality monitoring within regions of the National Park Service (NPS). Since 2007, water quality monitoring at SLBE has been done in conjunction with the NPS Great Lakes Inventory and Monitoring Network (GLKN). While developing a monitoring protocol for inland lakes a national review panel, assembled by the National Park Service – Water Resources Division, recommended a suite of five parameters be measured for all NPS monitored inland lakes. In addition to these five mandated parameters (temperature, pH, specific conductance, dissolved oxygen, and flow/water level) a measure of water clarity (Secchi depth or transparency tube depth) was added to the core suite. The core suite was ranked highest among potential vital signs for aquatic systems of GLKN parks, although it was recognized that these measurements were less diagnostic of water quality degradation than biotic communities and other water quality variables, such as nutrient concentrations.

Inputs of excess nutrients, invasion and spread of exotic species, and contaminants from atmospheric fallout and surface runoff, and how these stressors affect the chemical and biological functions of lakes are key issues of concern to the NPS. By monitoring an advanced suite of parameters (nitrogen and phosphorus species, dissolved organic carbon, major ions, dissolved silica, and chlorophyll-a), data can be collected for a more thorough understanding of changes in lakes over time. The primary objective of this monitoring program is to monitor water quality in order to describe the current status and to detect trends of common limnological parameters within sampled lakes. The hope is to be able to provide early warnings of change, work with researchers to understand the causes of change, and provide interpretation of our results to the public.

Starting in 2007, SLBDNL has focused its water quality monitoring efforts on ten inland lakes: Manitou, Florence, Shell Tucker, Narada Bass Loon, Round, Otter, and North Bar. Each lake, excluding Narada, is sampled three times during the field season by park natural resources staff. At each lake a multi-probe datasonde is used to collect depth profiles of temperature, pH, conductivity, and dissolved oxygen. Additional measurements recorded on-site include water clarity, water level relative to a benchmark, and a list of physical and environmental conditions. Additionally, water samples are collected and shipped to a contract laboratory facility for analyses of the advanced suite of parameters, including: nutrients (total phosphorus, total nitrogen, nitrate+nitrite-nitrogen, ammonium-nitrogen, dissolved silica), major ions (calcium, sodium, magnesium, potassium, sulfate, and chloride), dissolved organic carbon, alkalinity, and chlorophyll-a.

Of the 27 inland lakes at least partially within the SLBDNL boundary, very few fall within the Good Harbor Bay Watershed. In fact, Shell and Bass Lakes are the only inland lakes within the watershed that is part of the water quality monitoring program at SLBDNL. . All the information collected through SLBE's inland lakes water quality monitoring program is submitted to the U.S. Environmental Protection Agency (EPA) and made available to the public through the EPA's STORET database. For additional information on natural resources within the National Lakeshore, please visit the SLBE website at: www.nps.gov/slbe.

CHAPTER 4: THREATS TO WATER QUALITY IN THE GOOD HARBOR BAY WATERSHED

4.1: WATER QUALITY STANDARDS AND DESIGNATED USES

Each of Michigan's surface waters is protected by water quality standards for specific designated uses (Table 20). 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. The water quality standards are found in Table 21 (page 110).

Table 20: 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

It is important to note that an additional coldwater fishery state designated use applies to Lime Creek, Shetland Creek and Shalda Creek from the outlet on Little Traverse Lake to Lake Michigan. Designated trout and salmon streams require high dissolved oxygen content and year-round temperatures below 74 degrees Fahrenheit. These are high water quality systems that depend on stable groundwater flows that are low in nutrients. The predominantly sandy loam soils of the region are highly permeable and very susceptible to the forces of erosion. Poor land use and development of land adjacent to stream corridors typically leads to excessive sediment being carried by stormwater flowing across the land into the stream channel. This can bury large woody debris and other in-stream habitat, which effectively turns the system into an aquatic desert.

Table 21: State of Michigan Water Quality Standards 3106

Pollutant	Water quality standards*	Designated Uses Affected
Dissolved solids	500 mg/L monthly average or 750 mg/L at any time	All
Chlorides	125 mg/L monthly average	Public Water Supply
pH	6.5 to 9/0	All but navigation
Taste or odor-producing	Any concentration	Public Water Supply, Industrial
Toxic substances (selected shown here; see rule for complete listing)	DDT and metabolites: 0.00011 µg/L ; Mercury, including methylmercury: 0.0013 µg/L ; PCBs (class): 0.00012 µg/L ; 2,3,7,8-TCDD: 0.0000000031µg/L	All but navigation
Radioactive substances	Pursuant to U.S nuclear regulatory commission and EPA standards	All but navigation
Plant nutrients	Phosphorus: 1mg/L monthly average for permitted point-source discharges	All
Microorganisms	130 *Escherichia coli* per 100 ml 30-day mean of 5 or more sampling events	Total body contact recreation
	300 *E. coli* per 100 ml 30-day maximum	Total body contact recreation
	1,000 *E. coli* per 100 ml 30-day maximum	Partial body contact recreation
	Human sewage discharges (treated or untreated) 200 *E. coli* per 100 ml 30-day mean or 400 *E. coli* per 100 ml in 7 days or less	

Table 21: State of Michigan Water Quality Standards 3106 (Cont'd)

Pollutant	Water quality standards*	Designated Uses Affected
Dissolved oxygen	Minimum 7 mg/L for coldwater designated streams, inland lakes, and Great Lakes/connecting waters; minimum 5 mg/L for all other waters	Coldwater fishery
	Minimum 5 mg/L daily average	Warmwater fishery
Temperature	Natural daily and seasonal temperature fluctuations shall be preserved Monthly averages for inland lakes: J F M A M J J A S O N D 45 45 50 60 70 75 80 85 80 70 60 50 Monthly averages for inland streams in this watershed: J F M A M J J A S O N D 38 38 41 56 70 80 83 81 74 64 49 39	Coldwater fishery, other indigenous aquatic life and wildlife, warmwater fishery

*Data from Appendix B2 of DEQ's Integrated Water Quality Report – Water Quality and Pollution Control in Michigan (DEQ 2010)

4.2 IMPAIRED AND DEGRADED DESIGNATED USES

If a body of water or stream reach is impacted to the point of 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 2010). 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 Good Harbor Bay watershed was last monitored in 2013 by the Surface Water Assessment Section, and results show that none of the designated uses are impaired on a watershed-wide level.

Due to widespread mercury contamination from industrial emissions occurring in other states lying upwind of Michigan (in terms of predominate weather patterns), all of Michigan's inland lakes, including lakes in the Good Harbor Bay Watershed, are not meeting water quality standards for fish consumption. Fish consumption advisories for PCBs or mercury are the primary cause of inland lakes not meeting water quality standards (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. The problem of mercury contamination and other related toxic contamination problems (i.e., PCB, chlordane, etc.) in the Good Harbor Bay watershed will not be discussed in depth in this Protection Plan, since it is caused by atmospheric deposition of industrial emissions from other states and the DEQ does not consider it to be a treatable 303 (d) impairment.

Degraded water bodies are defined as those that currently meet water quality standards, but may not in the near future. Currently, the designated uses of the Good Harbor Bay watershed are degraded from inputs of phosphorus from various sources within the watershed, increasing human development along with exotic species introduction and proliferation. The GHBWPP has identified the warmwater/coldwater fishery, other indigenous aquatic life and wildlife, and total body contact designated uses as degraded (Table 22). Degraded 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 Good Harbor Bay watershed.

Table 22: Degraded or Impaired Designated Uses in the Good Harbor Bay River Watershed

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

4.3 DESIRED USES

Steering committee and stakeholder input identified the need for establishing Desired Uses to address concerns particular to the watershed that are not addressed by designated uses, which are based on state water quality standards. Desired uses are defined as the ways in which people use the watershed and how they would like to manage and protect the watershed to ensure the sustainability of those uses for future generations. They may range from very general to very specific. Desired uses often help to reflect more qualitative community concerns such as poor sport fishing opportunities or deterioration of scenic viewsheds. Desired uses for the Good Harbor Bay watershed include uses for recreational, aesthetic, human health, and ecosystem preservation (Table 23).

Table 23: Desired Uses for the Good Harbor Bay Watershed

Desired Use Category	Location	Purpose
Recreational Opportunities	Entire watershed	*Sustain high quality inland lake fisheries, coldwater stream fisheries, hunting, paddling, swimming and boating. Develop and promote additional outdoor passive recreational activities such as mountain biking opportunities.
Aesthetics	Forested ridgelines, view corridors and surface water bodies	*Protect forested ridgelines from development to protect water quality and scenic view corridors. *Maintain water clarity and prevent 'whiting' events *Prevent excessive algal growth
Human Health	Lakes, rivers, groundwater	*Primarily groundwater potable water supply.
Ecosystem Preservation	Priority areas	*Promote sustainable watershed development *Protect fish & wildlife habitat *Preserve natural & intact riparian corridors

4.4 POLLUTANTS, SOURCES, AND CAUSES

There are a number of different pollutants and environmental stressors that adversely affect each of the designated and desired uses (Table 24). 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. 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. Environmental stressors representing activities and conditions that negatively impact the designated and/or desired uses of the Good Harbor Bay watershed include invasive species, loss of habitat, excess nutrients, and more (Table 25).

Table 24: Pollutants and Environmental Stressors Affecting Designated Uses in the Good Harbor Bay Watershed

Pollutant or Environmental Stressor	Designated Uses Affected	Desired Uses Affected
Loss of Habitat	Warmwater/Coldwater Fishery	Aesthetics
	Other Indigenous Aquatic Life	Recreation
Invasive Species	Coldwater Fishery	Aesthetics
	Other Indigenous Aquatic Life	Recreation
	Total Body Contact	Ecosystem Preservation
Nutrients	Warmwater/Coldwater Fishery	Aesthetics
	Other Indigenous Aquatic Life	Human Health
	Total Body Contact	
Fluctuation Lake Levels/Altered Hydrology	Coldwater Fishery	Aesthetics
	Other Indigenous Aquatic Life	Ecosystem Preservation
Sediment	Warmwater/Coldwater Fishery	Aesthetics
	Other Indigenous Aquatic Life	Recreation
Pathogens	Total Body Contact	Human Health
(*E. Coli*)		Recreation
Toxins (Mycrocystin, Pesticides/Herbicides, Oils, Gas, Grease, Salt/Chlorides, Copper Sulfate,)	Warmwater/Coldwater Fishery	Human Health
	Other Indigenous Aquatic Life	Recreation
	Fish Consumption	Ecosystem Preservation
Thermal Pollution	Warmwater/Coldwater Fishery	Ecosystem Preservation
	Other Indigenous Aquatic Life	

Note: This is a general list that encompasses stressors and/or pollutants for the entire Good Harbor Bay watershed. Not all reaches in the watershed are impacted by all of the pollutants and/or stressors listed above.

Sources and Causes of Pollutants

A Comprehensive Watershed Protection Table was developed listing potential (p), suspected (s) and known (k) sources and causes of watershed pollutants and environmental stressors (Table 25). This table summarizes key information necessary to focus on water quality protection, provides specific targets to act upon for watershed management and forms the basis for 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 member local knowledge and personal contact with watershed residents. Table 26 then ranks the pollutants and stressors in the Good Harbor Bay Watershed.

The Comprehensive Watershed Protection Table (Table 25) 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.

Table 25: Pollutants, Sources, and Causes of Water Quality Degradation in the Good Harbor Bay Watershed (Comprehensive Watershed Protection Table)

Environmental Stressor or Pollutant	Impaired or Affected Designated Use	Sources: K = known, S = suspected, P = potential	Causes: K = known, S = suspected, P = potential
Loss of Habitat	Warm/ Coldwater Fishery Other Indigenous Aquatic Life	Shoreline erosion (k)	Climate Change (s) Fluctuations in precipitation (k) Landscaping practices (k)
		Conversion of vegetated/forested areas to developed land uses (s)	Increasing local population w/o sufficient land use regulations in local zoning ordinances to protect high priority land protection areas (s) Improper residential lot & driveway design (s)
		Native habitat out competed by invasive species (k)	Availability and preference for invasive perennials at nursery & landscaping stores (k) Lack of awareness and/or concern (k) Lack of restrictions on boat travel (k)
Invasive Species	Warm/Coldwater Fishery Other Aquatic Life Navigation Total Body Contact	Landscaping practices (k)	Availability and preference for invasive perennials at nursery & landscaping stores (k) Lack of awareness and/or concern (s)

Table 25: Comprehensive Watershed Protection Table (Cont'd)

Environmental Stressor or Pollutant	Impaired or Affected Designated Use	Sources: K = known, S = suspected, P = potential	Causes: K = known, S = suspected, P = potential
Invasive Species (Cont'd)		Anthropomorphic introduction of Invasive Species (k)	Lack of restrictions on boat travel (k) Lack of education and/or knowledge on invasive species and BMPs (k) Not properly cleaning boats between lakes (k) Direct human introduction via shoes, cars, aquariums, pets, fishing, live bait, etc (s) Migration of invasive species from Lake Michigan (s)
		Wildlife transporting invasive species (k)	Anthropomorphic introduction of invasive species that are spread by wildlife (k)
Nutrients	Warm/ Coldwater Fishery Other Indigenous Aquatic Life Total Body Contact	Residential, Agricultural Commercial Fertilizer Use (k)	Improper application (amount, timing, frequency, location, method, P content) (s)
		Septic Systems (s)	Inadequate design, sited, sized, maintained (s) High density/age of systems (s) Lack of required inspections or point of sale ordinance (s) Lack of information/education on septic system care and maintenance (s)

Table 25: Comprehensive Watershed Protection Table (Cont'd)

Environmental Stressor or Pollutant	Impaired or Affected Designated Use	Sources: K = known, S = suspected, P = potential	Causes: K = known, S = suspected, P = potential
Nutrients		Soils exposed to stormwater runoff (k)	Elimination of riparian vegetation from natural shorelines (s) Poor agricultural & forestry practices, improper road construction or land use practices (s) Improper landscaping practices on private waterfront residential properties (leaving large amounts of biomass to decompose)(s)
		High water levels (k)	Climate change (s) Fluctuations in precipitation (k)
		Anthropomorphic influences(s)	Human or pets bathing in water bodies (s) Dry/Gray wells (s) Improper runoff design (s)
		Transportation (s)	Potential spills or contamination from vehicles on public roadways (s)
		Agriculture (s)	Runoff into streams/water bodies (s) Poorly managed livestock operations (s) Conversion of non-productive and/or forested land to agriculture (s)
		Atmospheric Deposition (k)	Industrial emissions (k)

Table 25: Comprehensive Watershed Protection Table (Cont'd)

Environmental Stressor or Pollutant	Impaired or Affected Designated Use	Sources: K = known, S = suspected, P = potential	Causes: K = known, S = suspected, P = potential
Hydrology	Warm/ Coldwater Fishery Other Indigenous Aquatic Life	Intense precipitation periods (k)	Climate change (s) Inadequately sized culverts (s) Sedimentation (k) Stream obstructions (p)
Sediment	Warm/Cold water fishery Other indigenous Aquatic Life Navigation	Road and stream crossings (k)	Erosion of embankments (k) Road sanding (s) Inadequate design/construction/maintenance (k) Lack of erosion/surface runoff controls (k) Steep approaches (k) Reduced flow capacity at culverts, crossings or bridges (k)
		Bank/Shoreline erosion (k)	Removal of riparian and native vegetation from natural shorelines (s) Boat traffic/wakes (p) Natural forces (e.g.) wind/wave action (p) Fluctuation in water levels (s) Inadequate design, construction, and/or maintenance of culverts and road/stream crossings (s) Vulnerability of water ways to changing climate conditions (s)

Table 25: Comprehensive Watershed Protection Table (Cont'd)

