Higgins Lake Watershed Management Plan

Updated September 2007

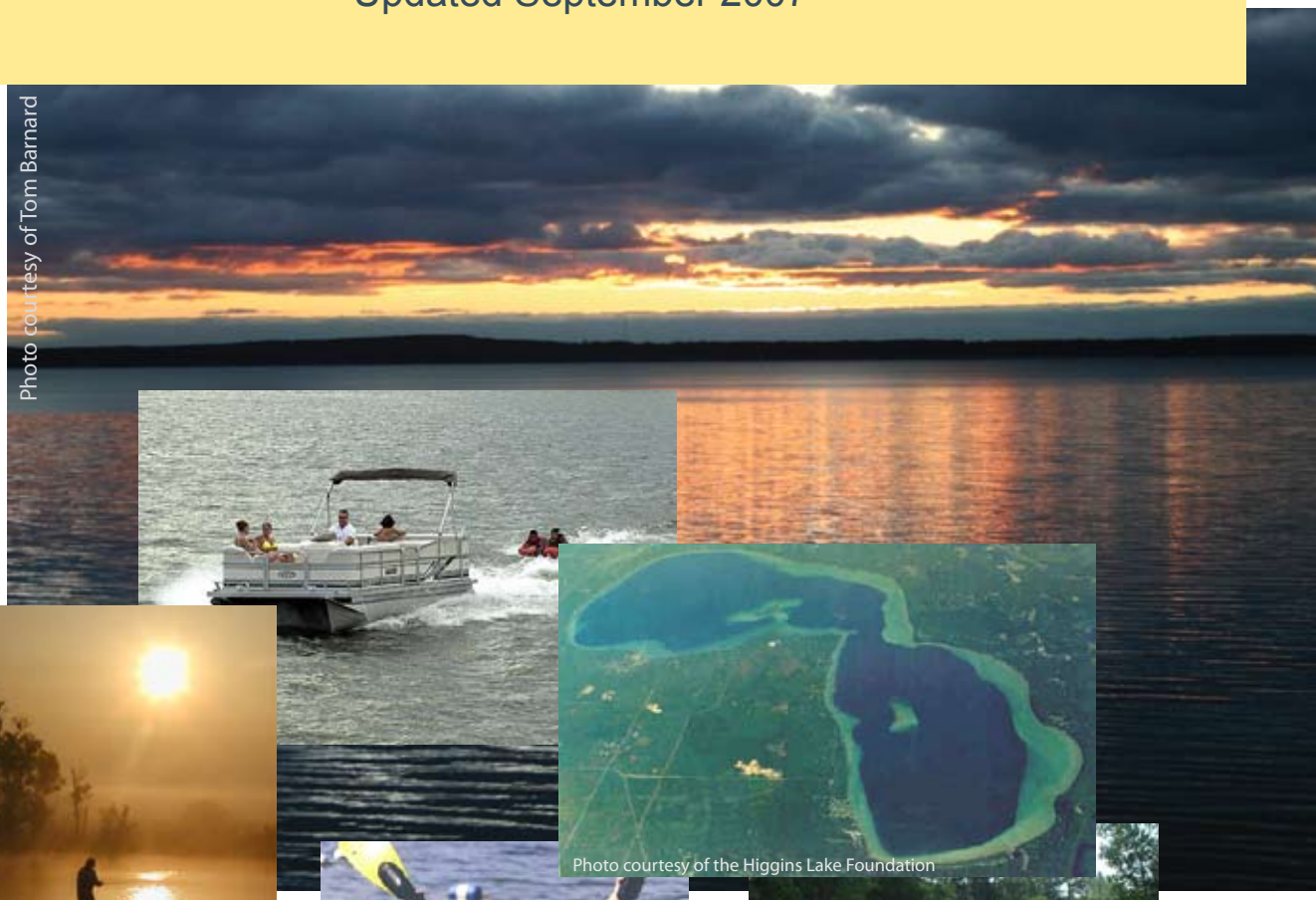

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS

LITERATURE CITED

OTHER RELEVANT LITERATURE

APPENDICES

REFERENCE DOCUMENTS

I. EXECUTIVE SUMMARY

The Higgins Lake Watershed covers nearly 29,000 acres in central northern Michigan and forms the headwaters for the Muskegon River Watershed. Although much of the watershed remains forested with pockets of rural development scattered throughout, intensive development has occurred around the lake. Research has documented that this development has a negative impact on the high water quality of Higgins Lake (Minnerick, 2001). The US Census indicates that growth in the region is continuing rapidly, thus pressures on the resource will continue to increase. As nearly every activity on the land has the potential to affect water quality, watershed management is vital to any water quality protection effort.

The Higgins Lake Watershed is well known for camping, fishing, hiking, hunting, skiing, swimming, boating, SCUBA diving, and other water activities and has been identified as one of the fastest growing areas in Michigan. Due to the extensive demands on the resources of the watershed, it is vital that protective land and water management policies are in place to ensure the quality of the environment within the watershed is maintained. The drainage basin for the watershed, Higgins Lake, has a long hydrologic retention time, estimated at 12.4 years (Minnerick, 2001). Thus, once a pollutant enters the lake it takes a very long time to be flushed out, which also contributes to the need for sound watershed management policies. Pollutant sources for the Higgins Lake Watershed include:

- Septic Systems
- Stormwater Runoff
- Shoreline Erosion
- Fertilizer Use
- Lakeshore Development
- Invasive Exotic Species

In August of 2000 the Higgins Lake Watershed Partnership launched a ten-year initiative to improve the ecological integrity of the watershed. The first priority of the Partnership was to develop a Watershed Management Plan, which was initially completed in 2002. This Management Plan was updated in 2006 to meet the new requirements set forth by the Environmental Protection Agency. By utilizing this management tool, efforts to implement water quality protection have been better coordinated and more effective and apply the appropriate skills of the many stakeholders within the Higgins Lake Watershed. The Management Plan will be reviewed every two years to allow the partners to evaluate their role, address changing conditions, and assess progress in meeting their mission and goals.

The Higgins Lake Watershed Partnership acts as a Steering Committee of watershed stakeholders to assess watershed concerns and provide input into the overall watershed planning effort. Steering Committee members include local governmental officials, conservation groups, environmental organizations, property owners, regional planning agencies, health departments, area businesspersons, concerned citizens and other stakeholders.

The stakeholders in the watershed recognize the need for sound watershed management practices in order to maintain the integrity of this high quality resource. The following goals were established to address this need as well as respond to the concerns about threats to water quality:

1) Reduce the amount of nutrients and contaminants from sources within the critical areas of the watershed.
2) Institute responsible land use practices within the watershed.
3) Protect habitat diversity within the watershed by monitoring and reducing aquatic nuisance species.
4) Protect shoreline habitats by reducing erosion.
5) Work to ensure the availability of high-quality recreational activities within the watershed and that these activities are conducted in such a way as to not degrade the integrity of the watershed.
6) Facilitate continued efforts to ensure implementation of the Plan and coordination of funding proposals.

Watershed planning brings together stakeholders to consider the desired uses of the watershed, threats and impairments to those uses, and specific nonpoint source pollutants that are contributing to the identified problems. A coordinated effort is necessary to develop a Watershed Management Plan that builds upon the strengths of existing programs and resources and addresses the water quality concerns in an integrated, cost-effective manner, regardless of existing political boundaries. This Plan should be updated every few years to ensure that it adjusts to the changing needs and problems within the watershed. As threats to water quality change, the focus of watershed management efforts will change with them.

II. DESCRIPTION OF THE HIGGINS LAKE WATERSHED

A. Geography

The Higgins Lake Watershed is situated in northern Michigan's central highland region of the Lower Peninsula almost exactly on the surface divide between the Lake Huron and Lake Michigan drainage basins. Lake waters flow to Lake Michigan via the Cut River, Houghton Lake and the Muskegon River. Only one mile north of the lake is Beaver Creek, which flows into the Au Sable River and thence into Lake Huron.

