FINAL REPORT

South Bar Lake, Empire, MI
Water Quality Monitoring

Submitted to:

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South Bar Lake/ Village of Empire
Water Quality Monitoring and
Storm Runoff Assessment

Background and Previous Work

South Bar Lake, immediately adjacent to the north of the Village of Empire (hereafter referred to as "Village"), is a prime recreational area in Leelanau County. South Bar Lake is approximately 81 acres in size. The lake is heavily used seasonally for fishing and swimming and its close proximity to Lake Michigan makes it a destination for local residents as well as tourists. Excellent public facilities and access have been developed and are present at the southwest end of the lake via Niagra Street and S. Lake Michigan Drive. Because South Bar Lake is shallow, there is more potential for widespread aquatic plant growth throughout the lake, making some recreational activities (such as swimming and boating) somewhat less desirable or more difficult. Therefore, maintaining water quality and limiting nutrient/pollutant input will help to maintain this recreational resource in future years.

In 2009, the Village contracted with Great Lakes Environmental Center (GLEC) of Traverse City, MI to complete a preliminary assessment of water quality and nutrient input to South Bar Lake. The results indicated the water quality in the lake is acceptable, but not as high quality as other lakes in the Grand Traverse Region. This is due, in part, to South Bar Lake's specific characteristics, but may also result from impacts to the lake from surface water runoff. Measurements of phosphorus input to the lake at the three primary inlets demonstrated that the predominant source of nutrients was from the south inlet, near the north end of the Village. Similarly, nitrogen inputs at the south and Florence (mid-lake) inlet were considerably higher than the northern most inlet. Because the nutrient loading estimates were performed only once, the Village contracted with GLEC to comprehensively evaluate nutrient loading at three times during the year to better define this issue. In addition, GLEC partnered with The Watershed Center Grand Traverse Bay (TWC) to perform a shoreline vegetation buffer inventory on South Bar Lake, a chladophora (nuisance algae)

survey as well as an assessment of road/stream crossings of these inlet tributaries. Chladophora is often monitored in inland lakes as it can be a good indicator of nutrient problems and may point to sources of nutrients entering into the lake.

Water Quality Concerns

Within the any watershed there are a number of distinct concerns which may impact water quality. Agricultural activities (crop lands, orchards, livestock) may contaminate surface waters by nutrient and pesticide leaching which may ultimately impact both stream and lake biology. Similarly, groundwater may be impacted by pesticide/nutrient leaching from agricultural practices. Offsite movement of pesticides may also impact adjacent, nonagricultural wetlands, deciduous/ coniferous forests and rangelands. Also of concern, road/stream crossings may contribute nutrients and sediment to tributaries which can directly impact the lake.

Technical Approach

Lake Sampling. Sampling was conducted at South Bar Lake on July 17 and October 2, 2013 as well as on May 9, 2014. The lake sampling locations for water quality measurements analysis are shown in Figure 1**.** Lake water samples were collected at the surface with a polypropylene sampling bottle and transferred to 0.25 L glass bottles acidified with H_2SO_4. These samples were analyzed for total phosphorus and nitrate/nitrite nitrogen by Great Lakes Environmental Center (GLEC) in Traverse City, MI. All nutrient samples were analyzed by GLEC using established Standard Operating Procedures (SOPs) and analytical techniques (SOPs on file at GLEC). In addition, a Hydrolab® Quanta was used to measure pH, temperature, dissolved oxygen, oxidation-reduction potential (redox) and conductivity every foot from the surface to three feet and at three foot intervals to the lake bottom, approximately 10 feet. These variables are generally accepted lake water quality parameters which can be used to assess the relative water quality of the lake.

Tributary Monitoring. Tributaries were monitored a three times (summer and fall in 2013, spring 2014 on same dates as lake water quality sampling) at the inlets and at the outlet of the

lake (Figure 1). The tributaries were monitored for total phosphorus and nitrate/nitrite nitrogen by collecting water samples in 0.25 L acidified glass sample bottles. In addition, flow rates at the inlets and main outlet (Figure 1) were measured by a digital flowmeter at approximately 20 equal intervals across the stream bed. The flow at each interval, and the cross sectional area were combined to provide a total cross sectional flow for the stream. This flow rate, in conjunction with the measured nutrient parameters, allow for the estimation of nutrient loading of phosphorus and nitrogen, and a total "phosphorus and nitrogen "budget" to be calculated (nutrient inflow – nutrient outflow). It should be noted that this nutrient "budget" can change daily and will change seasonally depending on local conditions, including rain events or snow melt.