Environmental Stressor or Pollutant	Impaired or Affected Designated Use	Sources: K = known, S = suspected, P = potential	Causes: K = known, S = suspected, P = potential
Sediment		Residential, Commercial and/or Road Construction (k)	Inadequate soil erosion and stormwater management practices (k) Direct runoff entering water bodies from residential and developed areas (k) Impervious surfaces not allowing proper infiltration or directing water in an inappropriate direction (s)
		Soil exposed to stormwater runoff (k)	Improper landscaping or land use practices, lack of riparian vegetation (k)
		Forestry Practices (k)	Inadequate road design, management (k) Inadequate timber harvest practices (k)
		Agriculture (s)	Runoff into streams/waterbodies (k) Poorly managed livestock operations (s)
Pathogens (E. coli and Fecal Coliform indicators)	Total Body Contact	Animal Waste (p)	Improper disposal of pet waste (s) Poorly managed livestock operations adjacent to water bodies. (p)
		Septic Systems (p)	Poorly designed,sited,sized,maintained (p) High density/age of systems (p) Uninspected systems (p)

Table 25: Comprehensive Watershed Protection Table (Cont'd)

Environmental Stressor or Pollutant	Impaired or Affected Designated Use	Sources: K = known, S = suspected, P = potential	Causes: K = known, S = suspected, P = potential
Toxins **(Pesticides, Herbicides, Oils, Gas, Grease, Microcystin, Etc.)**	Warm/ Coldwater Fishery Other Indigenous Aquatic Life Fish Consumption	Contaminated groundwater (k)	Improper maintenance septic systems (s) Improper use of chemicals and toxins (s) Inadequate disposal facilities, illegal dumping (k)
		Runoff from developed areas (p)	Direct runoff of paved surfaces to surface water (roads, parking lots, driveways) (p) Infiltration to groundwater from improper storage and over use (p)
		Atmospheric Deposition (k)	Industrial emissions (k)
		Contaminated Sediments (k)	Inadequate disposal facilities, illegal dumping (k)
		Oil, Natural Gas, Hydrocarbon, & Underground Injection Wells (k)	Improper storage and handing or gas and water craft fueling (s) Natural Gas Fracking operation (k), Inadequate Fracking fluid Storage (p) Abandoned Wells (leaking, uncapped) (p)
		Underground Storage Tanks (p)	Leaking tanks (p)

Table 25: Comprehensive Watershed Protection Table (Cont'd)

Environmental Stressor or Pollutant	Impaired or Affected Designated Use	Sources: K = known, S = suspected, P = potential	Causes: K = known, S = suspected, P = potential
Thermal Pollution	Coldwater Fishery Other Indigenous Aquatic Life	Runoff from developed areas (s)	Stormwater runoff being allowed to directly enter surface water bodies (k)
		Lack of Streamside Canopy (p)	Removal of streamside vegetation (p)
		Ponds, impoundments, & other water-control devices (p)	Top draw structures (p) Poorly maintained ponds & other water control devices (p)

4.5 PRIORITY POLLUTANT RANKING

It is important to rank and prioritize pollutants and stressors in order to focus funding and implementation efforts. However this is a complex task due to the synergistic relationships of the pollutants and stressors, which creates greater impacts than any one pollutant or stressor does on its own. Thus it is important to recognize and address medium and low priority pollutants as well as high priority ones in order to help maintain the Good Harbor Bay watershed's overall good water quality. Table 26, on the next page, outlines the steering committees pollutant priorities for the watershed. Table 27 then ranks the pollutants and stressors in the Good Harbor Bay Watershed.

Table 26: Pollutant Priorities for the Good Harbor Bay Watershed

Pollutant	Priority in Watershed
Loss of Habitat	High
Invasive Species	High
Nutrients	High
Hydrology	High
Sediment	Medium
Pathogens (*E. Coli*)	Medium
Toxins (Mycrocystin, Pesticides/Herbicides, Oils, Gas, Grease, Salt/Chlorides, Copper Sulfate,)	Medium
Thermal Pollution	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 27). 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 5.

Table 27: Pollutant Source Priority Ranking

Environmental Stressor or Pollutant	Sources: K = known, S = suspected, P = potential	Priority
Loss of Habitat	Shoreline erosion (k)	HIGH
	Native habitat out competed by invasive species (k)	HIGH
	Conversion of vegetated/forested areas to developed land uses (s)	MEDIUM
Invasive Species	Landscaping practices (k)	HIGH
	Anthropomorphic introduction of Invasive Species (k)	MED
	Wildlife transporting invasive species (k)	LOW
Nutrients	Residential, Agricultural or Commercial Fertilizer Use (k)	HIGH
	Septic Systems (s)	HIGH
	Fluctuating water levels/climate change (k)	HIGH
	Soils exposed to stormwater runoff (k)	MEDIUM
	Agriculture (s)	LOW
Hydrology	Intense precipitation periods (k)	HIGH
	Runoff (k)	HIGH
Sediment	Road and stream crossings (k)	HIGH
	Bank/Shoreline erosion (k)	HIGH
	Residential, Commercial or Road Construction (k)	MEDIUM

Table 27: Pollutant Source Priority Ranking (Cont'd)

Environmental Stressor or Pollutant	Sources: K = known, S = suspected, P = potential	Priority
Sediment (Cont'd)	Soil exposed to stormwater runoff (k)	MEDIUM
	Forestry Practices (k)	MEDIUM
	Agriculture (k)	LOW
Pathogens (*E. Coli* and Fecal Coliform indicators)	Septic Systems (p)	HIGH
	Animal Waste (p)	LOW
Toxins	Runoff from developed areas (p)	HIGH
(Pesticides, Herbicides, Oils, Gas, Grease, Etc.)	Contaminated groundwater (k)	MEDIUM
	Atmospheric Deposition (k)	LOW
	Contaminated Sediments (k)	LOW
	Oil, Natural Gas, Hydrocarbon, & Underground Injection Wells (p)	LOW
	Underground Storage Tanks (p)	LOW
Thermal Pollution	Runoff from developed areas (s)	LOW
	Lack of Streamside Canopy (p)	LOW
	Ponds, impoundments, & other water-control devices (p)	LOW
	Sedimentation in stream channel (s)	LOW

4.6: POLLUTANTS AND ENVIRONMENTAL STRESSORS OF CONCERN

Nutrients

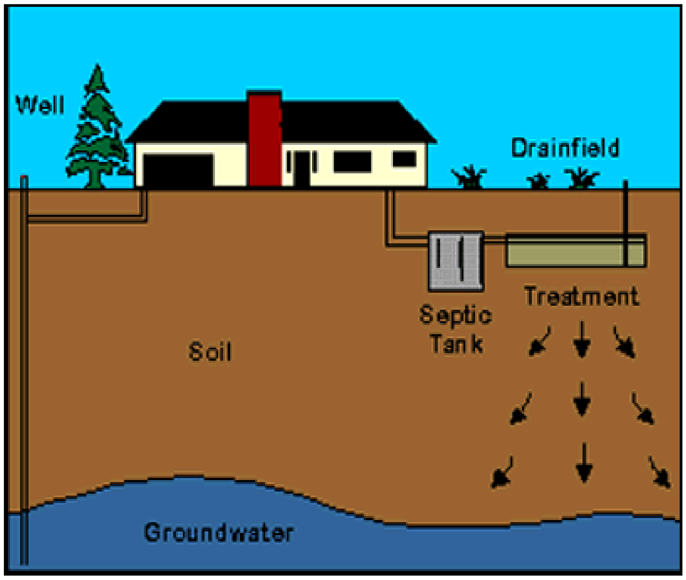
Nitrogen and phosphorus are critical nutrients for all types of plants, including aquatic species. Phosphorus has shown to contribute to excessive algae growth. Phosphorus is the primary nutrient of concern in the Good Harbor Bay watershed.

Sources of increased nutrients to the Good Harbor Bay watershed resulting from human activities include residential and commercial fertilizer use, stormwater runoff and septic system effluent.

Fertilizers

Residential and agricultural fertilizer applications can be a significant source of nutrient input to the watershed. Since phosphorus is most often the limiting nutrient in aquatic systems, phosphorus concentrations in fertilizers could have a dramatic impact on water quality in the Good Harbor Bay watershed due to the high groundwater flow and permeable soils. The Good Harbor Bay Improvement Association has advocated for years to apply phosphorus-free fertilizers anywhere near surface water bodies to help prevent excessive nutrient inputs.

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.

Another potential source of nutrient enrichment in the Good Harbor Bay watershed is from failing septic systems. Septic systems are the most common method of treating wastewater from toilets, wash basins, bathtubs, washing machines, and other water-consumptive items in the Good Harbor Bay Watershed., There are no municipal water systems in the Good Harbor Bay Watershed 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 or 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 and water bodies.

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 nutrient loading into groundwater flows.

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 proliferate under nutrient rich conditions, which increases their competitive advantage over native species

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. Excessive sedimentation can severely degrade an entire aquatic ecosystem 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.

Significant sources of sediment to Good Harbor Bay, Lime and Little Traverse Lake tributaries include activities that cause streambank erosion such as road/stream crossings, high precipitation events, residential development, and other construction events.

Excavation and earth moving or other activity in which soil is disturbed can result in sediment transport to nearby streams if proper precautions are not taken to prevent sediment transport in storm water runoff. Impervious surfaces (roads, rooftops and parking lots) create erosive storm water run-off forces that degrade water quality if allowed to directly enter surface water bodies. Properly infiltrating storm water run-off into groundwater flows through installation of retention basins, improving degraded road stream crossings and managing recreational traffic in the lower watershed will help prevent additional sedimentation of aquatic habitat.

This watershed does not have a formal road and stream crossing survey. This was identified as a high priority task in Chapter 8 (Table 32). The outlet for Little Traverse Lake is a culvert which crosses the west end of Little Traverse Lake road. It is felt to be undersized and under capacity and identified as a task in this watershed plan. The concern is over high lake levels in Little Traverse Lake caused in part by the undersized culvert, low elevation gradient and beaver activity further downstream. There are various groups around Little Traverse Lake working with the Leelanau County Road Commission, Sleeping Bear Dunes National Lakeshore (SBDNL) and Cleveland Township to address the concern over the culvert and high lake levels. A hydrology report, written by a geologist from the SBDNL, along with engineering reports are included as an appendix to this watershed plan (Appendix B-D).

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 and decreases visibility. Excessive amounts of fine sediment can actually clogging fish and insect gills.

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.

Impact #7 Organically rich suspended sediments (silt) undergo aerobic respiration as they breakdown, which uses up dissolved oxygen. Excessive sedimentation with silt or other organic laiden sediments can increase Biological Oxygen Demand due to the microbial decomposition, which in turn can cause in-stream dissolved oxygen concentrations to plummet below the levels required by fish and macroinvertebrates.

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.

The most critical documented aquatic invasive species in the upper Good Harbor Bay watershed are the zebra mussel and *Eurasian Watermilfoil* infestations in the inland lakes.

In recent years, invasive plants have received more and more attention as their adverse effects on natural ecosystems becomes better understood. Within the Good Harbor Bay Watershed, invasive plants can be found in aquatic, wetland, and terrestrial habitats. Some species have been present for many years and are well established, while others are recently arrived and less common. Some of the terrestrial species of primary concern have been garlic mustard, autumn olive, Japanese barberry, Canada thistle, bull thistle, baby’s breath, Japanese knotweed, giant knotweed, and oriental bittersweet. The latter four species are early detection/rapid response (ED/RR) priorities because of their recent introduction, small population sizes and destructive potential. Wetland species of primary concern are phragmites, narrow-leaved cattail, Eurasian swamp thistle, reed canary grass, and purple loosestrife. Phragmites is present in relatively few high-density infestations in the watershed and is still an ED/RR priority. Eurasian water-milfoil is the most common aquatic species, and is present in several lakes in the watershed.

The monitoring and control of invasive plants in the Good Harbor Bay watershed is done by several different groups. First, many private landowners have become aware of the more common invasive species such as garlic mustard or phragmites, and conduct treatments on their own properties. The Northwest Michigan Invasive Species Network (ISN) is a coalition of partner organizations that covers four counties, which includes all of the Good Harbor Bay Watershed. The group has 23 partner organizations and focuses on invasive plant education, prevention, monitoring, and treatment. ISN has a full-time coordinator who divides time between the all four counties and all partner organizations along with seasonal ISN staff and crews. Sleeping Bear Dunes National Lakeshore has staff that does invasive plant treatments on park property within the watershed. The Leelanau Conservancy also treats invasive species found on their natural areas and on neighboring private and public lands within the watershed. The Leelanau Conservancy also surveys all of the Eastern Lake Michigan shoreline for ED/RR species and treats when necessary with landowner permission. The Leelanau Conservation District has begun treating invasive plants, specifically focusing on phragmites, on inland lakes and the Great Lakes Shoreline, including monitoring and treatment along Grand Traverse Bay. In addition, some lake and property associations treat invasive plants within their areas of influence.

The treatment and control of invasive plants is dependent on available funding, expertise, and awareness. It is nearly impossible to eradicate a species once it is established, so priorities must be set in control efforts based on the probability of success and the value of the ecosystem being invaded. ED/RR species such as Japanese knotweed, giant knotweed, oriental bittersweet, baby's breath and phragmites should be treated as soon as possible after they are detected in order to minimize the cost of control and maximize the potential for successful treatment. Of the species that are more common, it is best to treat them as soon as possible after they invade a new area. ISN has funded control for phragmites and knotweed species as the infestations become known, along with allocating funding to partners for other ED/RR priorities. There have been massive efforts in the past three years to locate and treat infestations of phragmites and garlic mustard, which are relatively common, yet have not taken over as they have in other parts of the state. In 2011, ISN (formerly Northwest Michigan Cooperative Weed Management Area) funded phragmites treatments at three sites in the watershed and the Leelanau Conservancy continues monitoring and treatment. The Long Lake Association has been treating Eurasian water-milfoil for more than three years. Future infestations of invasive plants will be inventoried, prioritized, and treated as they are discovered according to availability of resources.

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 among 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.

Loss of Habitat

The population of Leelanau increased by 10% from 2000 to 2010 (U.S. Census). As the population grows throughout the currently rural watershed, the increasing residential and road development fragments the large forested parcels and impedes wildlife movement. Areas of higher quality habitat become smaller and smaller isolated pockets of remnant habitat, many of the important natural process such as seed dispersal and movement of large mammals are lost. The remaining populations become more vulnerable to disease as well and the impact of increasingly nearby human development. Fortunately large portions of the

Good Harbor Bay watershed are already protected under State Forest or National Lakeshore management. Proper land-use practices on the remaining private land across the watershed can help focus future residential growth near existing villages and population centers to prevent hap-hazard development of high quality forested habitat into large residential lots with no nearby community infrastructure.

While the vast majority of the watershed has riparian habitats protected, and there is fairly high quality habitat along the stream, there is concern for aquatic habitat loss. Habitat along the streams and the riparian systems provides adequate coarse woody debris but flow and sedimentation is a concern. An inventory of Aquatic organism and passage issues is part of the implementation tasks as there could be issues with sedimentation relating to hydrologic impacts from inadequate road and stream crossings interrupting the flow.

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 Good Harbor Bay Watershed which is the heart of the region's attraction and draw for over a million annual tourists and residents.

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 all of the inland lakes to protect human health as a result of high chlordane, mercury and PCB (polychlorinated biphenyl) concentrations.

In addition to the substances noted above, another potentially toxic substances in the Good Harbor Bay watershed is sodium chloride. 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 impair fish and macroinvertebrate communities.

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.*

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 Good Harbor Bay 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 stream banks and shorelines from waterfowl like ducks and geese.

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^{o}F range(15-20^{o}C) or below. Lethal maximum temperatures vary with different trout species, but temperatures above 76^{o}F (24.4^{o}C) can be lethal.

Other sources of thermal pollution in the Good Harbor Bay watershed are heated stormwater runoff from paved surfaces, the removal of shade vegetation along stream banks 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.

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^{o}C to 5.8^{o}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 coldwater aquatic species. For example, coldwater 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 GHBWPP. However it will be important for Leelanau County residents to plan for alternative sources of heat to have the greatest impact on reducing climate change.

Typical Impacts from Thermal Pollution

Impact #1: Surges of heated water during rainstorms can shock and stress aquatic life, which have adapted to coldwater 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: Warmwater 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 coldwater species such as brook trout.