The Higgins Lake Watershed is located in Roscommon and Crawford counties with minor acreage in Kalkaska and Missaukee counties. The area comprising the Higgins Lake Watershed is a highly popular tourist destination due to its clear water, natural setting, wildlife habitats, and proximity to two major highway corridors, I-75 and US-127 (See Figure 1). Visitors from southern portions of Michigan's Lower Peninsula can reach the lake within a few hours traveling time making it conveniently located for tourist activity. The Higgins Lake Watershed is also home to two state parks that bring an estimated 673,000 visitors per year to the area.

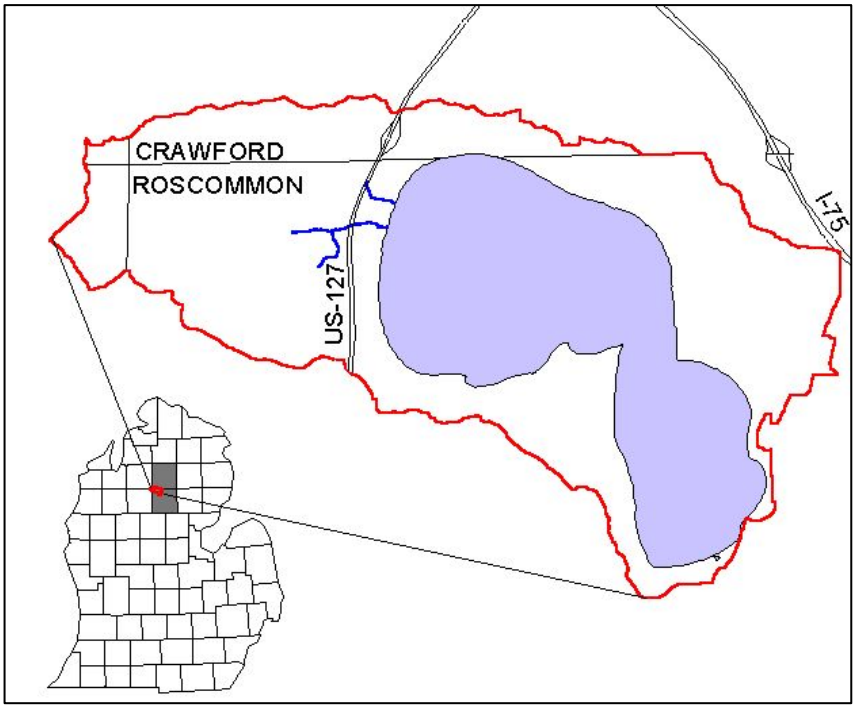


Figure 1: Higgins Lake Watershed Boundary

The watershed covers a geographic area of 28,738 acres (Grand Valley State University, 1998) and forms the headwaters for the Muskegon River Watershed eventually flowing to Lake Michigan. The distance between the watershed boundaries (from east to west) is slightly over 11.3 miles while the north to south width is about 6.5 miles at its widest point. The lowest elevation occurs at the surface of Higgins Lake, which is 1,154 feet above sea level, with the highest elevations forming the watershed perimeter at roughly 1,300 feet above sea level.

B. History of the Region

The shores of Higgins Lake hosted Native American encampments according to early survey parties in the region. The Chippewa's called it Majinabeesh, "sparkling water." In 1839, John Brink of the State Geological Survey mapped and named it Forginson Lake. It was renamed Higgins Lake in honor of Sylvester Higgins, a state cartographer, following an 1852 survey by William A. Burt. It is not known whether Higgins ever saw the lake that bears his name (Higgins Lake A*Syst, 1998).

In the early nineteenth century some of the best stands of white pine forests in Michigan were located in Roscommon and Crawford counties. Logging near Higgins Lake and the area streams and rivers began around 1875 (Jones, 1991). As pine supplies dwindled, several Saginaw lumber barons built camps on Higgins Lake, and in the summer, brought their families to live there also. The transportation of timber from the region began in Higgins Lake and flowed down the waterways to Muskegon. By 1900, the pines around Higgins had been depleted and the "green gold rush" in the region was over.

The abundance of huckleberries, which grew in the pine needles under the white pine trees, was an interesting offshoot of the lumber days. Pickers were plentiful in the region sending hundreds of bushels of berries to city markets each week during the season (Jones, 1991). Once the timber was removed from the area, farmers followed. However, the soils in the area were poor and farmers soon found they were only able to produce a subsistence existence from farming in the region (Jones, 1991).

The first half of the twentieth century was marked by steady but unspectacular growth of private vacation cottages, as highways leading north were hard surfaced. In response to improved access from population centers, the South State Park was established in 1927 followed by the establishment of the North State Park in 1963. By the 1960s, forests of oak, maple and pine had regenerated and many species of fish and wildlife were thriving. Both land and water proved to be irresistible, all-season attractions for outdoor activities. The completion of expressways US-127 in 1969 and I-75 in 1971 brought an unprecedented influx of new property owners and visitors.

C. Higgins Lake

The drainage basin for the watershed is Higgins Lake. Higgins Lake is one of Michigan's larger and more spectacular lakes, with a surface area of 10,198 acres (Grand Valley State University, 1998) and a volume of nearly 20 billion cubic feet (Jones, 1991). Higgins Lake has a long hydrologic retention time, estimated at 12.4 years (Minnerick, 2001) and is a clear water lake that ranks tenth in size in the State of Michigan and fifth in depth.

The shoreline of Higgins Lake covers 21.8 miles (Grand Valley State University, 1998). The mean depth of the lake is 44.3 feet with about one-third of Higgins Lake being shoal (0-20 ft.) and about one-half of the lake exceeding depths of 50 feet (Schultz & Fairchild, 1984). There are two deep basins in the lake. The north basin is 135 feet deep and the south basin is 100 feet deep. (See Figure 2).

A dam located at the Cut River outlet regulates the level of Higgins Lake. A summer legal lake level was established in 1926. In 1982 a Roscommon County Circuit Court order confirmed the summer legal lake level at 1154.11 feet elevation above sea level and a winter legal lake level of 1153.61 feet above sea level (Higgins Lake A*Syst, 1998). The Roscommon County Board of Commissioners is vested with the authority and responsibility for maintaining the legal levels of Higgins Lake through management of the Cut River Dam. Daily lake stage records for Higgins Lake are available via the Internet at http://mi.waterdata.usgs.gov/nwis/current or by phone at 989-821-3313.

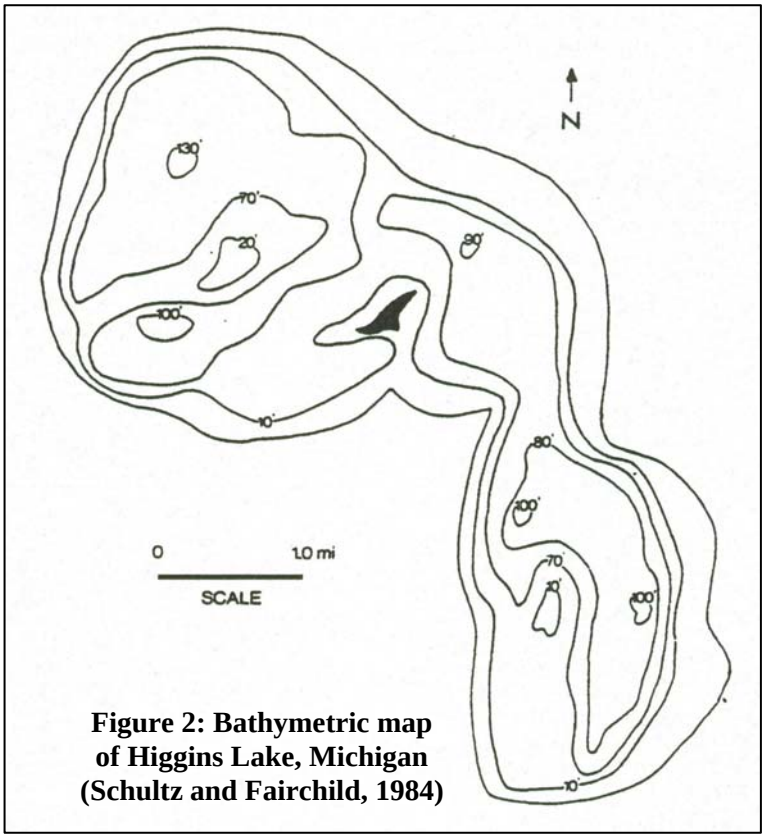


Figure 2: Bathymetric map of Higgins Lake, Michigan (Schultz and Fairchild, 1984)

D. Geology

The origin of Higgins Lake is of Pleistocene glacial ice block underlain by Mississippian Period bedrock (Dorr & Eschman, 1977). Lakes of this nature are formed as a result of melting ice blocks left behind in an area scoured out by the glacier as it retreated (Goldman & Horne, 1983).