Shoreline Buffer Inventory. A shoreline buffer (or greenbelt) survey was conducted parcel by parcel along the entire perimeter of South Bar Lake on August 5, 2013. The survey followed procedures outlined in The Watershed Center's (TWC) "Conducting a Shoreline Greenbelt Survey Training Manual" (drafted June 2008). In addition to general information gathered identifying the particular parcel location and ownership information, various other information was gathered including the following; shoreline access type/material, greenbelt length and depth, amount of turf grass present, density of vegetation, amount of different types of plant species present, presence of erosion and types of erosion control structures, and emergent vegetation. These factors were entered into an Excel spreadsheet and scored according to TWC's "Shoreline Greenbelt Survey Scoring Guide" which accompanied the training manual.

Cladophora Survey.A cladophora survey was completed along the perimeter of South Bar Lake according to procedures used by the Glen Lake Association for their annual cladophora shoreline surveys. The survey is conducted by measuring amounts of cladophora, a filamentous algae, in the shallow water shoreline areas for the purpose of determining where phosphorous and /or nitrogen may be entering the lake. The cladophora survey was conducted on August 7, 2013. Data from the survey were summarized in an Excel spreadsheet and included information such as GPS coordinates of the patches, patch length

and width, length of the strands of cladophora, possible causes, and any relevant notes from the site.

Road Stream Crossings. A total of 4 road stream crossings were analyzed in Spring 2014 using the "Great Lakes Road Stream Crossing Inventory" Instructions and Datasheets developed by Huron Pines and the Wisconsin DNR (April 2011). A map of inventoried sites was generated. The inventory documented various types of information for each crossing including: general information (i.e. GPS point, stream/road names), crossing information (type, structure shape, inlet/outlet type, length/width/height, velocity in crossing, depth of water), stream information (flow level, scour pool or upstream pond present), road information (type, ownership, surface, width, location of low point, approaches, slope of embankment), erosion information, and a site drawing.

Stormwater Assessment. The Watershed Center conducted a stormwater assessment for the Village of Empire, similar to those conducted in the Grand Traverse Bay watershed. Since stormwater is one of the main ways pollutants enter a waterbody it is important to effectively manage stormwater inputs coming from all areas, including small communities. In Spring 2014 TWC staff met with the Village's Deputy Clerk and toured the village to conduct the stormwater assessment.

Results of Monitoring Activities

Lake Water Quality. Comprehensive lake monitoring, including Hydrolab® measurements (dissolved oxygen, temperature, pH, redox, conductivity) and samples for total phosphorus, nitrate/nitrite nitrogen were completed on South Bar Lake. Samples were taken once in the early summer 2013, fall of 2013 and spring of 2014. The relevant observations from these monitoring activities are as follows:

- Water quality on South Bar Lake is generally good and falls into the low mesotrophic range for most water quality parameters. Average concentration of total phosphorus for the three sample events was 0.0131 mg/L (slightly higher than measured in 2009)

and nitrate/nitrite nitrogen (NOx) was 0.558 mg/L (Table 1). Values for total phosphorus are slightly elevated compared to most other area lakes in Northern Michigan (Table 3), but are not unusual for a small, very shallow lake such as South Bar Lake. Nitrate/nitrite nitrogen concentrations are consistent with values seen in other area lakes (data not shown).

- Levels of dissolved oxygen in lake water are adequate, with slight depletion noted near the bottom of South Bar Lake only in the October 2, 2013 sample event. This slight oxygen depletion may be characteristic of biological processes at the lake bottom, including breakdown of organic matter which can consume oxygen, but the depletion is likely not significant enough to result in excessive release of sediment phosphorus or impact fish habitat. Temperature profiles demonstrate a consistent temperature range throughout the water column from surface to bottom. The temperature and dissolved oxygen profiles for the Hydrolab are presented in Figure 2.