Altered Hydrology

The two major natural hydrologic functions that help drive the Good Harbor Bay watershed are groundwater infiltration and discharge. As water flows out of the ground and coalesces into stream channels it carves the path of least resistance. When natural hydrologic flow patterns are altered for transportation infrastructure, large-scale water withdrawals or to create artificial lake levels, the entire hydrologic process becomes compromised. Natural sediment transport regimens become interrupted and aquatic habitat is quickly compromised. One of the main issues in the GHB watershed potentially impacting water quality is the culvert on the west end of Little Traverse Lake. This is referred to as the Little Traverse Lake Outlet System (See the priority and critical areas section below for more details on this topic). The undersized and improperly designed culvert blocks sediment transport along the stream bottom and creates a massive back-up and accumulation of very fine sands and organic silt above the dam structure. The most common altered hydrologic condition throughout the watershed is found in the myriad of un-named groundwater tributary streams that are have been compromised by the installation of undersized culverts that creates a ‘choke-point’ as well as creating biologically unsuitable current forces that can fragment stream segments. The undersized structures are also prone to creating ‘perched’ conditions, where the downstream end of the tube is actually perched above the receiving stream channel creating an impassable waterfall.

Typical Impacts from Altered Hydrology

Impact #1: Compromised sediment transport system above low-head dams or undersized culverts.

Impact #2: Biologically intolerable current forces from undersized culverts.

Impact #3: Undersized culverts can promote a ‘perched’ condition and further fragment the stream channel

4.7 PRIORITY AND CRITICAL AREAS

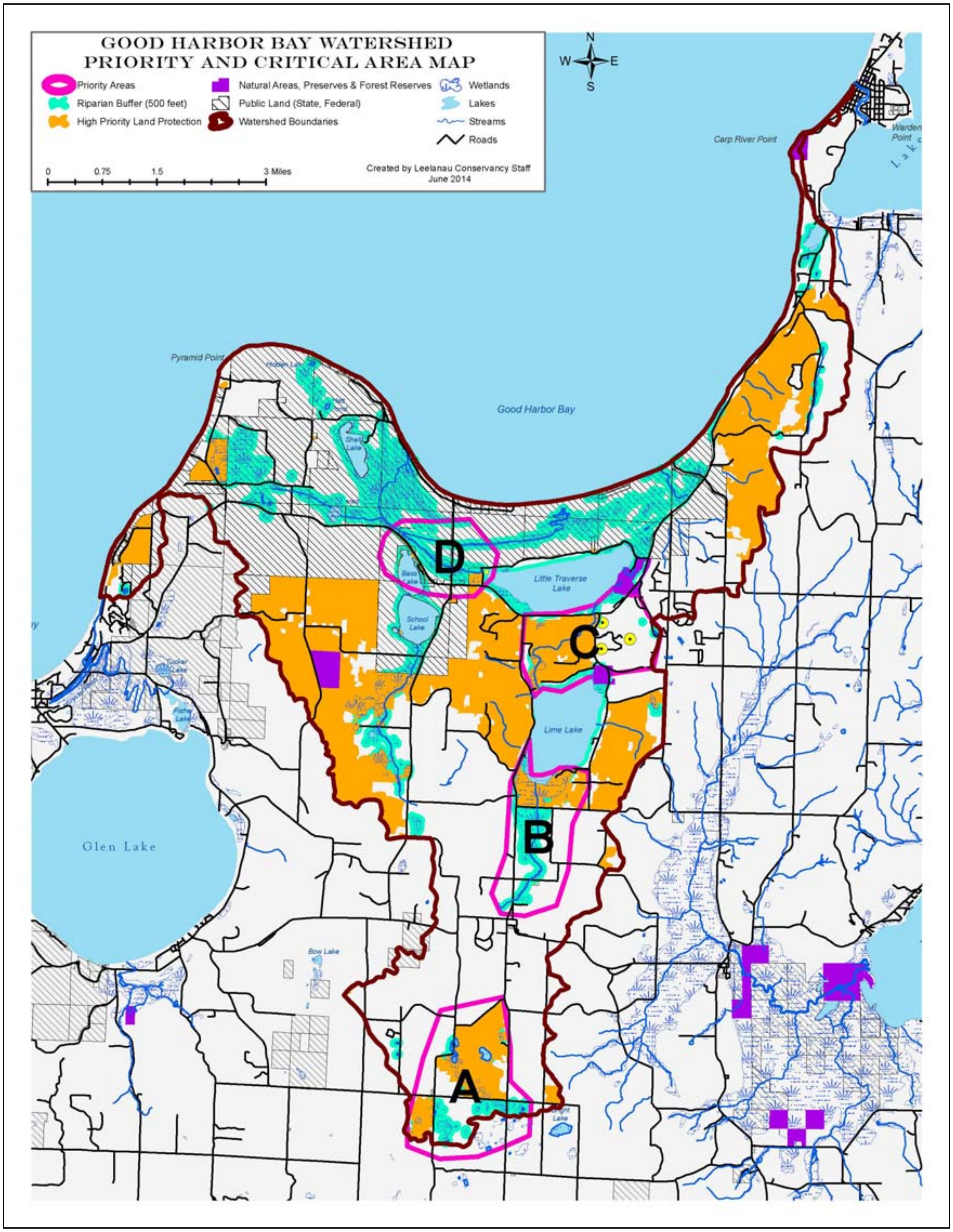
Although watershed management plans address the entire watershed, there are certain areas within the Good Harbor Bay watershed that warrant more extensive management or specific protection consideration. Areas that are most sensitive to impacts from pollutants are considered **Priority Areas.** Areas that require focused monitoring, restoration, remediation and/or rehabilitation are considered **Critical Areas**.

Priority Areas

Priority areas in the Good Harbor Bay watershed are defined as the geographic portions of the watershed that are most sensitive to impacts from pollutants and environmental stressors. The prescribed goals, objectives and tasks for these areas typically focus on preservation and protection. The priority areas were identified by analyzing the sources, causes, and prioritization of watershed pollutants (Tables 24-26). Other resources used to identify the Priority areas include; scientific research reports, the Michigan Natural Features Inventory, water quality monitoring reports, and assessment by scientific consultants to the Good Harbor Bay Watershed Steering Committee.

The priority areas for the Good Harbor Bay watershed are divided four different tiers of protection priorities that cover four geographic areas of the watershed. These tiers and areas are described below and shown in (Figure 28):

Figure 28: Priority and Critical Areas Map



Priority Area Descriptions –

Area A- This area includes the kettle lakes and wetlands in the very upper part of the watershed in Kasson Township. This area contains several isolated kettle lakes with wetland complexes and significant amounts of forested land-use that maintains groundwater recharge for the watershed.

Area B- This area focuses on the wetlands and stream corridors feeding Lime Lake and includes the wetlands, riparian corridors, along Lime Creek.

Area C- This area focuses on the outlet of Lime Lake, Shetland Creek, between Lime Lake and Little Traverse Lake. This area also contains the majority of the coldwater fishery habitat for the watershed.

Area D- This area includes the wetland complex on the western end of Little Traverse Lake (Shalda Creek), which flows through the Sleeping Bear Dunes National Lakeshore and eventually into Lake Michigan.

Tier 1:

- Habitat for or areas with threatened, endangered or species of special concern
- Existing public or protected land within the SBDNL, State, Conservancies and or natural areas and preserves
- High Risk Erosion Areas

Tier 2:

- Surface water bodies (lakes/streams), shorelines, wetlands and land within 500’ of them.
- High Priority Land Protection areas (Top two tiers of Natural Lands Inventory and 500 foot Riparian Buffer)
- Ground water recharge areas

Tier 3:

- Steep Slopes
- Wildlife Corridors

Given there is habitat for rare, endangered and/or threatened species in the Good Harbor Bay Watershed (Section 2.7), the first priority area (Tier 1) focuses efforts where these species may occur as well as within the national lakeshore, state land and other protected land. Since these areas tend to have high quality habitats and include important wetlands and shoreline, continuing to protect these ecological values will contribute to the overall watershed health. Tier 1 also includes the main wetland complexes feeding Lime and Little Traverse Lakes. These diverse wetlands contain superb ecological examples of rich conifer swamp, poor conifer swamp, and emergent and submergent wetland communities.

Tier 2 Prioritizes the protection of all undeveloped land within 500 feet of all streams, bodies of water and wetlands in the designated priority areas. In addition, conservation planning by regional land conservancies has identified large, priority parcels tied to water quality by analyzing multiple datasets. The resulting set of mostly privately owned parcels is prioritized for voluntary permanent land protection options due to their water quality protection and wildlife corridor functions. Groundwater recharge areas are critical to groundwater driven systems such as the Good Harbor Bay Watershed. Groundwater recharge and discharge areas as defined by the most acceptable groundwater mapping technology available should be prioritized for protection. Keeping these areas in a natural state facilitates natural groundwater flow and promotes high water quality.

Tier 3 includes wildlife corridors and steep slopes. While there are not a lot of steep slopes in this watershed, it is important to control erosion and protect streams and water bodies with significant buffers for wildlife and water quality. It is a priority in the Good Harbor Bay Watershed to implement best management practices that will protect the water bodies from increased sediment. It is also a priority to protect wildlife habitat and ecological diversity by connecting natural lands and promoting best management practices for wildlife enhancement.

Critical Areas

Critical Areas are specific sections of the watershed that are suspected to contribute a significant amount of pollutants or have been documented as impacted by stressors or pollutants and require restoration to achieve designated or desired uses. Critical Area designation indicates that implementation of identified tasks will be needed to achieve load reductions identified in the plan (Figure 32). The critical areas for the Good Harbor Bay watershed include the following areas:

- Little Traverse Lake outlet system
- Lime Creek Road Crossings- Narlock and Cemetery Road
- Sugar Loaf Resort and area golf courses

Descriptions of Critical Areas-

Little Traverse Lake Outlet System- by Yarrow Brown, Len Allgaier and Lou Gurthet

In the past 5 years total rainfall in Leelanau County has increased dramatically (28" to 48" annual) with intense events (3-6 inches per) challenging the outlet system on Little Traverse Lake with unprecedented volumes of surplus water (Farm log per Len Allgaier). The high water levels that Little Traverse Lake has been experiencing, specifically on the north side, has raised concerns over the culvert on the west end of the lake and continuing downstream across County Road 669. Local residents along with various organizations including the Little Traverse Lake Property Owners Association, Cleveland Township, Little Traverse Conservationists, the Michigan Department of Environmental Quality, Sleeping Bear Dunes National Lake Shore, the Leelanau County Road Commission and the Grand Traverse Band of Ottawa and Chippewa Indians, have been working together to come up with a reasonable solution. Various meetings have been held and will continue to be held to resolve this issue. Below is a summary of the studies and events leading up to the recommendation of how to address the high water and outlet system concern.

It should be noted that there are some concerns by Little Traverse Lake residents over any changes in the lake levels that could result in low water. This is taken into consideration in the reports outlined below.

In 2011, the Sleeping Bear Dunes National Lakeshore (SBDNL) commissioned a hydrologist to look at the Little Traverse Lake outlet system. A report titled: Hydraulic Assessment of Little Traverse Lake and Shalda Creek, was completed in July 2012 by Mike Martin, Hydrologist (WRD). This report is summarized below and can be found in Appendix C.

The goal of the report was to identify and describe possible causes of the observed lake levels based on site reconnaissance and provide recommendations for future management decisions. It also provided several approaches for quantifying the causes of these elevated levels. The elevated levels for Little Traverse Lake (LTL) were reported to be about 6 to 12 inches over "normal." One perceived cause of the higher-than-normal lake levels is downstream beaver activity, specifically, dam building in the downstream reaches of the creek that drains the lake. However, there are other conditions associated with the lake/stream system that could cause elevated lake levels.

The study looked at the overall setting, the flow, the physical characteristics and ecological features. They came up with five points of discussion regarding the lake levels and flow conditions on Shalda Creek:

(1) the channel of Shalda creek is very low gradient due to the surrounding terrain;

(2) extensive wetland environments exist on the margins of the creek creating broad reaches of reduced hydraulic conveyance;

(3) the culvert crossing immediately downstream from LTL represents a substantial constriction in the natural stream channel and certainly adds to elevated lake levels, especially during, times of high inflow into the lake;

(4) beaver dams create local areas of lowered channel gradient and backwater conditions for, some distance upstream; and
(5) higher than normal precipitation input may be at least part of the reason for the observed lake levels.

According to the report, the examination and site visit did not yield a conclusive explanation for the observed lake levels, stating there may be a number of contributing factors. It is not clear which elements of the stream system are having the greatest effect on observed lake levels, but it could very well be a combination of higher than average hydrologic input coupled with the physical features that reduce conveyance in the system (extensive side channel wetlands, beaver dams, and culverts, specifically the one directly downstream of LTL). To learn more about the recommendations in this report see Appendix C.

In the fall of 2013, LTLPOA convened a meeting with officials from Cleveland Township, Leelanau County Road and Drain Commission, and the Sleeping Bear Dunes National Lakeshore to discuss the need to commission a hydrology report with the purpose of learning about what influences water levels on the LTL and what actions might be taken to alleviate high water level conditions. Specific concern revolved around the culverts at Traverse Lake Road and at county road 669 on Shalda Creek and other contributing factors. After further review, LTLPOA contracted on Feb 12, 2014 with Gosling Czubak Engineering Sciences, Inc. to provide a Phase I hydrology study. The above participants contributed to assist in financing the study.

The goal of the investigation was to obtain factual data about the creek system all the way to Lake Michigan; to determine if these culverts have an impact on current lake levels; and if any other factor may be involved, including beaver dams downstream of CR 669. The investigation also analyzed possible methods to lowering lake levels, including up-sizing existing road culverts or replacing the culverts with clear span bridges. The Phase I investigation by Gosling Czubak titled "Little Traverse Lake Water Level Investigation", dated July 15, 2015 is summarized below and can be found in Appendix D.

The report looked at seven factors:

1. What are the culvert sizes and the true water surface elevation at key locations from the lake outlet to just downstream of the culvert at W. Lake Michigan Road?
2. Are all the water surface gauges on the same datum (do they correspond to each other)?
3. What is the location, size, and water level of the beaver dam downstream of CR 669?
4. What is the “normal” f low rate range through Shalda Creek?
5. What is the range of flow rate during storm events?
6. Rainfall and Water Level Gauge Readings
7. General Observations

Based on the field measurements and other information, the study performed two types of analysis on the culverts. One is an individual analysis of each culvert, without any attempt to model connectivity to other creek features. The second analysis is an attempt to evaluate how the system works as a whole and how performance at one culvert affects another. The analysis focused on the section of Shalda Creek between the beaver dam and the lake outlet.

The following questions were asked:

1. Do the calculated water surface levels at the culverts match real world observations?
Yes. Using the measured flow and water gauge readings were able to calibrate a hydraulic model of each culvert that followed real world observations very closely.

2. Does the culvert at Traverse Lake Road impede creek flow or impact Little Traverse Lake levels?
Yes. The culvert at Traverse Lake Road normally experiences a high tailwater condition that limits the capacity of the culvert. At flows lower than about 60 cfs, capacity of the culvert would be improved if the tailwater condition is lowered. However, at flows greater than 60 cfs, the culvert operates under “inlet control”

conditions. This means that no matter how low the tailwater condition is, the water can't get into the inlet fast enough, so the headwater level will be about the same, regardless of the tailwater condition.

3. Does the culvert at County Road 669 impede creek flow or impact Little Traverse Lake levels?
Yes, but to a lesser degree than the W. Traverse Lake Road culvert. This culvert also normally experiences a high tailwater condition that limits its capacity. At flows lower than about 120 cfs, capacity of the culvert would be improved if the tailwater condition is lowered. However, at flows greater than 120 cfs, the culvert operates under "inlet control" conditions. This means that the headwater level will be about the same, regardless of the tailwater condition.