The watershed represents a glacial outwash plain known as the Grayling Outwash plain. This is a broad outwash plain including sandy ice-disintegration ridges, jack pine barrens, some white pine-red pine forests, and northern hardwood forests. There is no exposed bedrock; glacial drift is 250 to 800 feet thick, some of the thickest in the State (Albert, 1995). Landscape features are intermorainic, probably originating 11,000 years ago. Hills near the north and south shores of Higgins Lake are marginal moraines. (Limno-Tech, 1992).

E. Hydrology

Higgins Lake is limited in supply of surface fed water. There are only two small feeder streams, Big and Little Creeks. Inflows from these creeks are estimated to respectively contribute 4.3% and 1.4% of the water volume of Higgins Lake (1.7 and .43 ft^3/s respectively). The only outlet is Cut River which is controlled by a low-head dam with removable boards. A USGS gaging station was in place on Cut River from 1942 and 1950, at that time the average flow was 44.2 ft^3/s (Minnerick, 2001). An additional 51.3% comes from groundwater with the remaining 43% derived from direct rainfall (Limno-Tech, 1992). Higgins Lake volume is 1.99×10^{10} cubic feet (Schultz, 1984). The flushing rate of Higgins Lake is less than 10% of the lake's volume per year with a hydrologic residence time of 12.4 years.

Groundwater flows are influenced by the marginal moraines and generally follow the surface contours. When standing in the lake one can feel upflowing cold "springs" that represent groundwater flow into the lake.

This average water budget for Higgins Lake is noted in Figure 3 below.

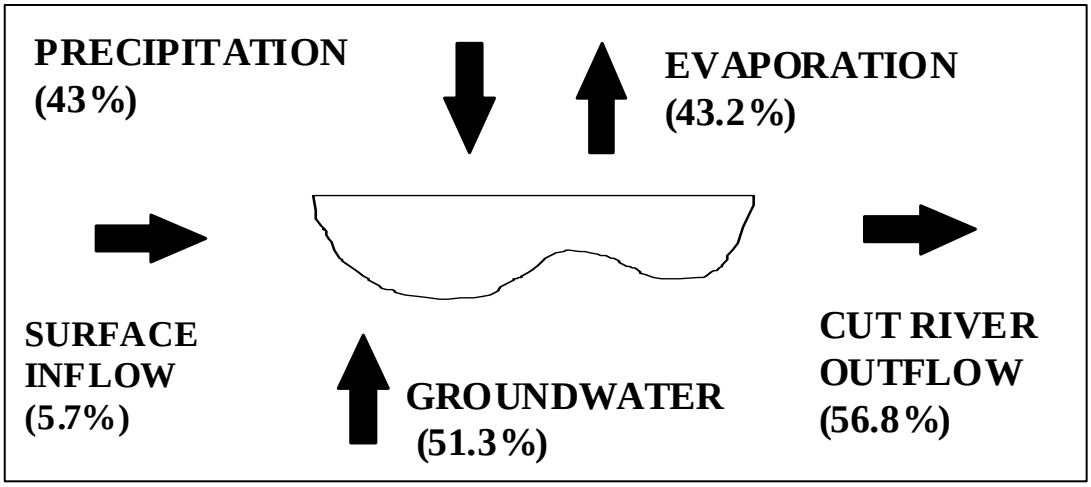


Figure 3: Average Water Budget for Higgins Lake

F. Water Quality

A lake's condition is influenced by many factors, such as the amount of recreational use it receives, shoreline development and water quality. Lake water quality is a general term covering many aspects of lake chemistry and biology. The health of a lake is determined by its water quality.

Increasing productivity can impact water quality and result in problems such as excessive weed growth, algal blooms and mucky bottom sediments. Productivity refers to the amount of plant and animal life that can be produced within the lake.

Plant nutrients are a major factor in the increase of lake productivity. In most Michigan lakes, phosphorus is the nutrient most responsible for increasing lake productivity (Cooperative Lakes Monitoring Program, 2003).

Table 1 is a list of water quality surveys which have taken place over the last 20 years at Higgins Lake. According to the various results it is determined the Higgins Lake is an oligotrophic lake and currently exhibits high water quality. However, there are indicators that increased development and associated impacts including septic systems, impervious surface, access issues, fertilizer use, etc. are starting to show their impacts on water quality. Higher concentrations of *E. coli* bacteria and nutrients have been found in near-shore ground water as a result of on-site septic systems. Since over 50% of Higgins Lake water budget comes from ground water the effects of these higher concentrations can lead to decreased water quality. In addition, studies indicate that Higgins Lake is just starting to accumulate organic material in bottom sediment.

Table 1: Water Quality Sampling Results		
Water Quality Study	**Parameters Tested**	**Results**
A Water Quality Study of Higgins Lake 1984	Total Nitrogen	163 ug/l (NB) 214 ug/l (SB) Winter sampling 85 ug/l (NB) 245 (SB) Summer sampling
	Ammonia	11-21 ug/l (NB) 12-36 ug/l (SB) Winter sampling 6-52 ug/l (NB) 18-66 ug/l (SB) Summer sampling
	Phosphorous	5.3 ug/l (NB) 6.2 ug/l (SB) Winter sampling (little variation in depth) 11.3 ug/l (NB) 183 ug/l (SB) Summer sampling
	Chlorophyll *a*	2.3 ug/l (NB) 2.4 ug/l (SB) (indicative of oligotrophic conditions)
	Temperature	39-50 degrees Fahrenheit (Summer temperature for hypolimnion)
Higgins Lake Diagnostic and Feasibility Study 1992	Watershed Phosphorous loading	3,974 lbs/year
	Road end sediment/phosphorous loading	246.5 tons/year sediment; 1,470 P lbs/year
	Storm drain phosphorous loading	0.3 to 1.01 mg/l (average based on 4 grab samples at 4 storm drains)
	Dissolved oxygen	12.0-12.4 mg/l (NB) and 11.2-11.9 (SB) Spring sampling 8.2-8.5 (surface for both basins) August sampling 3.8 mg/l (NB) 5.8 mg/l (SB) August sampling— hypolimnion
	Phosphorous	.003 to .006 mg/l (Spring and summer surface sampling averages) .008 to .023 mg/l (Spring and summer deep sampling averages)
	pH	8.5 to 7.9 (Summer levels)
	Secchi disk	41 feet (NB) 32.5 feet (SB)
Higgins Lake Storm Water, Sedimentation and Road End Erosion Inventory 1993	Road end and drain erosion sediment load	507 tons/year
Higgins Lake Septic System and Lawn Fertilizer Management Zones 1994	Nitrogen concentrations in groundwater	4.5 to 43 mg/L (the Michigan drinking water standard is 10 mg/L)
	Phosphorous concentration is groundwater	2.1-9.9 mg/L (compared to .1.3 to 3.7 mg/L in mid-lake surface water)
Water Quality and Bottom Sediments Study 1998	Surface phosphorous concentrations	5-6 ug/L
	Surface nitrogen concentrations	6-32 ug/L
	Alkalinity	102-105 mg/L
	Secchi Disk	28-33 feet spring averages 20-25 feet summer averages
	Chlorophyll *a*	>1 ug/L (six surface stations)
	Lake Water Quality Index	96 (excellent lake water quality)
	Mineral content in bottom sediment	83% average (indicates the lake is just starting to accumulate organic material)