Tributary Monitoring. Monitoring of tributaries to South Bar Lake was limited to those sources of water to the lake as well as the outlet. The tributaries were monitored for total phosphorus and nitrate/nitrite nitrogen. It should be noted that the impact of surface water runoff on nutrient loading of tributaries, streams, rivers and lakes is well documented. Less often considered are impacts of atmospheric "dry deposition" which can also result in nutrient input to the local watershed, and subsequent loading into tributaries via surface water runoff. Dry deposition can be defined as the deposition of pollutants, including gases, nutrients and particulate matter, as they settle out of the atmosphere. Local agriculture can be sources of this deposition, as surface dust (containing nutrients and pesticides) can be suspended in air and deposited downrange in the watershed. The following conclusions can be made based on the analysis of the tributary data:

- Total phosphorus concentrations at the Southend Inlet (nearest the Village of Empire) was highest of all tributaries in for all three sample events (0.119 mg/L average), with all other inlets and the outlet approximately the same, in the range of .0066 to .0133 mg/L (Table 2). Although this concentration was approximately ten times (10X) the

average of the other sites, this was mitigated as the flow was only about 15% of the average of the other three sites (Lake Michigan Inlet, Florence Inlet and the Outlet).

- Levels of nitrate/nitrite nitrogen were more variable, but the Southend Inlet continued to have the highest concentration, approximately 2X of the next highest (Lake Michigan Inlet), and the Outlet was consistently the lowest. Again, because of low flows, the Southend Inlet contribution of nitrogen was reduced. The impacts of nitrogen usage in the Lake by vegetation or other aquatic sources can be seen by the relatively low amount of nitrogen leaving the Lake.
- Taking into account the flow rates, loading of total phosphorus (net of phosphorus input – phosphorus at outlet) into South Bar Lake ranged from a low of – 0.1025 lbs./day (Spring 2014) to 0.1453 lbs. per day (October, 2013). A negative input of phosphorus in the spring may be due to flushing of phosphorus in spring runoff, weather conditions and a result of a late spring with minimal agricultural activity in progress. It is expected that loading rates will vary considerably over the year depending on local conditions and timing of measurements.
- Loading of nitrate/nitrite nitrogen into the lake (net input) ranged from a low of 18.18 lbs/day (Spring 2014) to a maximum of 25.94 lbs/day (July, 2013). Again, the measurement in Spring 2014 may show the impact of possible flushing, late spring and low activity in the watershed.

It is difficult to compare nutrient loading between area lakes, due to differences in the size and number of tributaries, the timing of sampling (during dry or wet periods) and the frequency of sampling. A comparison of tributary total phosphorus and nitrate/nitrite nitrogen levels for other Leelanau county tributaries is shown in Table 4, in order to provide some perspective (note that these are concentrations, not loading). Overall, the phosphorus and nitrogen loading is somewhat modest but higher than averages for other tributaries in the County (compare column 3 in Table 2 with values in Table 4). However, South Bar Lake is very shallow and small, and small amounts of additional nutrients over time may contribute to additional growth of algae and aquatic plants.

Shoreline Buffer/Chladophora Survey. Results show that more than 75% of the shoreline has an 'excellent' or 'very good' shoreline buffer:

- Excellent - 46%
- Very Good - 31%
- Good - 14%
- Poor - 5%
- None/Very Poor - 4%

The shoreline buffer survey incorporated may different variables, including shoreline description, slope characteristics, any structures present, greenbelt information, turf presence and density, vegetation diversity, and any erosion present. The large proportion of shoreline rated good to excellent (91%) is indicative of the quality of development and maintenance of nearshore habitat which are critical to maintaining the general health of the Lake.

With respect to chladophora, the survey is conducted by measuring amounts of cladophora, a filamentous algae, in the shallow water shoreline areas for the purpose of determining where phosphorous and /or nitrogen may be entering the lake. The cladophora survey was conducted on 8/7/13 with a total of 11 patches found (Figure 3). Data from the survey was summarized in an Excel spreadsheet and includes information such as GPS coordinates of the patches, patch length and width, length of the strands of cladophora, possible causes, and any relevant notes from the site. Possible causes for the cladophora noted include 'septics' and 'natural causes'. The results indicate that there are no readily apparent causes for the cladophora noted such as lawn fertilization, lakeside dumping, animal waste, and bank erosion. Further, 11 total patches of cladophora are relatively small, but this survey could be repeated in upcoming years to determine any changes in the lake. Note that the 11 patches include some long stretches (#45-47, #57-59, #54-55) which were each considered a single "patch".