4. What is the size and capacity of the culver t on West Lake Michigan Road?
The culvert on West Lake Michigan Road is actually two culverts. The capacity of this culvert system is much greater than the upper culverts due to its larger effective opening and its relatively low tailwater condition. The culvert generally operates under inlet control and has a capacity of about 140 cfs before overtopping the top of the culvert.

5. If the culvert(s) were removed or increased in size, how would lake levels change?
To effectively answer this question, additional stream cross section data is needed, along with a detailed water surface profile analysis. Based on the very preliminary stream data gathered as part of this first phase of investigation, the answer is: Yes, but the change is relatively minor and does not lower lake levels enough to eliminate the problems that have been associated with high water levels.

6. Does the beaver dam impact lake levels?

Yes, depending on the flow conditions. The way each dam affects creek flow and lake levels can vary at each dam location. A beaver dam does create a higher tailwater condition at the culverts than might naturally occur. Under higher flow conditions the culverts are under inlet control, so removing a beaver dam would have less affect on lake levels. However, removing a beaver dam could keep the "base" lake level lower so that when high flows do occur the impact from high lake levels could be of a shorter duration (lake levels could return to the base level more quickly). It was beyond the scope of this report to calculate how water levels would change if the beaver dams were removed.

The results of this study state that overall hydrologic system is quite complex. Implementation of any option requires more in depth analysis, but they offer general conclusions and options are offered for discussion. The report provided a table that includes a summary of several options considered, the advantage/disadvantage each option brings, the expected impact to lake levels, and the relative cost to implement.

In summary, replacing the existing culverts with higher capacity culverts or a clear span bridge may not produce the desired lake level reduction unless it is coupled with some form of beaver dam control. Beaver dam control without culvert modifications will continue to produce high lake levels at flows near or above 70 cfs. For more details see Appendix E.

The LTPOA voted to underwrite a report (Phase II) to study the impact of Beavers on the LTL outlet system and this will be available in Spring of 2015.

As a follow up to this Gosling Czubak Engineering (Phase I), July 15, 2014 report, Cleveland Township contracted with Gosling Czubak Engineering on November 11th, 2014 to provide preliminary engineering related to replacing culverts on Shalda Creek, downstream of Little Traverse Lake. This report is considered Phase III. The goal of this work is to provide the Cleveland Township with a Preliminary Opinion of Cost to replace the culvert at Traverse Lake Road and CR 669 with either a larger culvert system or a clear span bridge. A preliminary Phase III report was completed in March 2015 and is included in Appendix E.

The results of the Phase III Study- Culvert Replacement Preliminary Engineering Report by Gosling Czubak Engineering Sciences, Inc. include recommendations to replace the culverts both on Little Traverse Lake Road and County Road 669 and are identified as a task for the plan in Chapter 8, Category 4: Shoreline and Stream

Bank Protection (SSPB), Table 34 (Page 192). Over the spring and summer of 2015, the various groups involved in this project will be meeting to discuss funding opportunities and ways to address the situation.

Lime Creek Road Crossings- Narlock and Cemetery Road

A road and stream crossing survey would help determine the severity of these road and stream crossings, but there is concern that these crossings are in need of investigation as they are the two major roads that bisect Lime Creek, the main tributary to Lime Lake. The Leelanau Conservancy has a stream sampling location off of Narlock road and collects Total Phosphorus and discharge data.

Sugar Loaf Resort and area golf courses

Sugar Loaf Resort and area golf course are a potential concern since some of the practices used on the maintenance and upkeep of the land may input excessive nutrients into the watershed. It will be important to monitor the water and keep informed of the monitor well data to ensure excess nutrients are not entering groundwater or surface water in the GHB watershed.

4.8 UNDERSTANDING CONSERVATION EASEMENTS

One of the main goals of the Good Harbor Bay Watershed Protection Plan is to prevent increases in nutrient loading to the Good Harbor Bay and other water bodies. The nutrient loading model is grounded in the fact that natural land uses such as forest and wetlands produce far less total phosphorus loading than residential or other developed land uses. Permanent conservation easements are an important tool available to private landowners that wish to voluntarily prevent conversion of their natural lands. A conservation easement is a voluntary legal agreement between a landowner and a land trust that permanently limits a property's development potential while protecting its conservation values.

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

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. *Their mission is to conserve the land, water and scenic character of Leelanau County.* The Leelanau Conservancy has protected over 11, 000 acres in Leelanau County, mostly in private conservation easements. The Conservancy owns and manages about 2000 acres which are open to the public for passive recreation. The Conservancy works with interested landowners to establish permanent voluntary conservation easements over ecologically important land. They operate with the philosophy that a good conservation transaction must be good for both the land and the people involved.

How Conservation Easements Work

When a person owns land, they also "own" many rights associated with it. These property rights include the right to harvest timber, build structures, divide the property, conduct agriculture, and lease mineral rights and so on (subject to zoning or other land use restrictions). Conservation easements permanently restrict or eliminate the property rights that could degrade the documented conservation values found on the property. For example, a landowner may restrict the ability to develop more than 1 home site in the future, but retain the ability to manage the forest for sustainable timber harvest according to an approved forest management plan and maintain trails or two-track roads. These perpetual restrictions run with the land and all future owners are bound by the conservation easement's terms. 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 interested landowner to determine if their land qualifies for permanent protection and help them determine the most appropriate conservation easement terms to protect the documented conservation values. Every conservation easement is a unique and customized to meet the desired uses of the landowner, provided they will not degrade the conservation values. 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 an important tool in generational financial planning. Conservation easements may cover all or just a portion of the property and they often allow some future construction within an approved area, if that is compatible with the easement's conservation objectives and the landowner's desires. For more information on conservation easements in Leelanau County, please contact the Leelanau Conservancy: www.leelanauconservancy.org or by calling 231-256-9665.

CHAPTER 5: BEST MANAGEMENT PRACTICES

5.1 OVERVIEW OF 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). Each treatment site must be evaluated independently, and specific BMPs can be selected to perform under given site conditions. Correct installation and maintenance are essential for optimum load reductions.

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. Non-structural BMPs focus on source control treatments which are far more cost effective than restoration efforts after degradation has occurred (Like the common saying, “An ounce of prevention is worth a pound of cure”). Individual non-structural BMPs often address multiple pollutants or stressors simultaneously. Establishing a perpetual conservation easement over priority areas will prevent a number of different pollutants (sediment, nutrients, toxins, etc.) from entering the watershed.

Table 28 identifies possible BMPs to address common sources and causes of pollutants or stressors in the Good Harbor Bay watershed 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.

Table 28: BMP Examples by Pollutant 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 Chapter 8)*	-Conservation Resource Alliance (CRA -Guidebook of BMPs for Michigan Watersheds -MI Low Impact Development Manual -Green Infrastructure Manual -Michigan Ag BMP Manual
Stormwater and Impervious Surfaces	Sediment Nutrients Toxins Pathogens Increased Temperature	-Develop stormwater management plans, d other applications such as the Platte Lakes Area Management Plan overlay district - Also See Table 29	See Table 30	-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 – Storm center website

Table 28: BMP Examples by Pollutant Source (Cont'd)

Major Source or Cause	Affected Pollutant	Potential Actions to Address Pollution Source/Cause	Potential Load Reduction	Information Source
Road Crossings - eroding, failing, outdated	Sediment Nutrients	-Road Crossing BMPs (vary widely – See Road Stream Crossings)	Varies *(see milestones in Chapter 8)*	-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 Phosphorus -Education on proper use of fertilizers: workshops, brochures, flyers, videos, etc.	Not available	-Public Information and Education Strategy (Chapter 9)
Septic Systems (Leaking)	Nutrients Pathogens	-Education on proper septic system maintenance -Septic system inspections -Ensure proper septic system design -Demo projects for alternative wastewater treatment systems -Chemical treatment of septic systems to reduce nutrient loading	Varies/ Not available	-Leelanau/Benzie Health Department -Public Information and Education Strategy (Chapter 9)

Table 28: 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*
Development and Construction	Sediment Habitat Loss	-Implement soil erosion control measures -Utilize proper construction BMPs like barriers, staging and scheduling, access roads, and grading) -Establishing perpetual conservation easements with voluntary landowners in priority areas	Varies/ Not available	-MI Low Impact Development Manual -Green Infrastructure Manual -Public Information and Education Strategy (Chapter 9)
Purposeful or Accidental Introduction of Invasive Species	Invasive Species	-Boat washing stations -Workshops, Brochures, Flyers, Videos, Etc. -Educational Programs	Not available	-Benzie Conservation District -Public Information and Education Strategy (Chapter 9)

* 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

5.2 POLLUTANT LOAD REDUCTIONS

Pollutant Reduction Estimates for Land Conservation Practices

To help maintain the high water quality resources of the Good Harbor Bay watershed it is important to address known sources of pollution while at the same time preventing increases in pollutant loading overtime from emerging or currently unknown pollutant sources. Protecting Priority Areas identified in the GHBWPP with voluntary conservation easements is an excellent strategy to meet this objective. The Leelanau Conservancy is the local land conservancy using these strategies to protect high quality land in the Good Harbor Bay 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 the idea is to estimate 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 a more developed land use.

Table 29 represents the total pollutant loads for Total Suspended Solids, Total Nitrogen and Total Phosphorus (Lbs /yr) per land use type for the Good Harbor Bay Watershed. The numbers were calculated by multiplying the land use acreages from Table 9 (page 53) and estimated pollutant loads from Table 29 on the next page.

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

Table 30: Total estimated pollutant loads for the Good Harbor Bay Watershed

Land Use	Acres	Total Suspended Solids	Total Nitrogen	Total Phosphorus
Forested (non-wetlands)	22,061.3	441,226	4412.23	2,868
Agriculture	2,811.2	430,113.6	6,746.89	506
Urban	1,649.1	253,961.4	5,112.2	659.6
Barren (beaches, dune, rock)	736.9	29,476	368.45	66.3
Total	27,258.5	115,4777	16,639.8	4,099.9

Note: Numbers are in Pounds/year. Averages were taken from Table 9 (page 53) in order to group land use categories appropriately. Water is not included in this table.

Permanent Conservation Easement Pollutant Load Reduction (lb/yr)

The total pollutant load reduction from a permanent conservation easement is determined by subtracting the total pollutant loading coefficient for the more developed land use, such as low density residential, from the total pollutant loading coefficient for a more natural land use, such as wetland or forest.

Below are the annual pollutant loading coefficients for various land uses found in the Good Harbor Bay watershed as determined by measured total phosphorus concentrations and their respective nitrogen and sediment ratios. Subtracting annual pollutant loads for forested land uses below from the annual pollutant loads for low density residential (LDR) and then multiplying by the conservation easement acreage yields an estimation of the reduction in annual pollutant load resulting from a permanent conservation easement implementation in Priority Areas.

(Low Density Residential lbs/ac/yr – Forested lbs/ac/yr) x Conservation Easement acres = Load reduction from permanent conservation easement

Annual Pollutant Loading Coefficients

Multipliers for Natural Land		
Sediment	134	(Res @ 154 - Open Space @ 20)
TN	2.9	(Res @ 3.1 - Open Space @ .2)
TP	0.27	(Res @ .4 - Open Space @ .13)
Multipliers for Agriculture		
Sediment	1	(Res @ 154-Ag @ 153)
TN	0.7	(Res @ 3.1-Ag @ 2.4)
TP	0.22	(Res @ .4-Ag @ .18)

The watershed plan goal is to permanently protect 2500 acres of land within identified Priority Areas throughout the watershed by 2024 (See Land Protection and Management Goals in Chapter 8. Successful implementation of permanent voluntary conservation easements over 2500 acres will prevent 168,750 tons of sediment, 4500 lbs N, and 602.6 lbs P from entering the Good Harbor Bay watershed each year.

Table 32: Estimation of the reduction in annual pollutant load from permanent conservation easement implementation in Priority Areas

Future Conservation Easements
(potentially protected)

Conservation Easement	Acres	Sediment (tons)	Nitrogen (lbs.)	Phos. (lbs.)
Natural Land	1250	167500	3625	337.5
Farmland	1250	1250	875	265.1
Total	**2500**	**168750**	**4500**	**602.6**

Pollutant Reduction Estimates for Stormwater BMPs

The primary stormwater source in the Good Harbor Bay watershed is direct runoff from roadways. Table 32 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 often a more useful way of conveying the data to the general public rather than using specific concentration values, which can be difficult to comprehend for the average person.

It should be noted that the percent removal values in Table 32 are comparative numbers that approximate how much pollutant is removed as compared to no BMP implementation. For example, it is assumed that porous pavement values approximate the percentage of pollutants removed compared to regular pavement storm water runoff; or that Riparian Buffer values approximate the percentage of pollutants removed as compared to runoff from a landscaped, fertilized lawn. 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 32: 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

Table 32: Pollutant Removal Effectiveness of Selected Potential Stormwater BMPs (Cont'd)

Management Practice	Total % Phosphorus Removal	Total % Nitrogen Removal	Total % Suspended Solids Removal	% Metal and Bacteria Removal	Other Considerations
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
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 28 and 29 is dynamic and may be updated to reflect new information and data as it is available.

CHAPTER 6: WATERSHED PLANNING EFFORTS

6.1 STEERING COMMITTEE, STAKEHOLDER AND PARTNER OUTREACH

Survey Results

(with contributions by Ann Mason and Jerry Leanderson)

The GHBWPP Steering committee conducted a paper (Appendix D) and on-line survey (http://www.surveymonkey.com/s/N7VXX55) during the course of the watershed planning process. There were two versions of the survey. The first survey was created in April of 2011 did not include information about the various locations (lakes, streams or national park) in the watershed, but received 80 responses. The second version of the survey (appendix D), which was updated a few months later, was mailed to riparian owners in the watershed (lake residents, and those who lived along streams, wetlands and the lake MI shoreline) in spring of 2014. This survey was more comprehensive and received 80 responses. The results below include comparisons from both surveys. Below is a summary of those results and the details can be found in Appendix D.

Within the watershed, inland lake/stream residents, Lake Michigan residents, full-time and seasonal residents have different perceptions of what's important to the watershed and how it should be used and protected. Inland lake/stream residents, both year round and seasonal are more concerned with natural habitat and the effects of development than are seasonal/visitor residents or Lake Michigan residents, either seasonal or year-round. The timing of the survey was a factor. If the survey had been done in August/September instead of April/May, the importance of lake levels might have been seen differently, at least on Little Traverse Lake!

There are also major areas of agreement among these groups. In response to the question "how would you like to see the Watershed 50 years from now", almost all of the respondents said things like "I hope it will remain as it is", "same as today", "beautiful as it is now".

Clean water without algae is a universal high priority.

Invasive species were of concern to nearly every survey respondent. They may not have opinions or knowledge about nutrient infusion, sediment, pathogens, toxins and thermal pollution, but they definitely are aware of the effects of invasive species, whether zebra mussels, Asian carp, dumping from ocean-going vessels, phragmites, humans, etc.

The majority of the responses were from Full Time/Year Round Residents (35%) with seasonal or part-time residents coming in at 29.4% for responses. When asked what part of the watershed survey respondents were most familiar with, most stated Lake Michigan (41%). Respondents were also mostly familiar with Little Traverse Lake (33%) and Sleeping Bear Dunes National Lakeshore (14%). Survey respondents were asked about the types of activities they enjoy in the watershed and where they enjoy these activities. Swimming was most popular on the Lake Michigan Shoreline while motor boating was most popular on the inlands lakes (Lime and Little Traverse). Fishing was most popular on Lake Michigan, but also on the inland lakes.

When asked what the highest priority threat was in the watershed, Invasive Species, Loss of Habitat and Toxins where all ranked high (Figure 29). When asked what the lowest threats were in the watershed, Fluctuations in Lake Levels and thermal pollution where all ranked low (Figure 30).