Effect of Residential Development on the Water Quality of Higgins Lake 2001	Chloride Nitrogen Total phosphorous	7.2 mg/L (Epilimnion) 7.1 mg/L (Hypolimnion) NB .005 mg/L (Epilimnion) .005 mg/L (Hypolimnion) NB .004 mg/L (Epilimnion) .006 mg/L (Hypolimnion) NB
	Chloride Nitrogen Total phosphorous	7.4 mg/L (Epilimnion) 7.0 mg/L (Hypolimnion) SB .005 mg/L (Epilimnion) .005 mg/L (Hypolimnion) SB .003 mg/L (Epilimnion) .006 mg/L (Hypolimnion) SB
	Nitrogen (ground water sample) Phosphorous (ground water sample)	0.20 mg/L (23 times higher in ground water than in near-shore lake water) 0.023 mg/L (3 times higher in ground water than in near-shore lake water)
	Secchi disk	24.3 feet average (NB) 20.3 feet average (SB)
	Chlorophyll *a*	.43 ug/L (NB) .34 ug/L (SB)
	E. coli	375/100 mL (Upstream Big Creek) 425/100mL (Mouth of Big Creek) *(E. coli bacteria were found in ground water at sites where building density exceeded 0.40 building/acre, indicating that effluent from septic systems is leaching to ground water which eventually flows into the lake.)*

Note: NB=North Basin, SB=South Basin
Epilimnion=Top layer of a thermally stratified lake
Hypolimnion=Bottom layer in a thermally stratified lake

G. Trophic Status

Over time, all lakes undergo a natural aging process where they begin to fill in with sediment and nutrient materials. This process, called natural eutrophication, is complex, exceptionally slow (on a geological time scale), and generally irreversible. Lakes undergoing natural eutrophication often have good water quality and exhibit a diverse biological community throughout their existence.

This process differs from what is called cultural eutrophication. Cultural eutrophication is an accelerated input of plant nutrients and sediment that promotes excessive plant growth and results in diminished or detrimental changes in water quality. The process is almost always associated with activities of people in the watershed. Cultural eutrophication can be reversed and a lake can return to its original state, but this means only a return to pre-human conditions.

Some of the ecological consequences of cultural eutrophication include rapid plant growth, particularly the promotion of undesirable plants such as blue-green algae or nonindigenous plants such as Eurasian watermilfoil. Other symptoms include anoxic conditions in the bottom waters, fish stunting and fish kills, increased biochemical oxygen demand, and rapid shifts in species composition. Human related consequences include a decrease in aesthetics of the lake, interference with recreational activities, increased odors and sometimes decreased property values.

A lake's ability to support plant and animal life defines its level of productivity, or *trophic state.* Lakes are commonly classified based on their productivity. Low productive *oligotrophic* lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in cool, deep-bottom waters during late summer to support cold water fish, such as trout and whitefish. By contrast, high productive *eutrophic* lakes are generally shallow and turbid and support abundant aquatic plant growth. In deep areas of eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish, such as bass and pike. Lakes that fall between these two classifications are called *mesotrophic* lakes.

One method of describing the productivity of a lake is to use a numerical index that can be calculated directly from water quality data. Carlson's Trophic-State Index (TSI) is widely used. Carlson's TSI was developed to compare lake data on water clarity, as measured by a Secchi disk, chlorophyll *a*, and total phosphorus (see Figure 4). These parameters are good indirect measures of a lake's productivity. The TSI expresses lake productivity on a continuous numerical scale from 0 to 100, with increasing numbers indicating more eutrophic conditions (Cooperative Lakes Monitoring Program, 2003).

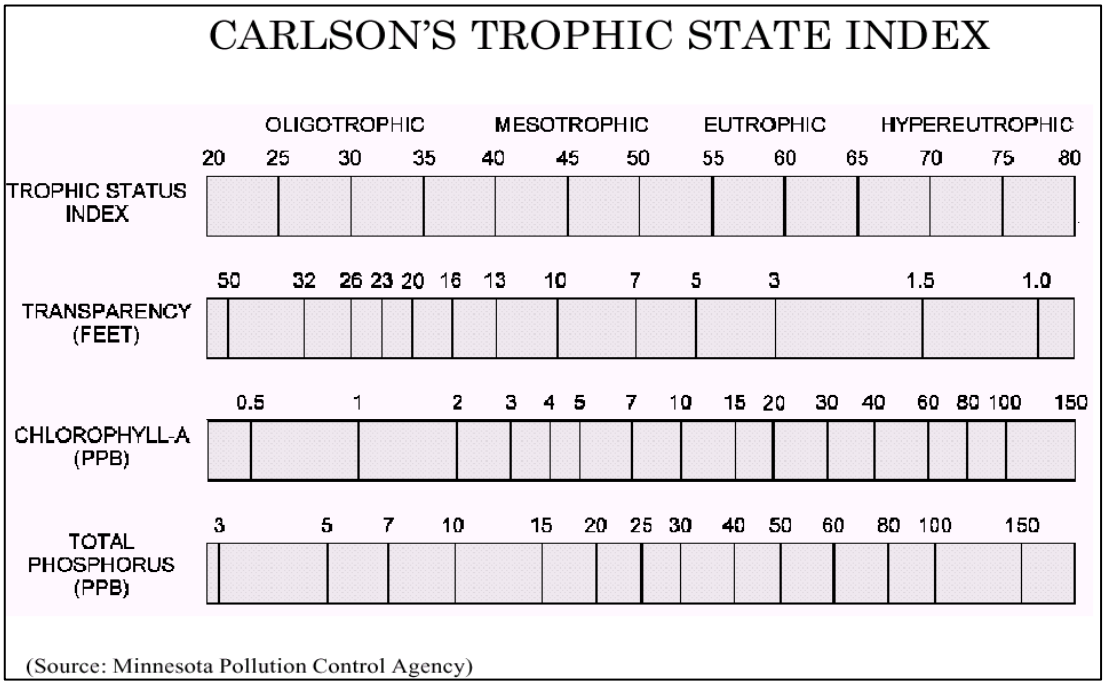


Figure 4: Carlson's Trophic State Index (Cooperative Lakes Monitoring Program, 2003)

Carlson developed mathematical relationships for calculating the TSI from measurements of Secchi depth transparency (TSI_{SD}), chlorophyll *a* (TSI_{CHL}), and total phosphorus (TSI_{TP}) in lakes during the summer season. The computer TSI values for an individual lake can be used to compare with other lakes, to evaluate changes within the lake over time and to estimate other water quality parameters within the lake.

Lakes with index values less than 40 are classified as oligotrophic (low productivity). Table 2 indicates 2005 TSI results for several northern Michigan lakes participating in the Cooperative Lakes Monitoring Program.

Higgins Lake has traditionally been classified as oligotrophic, with crystal clear water and low numbers of aquatic plants and algae growth. In recent years the water quality of Higgins Lake has edged closer to the less desirable category of mesotrophic, which can be recognized by larger weed beds, algae covered rocks, a murkier bottom and cloudier water. Such changes in water quality can be linked to the large increase in development within the watershed area and are particularly noticeable in the near-shore area of Higgins Lake (Minnerick, 2001).

Table 2: Cooperative Lakes Monitoring Program Results

Lake	County	TSI_{SD}	TSI_{CHL}	TSI_{TP}
Long	Grand Traverse	28	39	30
Higgins	Roscommon	25	31	36
Hubbard	Alcona	35	38	42
Silver	Grand Traverse	30	36	32
Mullett	Cheboygan	36	31	34
Houghton Lake	Roscommon	47	44	49
Pentwater	Oceana	**	52	55

** Data unavailable.

H. Soil Types

The soils in the Higgins Lake Watershed are glacial deposits of dominantly sandy soils. Soils within the watershed are generally classified by the USDA Natural Resources Conservation Service as Udipsamments, Glossudalfs, Haplosaprists, Humaquepts, Haplorthods and Endoaquods (Kroell, 2002). The dominant soils within the watershed are list below:

Graycalm
Landform: Outwash plains, lake plains, moraines
Slope range: 0 to 45 percent
Drainage class: Somewhat excessively drained
Position on landform: Flats, knolls, ridges
Parent material: Sandy sediments
Slope: Nearly level to steep

Grayling
Landform: Outwash plains, lake plains, moraines
Slope range: 0 to 45 percent
Drainage class: Excessively drained
Position on landform: Flats, knolls, ridges
Surface textural class: Sand
Slope: Nearly level to steep