Road Stream Crossings. A total of 4 road stream crossings were analyzed in Spring 2014 using the "Great Lakes Road Stream Crossing Inventory" Instructions and Datasheets developed by Huron Pines and the Wisconsin DNR in April 2011. A map of inventoried sites is below (Figure 4). The inventory documented various types of information for each crossing including: general information (i.e. GPS point, stream/road names), crossing

information (type, structure shape, inlet/outlet type, length/width/height, velocity in crossing, depth of water), stream information (flow level, scour pool or upstream pond present), road information (type, ownership, surface, width, location of low point, approaches, slope of embankment), erosion information, and a site drawing. Site #1 was at a small creek crossing on Lake Michigan Drive at the northern end of South Bar Lake. No major issues were noted at this site. Site #2 was near the Florence Inlet that outlets to South Bar Lake on the Northeast side (see aerial photo, Figure 4). Minor erosion was noted at this site, as well as a small dam and impoundment directly upstream of the crossing location. A large amount of algae was also noted in the downstream portion of the stream, indicating nutrient input from someplace. Site #3 was on the same stream where it crosses M-22, just upstream of Site #2. No major issues were recorded at this site, however, it was noted that the banks down to the stream at this location were quite steep. Site #4 was located at the outlet of South Bar Lake, minor erosion issues resulting from road runoff were noted at this site.

Stormwater Assessment. TWC conducted a stormwater assessment for the Village of Empire, similar to those conducted in the Grand Traverse Bay watershed. Since stormwater is one of the main ways pollutants enter a waterbody it is important to effectively manage stormwater inputs coming from all areas, including small communities. In Spring 2014 TWC staff met with the Village's Deputy Clerk and toured the village to conduct the stormwater assessment. Initial conversations with the Deputy Clerk revealed that a series of underground infiltration trenches had been installed throughout the village some years ago to handle their stormwater runoff. The underground infiltration trenches collect stormwater runoff from the roads, rooftops, and parking lots throughout the Village and infiltrate it naturally underground along the Village's two main roads, Front Street and M-22 (Figure 5). Their system is so effective that virtually none of the stormwater runoff in the Village of Empire makes it to surface water. Historically some runoff did make it to a channel originating from a culvert outlet at the corner of Niagra Street and S. Lake Street. However, when the underground infiltration system was installed this outlet was abandoned. Additionally, a raised berm/sidewalk prevents overland surface runoff from making it to this channel. The only flow in the channel at this point is groundwater seepage.

Summary

Based on the limited monitoring completed during 2009, and the more comprehensive monitoring completed in 2013 and 2014, the overall water quality of the South Bar Lake is generally good. Lake water quality is generally classified on the basis of several lake parameters (total phosphorus, secchi depth, chlorophyll a levels, hypolimnion oxygen, and percent organic matter) and the trophic state determination is summarized in Table 5). Because only total phosphorus and dissolved oxygen were measured in South Bar Lake, it is more difficult to quantitatively assess lake health. Based on limited parameters, lake water quality would be classified as mesotrophic, but bordering on levels which would be considered marginally oligotrophic. Lakes classified as oligotrophic are best, followed by mesotrophic and eutrophic. South Bar Lake is very shallow, which may result in elevated water temperatures and higher levels of aquatic plants and algae. This could contribute to the mesotrophic status. Most lakes in Northern Michigan are oligotrophic, or slightly mesotrophic.

Results of the shoreline survey, chladophora survey, road/stream crossings and stormwater runoff analysis indicate that areas around the Lake are generally in very good shape, and may not be contributing significantly to nutrient accumulation or degradation of South Bar Lake.

Specific Recommendations

Although the overall water quality in the South Bar Lake is still relatively good, there are some indications that degradation in water quality may occur in the future without continuing proper management practices. The following recommendations are made:

- Continue to encourage land management practices, were applicable, which help to minimize nutrient inputs to tributaries to South Bar Lake. Such strategies would include the use of vegetative buffer strips, water retention ponds, etc., particularly for inputs which may result from runoff from the Village or areas near tributaries where nutrient loading may be significant. The Southend Inlet, although low flow,

consistently showed the highest concentrations of phosphorus and nitrogen.