Figure 29: Survey results- Threats in the GHB watershed considered a HIGH priority

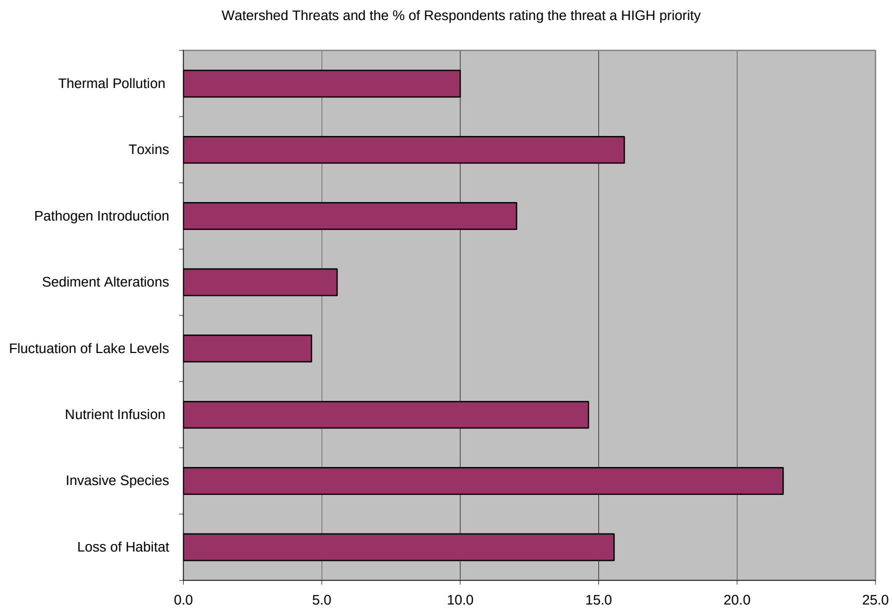
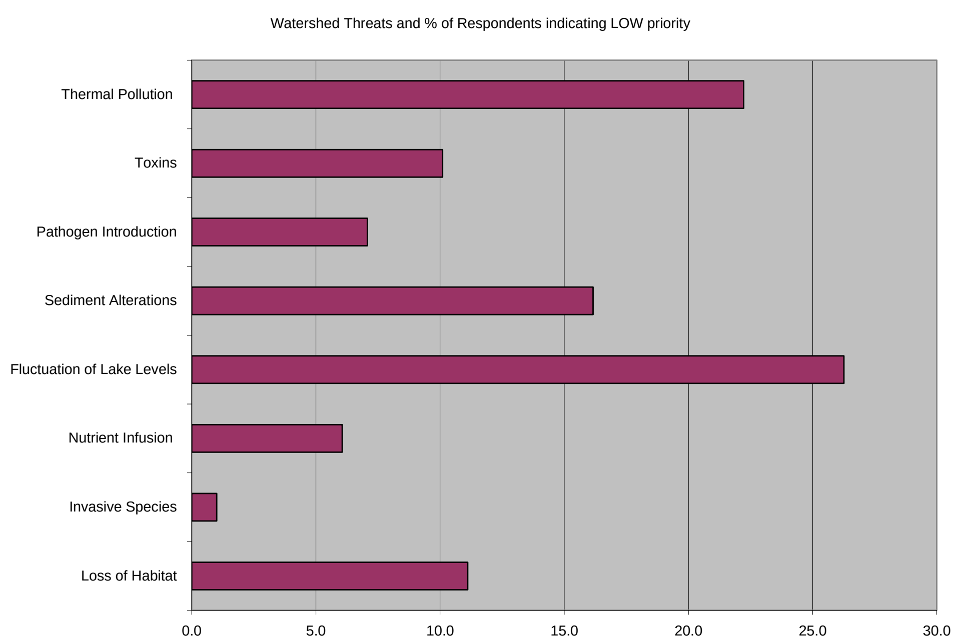


Figure 30: Survey results- Threats in the GHB watershed considered a LOW priority



When asked if there are any specific sites in the watershed that deserve special attention and/or management, over 72% of respondents said YES. Of the comments relating to this question, about 13% stated the Lake Michigan Shoreline and 13% mentioned the Tributaries to the lakes. About 6.5% mentioned sugarloaf resort. When asked: “What do you feel is the greatest threat to the Good Harbor Bay Watershed?” the majority of the responses were: Invasive Species (30%), Pollution (15%) and Development (11%).

When asked “What changes specifically, if any, have you noticed since you've lived in the watershed in and WHERE you have noticed these changes?” The majority of respondents noticed changes along the Lake Michigan Shoreline (71%). The comments indicated low lake levels being a the change (19%) along with algae (19%) and invasive species (17%). High lake levels and zebra mussels were mentioned specifically as a change in Little Traverse Lake. On Lime Lake, the comments mentioned zebra mussels, development and algae as changes. Increased beaver activity was mentioned as a change on Shetland, Shalda and Lime Creeks. The increased use and traffic was mentioned as a change in the Sleeping Bear Dunes National Lakeshore.

To share a few quotes:

"Many huge 'cottages' and the water resources required by them" are a concern.

"This area is not only the best in Michigan but all the USA. And usually not overflowing with people!"

"The greatest threat to the watershed is loss of natural habitat".

"The greatest threat is increased human footprint".

"cannot walk on the shore (of Good Harbor Bay) because of the buildup of algae and dead birds"

"No great loss of beach and natural trees. Very limited development"

6.2 GOOD HARBOR BAY WATERSHED PLAN ACCOMPLISHMENTS TO DATE

Lime Lake Association

- Newsletters put out 2x/year and the majority of the newsletters include information about watershed plan
- Put up boat washing/invasive sign at boat launch
- Shoreline Erosion study- set up in 2013 and ongoing (2014 +)
- Hosted annual meeting with Yarrow Brown to present on watershed plan and accomplishments
- Partner/initiator in watershed plan
- Support of water sampling program

Little Traverse Lake Property Owners Association

- 2newsletters per year including information about watershed plan
- Put up boat washing/invasive sign at boat launch
- Shoreline Erosion study- set up in 2013 and ongoing (2014 +)
- Hosted annual meeting with Yarrow Brown to present on watershed plan and accomplishments
- Partner/initiator in watershed plan
- Volunteers help with stream sampling in watershed
- Support of water sampling program

Little Traverse Conservationists

- Research on LTL water levels and culvert design
- Shoreline Erosion study- set up in 2013 and ongoing (2014 +)

Leelanau Conservation District

- Supported mailing to Riparian landowners- Spring 2014 and stakeholder mailing (7/2014)
- Phragmites and other invasive species surveys
- Working with landowners and producers in the watershed
- District Forester hired in 2013 and hosting workshop

- Partner in shoreline workshops

Leelanau Clean Water

- Host shoreline and septic workshops

Leelanau Conservancy

- Host water sampling program and water quality database
- Facilitated the watershed planning process
- Protected 735 acres of private land and 189.3 acres of public land in the watershed from 1988-2014 (Total = 924.3)

Sleeping Bear Dunes National Lakeshore

- Water sampling on beaches, lakes and streams in SBDNL
- Support for culvert project on outlet of Little Traverse Lake
- Participation in GHB steering committee

Michigan DNR Fisheries Division-

- Lime Lake Fisheries Survey conducted in 2010
- Lime Lake Status of the Fishery Report completed in 2011
- Little Traverse Lake Fisheries Survey conducted in 2013
- Little Traverse Lake Status of the Fishery Report completed in 2014
- Tributaries to Little Traverse Lake and Lime Lake are scheduled to be electrofished in July of 2014

CHAPTER 7 WATERSHED GOALS AND OBJECTIVES

The overall mission for the Good Harbor Bay Watershed Protection Plan is to identify actions, or protection measures, and provide guidance for the implementation of those actions, which will reduce the potential negative impacts that pollutants and environmental stressors could have on the designated watershed uses. The overall goal for the Good Harbor Bay Watershed Protection Plan is to support and protect all identified, designated and desired watershed uses while maintaining the distinctive environmental characteristics and high water quality of the Good Harbor Bay Watershed.

After reviewing the pollutant priorities, stakeholder survey and discussing the priorities in the watershed, the project steering committee developed six broad goals for the Good Harbor Bay Watershed (Table 33). Working to attain these goals will ensure that the designated and desired uses described in Chapter 4 are maintained or improved.

Watershed Goals:

1. Protect aquatic and terrestrial ecosystems.
2. Protect the quality and quantity of water resources.
3. Preserve high quality of recreational opportunities.
4. Ensure that all property owners, visitors, users and other stakeholders understand stewardship and are able to support and promote watershed protection activities.
5. Protect the health and safety of watershed users, residents and stakeholders.
6. Protect the economic viability within the watershed while ensuring water quality and quantity resources are protected.

Table 33: Good Harbor Bay Watershed Goals

Goal	Designated or Desired Use Addressed	Pollutant/Environmental Stressor Addressed
#1-Protect aquatic and terrestrial ecosystems.	Warm/Coldwater Fishery, Other Aquatic Life, Navigation Desired Use: Aesthetics, *Ecosystem Preservation*	Loss of habitat, invasive species, nutrients, thermal pollution
#2-Protect and improve the quality of water resources.	ALL	Nutrients, hydrology, sediment, pathogens, toxins
#3-Preserve high quality of recreational opportunities.	Warm/Coldwater Fishery, Total Body Contact, Navigation Desired Use: *Recreation*	Loss of habitat, pathogens, toxins, thermal pollution, nutrients
#4-Implement/promote educational programs that support stewardship and watershed planning goals, activities, and programs.	All	Loss of habitat, nutrients, pathogens, invasive species, toxins
#5- Protect the health and safety of watershed users, residents and stakeholders	Warm/Coldwater Fishery, Partial/Total Body Contact, Navigation, Fish consumption Desired Use: Human Health	Nutrients, Sediment, pathogens, toxins, thermal pollution
#6- Protect the economic viability within the watershed while ensuring water quality and quantity resources are protected	Warm/Coldwater Fishery, Habitat, Partial and Total Body Contact, Agriculture Desired Use: *Recreation, Ecosystem Preservation*	Hydrology, Loss of habitat, Sediment, pathogens, toxins

Goal #1

Protect aquatic and terrestrial ecosystems

Designated uses: warm/coldwater fishery, other aquatic life

Desired uses: ecosystem preservation

Pollutants or stressors addressed: Loss of habitat, invasive species, nutrients, thermal pollution

Objective 1.1	Inventory and evaluate the constituents, resources and conditions of our natural systems.
Objective 1.2	Establish land and water management practices that conserve and protect the natural resources of the watershed and consider the influences driven by climate change.
Objective 1.3	Preserve the biodiversity of the watershed.
Objective 1.4	Protect and restore critical habitat areas for aquatic life and fish.
Objective 1.5	Protect shoreline habitats and promote the wise use of shorelines.
Objective 1.6	Preserve the distinctive character and aesthetic qualities of the watershed including viewsheds and scenic hillsides.
Objective 1.7	Manage and control existing invasive species and minimize the spread of new invasive species.
Objective 1.8	Maintain and enhance ecosystem functions of the wetland and riparian areas in the watershed.

Goal #2

Protect the quality and quantity of water resources.

Designated Uses: Warm/Coldwater Fishery, Other Aquatic Life, Total Body Contact

Desired Use: Human Health

Pollutants or Stressors Addressed: Nutrients, hydrology, sediment, pathogens, toxins, thermal pollution

Objective 2.1 Identify threats to high quality water and surrounding ecosystems that are likely influences within watershed.

Objective 2.2 Control and reduce the amount of pollutants in stormwater, stormwater runoff entering surface waterbodies.

Objective 2.3 Identify verifying tests, best practices and action strategies to deal with threats.

Objective 2.4 Maintain and enhance existing long term water quality testing program and procedures.

Objective 2.5 Prioritize, stabilize and/or improve road-stream crossing embankments and approaches.

Objective 2.6 Control and/or minimize the input of pollutants, pathogens and toxic compounds into surface water and groundwater.

Objective 2.7 Prioritize, stabilize and/or improve shoreline, stream and banks to prevent erosion.

Objective 2.8 Assure plans and actions reflect the expected influences tied to climate change.

Objective 2.9 Understand existing hydrology and strive for hydrologic practices that will enhance, expand and support water quality.

Goal #3

Preserve high quality recreational opportunities in the watershed

Designated Uses: Warm/Coldwater Fishery, Total Body Contact, Navigation

Desired Use: Recreation

Pollutants or Stressors Addressed: Loss of habitat, pathogens, toxins, thermal pollution, nutrients

Objective 3.1	Support desired recreational uses while maintaining distinctive environmental characteristics and aquatic biological communities throughout the watershed.
Objective 3.2	Maintain and promote high quality and diverse fishing opportunities throughout the Good Harbor Bay Watershed.
Objective 3.3	Maintain and promote high water quality to ensure safe and clean areas for public swimming and other types of water recreation.
Objective 3.4	Maintain and protect un-fragmented large tracts of wetlands, wildlife corridors and forested habitat on public and private lands across the watershed.

Goal #4

Ensure that all watershed property owners, visitors, users and other stakeholders understand stewardship and are able to support and promote watershed protection activities.

Public I/E Campaign

Designated Uses: All

Desired Uses: All

Pollutants or Stressors Addressed: Loss of habitat, nutrients, pathogens, invasive species, toxins

Objective 4.1 Implement Information and Education Strategy outlined in Chapter 9.

Objective 4.2 Raise awareness, understanding, commitment and action within the Good Harbor Bay Watershed so that private practices and public policy enhance attainment of the watershed goals.

Objective 4.3 Involve the citizens, public agencies, user groups and landowners in implementation of the watershed protection plan through meetings, events and workshops with individuals or groups.

Objective 4.4 Measure effectiveness of outreach activities in increasing awareness and reduction of Non-Point Source (NPS) pollution, including shoreline erosion.

Objective 4.6 Increase awareness of proper septic system maintenance, fertilizer use and storage of organic wastes and fertilizers.

Objective 4.7 Encourage appropriate provisions for site plan development and review for water quality and natural resources protection.

Goal #5

Protect the health and safety of watershed users, residents and stakeholders

Designated Uses: Warm/Coldwater Fishery, Partial/Total Body Contact, Navigation, Fish consumption

Desired Uses: Human Health

Pollutants or Stressors Addressed: Nutrients, Sediment, pathogens, toxins, thermal pollution

Objective 5.1 Identify and address threats to groundwater and surface water to ensure public drinking water is protected.

Objective 5.2 Monitor swimmers itch and develop a program to address swimmers itch concerns in the watershed.

Objective 5.3 Monitor water bodies, including the Lake Michigan shoreline and interface areas, for E. coli (fecal coliform), botulism, and fish die offs and address areas of concern.

Objective 5.4 Partner with the health department, county and townships to promote proper septic system maintenance and replacement.

Goal #6

Protect the economic viability within the watershed while ensuring water quality and quantity resources are protected

Designated Uses: Warm/Coldwater Fishery, Habitat, Partial and Total Body Contact, Agriculture

Desired Uses: Recreation, Ecosystem Preservation

Pollutants or Stressors Addressed: Hydrology, Loss of habitat, Sediment, pathogens, toxins

Objective 6.1 Promote developments and land use activities that work in harmony with watershed protection

Objective 6.2 Adopt the most economically sound approaches to ecologically sound watershed practices

Objective 6.3 When developing watershed protection policies give consideration to the property values, local business and tourism.

CHAPTER 8 IMPLEMENTATION TASKS AND ACTIONS

8.1 IMPLEMENTATION TASK CHART FOR EACH GOAL AND OBJECTIVE

Objectives and Tasks

The goals detailed in Chapter 7 for the Good Harbor Bay watershed were developed by the Steering Committee to protect the designated and desired uses of the watershed. The goals are recommendations for implementation efforts within the watershed. Each goal has multiple objectives that outline how the goal can be reached. Tasks were then assigned to address the individual goals and multiple objectives. The detailed task implementation chart (Table 34) has broken the tasks into nine (9) major categories: Water quality, Fish & Wildlife habitat, shoreline and stream bank protection, invasive species, best management practices, outreach and education, land protection, public health/safety, and economy. This table (Table 34) describes the task by category, provides interim milestones, approximates projected costs and assigns a plausible timeline for completion. The chart also identifies possible project partners, however, this does not imply any sort of commitment on behalf of these organizations to accomplish these task criteria. These 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 22 & 23, Figures 33 & 34). The implementation tasks in Table 34 are designed to address individual watershed objectives under each main goal. Some of the tasks utilize are designed to address multiple objectives under one treatment.