Klacking
Landform: Outwash plains, lake plains, moraines
Slope range: 0 to 45 percent
Drainage class: Well drained
Position on landform: Flats, knolls, ridges
Parent material: Sandy and loamy sediments
Surface textural class: Sand
Slope: Nearly level to steep

Tawas
Landform: Lake plains, outwash plains, moraines
Slope range: 0 to 2 percent
Drainage class: Very poorly drained
Position on landform: Low flats, depressions, drainageways
Parent material: Organic material over sandy sediments
Surface textural class: Muck
Slope: Nearly level

Lupton
Landform: Lake plains, outwash plains, moraines
Slope range: 0 to 2 percent
Drainage class: Very poorly drained
Position on landform: Low flats, depressions, drainageways
Parent material: Organic material
Surface textural class: Muck
Slope: Nearly level

Croswell
Landform: Lake plains, outwash plains, moraines
Slope range: 0 to 6 percent
Drainage class: Moderately well drained
Position on landform: Flats, knolls
Parent material: Sandy sediments
Surface textural class: Sand
Slope: Nearly level, undulating

Au Gres
Landform: Lake plains, outwash plains, moraines
Slope range: 0 to 3 percent
Drainage class: Somewhat poorly drained
Position on landform: Low flats, low knolls, swales
Parent material: Sandy sediments
Surface textural class: Sand
Slope: Nearly level, undulating

Perecheney
Landform: Outwash plains, lake plains, moraines
Slope range: 0 to 45 percent
Drainage class: Moderately well drained
Position on landform: Flats, knolls, ridges
Parent material: Sandy and loamy sediments
Surface textural class: Sand
Slope: Nearly level to gently rolling

Rubicon
Landform: Outwash plains, till plains and moraines
Slope range: 0 to 30 percent
Drainage class: Somewhat excessively drained
Position on landform: Flats, knolls, ridges
Parent material: Sandy sediments
Surface textural class: Sand
Slope: Nearly level to steep

Montcalm
Landform: Outwash plains, till plains and moraines.
Slope range: 0 to 30 percent
Drainage class: Well drained
Position on landform: Flats, knolls, ridges
Parent material: Sandy and loamy sediments
Surface textural class: Loamy sand
Slope: Nearly level to steep

I. Land Use / Land Cover

The Michigan Natural Features Inventory, land use circa 1800 (see Figure 5) is a statewide database for Michigan based on tree data and description of the vegetation and land between 1816 and 1856 by original surveyors from the General Land Office (GLO). During the pre-settlement period forests covered 58% of the Higgins Lake Watershed region, wetlands occupied 6% and surface water 36%.

Land Cover, circa 1800, for the Higgins Lake Watershed

Aspen-Birch Forest	633 acres
Hemlock-White Pine Forest	669 acres
Jack Pine-Red Pine Forest	2,944 acres
White Pine-Red Pine Forest	4,708 acres
Mixed Pine-Oak Forest	7,726 acres
Forest Cover	16,680 acres
Shrub Swamp/Emergent Marsh	110 acres
Mixed Conifer Swamps	1,714 acres
Wetland Cover	1,824 acres
Surface Water Cover	10,227 acres
TOTAL COVER	**28,731 acres**

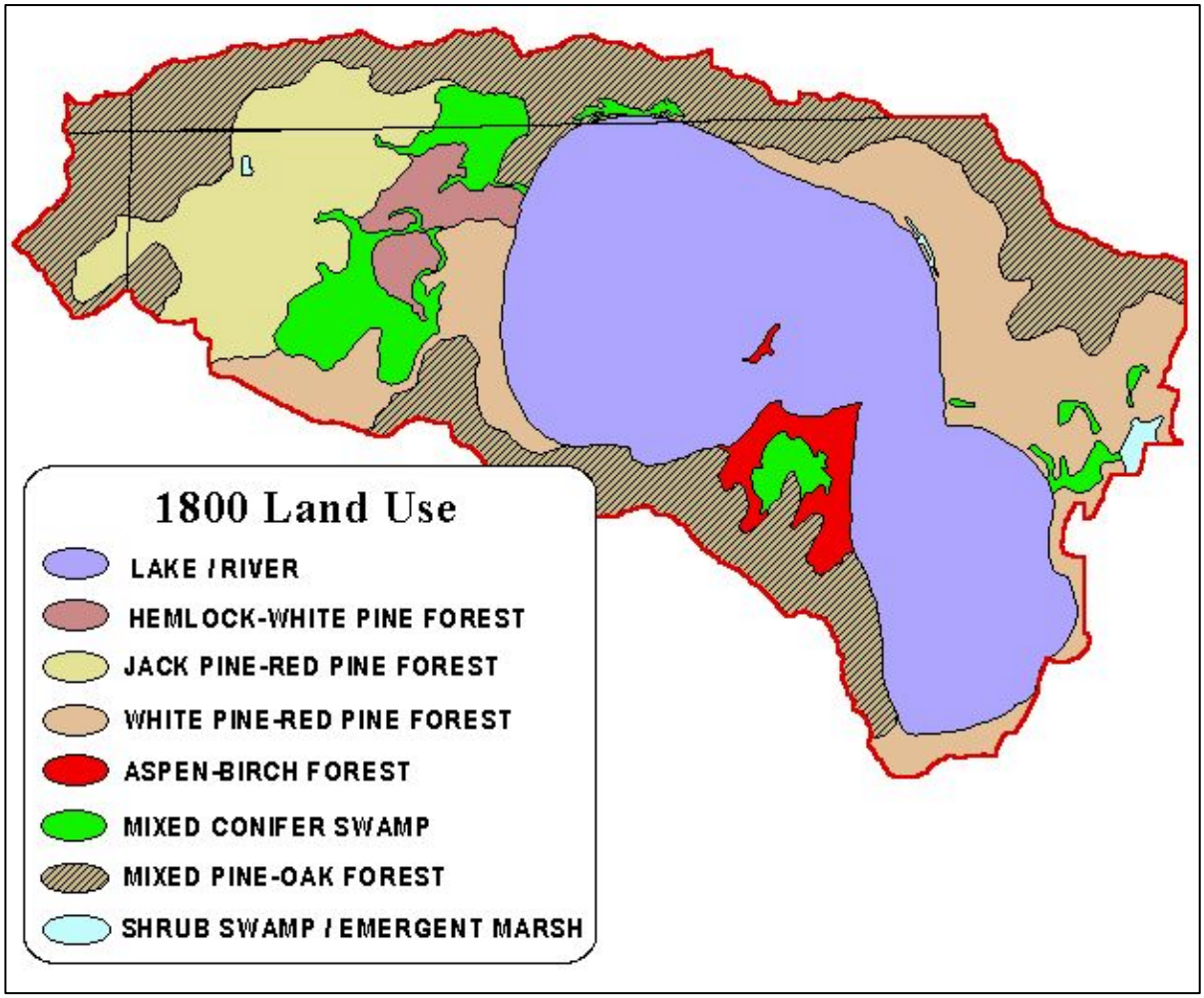


Figure 5: Higgins Lake Watershed Land Use/Land Cover, circa 1800

Pre-settlement vegetation within the watershed consisted mostly of northern hardwood forests as well as forests of white pine and red pine. Where clay deposits were near the surface, shallow peatlands commonly occupied large areas. The small ice-block depressions on the outwash plains typically contained shrub swamps or sphagnum bogs, probably the result of commonly recurring fires and wet soil. The dominant shrub was usually leatherleaf (Albert, 1995).

The 1978 Michigan Resource Information System (MIRIS) constitutes the most complete land use/land cover classification database for Michigan since the GLO surveys. This data demonstrates a significant change in land use over the pre-settlement status (see Table 3, Figure 6). MIRIS data indicates forested areas within the Higgins Lake Watershed reduced to 50% (14,429 acres). Wetland areas also decreased to 2% (659 acres) of the watershed. The introduction of commercial/residential areas and agricultural land constituted 9% with a total of 2,718 acres. The addition of rangeland/barren area totals 3% (737 acres). Surface water remained consistent at 36% of the watershed.