- Investigate possible erosion and sources of nutrients at road/stream crossing #2 near Florence Inlet, as well as some erosion issues due to road runoff at the outlet of South Bar Lake.
- Because the Village's infiltration trenches handle the stormwater runoff so well, no further recommendations are warranted at this point, other than to stress continued maintenance is key to the proper functioning of their system. Conversations with the Village staff indicated their systems are cleaned out on a yearly basis. The Village of Empire should be commended for being so proactive in addressing stormwater runoff.
- Based on desire and available funds, continued monitoring of tributaries phosphorus and nitrogen levels, and lake water quality levels could be completed periodically, but not necessarily more than every 4-5 years. Given the current state of the Lake and surroundings, nothing indicates than monitoring should occur more frequently.

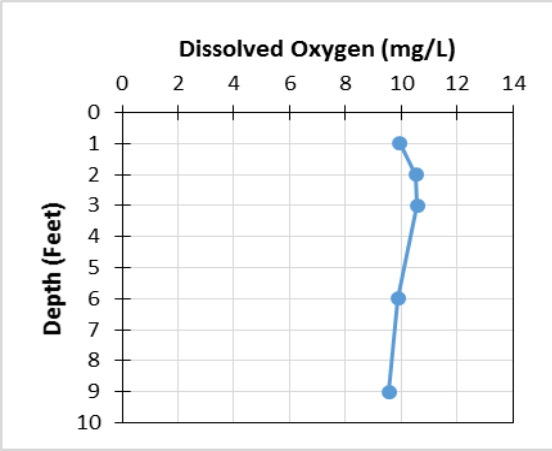
REFERENCES

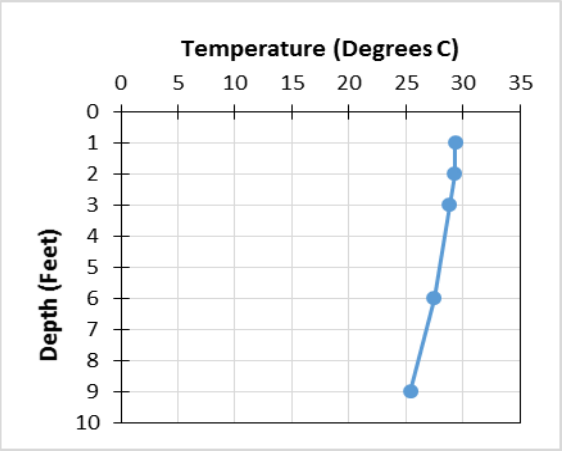
Chapra, S.C. 1997. Surface Water Quality Modeling. McGraw-Hill, New York.

Figure 1. South Bar Lake Monitoring Sites, July 2, 2009.

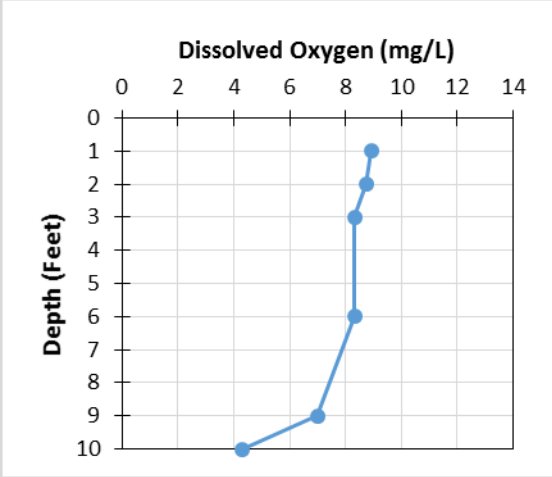
Figure 2. South Bar Lake Hydrolab Profiles