Priority Level

Each task has been given a priority level based on the following criteria:

1. High-
2. Medium-
3. Low-

Unit Cost/Cost Estimate

An estimated cost is provided when available and applicable. An estimated total cost is provided when it is able to be calculated. Table 32 summarizes the Goals by Designated and Desired uses.

Milestones

Milestones are identified, when possible, to establish a measurable benchmark for determining the progress of a specific task or action.

Timeframe

A timeframe of 10 years was used to determine the scope of activities and the estimated costs for implementing the tasks. The year in which the task or action is to begin or end is noted. When a task or action is ongoing, it is noted as spanning the ten years.

Funding Sources

Likely funding sources for task implementation include State and Federal grant sources (DEQ: CMI, CWA Sec. 319, GLRI, NAWCA, GLFT, MDNR), private foundations, private fundraising from the Platte Lake Improvement Association and other lake associations, local land conservancies and volunteer time.

Potential Partners

Potential partners and target audiences are outlined on the next page with acronyms. These include anyone who have the interest or capacity to implement a task or action. However, they are not obligated to fulfill the task or action. It is anticipated they will consider pursuing funds to implement the task or action, work with other identified potential partners and communicate any progress with the Good Harbor Bay Watershed Protection Plan Steering Committee or project partners.

Targeted Audiences

These are audiences are those groups and individuals that would be appropriate for information and educational outreach.

Potential Project Partner Acronyms:

BCD- Benzie Conservation District

BCRC – Benzie County Road Commission

BCPRC-Benzie County Parks & Recreation Commission

BLHD – Benzie-Leelanau Health Department

CRA – Conservation Resource Alliance

EPA – Environmental Protection Agency

GTBOCI – Grand Traverse Band of Ottawa and Chippewa Indians

GTRLC- Grand Traverse Regional Land Conservancy

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

LA- Lake Associations

MDNR – Michigan Department of Natural Resources

MDEQ- Michigan Department of Environmental Quality

M-DOT – Michigan Department of Transportation

MNSP-Michigan Natural Shoreline Partnership

MSU-E – Michigan State University Extension

NRCS – USDA Natural Resources Conservation

PLIA – Good Harbor Bay Improvement Association

NWMCOG – Northwest Michigan Council of

Governments

NWMSBF-Northwest Michigan Sustainable Business Forum

OWTTF – Onsite Wastewater Treatment Task Force

SBDNL- Sleeping Bear Dunes National Lakeshore

USFWS – United States Fish & Wildlife Service

Others:

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

Target Audiences Include:

Builder/Developer/Realtor

Education

Households

Local Governments

Riparian Landowners

Tourists

General

Funding Sources:

DEQ: CMI- Department of Environmental Quality, Clean Michigan Initiative

CWA Sec. 319- Clean Water Act

GLRI- Great Lakes Restoration Initiative

NAWCA- National

GLFT- Great Lakes Fisheries Trust

MDNR- Michigan Department of Natural Resources

The tables on the following pages (Table 34) include the tasks for implementing the watershed plan. The evaluation strategy and the information and education strategy are presented in the next two chapters (Chapters 9 and 10).

Table 34: Tasks for Implementing the Good Harbor Bay Watershed Plan

Category 1: Water Quality (WQ)

Categories/Tasks	*Priority:* HIGH, MED, LOW	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
WQ1- Maintain current water quality program	HIGH	$11,000/year (analysis and report)	Annual review of water quality monitoring results. Reported in Lake Association publications and on Leelanau Conservancy website	X	X	X	X	X	X	X	X	X	X	Leelanau Conservancy	2.4
WQ2-Establish a water quality monitoring program for water quality threats and hot spots, including E. coli and appropriate training for water quality testing and sources for hot spots	HIGH	$10,000 initial and $5,000/year	Start sampling program and training in 2016 and continue yearly as funding is available.		X	X	X	X	X	X	X			LTC, LLA, LTLPOA, LCD, SBDNL, CRA	2.1,2.4
WQ3-Stay current with ongoing research on swimmer's itch in Northern Michigan	HIGH	$0.00	LLA biologist will keep the steering committee and lake associations informed annually or research progress	X	X	X	X	X	X	X	X	X	X	LLA, LTPOA	2.1
WQ4- Assess the need for & feasibility of instituting a new swimmer's itch control program using new technology on Lime and Little Traverse Lakes	HIGH	$20,000/year	Once research is complete, inform lake associations and develop a control program 2020		X	X	X	X	X					LLA, LTPOA, LTC	2.1

Category 1: Water Quality (WQ) (Continued)

Categories/Tasks	*Priority: HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
WQ5- Implement swimmer's itch control measure on Lime and Little Traverse Lakes	HIGH	$40,000/year	Pending funding and research results, implement control measures by 2017, assess annually			X	X	X	X	X	X	X	X	LLA, LTPOA, LTC	2.1
WQ6- Investigate public health effects in the watershed including well water quality, swimmers itch and *E. coli* testing	MEDIUM	$1000/year	Lake Association will develop a task force by 2015. Plan by 2018.		X			X						LCD, LLA, LTC, LTLPOA, Conservancy	2.1
WQ7- Establish watershed wide central database for water quality data.	MEDIUM	$12,000 to start $6,000 annual	Raise funding and do research on feasibility by 2015. Launch central database by 2018.			X	X	X	X	X	X	X	X	LCD, LLA, LTC, LTLPOA, Leelanau Conservancy	2.4
WQ8-Conduct data analysis and investigate impacts to living organisms and impact of threats on water quality and use this information to establish limits on the watershed threats	MEDIUM	$1000/year	Develop a summary report of water quality testing and investigating every 3 years. First report in 2015.			X			X			X		LCD, LLA, LTC, LTLPOA, Conservancy	1.3,1.4,3.3, 2.6,2.1,2.4

Category 1: Water Quality (WQ) (Continued)

Categories/Tasks	***<u>Priority:</u> HIGH, MED, LOW***	***Estimated Cost***	***Milestone***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***Potential Project Partners***	***Objective(s) Addressed***
WQ9- Develop a plan for threat reduction and mitigation strategies in the watershed	MEDIUM	$1000/year	Lake Association will develop a task force by 2018 and implement plan by 2020		X			X	X	X	X	X	X	LCD, LLA, LTC, LTLPOA, Leelanau Conservan	2.2,2.1,1.2,1.1
WQ 10-Develop a lake nutrient loading model for the major lakes in the watershed.	LOW	$60K sampling, $30K development of model	Develop a lake nutrient loading model for the major lakes in the watershed by 2018 as funding is available.						X					LCD, LTC, LLA, LTLPOA, Leelanau Conservancy	2.3, 2.4

Category 2: Fish and Wildlife Habitat (FWH)

Categories/Tasks	*Priority: HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
FWH1-Maintain high quality inland lake fisheries	HIGH	$9,782 annually	Receiving positive angler comments	X	X	X	X	X	X	X	X	X	X	MDNR, GTBOCI, NFWS	1.1,1.4,1.3, 2.2, 3.2
FWH2-Work with interested landowners to promote placement of large woody debris in near-shore zones of lakes through-out the watershed for fish habitat.	MEDIUM	$1500/year over ten years	1. Develop literature for property owners. 2. Create a "demo site" of a natural shoreline property	X	X	X	X	X	X	X	X	X	X	MDNR, PLIA, BCD, SBDNL, CRA	1.2,1.3,1.4
FWH3- Monitor fisheries population on inland lakes and streams, draft subsequent status reports	MEDIUM	Lake surveys are conducted once every ten years. Stream surveys are conducted once every five-ten years. $5500 per lake	Completion of survey write-ups (available to the public) within one year of the surveys completion. Lime Lake surveyed in 2009/ LT Lake surveyed in 2013					X				X		MDNR, GTBOCI, NFWS	3.2, 3.1, 1.1
FWH4- Implement BMP's and habitat restoration as needed and as funding is available. Compile list of priority areas.	MEDIUM	<u>Estimate</u> $80/foot for 1000 feet = $8,000	Initiate projects as funding available, ongoing			X	X	X	X	X	X	X	X	CRA, GTBOCI LLA, LTC, MDNR, LTLPOA, LCD	1.1, 1.2, 1.5, 2.7

Category 2: Fish and Wildlife Habitat (FWH) (Cont'd)

Categories/Tasks	***Priority:*** *HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
FWH6- Implement Wild-Link program to identify, protect and enhance fish and wildlife habitat on private property within ecological corridors throughout the watershed.	MEDIUM	$15,000/year ever other year	Four projects by 2015, ongoing as funding is available			X		X		X		X		CRA, LCD, GTRLC, LC	3.4,1.2,1.3,2.7

Category 3: Invasive Species (IS)

Categories/Tasks	*Priority:* HIGH, MED, LOW	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
IS 1- Continue to implement invasive species treatment program, including monitoring for new and the spread of existing aquatic and terrestrial invasive species in watershed	HIGH	$10,000/year for 9 years	2016- begin treatment program for highest priority species and establish index of existing populations to prioritize treatment; 2018-address medium priority species. Review		X	X	X	X	X	X	X	X	X	LCD, LA's, Leelanau Conservancy, CRA, GTBOCI, MDNR	1.2, 1.6, 1.7
IS2- Implement an education program to inform watershed users about invasive species and create a yearly status report on the current conditions of invasive species	HIGH	$5000/year	Grant funding dependent. Hire watershed coordinator by 2018.					X	X	X	X	X	X	LCD, LA's	1.7, 4.1
IS3- Establish boat washing stations on Lime and Little Traverse Lakes to help control the introduction of invasive species	MEDIUM	$6000/start up per lake and $1000/year maintenance	Apply for funding to install a boat washing station by 2018 on Lime Lake and Little Traverse Lakes				X	X	X	X	X	X	X	LCD, LA's, MDNR	1.7

Category 4: Shoreline and Stream Bank Protection (SSPB)

Categories/Tasks	***Priority:*** *HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
SSBP 1- Evaluate and address the culvert and road/stream crossings in the watershed for shoreline erosion, high water levels, potential contamination from septic systems, and other concerns, particularly on the west end of Little Traverse Lake and along County Road 669 and along Cemetery Rd, Narlock Rd.	HIGH	$20,000 for survey (see task SSBP2 below)	Grant dependent. Conduct road and stream crossing survey by 2018 and implement projects by 2020				X		X					NRCS, GTBOCI , CRA, LA's, LCD, DC, LCRC, NPS, Cleveland Twp	1.5,1.7, 1.1, 2.2, 2.6, 2.5
SSBP2-Restore adequate storm water handling and stream conditions to the Little Traverse Lake outlet, Shalda Creek, and its passage under County Road 669 taking into consideration the LTL Lake levels.	HIGH	$900,000 for LTL and 669 culverts (Gosling Report)	Grant dependent. Obtain funding for a replacement of culverts on LTL road and Co Road 669 in 2016-2017.		X	X								NRCS, GTBOCI , CRA, LA's, LCD, DC, LCRC	2.9
SSBP 3- Evaluate and understand water level fluctuations and seasonal changes in water levels in the watershed and how to accept the conditions without negative shoreline impacts	HIGH	$10, 000 initial survey	Conduct initial hydrologic and engineering survey to come up with future plan in 2016.		X									LTLPOA, LTC, GTBOCI, LCRC	2.9, 3.3, 2.2, 2.5
SSBP 4- Inventory the shoreline, streams and lakes in the watershed for erosion, development, invasive species, etc and develop a restoration plan for high priority sites.	MEDIUM	$1000/year	Volunteers from Lake Associations to conduct survey yearly starting in 2014. Update LA's yearly on findings	X	X	X	X	X	X	X	X	X	X	LA's, LCD	1.5,1.7, 1.1

Category 4: Shoreline and Stream Bank Protection (SSPB) (Cont'd)

Categories/Tasks	*__Priority:__* *HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
SSBP 5 - Work with interested landowners to remove invasive species, improve riparian corridors and restore degraded habitat along the shorelines of Lake Michigan, Inland Lakes and tributary streams in the watershed	MEDIUM	$50,000/site for 3 sites	Identify priority sites and obtain cost-share funds by 2017. Complete treatment on 3 priority sites by 2021			X				X				CRA, MDNR, LCD, LA's	2.1,1.2, 1.7, 1.5
SSBP 6- Conduct workshops on natural shoreline management for shoreline property owners promoting native plants, soft engineering, and natural landscaping to improve fish/wildlife habitat, reduce nutrient runoff into lakes, and decrease erosion.	MEDIUM	$2000/year for 10 years	2 workshops/yr.	X	X	X	X	X	X	X	X	X	X	LCD, LA, NRCS, LA	1.5, 1.7
SSBP 7-Inventory the status of aquatic habitats in portions of the watershed	LOW	$5000 for inventory	Complete inventory by 2018				X							CRA, BCD, LA's	1.1, 1.5, 1.7

Category 5: Best Management Practices

Categories/Tasks	***Priority:*** *HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
BMP 1- Work with project partners to develop a road and stream crossing survey	HIGH	$10K for inventory	Road and Stream crossing completed by 2018,				X							CRA, LCD, LA, NRCS, GTBOCI	1.2, 2.5
BMP 2- Implement road and stream crossing BMP projects on high and medium priority sites	HIGH	200,000/year for duration of plan- Total = $1.4M	Road and Stream crossing completed by 2015, Four projects by 2018, ongoing as funding is available					X	X	X	X	X	X	CRA, LCD, LA, NRCS, GTBOCI	1.2, 2.5
BMP 3-Conduct *Cladophora* and other surveys to determine failing septic systems yearly	HIGH	$0	Start survey in 2015	X	X	X	X	X	X	X	X	X	X	LA's,	2.1,2.6,1.1
BMP4-Implement a cost share program to replaced outdated or failing septic systems around lakeshores, wetlands or streams.		$50,000/year for five years depending on funding	Implement cost share program as funding is available- within 5 years						X	X	X	X	X	LCD, BLDHD	2.1,2.6,1.1

Category 5: Best Management Practices (BMP) (Cont'd)

Categories/Tasks	***Priority:*** *HIGH, MED, LOW*	***Estimated Cost***	***Milestone***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***Potential Project Partners***	***Objective(s) Addressed***
BMP 5-Inventory abandoned and poorly capped wells and correct properly to prevent contaminants from moving into and among groundwater aquifers via this route.	MEDIUM	$10,000 for inventory and $2000 for report	Start inventory by 2015 work with partners to distribute a report on findings by 2016, Inventory every 10 years			X		X						MDA-Wellhead Stewardship Program, BLDHD	1.1,2.1, 2.2
BMP 6-Work with landowners to promote forest management practices that are in compliance with current BMPs, as outlined in "Quality Management Practices on Forest Land," (1994) MDNR	MEDIUM	$30,000/year for 10 years	Establish relationships with private forestland owners and managers. Adoption of 5 management plans/ yr. on private forest land.	X	X	X	X	X	X	X	X	X	X	MDNR, NRCS, LCD, CRA	3.4, 1.7, 1.3

Category 6: Information, Outreach and Education (IOE)

Categories/Tasks	*Priority: HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
IOE 1- Partner with Glen Lake Schools and other organizations to provide information, programs and education on watershed planning, water quality monitoring and watershed protection	HIGH	$5000/year for 10 years	Establish contacts with Glen Lake School, launch educational program by 2015	X	X	X	X	X	X	X	X	X	X	Schools, LCD, LLA, LTPOA	4.2
IOE 2- Develop communication strategy for watershed users on topics such as invasive species, shoreline/stream bank protection and other watershed best management practices.	HIGH	$1000/year	Develop strategy with steering committee and implement strategy by 2016		X	X	X	X	X	X	X	X	X	LCD, LLA, LTPOA	4.2,4.3
IOE 3- Develop an education program for watershed users on topics such as invasive species, shoreline/stream bank protection and other watershed best management practices.	HIGH	$1000/year	Develop implement education program by 2016		X	X	X	X	X	X	X	X	X	LCD, LLA, LTPOA	4.2,4.3
IOE 4- Encourage appropriate provisions during or before site plan review for water quality and natural resources in the approval process.	HIGH	$1000/yr. for 10 years	Attend planning commission meetings regularly	X	X	X	X	X	X	X	X	X	X	BCD, PLIA, LA, BWC	4.7, 4.3