In 1983 another land use/land cover analysis was completed by the United States Geological Survey (USGS). This data was not as refined as the 1978 MIRIS data, but did cover relatively the same land use/land cover classifications. The 1983 data indicates little change in land use for the Higgins Lake Watershed region. Forested areas remain the dominate cover in the region constituting 51% (14,743 acres). Wetland areas slightly increased comprising 3% (792 acres), Commercial/residential and agricultural land also increased slightly consisting of 9% and 1% of the watershed respectively (2,954 acres). Rangeland/barren area slightly decreased to 2% (517 acres). Surface water decreased to 34% of the watershed, which is most likely due to differing mapping techniques.

Table 3: Higgins Lake Watershed
Land Use Classification

Land Use Type	1800	1978	1983	1998
Commercial/Residential	0 (0%)	2,631 (9%)	2,643 (9%)	3,629 (13%)
Surface Water	10,227 (36%)	10,188 (36%)	9,725 (34%)	10,198 (36%)
Wetland	1,824 (6%)	659 (2%)	792 (3%)	690 (2%)
Agricultural Land	0 (0%)	87 (<1%)	311 (1%)	53 (<1%)
Rangeland/Barren	0 (0%)	737 (3%)	517 (2%)	384 (1%)
Forest Land	16,680 (58%)	14,429 (50%)	14,743 (51%)	13,777 (48%)
Total Acreage	**28,731**	**28,731**	**28,731**	**28,731**

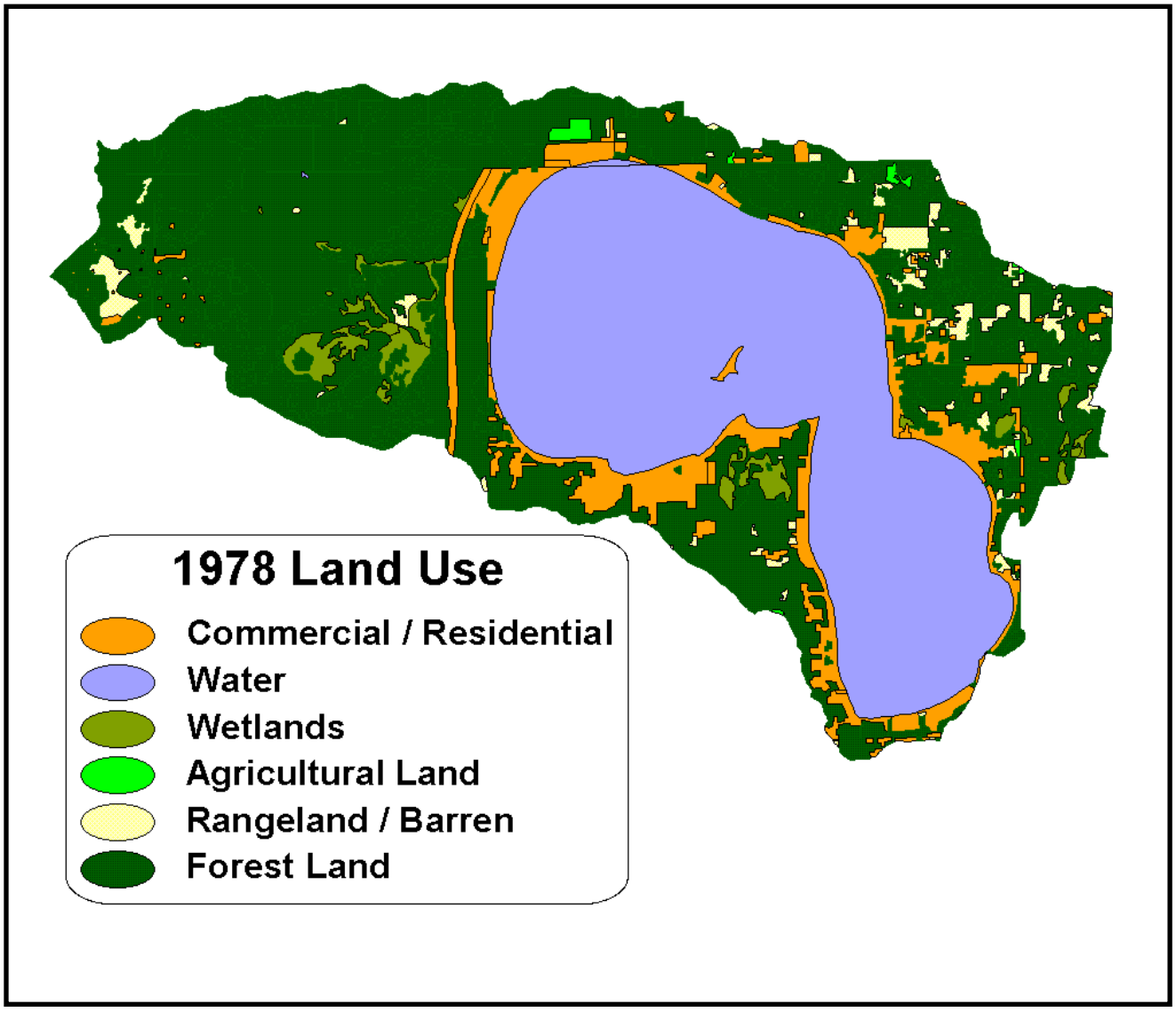


Figure 6: Higgins Lake Watershed Land Use/Land Cover, 1978 MIRIS

Another land use classification was completed for the watershed area utilizing 1998 aerial photography. This classification was produced by Grand Valley State University, Annis Water Resources Institute (see Figure 7). The classification for this land use analysis was patterned after the MIRIS data from 1978 so as to utilize both sets of data for a precise land use comparison. The 1998 land use data indicates a decrease in forest land within the watershed covering 48% (13,777 acres). Commercial/Residential land represents an increase constituting 13% of the watershed (3,629 acres). Agricultural land and wetland area show very little change at <1% (53 acres) and 2% (690 acres) respectively. Rangeland/barren area shows a slight decrease comprising 1% of the region (384 acres).