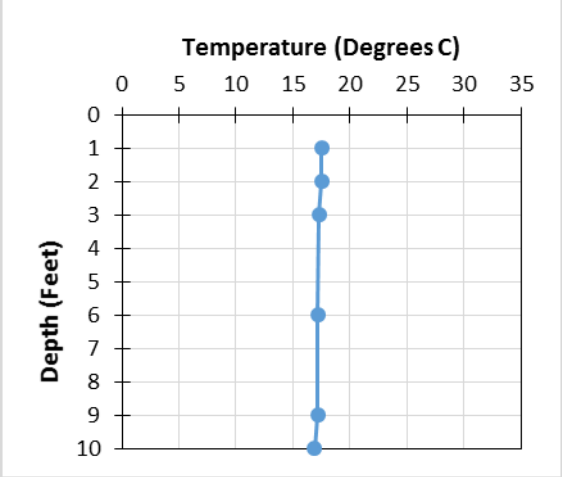
July 17, 2013



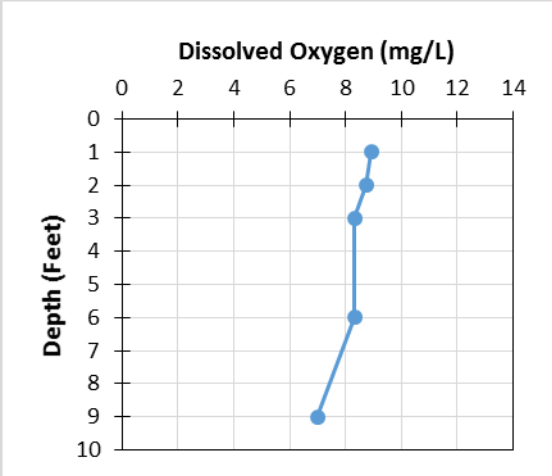


October 2, 2013





May 9, 2014



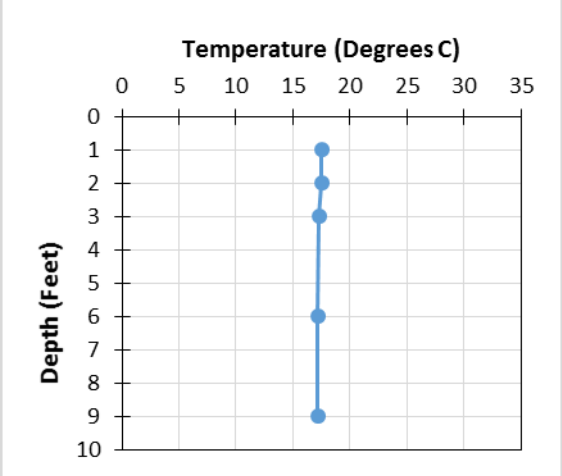


Table 1 . Total Phosphorus and Nitrate/Nitrite Nitrogen in South Bar Lake

DATE	Total Phosphorus (mg/L)		Nitrate/Nitrite N (mg/L)
July 17, 2013	0.017		0.0399
October 2, 2013	0.009		0.401
May 9, 2014	0.0134		1.233
Average	**0.0131**		**0.558**

Table 2. Total Phosphorus Loading by Tributaries – South Bar lake

July 7, 2013

Total Phosphorus (TP)**

Date: 7/7/13	Flow (cms)		TP** (mg/L)		Load (mg/day)		Load (kg/day)		Load (lbs/da)
Outlet	0.1177		0.0137		139289.544		0.1393		0.3064
Southend inlet	0.01177		0.1300		132178.176		0.1322		0.2908
Florence Inlet	0.05857		0.0072		36437.403		0.0364		0.0802
Lake Mi Inlet	0.00536		0.0165		7641.216		0.0076		0.0168

Loading Summary	TP In	TP Out	Net Load (+ is gain)
Kg/day	0.1762	0.1393	0.0369
lbs/day	0.3878	0.3064	0.0814

Nitrate/Nitrite Nitrogen (NOx)**

Date: 7/7/13	Flow (cms)		NOx** (mg/L)		Load (mg/day)		Load (kg/day)		Load (lbs/da)
Outlet	0.1177		0.0422		429052.464		0.4291		0.9439
Southend inlet	0.01177		3.99		4056853.248		4.057		8.9251
Florence Inlet	0.05857		1.43		7236873.072		7.2369		15.9211
Lake Mi Inlet	0.00536		2.00		926208.000		0.9262		2.0377

Loading Summary	NOx in	NOx out	Net Load (+ is gain)
Kg/day	12.2201	0.4291	11.791
lbs/day	26.8839	0.9439	25.94

** TP and NOx levels measured by Great Lakes Environmental Center

Table 2. Total Phosphorus Loading by Tributaries – South Bar Lake (Continued)

Oct 2, 2013

Total Phosphorus (TP)**

Date	Flow (cms)	TP** (mg/L)	Load (mg/day)	Load (kg/day)	Load (lbs/da)
Outlet	0.255	0.0079	59672.808	0.0597	0.1313
Southend inlet	0.01	0.096	82919.117	0.0829	0.1824
Florence Inlet	0.06	0.0076	39398.400	0.0394	0.0867
Lake Mi Inlet	0.003	0.0126	3389.209	0.0034	0.0075

Loading Summary	TP In	TP Out	Net Load (+ is gain)
Kg/day	0.1257	0.0597	0.066
lbs/day	0.2766	0.1313	0.1453