Category 6: Information, Outreach and Education (Continued)

Categories/Tasks	***Priority:*** ***HIGH, MED, LOW***	***Estimated Cost***	***Milestone***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***	***Potential Project Partners***	***Objective(s) Addressed***
IOE5- Find resources for a watershed coordinator position to work county-wide on watershed issues, including the Good Harbor bay Watershed	HIGH	$20,000/year for a part-time position	Obtain grant funding and work with local groups to find position by 2016			X	X	X	X	X	X	X	X	LCD, LA’s	4.1, 4.2, 1.1,
IOE 6- Provide water quality information and news about implementation tasks progress to local and regional media.	MEDIUM	$1000/year for ten years	Publicize watershed planning progress, updates to the watershed plan in lake association annual reports, in newspaper and on websites.	X	X	X	X	X	X	X	X	X	X	LCD, LA,	4.2, 4.3, 4.4
IOE 7- Advocate for zoning, master plans and ordinances that protect water quality, human health and natural resources	MEDIUM	$1000/year (staff time) for ten years	Attend at least 2 meetin annually	X	X	X	X	X	X	X	X	X	X	BLDHD, LA, LCD	4.3, 4.7
IOE 8-Promote adoption of Leelanau County Point of Sale Septic Ordinance and encourage enforcement of the ordinance and addressing failing septic	MEDIUM	$10,000 for staff time	Passage of ordinance in 2017		X									BLDHD, LA, LCD	4.3, 4.6

Category 6: Information, Outreach and Education (Continued)

Categories/Tasks	Priority: HIGH, MED, LOW	Estimated Cost	Milestone	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Potential Project Partners	Objective(s) Addressed
IOE 9- Continue publication of water quality monitoring and survey results to Lake Association members and the public	MEDIUM	$1000/year for 10 years	Update website and put information in newsletters. 2 publications	X	X	X	X	X	X	X	X	X	X	LCD, LA, Leelanau Conservancy	4.2, 4.3, 1.1,
IOE 10-Work with agricultural producers to obtain an approved Conservation Plan	MEDIUM	$25,000/year for 10 years	3 plans/year	X	X	X	X	X	X	X	X	X	X	USDA-NRCS, BCD	1.7, 4.3
IOE 11- implement USDA-NRCS conservation practices on agricultural producers land with approved conservation plans	MEDIUM	$50,000/year for 10 years	3 projects/year	X	X	X	X	X	X	X	X	X	X	USDA-NRCS, BCD	1.7, 4.3
IOE 12- Create applications for mobile devices to link outreach and education materials to more watershed users	LOW	$5,000/5 years	Create QR code for GHBWPP progress updates and display at access sites by 2019.					X						SBDNL	4.2, 4.3, 4.5
IOE 13- Inventory stairs or barriers where needed to facilitate safe human access to high quality recreation resources	LOW	$2,500 for inventory	Inventory priority sites by 2017. .			X								SBDNL, CRA, MDNR, BCD	4.2, 2.2, 3.1, 3.3
IOE 14- Install signage, stairs or barriers where needed to facilitate safe human access to high quality recreation resources and prevent impacts to wetlands, shorelines and steep banks.	LOW	$20,000 for treatments	Inventory priority sites by 2017. Install treatments at 3 sites by 2020.			X			X					SBDNL, CRA, MDNR, BCD	4.2, 2.2, 3.1, 3.3

Category 7: Land Protection (LP)

Categories/Tasks	*Priority: HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
LP 1- Establish voluntary conservation easements to protect identified Priority Areas	HIGH	$150,000/year as funding is available for 8 years	Permanent protection of 2500 acres by 2024 (1250 natural land and 1250 farmland). Goal to protect 1000 acres (total) by 2018.			X	X	X	X	X	X	X	X	Conservancy	1.8, 1.1, 1.3, 3.4
LP 2-Acquire and develop additional public access sites on public land, lakes and rivers in the watershed.	LOW	$200,000	Secure at least one parcel for additional or continued public access within the next five years.						X					MDNR, SBDNL	3.4, 3.1

Category 8: Public Health and Safety (PHS)

Categories/Tasks	Priority: HIGH, MED, LOW	Estimated Cost	Milestone	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Potential Project Partners	Objective(s) Addressed
PHS 1- Develop a sampling program for E. coli (fecal coliform bacteria) on inland lakes	HIGH	$5000/year	Work with SBNDL and LA's to expand sampling program for e. coli bacteria on inland lakes by 2018				X	X	X	X	X	X	X	LCD, LLA,SBNDL, LTLPOA	5.3
PHS-2: Develop a watershed level plan to address swimmer's itch in inland lakes	MEDIUM	$2,000/year	Work with area biologists to come up with a plan for swimmer's itch by 2018			X	X	X	X	X	X	X	X	LTLPOA, LLA	5.2
PHS-2: Implement a watershed level plan to address swimmer's itch in inland lakes	MEDIUM	$1,000/year	Implement plan for swimmer's itch by 2018				X	X	X	X	X	X	X	LTLPOA, LLA	5.2

Category 9: Economy

Categories/Tasks	Priority: HIGH, MED, LOW	Estimated Cost	Milestone	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Potential Project Partners	Objective(s) Addressed
E1-Ensure that zoning ordinances in all watershed communities include provisions to protect scenic vistas, agricultural lands, and historic or cultural sites.	MEDIUM	$0	Assemble a group to attend township meetings by 2016. Work with Township officials during annual zoning ordinance reviews		X	X	X	X	X	X	X	X	X	LCD, LLA, LTPOA, Townships	6.3
E2-Provide economic and community development incentives to entrepreneurial business efforts that help protect and/or allow people to experience the region's high-quality natural resources	MEDIUM	$50,000	Pending grant funding						X	X	X	X	X	Townships/ County	6.3
E3-Improve and expand existing fishing access by providing new or updated piers, platforms, and developed access points, including infrastructure to create opportunities for anglers with physical limitations	LOW	$750,000	Pending grant funding or budget funds to MDNR				X	X	X	X	X	X	X	MDNR. LLA, LTLPOA	6.3

Table 35: Summary Task Table

Categories/Tasks	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***	***2021***	***2022***	***2023***	***2024***
WQ1- Maintain current water quality program	X	X	X	X	X	X	X	X	X	X
WQ2-Establish a water quality monitoring program for water quality threats and hot spots.		X	X	X	X	X	X	X		
WQ3-Stay current with ongoing research on swimmer's itch in Northern Michigan	X	X	X	X	X	X	X	X	X	X
WQ4- Assess the need for & feasibility of instituting a new swimmer's itch control program on Lime and Little Traverse Lakes		X	X	X	X	X				
WQ5- Implement swimmer's itch control measures			X	X	X	X	X	X	X	X
WQ6- Investigate public health effects in the watershed including well water quality, swimmers itch and *E. coli* testing		X			X					
WQ7- Establish central database for water quality data.			X	X	X	X	X	X	X	X
WQ8-Conduct data analysis and investigate impacts to living organisms and impact of threats on water quality			X			X			X	
WQ9- Develop a plan for threat reduction and mitigation strategies in the watershed		X			X	X	X	X	X	X
WQ 10-Develop a lake nutrient loading model for the major lakes in the watershed.						X				
FWH1-Maintain high quality inland lake fisheries	X	X	X	X	X	X	X	X	X	X
FWH2-Work with interested landowners to promote placement of large woody debris in near-shore zones of lakes for fish habitat.	X	X	X	X	X	X	X	X	X	X
FWH3- Monitor fisheries population on inland lakes and streams, draft subsequent status reports					X				X	
FWH4- Implement BMP's and habitat restoration projects			X	X	X	X	X	X	X	X
FWH6- Implement Wild-Link program to identify, protect and enhance fish and wildlife habitat on private property			X		X		X		X	
IS 1- Continue to implement invasive species treatment program		X	X	X	X	X	X	X	X	X
IS2- Implement an education program to inform watershed users about invasive species					X	X	X	X	X	X

Categories/Tasks	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
IS3- Establish boat washing stations-Lime &Little Traverse Lakes				X	X	X	X	X	X	X
SSBP 1- Evaluate and address the culvert and road/stream crossings on priority sites				X		X				
SSBP2-Restore adequate storm water handling and stream conditions to the Little Traverse Lake outlet, Shalda Creek, and		X	X							
SSBP 3- Evaluate and understand water level fluctuations and seasonal changes in water levels		X								
SSBP 4- Inventory the shoreline, streams and lakes	X	X	X	X	X	X	X	X	X	X
SSBP 5 - Work with interested landowners to remove invasive species, improve riparian corridors and restore degraded habitat			X				X			
SSBP 6- Conduct workshops on natural shoreline management for shoreline property owners	X	X	X	X	X	X	X	X	X	X
SSBP 7-Inventory the status of aquatic habitats in portions of the watershed				X						
BMP 1- Develop a road and stream crossing survey				X						
BMP 2- Implement road and stream crossing BMP projects on high and medium priority sites					X	X	X	X	X	X
BMP 3-Conduct *Cladophora* and other surveys to determine failing septic systems yearly	X	X	X	X	X	X	X	X	X	X
BMP4-Implement a cost share program to replaced outdated or failing septic systems around lakeshores, wetlands or streams.						X	X	X	X	X
BMP 5-Inventory abandoned & poorly capped wells & correct properly.			X		X					
BMP 6-Work with landowners to promote forest management practices that are in compliance with current BMPs	X	X	X	X	X	X	X	X	X	X
IOE 1- Partner with Glen Lake Schools and other organizations to provide information, programs and education	X	X	X	X	X	X	X	X	X	X
IOE 2- Develop communication strategy for watershed users		X	X	X	X	X	X	X	X	X
IOE 3- Develop an education program for watershed users		X	X	X	X	X	X	X	X	X
IOE 4- Encourage appropriate provisions during or before site plan review for water quality.	X	X	X	X	X	X	X	X	X	X

Summary Task Table (Cont'd)

Categories/Tasks	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
IOE5- Find resources for a watershed coordinator position			X	X	X	X	X	X	X	X
IOE 6- Provide water quality information and news about implementation tasks progress to local and regional media.	X	X	X	X	X	X	X	X	X	X
IOE 7- Advocate for zoning, master plans and ordinances that protect water quality, human health and natural resources	X	X	X	X	X	X	X	X	X	X
IOE 8-Promote adoption of Point of Sale Septic Ordinance		X								
IOE 9- Continue publication of water quality monitoring and survey results to the public	X	X	X	X	X	X	X	X	X	X
IOE 10-Work with agricultural producers to obtain an approved Conservation Plan	X	X	X	X	X	X	X	X	X	X
IOE 11- implement USDA-NRCS conservation practices on agricultural producers land with approved conservation plans	X	X	X	X	X	X	X	X	X	X
IOE 12- Create applications for mobile devices to link outreach and education materials to more watershed users					X					
IOE 13- Inventory stairs or barriers where needed to facilitate safe human access to high quality recreation resources			X							
IOE 14- Install signage, stairs or barriers where needed to facilitate safe human access to high quality recreation resources			X			X				
LP 1- Establish voluntary conservation easements to protect identified Priority Areas			X	X	X	X	X	X	X	X
LP 2-Acquire and develop additional public access sites on public land, lakes and rivers in the watershed.						X				
PHS 1- Develop a sampling program for E. coli on inland lakes				X	X	X	X	X	X	X
PHS-2: Develop a watershed level plan to address swimmer's itch			X	X	X	X	X	X	X	X
PHS-2: Implement watershed plan to address swimmer's itch				X	X	X	X	X	X	X
E1-Ensure that zoning ordinances include provisions to protect scenic vistas, agricultural lands, and historic or cultural sites.		X	X	X	X	X	X	X	X	X
E2-Provide economic & community development incentives to help protect natural resources						X	X	X	X	X
E3-Improve and expand existing fishing access				X	X	X	X	X	X	X

Category Costs

The total cost for implementation efforts for all categories was determined using some of the information in Table 32 above, but also from individual stakeholders and organizations who will be doing the work. The total cost for implementation of the Good Harbor Bay Watershed Plan (excluding outreach activities) is **$7,026,320** (Table 36).

Table 36: Summary of Implementation Task Costs by Goal

Category	Cost
#1-Water quality (WQ)	$726,000
#2- Fish and Wildlife Habitat (FWH)	$202,820
#3- Invasive Species (IS)	$132,000
#4-Shoreline and Stream Bank Protection (SSBP)	$1,115,000
#5- Best Management Practices (BMP)	$1,972,000
#6- Information, Outreach and Education (IOE)	$1,095,500
#7- Land Protection (LP)	$1,400,000
#8- Public Health and Safety (PHS)	$58,000
#9- Economy	$325,000
Grand Total	**$7,026,320**

Summary

The lake associations, Leelanau Conservancy and the Leelanau Conservation District 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.

The GHB Steering Committee has identified several priority projects to undertake in the future, in addition to maintaining their current robust water quality and modeling efforts. One of the highest priority tasks is to learn more about the lake levels and outlet in Little Traverse Lake, maintain the water quality monitoring program and establish funding for a watershed coordinator to help implement the information and education task

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. Voluntary conservation easements established with interested landowners will prevent conversion of natural lands in priority areas to prevent additional pollutants from entering the watershed. Over the next five years, the Leelanau Conservancy has a goal of protecting 500 acres of land within identified Priority Areas, which will prevent 33.45 tons of sediment (or 66,900 lbs/yr), 4215 lbs N, and 91.5 lbs P from entering the Good Harbor Bay watershed each year.

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 8, including the continuation of water quality assessment and monitoring, installation and adoption of various Best Management Practices (Chapter 5), and educational tasks outlined in the IE Strategy (Chapter 9) 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 Good Harbor Bay Watershed Steering Committee should continue to meet annually during the implementation period to discuss and evaluate progress.

Important issues facing the Good Harbor Bay watershed include: increasing development and its associated increase in nutrient loading, invasive species and aging septic systems. Priority will be given to implementation tasks (both BMPs and educational initiatives) that work to reduce the impacts from these pollutants or stressors.

CHAPTER 9: INFORMATION AND EDUCATION STRATEGY

The Information and Education Strategy highlights the actions needed to successfully maintain and improve watershed education, awareness, and stewardship for the Good Harbor Bay 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 Lake Associations, but more work is needed. Both organizations publish newsletters and host educational events. 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 Good Harbor Bay watershed and its beautiful and unique qualities.

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.

Information and Education is one of the overall goals of the plan described on page 180. 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 unfamiliar with watershed issues. This Information and Education (IE) Strategy addresses the communication needs associated with implementing the Good Harbor Bay Watershed Protection Plan.

A variety of means have already been used by the Lime Lake Association, Little Traverse Lake Property Owners Association, Little Traverse Lake Conservationists, GTB, Leelanau Conservation District, Sleeping Bear Dunes National Lakeshore (SBDNL) and other organizations to inform the public regarding water quality issues for both Good Harbor Bay and its tributaries.

Some of these methods/publications include holding annual meetings/picnics, publishing newsletters and handouts, updating individual websites, participating in Leelanau Clean Water and collaborating with project partners.

Local Research Findings

The Good Harbor Bay 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 adjacent 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 <u>least</u> 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).

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 (Table 37) 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) (Table 38). 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).

Table 37: Results from Grand Traverse Bay Watershed Survey- Information Sources

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

Table 38: Results from Grand Traverse Bay Watershed Survey- Demographics

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 Good Harbor Bay 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, it was 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 Good Harbor Bay 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 Implementation and Education strategy focus on building awareness, educating target audiences, and inspiring action. In order to accomplish many of these I & E tasks, a part time position is needed such as a watershed coordinator. This position will be dependent on funding availability and the group does have a strategy in place to work on this project.