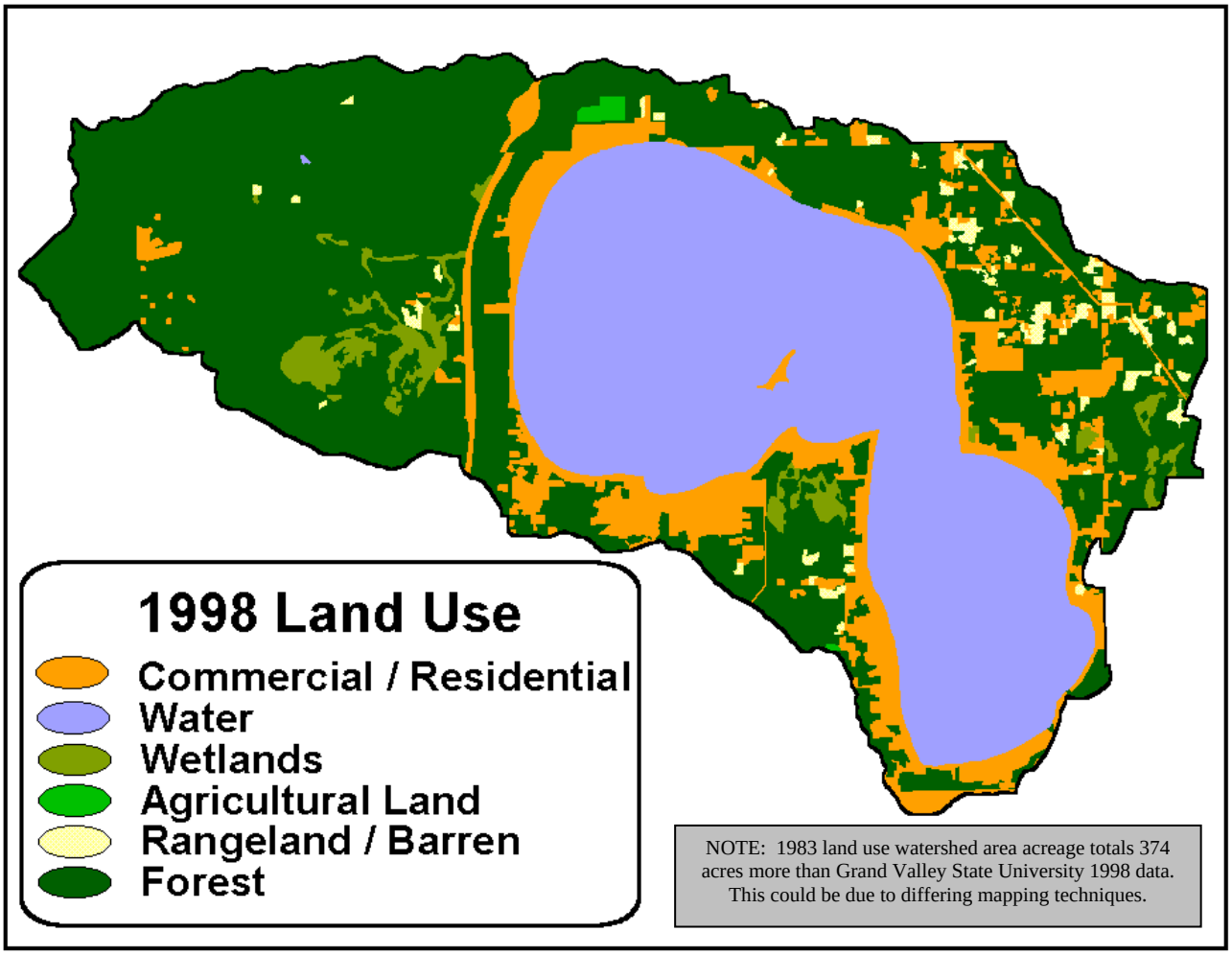


Figure 7: Higgins Lake Watershed Land Use/Land Cover, 1998
Grand Valley State University, Annis Water Resources

The most significant change in land use from 1978 to 1998 is the loss of forest land, wetlands, and open space to commercial and residential environments (see Table 4 and Figure 8). This represents a trend for the Higgins Lake Watershed indicating that residential and urban growth comes at a price of forest reduction. With the dramatic increases in population in the Higgins Lake Watershed region, the need for structured land use planning and protection becomes evident.

Avoidance of further forest reduction within the Higgins Lake Watershed will be dependent upon land use decisions at the local level. If the community wishes to protect natural resources and the environment through local land use regulations, then it must have a basis for these regulations in the comprehensive master plan and adopt zoning and related regulations consistent with the plan. The master plan provides the legal foundation for the local land use regulations (Ardizone & Wyckoff, 2003).

Table 4: Land Use Change Comparison			
Land Use Classification	**Year**		
	1978	**1998**	**% of Change**
Commercial/Residential	2,631 (9%)	3,629 (13%)	+4%
Surface Water	10,188 (36%)	10,198 (36%)	0%
Wetland	659 (2%)	690 (2%)	0%
Agricultural Land	87 (<1%)	53 (<1%)	0%
Rangeland/Barren	737 (3%)	384 (1%)	-2%
Forest Land	14,429 (50%)	13,777 (48%)	-2%

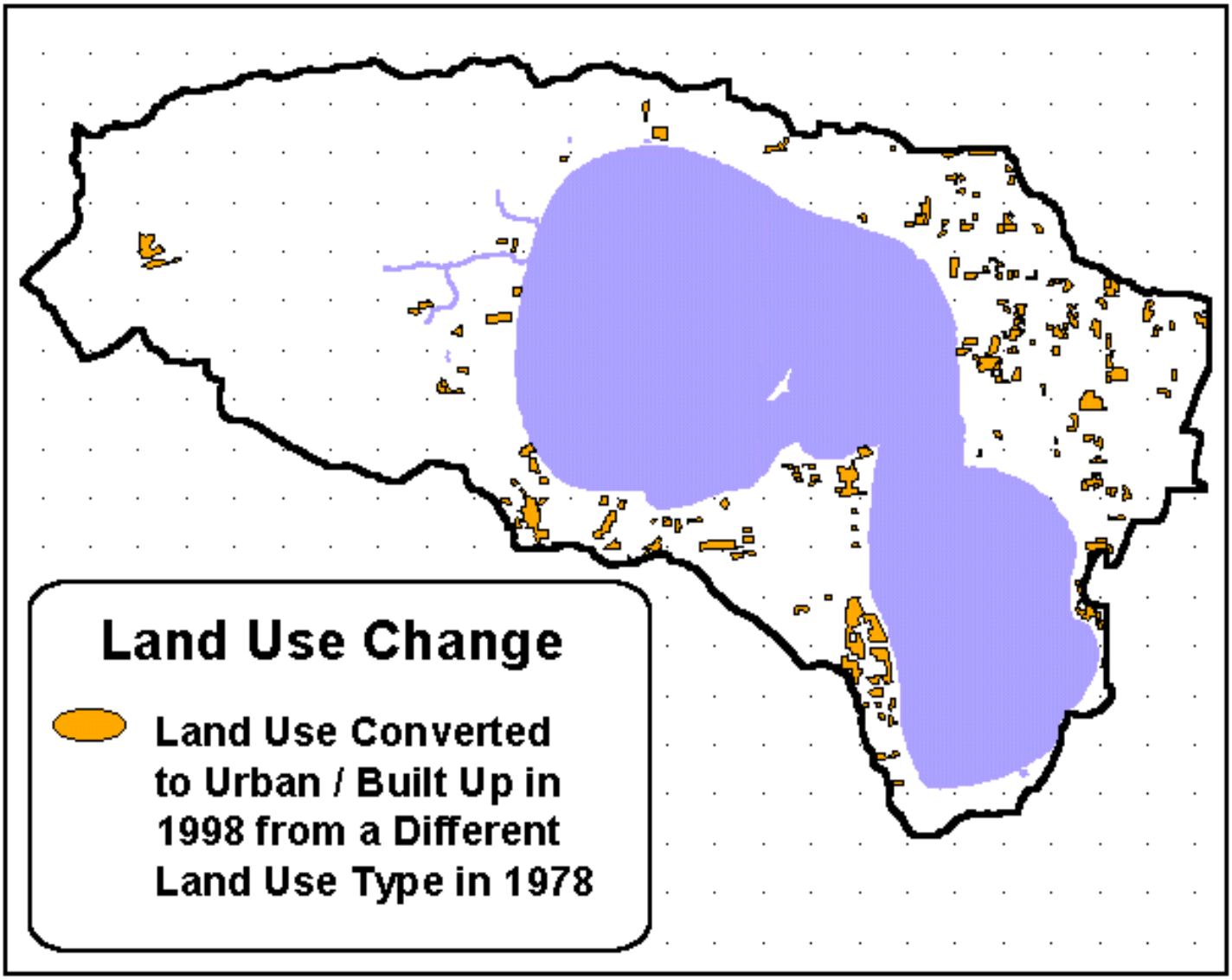


Figure 8: Higgins Lake Watershed Land Use/Land Cover Change, 1998
Grand Valley State University, Annis Water Resources Institute

J. Community Profile

Roscommon County's Gerrish and Lyon townships comprise the vast majority of residential areas within the watershed (see Figure 9). The population of these townships has shown a dramatic increase over the last several decades. The U.S. Census Bureau indicated 607 permanent residents in Gerrish Township and 453 in Lyon Township in 1960. The 2000 Census report indicated an increase of 506% in the permanent residential population for Gerrish Township bringing the total to 3072 permanent residents. Lyon Township also demonstrated a substantial increase of 323%, with a total of 1462 permanent residents in 2000.