Nitrate/Nitrite Nitrogen (NOx)**

Date	Flow (cms)	NOx** (mg/L)	Load (mg/day)	Load (kg/day)	Load (lbs/da)
Outlet	0.255	0.37	2794802.400	2.7948	6.1486
Southend inlet	0.01	5.11	4413715.488	4.4137	9.7102
Florence Inlet	0.06	1.67	8657280.000	8.6573	19.046
Lake Mi Inlet	0.003	2.61	702050.328	0.7021	1.5445

Loading Summary	NOx in	NOx out	Net Load (+ is gain)
Kg/day	13.7731	2.7948	10.9783
lbs/day	30.3007	6.1486	24.1521

** TP and NOx levels measured by Great Lakes Environmental Center

Table 2. Total Phosphorus Loading by Tributaries – South Bar Lake (Continued)

May 9, 2014

Total Phosphorus (TP)**

Date	Flow (cms)	TP** (mg/L)	Load (mg/day)	Load (kg/day)	Load (lbs/da)
Outlet	0.1474	0.0171	217742.152	0.2177	0.4790
Southend inlet	0.0110	0.1300	123361.056	0.1234	0.2714
Florence Inlet	0.0967	0.0051	42623.989	0.0426	0.0938
Lake Mi Inlet	0.0054	0.0109	5115640	0.0051	0.0113

Loading Summary	TP In	TP Out	Net Load (+ is gain)
Kg/day	0.1711	0.2177	-0.0466
lbs/day	0.3765	0.4790	-0.1025

Nitrate/Nitrite Nitrogen (NOx)**

Date	Flow (cms)	NOx** (mg/L)	Load (mg/day)	Load (kg/day)	Load (lbs/da)
Outlet	0.1474	0.880	11205444.1	11.2054	24.6520
Southend inlet	0.0110	4.330	4108872.096	4.1089	9.0395
Florence Inlet	0.0967	1.820	15210913.54	15.2109	33.464
Lake Mi Inlet	0.0054	2.156	1011864.269	1.0119	0.3285

Loading Summary	NOx in	NOx out	Net Load (+ is gain)
Kg/day	20.3317	11.2054	9.1263
lbs/day	42.8320	24.6520	18.1800

** TP and NOx levels measured by Great Lakes Environmental Center

Table 3. Total lake water phosphorus concentration in area lakes.

Lake	Water Total Phosphorus (mg/L)	
Torch	0.0017	
Burt	0.0022	
Lime	0.0044	
Crystal	0.0048	
North Leelanau	0.0048	
South Leelanau	0.0049	
Glen	0.0051	
Little Traverse	0.0051	
Cedar	0.0053	
Platte	0.0077	
Long Lake #1	0.0086	
Long Lake #2	0.0136	
Long Lake #3	0.0093	
South Bar Lake	**0.0131**	(Average)

Table 4. Five year average of total phosphorus and nitrate/nitrite nitrogen concentrations in 19 tributaries in Leelanau County, 1992-1996.

Tributary Name	5 year Average * TP (mg/L)	5 year Average NOx (mg/L)
Mebert	0.0022	1.146
Skeba	0.0021	1.029
Leo	0.0020	1.276
Rice	0.0019	0.410
Belnap	0.0019	0.871
Houdek	0.0017	1.623
Beaudwin	0.0017	2.055
Cedar River	0.0017	0.484
N. Cedar	0.0016	0.507
Weaver	0.0015	0.979
Ennis	0.0015	0.891
Little Finger Cr.	0.0014	0.950
Provemont	0.0013	2.368
Solon	0.0013	0.421
Cedar Creek	0.0012	0.980
Belanger	0.0011	1.380
S. Lime	0.0011	0.779
Hatlem	0.0010	0.424
Timberlee Cr.	0.0010	1.463

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*Data from: Nutrient Data and Budgets for Leelanau County Streams and Lakes, 1990-1996, Leelanau Conservancy Report 97-2.

Table 5. Trophic state classification as described by Chapra, 1997

Variable	Oligotrophic	Mesotrophic	Eutrophic	**South Bar Lake**
Total Phosphorus (mg/L)	<0.010	0.010 – 0.020	>0.020	**0.0131**
Chlorophyll a (µg/L)	<4	4 - 10	4 - 10	**Not Taken**
Secchi Depth (meters/feet)	>4 meters > 13 feet	2 - 4 6.6 - 13	< 2 < 6.6	**Not Taken**

Chapra, S.C. 1997. Surface Water Quality Modeling. McGraw-Hill, New York.