Five major objectives have been identified within Goal 4, which is to "**Ensure that all watershed property owners, visitors, users and other stakeholders understand stewardship and are able to support and promote watershed protection activities**". These include:

1. Raise awareness, understanding, commitment and action within the Good Harbor Bay Watershed so that private practices and public policy enhance attainment of the watershed goals.
2. Involve the citizens, public agencies, user groups and landowners in implementation of the watershed protection plan through meetings, events and workshops with individuals or groups.
3. Measure effectiveness of outreach activities in increasing awareness and reduction of Non-Point Source (NPS) pollution, including shoreline erosion.
4. Increase awareness of proper septic system maintenance, fertilizer use and storage of organic wastes and fertilizers.
5. Encourage appropriate provisions for site plan development and review for water quality and natural resources protection.

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 water body, 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 Good Harbor Bay 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 Good Harbor Bay 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 Good Harbor Bay watershed are still prone to less than adequate agriculture practices, runoff into streams or water bodies. 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 (Table 39). These messages will be refined as implementation moves forward. They may also be modified or customized depending on the message vehicle.

Table 39: Target audience Messages

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
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 39: Target audience Messages (Cont'd)

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 • NRCS recommended Conservation Practices
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

**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 (Table 37); the categories are the same as those used to outline the implementation tasks in Chapter 8 from the Information and Education category, but also include some other categories that specifically relate to I & E efforts. Several priority areas for the Good Harbor Bay watershed have been identified and the plan for rolling out the IE Strategy will correspond to these priority areas (Chapter 4, Section 4.7, Figure 28). 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 Chapter 4, Section 4.6.

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 has 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

Due to the large amount of public land under State and Federal control combined with the long history of active fisheries management within the Good Harbor Bay watershed, several important and significant partnerships have developed to address issues that impact multiple management agencies. The MDNR fisheries division is also an important partner with the general public in the Good Harbor Bay Watershed through their management of inland and anadromous fisheries in the watershed.

The Leelanau Clean Water group was formed in 2008 and includes several additional organizations in partnership with the Leelanau Conservation District to address water quality issues in Leelanau County. These are examples of the many partnerships that have formed and will continue forming as the project partners attempt to implement their respective tasks.

The total cost for implementation efforts for all categories is detailed in Chapter 8, Section 8.1. The total costs for I & E efforts, which includes Goals 1, 2, 4 and 6 from Tables 40 and 41 below is $1,145,000.

Table 40: Information and Education Tasks

Categories/Tasks	*Priority: HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
IOE 1- Partner with Glen Lake Schools and other organizations to provide information, programs and education on watershed planning, water quality monitoring and watershed protection	HIGH	$5000/year for 10 years	Establish contacts with Glen Lake School, launch educational program by 2015	X	X	X	X	X	X	X	X	X	X	Schools, LCD, LLA, LTPOA	4.2
IOE 2- Develop communication strategy for watershed users on topics such as invasive species, shoreline/stream bank protection and other watershed best management practices.	HIGH	$1000/year	Develop strategy with steering committee and implement strategy by 2016		X	X	X	X	X	X	X	X	X	LCD, LLA, LTPOA	4.2,4.3
IOE 3- Develop an education program for watershed users on topics such as invasive species, shoreline/stream bank protection and other watershed best management practices.	HIGH	$1000/year	Develop implement education program by 2016		X	X	X	X	X	X	X	X	X	LCD, LLA, LTPOA	4.2,4.3
IOE 4- Encourage appropriate provisions during or before site plan review for water quality and natural resources in the approval process.	HIGH	$1000/yr. for 10 years	Attend planning commission meetings regularly	X	X	X	X	X	X	X	X	X	X	BCD, PLIA, LA, BWC	4.7, 4.3

Table 40: Information, Outreach and Education Tasks (Continued)

Categories/Tasks	*Priority: HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
IOE5- Find resources for a watershed coordinator position to work county-wide on watershed issues, including the Good Harbor bay Watershed	HIGH	$20,000/year for a part-time position	Obtain grant funding and work with local groups to find position by 2016			X	X	X	X	X	X	X	X	LCD, LA's	4.1, 4.2, 1.1,
IOE 6- Provide water quality information and news about implementation tasks progress to local and regional media.	MEDIUM	$1000/year for ten years	Publicize watershed planning progress, updates to the watershed plan in lake association annual reports, in newspaper and on websites.	X	X	X	X	X	X	X	X	X	X	LCD, LA,	4.2, 4.3, 4.4
IOE 7- Advocate for zoning, master plans and ordinances that protect water quality, human health and natural resources	MEDIUM	$1000/year (staff time) for ten years	Attend at least 2 meetin annually	X	X	X	X	X	X	X	X	X	X	BLDHD, LA, LCD	4.3, 4.7
IOE 8-Promote adoption of Leelanau County Point of Sale Septic Ordinance and encourage enforcement of the ordinance and addressing failing septic	MEDIUM	$10,000 for staff time	Passage of ordinance in 2017		X									BLDHD, LA, LCD	4.3, 4.6

Table 40: Information, Outreach and Education Tasks (Continued)

Categories/Tasks	*Priority: HIGH, MED, LOW*	*Estimated Cost*	*Milestone*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*Potential Project Partners*	*Objective(s) Addressed*
IOE 9- Continue publication of water quality monitoring and survey results to Lake Association members and the public	MEDIUM	$1000/year for 10 years	Update website and put information in newsletters. 2 publications	X	X	X	X	X	X	X	X	X	X	LCD, LA, Leelanau Conservancy	4.2, 4.3, 1.1,
IOE 10-Work with agricultural producers to obtain an approved Conservation Plan	MEDIUM	$25,000/year for 10 years	3 plans/year	X	X	X	X	X	X	X	X	X	X	USDA-NRCS, BCD	1.7, 4.3
IOE 11- implement USDA-NRCS conservation practices on agricultural producers land with approved conservation plans	MEDIUM	$50,000/year for 10 years	3 projects/year	X	X	X	X	X	X	X	X	X	X	USDA-NRCS, BCD	1.7, 4.3
IOE 12- Create applications for mobile devices to link outreach and education materials to more watershed users	LOW	$5,000/5 years	Create QR code for GHBWPP progress updates and display at access sites by 2019.					X						SBDNL	4.2, 4.3, 4.5
IOE 13- Inventory stairs or barriers where needed to facilitate safe human access to high quality recreation resources	LOW	$2,500 for inventory	Inventory priority sites by 2017. .			X								SBDNL, CRA, MDNR, BCD	4.2, 2.2, 3.1, 3.3
IOE 14- Install signage, stairs or barriers where needed to facilitate safe human access to high quality recreation resources and prevent impacts to wetlands, shorelines and steep banks.	LOW	$20,000 for treatments	Inventory priority sites by 2017. Install treatments at 3 sites by 2020.			X			X					SBDNL, CRA, MDNR, BCD	4.2, 2.2, 3.1, 3.3

Table 41: Other Information and Education Related Tasks

Categories/Tasks	Priority: HIGH, MED, LOW	Estimated Cost	Milestone	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Potential Project Partners	Objective(s) Addressed
IS2- Implement an education program to inform watershed users about invasive species and create a yearly status report on the current conditions of invasive species	HIGH	$5000/year	Grant funding dependent. Hire watershed coordinator by 2018.					X	X	X	X	X	X	LCD, LA's	1.7, 4.1,
FWH 2-Work with interested landowners to promote placement of large woody debris in near-shore zones of lakes through-out the watershed for fish habitat.	MEDIUM	$1500/year over ten years	1. Develop literature for property owners. 2. Create a "demo site" of a natural shoreline property	X	X	X	X	X	X	X	X	X	X	MDNR, PLIA, BCD, SBDNL, CRA	1.2,1.3,1.4
SSBP 6- Conduct workshops on natural shoreline management for shoreline property owners promoting native plants, soft engineering, and natural landscaping to improve fish/wildlife habitat, reduce nutrient runoff into lakes, and decrease	MEDIUM	$2000/year for 10 years	2 workshops/yr.	X	X	X	X	X	X	X	X	X	X	LCD, LA, NRCS, LA	1.5, 1.7
BMP 4-Work with landowners to promote forest management practices that are in compliance with current BMPs, as outlined in "Quality Management Practices on Forest Land," (1994) MDNR	MEDIUM	$30,000/year for 10 years	Establish relationships with private forestland owners and managers. Adoption of 5 management plans/ yr. on private forest land.	X	X	X	X	X	X	X	X	X	X	MDNR, NRCS, LCD, CRA	3.4, 1.7, 1.3

CHAPTER 10: EVALUATION PROCEDURES

An evaluation strategy will be used to measure progress during the GHB Watershed Plan's implementation phase and to determine the degree to which water quality is being protected or impacted. The Steering Committee will meet two times/year to go over the watershed plan evaluate the progress.

The evaluation strategy for the GHB Watershed Plan includes:

- Continuation of the GHB Watershed Steering Committee
- Evaluation of GHB Watershed Plan Implementation
- Measuring and Evaluating Social Milestones
- Evaluation Strategy for Determining Water Quality Improvement
- GHB Watershed Plan Update

The following sections address each of these aspects of the evaluation strategy.

Continuation of the GHB Watershed Steering Committee

The GHB Watershed Steering Committee has been active in the implementation of the GHB Watershed Plan. The Steering Committee will continue to include at least one representative from the Lime Lake Associations (LLA), the Little Traverse Lake Property Owners Association (LTLPOA) and the Little Traverse Lake Conservationists (TLC). Representatives from organizations currently active on the Steering Committee, such as the Leelanau Conservation District, The Leelanau Conservancy, the Michigan Department of Environmental Quality, Michigan Department of Natural Resources (MDNR), Leelanau County Road Commission, township officials and representatives from the M-22 residents in Glen Arbor Township will be invited to all meeting and will be asked to provide input.

Other planning partners, including but not limited to Conservation Resource Alliance (CRA), Grand Traverse Band of Ottawa and Chippewa Indians (GTB), Grand Traverse Regional Land Conservancy (GTRLC), Natural Resources Conservation Service, NW Michigan Council of Governments, Benzie Leelanau Health Department, Sleeping Bear Dunes National Lakeshore (SBDNL), and The Homestead Resort owners will also be invited and asked for input.

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 five 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 Chapter 8 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 number of updated or new zoning ordinances adopted 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 not be limited to the following:

- Use the 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 money 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

Chapter 9 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 Good Harbor Bay Watershed Protection Plan. The LLA,LTLPOA, TLC, LCD 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 the Lake Association and Conservation District websites.
- Maintaining a list of ongoing and completed projects protecting water quality, along with their accomplishments and who is completing/completed the project.

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. The evaluation strategy is based on comparing established criteria with future monitoring results. The evaluation strategy will help identify whether water quality monitoring strategies are effectively documenting the progress of implementation tasks toward achieving measurable water quality improvement. The following criteria were developed to determine if the proposed pollutant reductions in the Good Harbor Bay watershed are being achieved and that water quality is being maintained or improved:

1. **Total phosphorus concentrations in Lime and Little Traverse Lake remain below 10.0** mg/m^3
   Assuming constant rates of phosphorus release from anaerobic bottom sediments, atmospheric deposition and direct shoreline input, achieving annual average concentrations of 10.0 mg/m^3 for the Lime and Little Traverse Lakes will be important to maintain the oligotrophic status of the lake.

2. **Total Nitrogen concentration in Lime Lake, Little Traverse Lake and their tributaries remain above 80 mg/m^3**
   The annual average nitrogen concentration of Lime and Little Traverse should remain above 80 mg/m^3 to discourage the growth of nitrogen fixing

blue green algae such as *Anabeana sp* and *Microcystis sp.* Nitrogen levels are not regulated in surface waters by the State of Michigan or USEPA the maximum levels should remain within statewide averages for inland lakes with a similar trophic status index as Lime and Little Traverse Lakes.

3. **Maintain high dissolved oxygen levels in the Lime Lake, Little Traverse Lake and their tributaries.**
   Dissolved oxygen concentrations in Lime and Little Traverse Lake and their tributaries are typically above the 7 mg/L standard that is required by the State of Michigan for water bodies that support coldwater fisheries. Thus, it should be considered that water quality throughout the watershed is being maintained if annual average dissolved oxygen concentrations in Lime and Little Traverse Lakes are above 7 mg/L.

4. **Reduce nutrient inputs from stormwater**
   Depending on numerous factors, such as drainage area, land-cover type, and time period between rain events, nutrient loads in stormwater can vary widely.

5. **Reduce stormwater sediment loads draining into the Lime and Little Traverse Lake and their tributaries.**

6. **Maintain pH levels within range of 6.5 to 9.0 in Lime and Little Traverse Lake and tributaries as required by the State of Michigan.**
   Data from the Conservancy Water Quality Monitoring program show that pH levels consistently fall within this range.

7. **Maintain coldwater ecosystems in all water bodies in the Good Harbor Watershed that are designated coldwater fisheries.**
   The major tributaries to Lime Lake, Little Traverse Lake and Lake Michigan (Lime Creek, Shetland Creek and Shalda Creek) must maintain water temperatures below 24° Celsius to sustain their coldwater fisheries. Water temperatures below the thermocline in Lime and Little Traverse Lakes should generally not exceed 18° Celsius throughout summer months.

8. **Reduce *Cladophora* algae growth on the Lime and Little Traverse Lake shoreline associated with human induced nutrient loading.**
   Cladophora algae occurs naturally in small amounts along the shorelines of Northern Michigan lakes, but grows more extensively and densely as nutrient availability increases. Surveys should be completed on Lime and Little Traverse Lake periodically. The most recent completed in 2014 on Little Traverse Lake, has documented the location of specific *Cladophora* colonies along the shoreline, as well as the density of growth. Thus, the same information generated during future surveys can be used to determine if there were reductions in the density or size of *Cladophora* growth as a result of water quality improvement projects.

9. **Maintain chlorophyll-a concentrations in surface waters typical for lakes in Northern Michigan.** Chlorophyll-a concentrations should be maintained within normal ranges for similar lakes in Northern Michigan to prevent problems associated with large phytoplanktonic algae blooms that can cause water quality problems (e.g., low dissolved oxygen levels). Typical peak chlorophyll-a concentrations for Lime and Little Traverse Lake should remain below 3 mg/m3.

10. **Maintain or improve water clarity for Lime and Little Traverse Lakes**
    Minimum summertime Secchi depth should be greater than 10 feet.

The tasks outlined on pages 188-190 for water quality outline the monitoring work that will be done to measure the majority of the above mentioned criteria. Much of the proposed tasks are dependent on future grant funding.

GHB Watershed Plan Update

The frequency for a complete evaluation of the GHB Watershed Plan will be approximately every 5 years. If updates to the Plan are needed prior to five years, the Steering Committee will coordinate with the DEQ and collect public input on any proposed changes.

CHAPTER 11: CONCLUSIONS

The Good Harbor Bay Watershed Protection Plan was developed to help guide efforts to protect water quality of Lime Lake, Little Traverse Lake, other inland lakes, Good Harbor Bay and its surrounding watershed. The watershed planning process was initiated in 2011 and allowed key decision-makers, organizations, resource management agencies and the public to learn about the watershed, what issues confront it and what they can do to protect it. The watershed plan was prepared by the Leelanau Conservancy and Good Harbor Bay Watershed Steering Committee with collaboration and input from major watershed stakeholders including the Good Harbor Bay Improvement Association and local units of government.

In 2011 these committed partners initiated a watershed planning process and formed a steering committee. This 2015 watershed plan includes significant information on the watershed, pollutant concentrations, pollutant sources, and load reduction estimates of various BMPs, measurable task milestones to guide plan implementation progress, and a set of criteria to evaluate the effectiveness of implementation efforts. The Good Harbor Bay Watershed Protection Plan is meant to assist decision-makers, resource managers, landowners, residents and visitors in the watershed in making sustainable decisions to help maintain, improve and protect water quality.

The success of the Good Harbor Bay Watershed Protection Plan will depend on continued support and participation from key partner groups, along with the availability of monies for implementation of the identified tasks. 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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