Figure 3: South Bar Lake Cladophora Survey

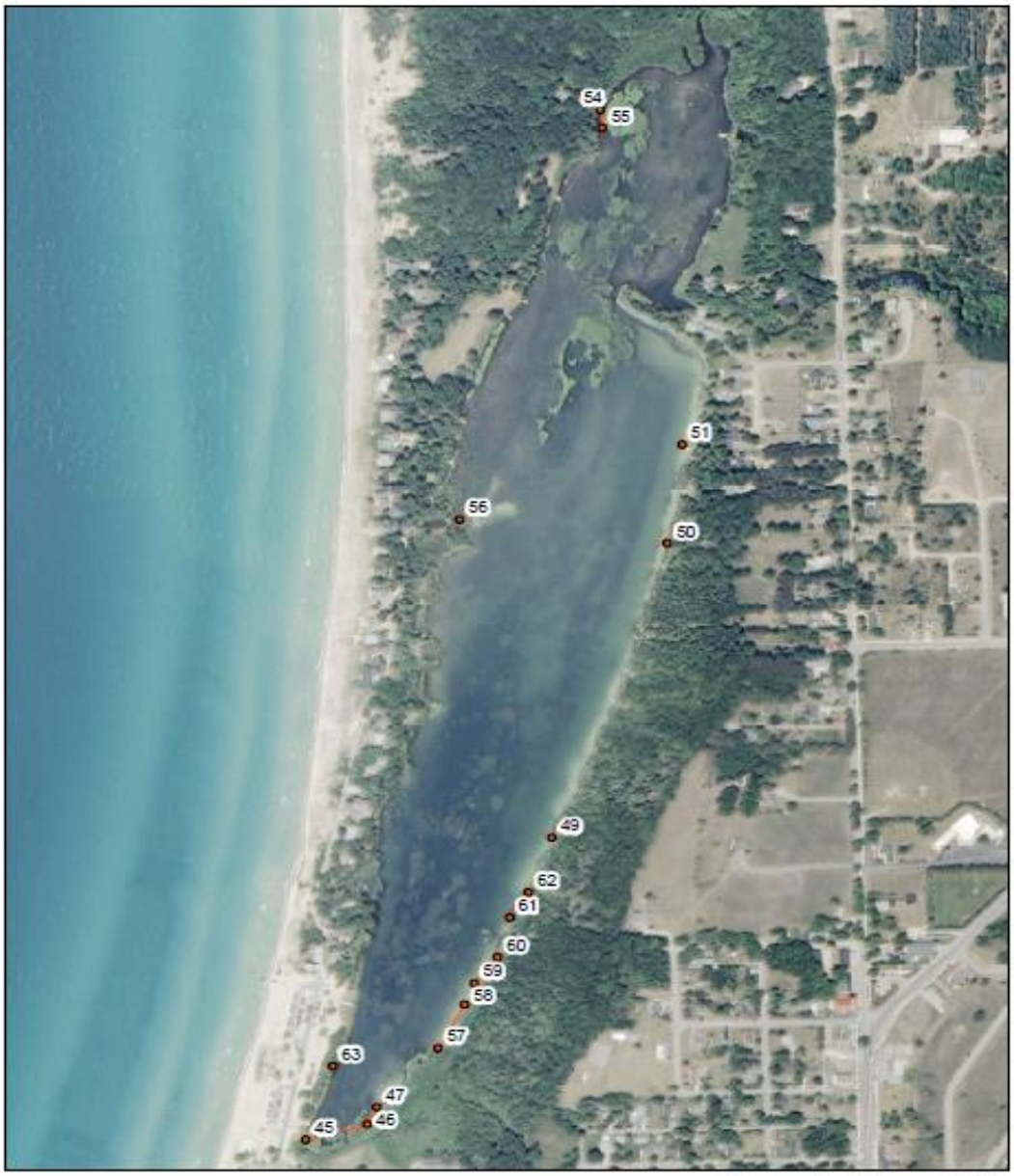

Figure 4: South Bar Lake Road Stream Crossings

Road Crossing Site #2 (photo from Google Maps)

Figure 5: Village of Empire Stormwater Infiltration System