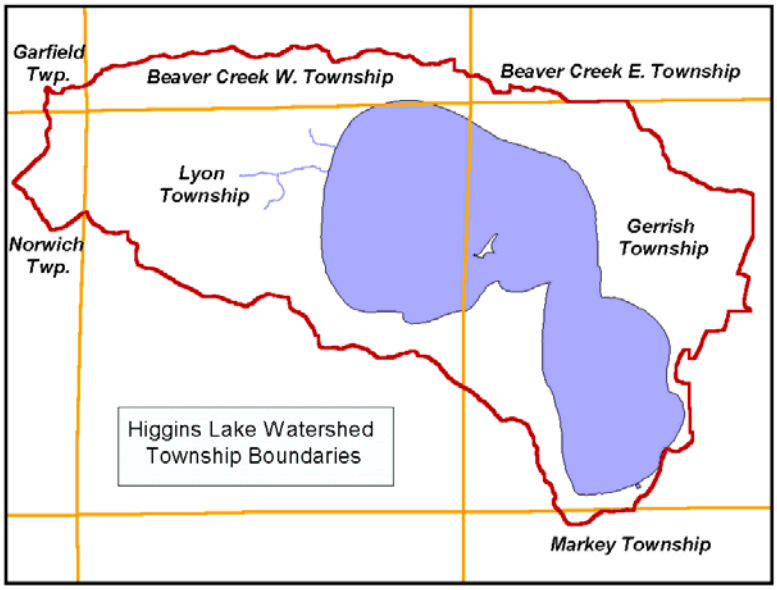


Figure 9: Higgins Lake Watershed Township Boundaries

The majority of the residents within these townships, however, are seasonal. An estimated summer residential population for Gerrish and Lyon townships combined is 23,000 (Boyle, 2002). This has given rise to rapidly expanding development of seasonal dwellings over the past 30 years. With this increased development, much of the native vegetation has been replaced by lawns and roads. As there are no public water or sewer systems within the watershed, each household and business has its own water well and septic tank with drain field, dry well, or holding tank. Resort and residential uses dominate the economic structure of the area. There is a small amount of commercial development, but virtually no industrial development.

Table 5: Yearly Park/Camp Visitors	
Ralph A. MacMullen Conference Center	12,527 persons
Camp Westminster	2,000 persons
North Higgins Lake State Park	104,408 persons
South Higgins Lake State Park	306,890 persons
MDNR Public Access (West Boat Launch)	10,000 vehicles
Total Visitors	**435,825** (persons/vehicles)

In addition to the seasonal and permanent residential population, the Higgins Lake Watershed hosts a vast number of visitors throughout the year (see Table 5). In 2004, the Ralph A. MacMullen Conference Center and Camp Westminster, both of which are located on the north shore of Higgins Lake, hosted 12,527 guests and 2,000 campers, respectively. There are also two State Parks located on the shores of Higgins Lake. The North Higgins Lake State Park hosted 104,408 visitors from October, 2003 through September, 2004 and the South Higgins Lake State Park hosted 306,890 visitors during that same time period. The South State Park opened in 1927, just six years after the State Park System was established. It consists of a mile of shoreline, has eight boat

launching ramps, and is Michigan's second largest State Park Campground. Additionally, the Department of Natural Resources' public access site recorded use by approximately 10,000 vehicles in 2000. Summer visitor numbers fluctuate greatly based on factors such as the economy and weather conditions. Summer visitor totals in previous years average closer to 700,000.

K. Land Ownership

The State of Michigan owns large tracts of land in the Higgins Lake Watershed. Much of this land is forested and is managed for periodic logging, but some is utilized for mineral resources as well. State ownership categorizations vary, including mineral rights, surface rights, mixed ownership, and/or a combination of ownership categories (see Figure 10). The State of Michigan owns a total of 11,095 acres of land within the watershed in some form, representing 39% of the watershed region.

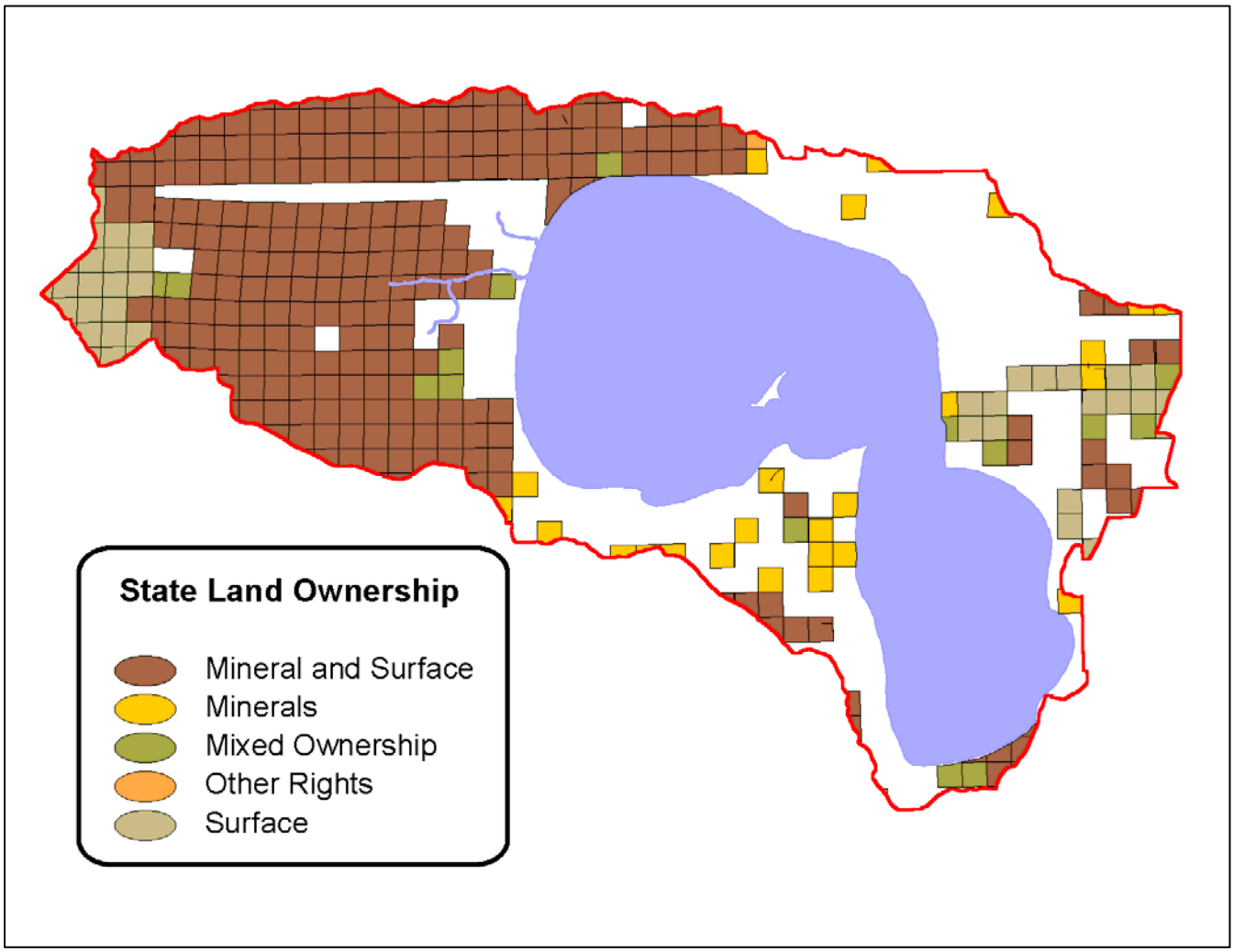


Figure 10: Higgins Lake Watershed State Land Ownership (Michigan DNR, Spatial Data Library)

L. Precipitation Characteristics

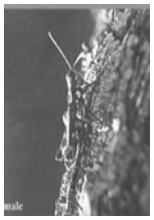
The average precipitation for the Higgins Lake Watershed is 28.43 inches per year. This information was obtained from the National Weather Service station in Houghton Lake, Michigan based on data collected from 1971 through 2000. The year 1991 had the greatest amount of precipitation with 37.45 inches while 1998 had the least amount of precipitation with 23.73 inches. The breakdown of seasonal averages for this time period is as follows:

Spring Season (Mar-Apr-May)	6.91 inches
Summer Season (Jun-Jul-Aug)	9.40 inches
Fall Season (Sep-Oct-Nov)	7.51 inches
Winter Season (Dec-Jan-Feb)	4.61 inches
YEARLY AVERAGE	**28.43 inches**

To verify the consistency of precipitation for the Houghton Lake weather station and the Higgins Lake Watershed area, local precipitation records were compared. The Roscommon County Road Commission precipitation records for snowfall at Higgins Lake were reviewed. Their recorded average snowfall for the winter seasons (December through February) of 1994/1995 to 2001/2002 was 4.52 inches. This is within 0.09 inches of the National Weather Service station recorded average for the winter season. Unfortunately, rainfall records for Higgins Lake were not available.

M. Natural Features

The Higgins Lake Watershed is home to American Bald Eagles (*Haliaeetus leucocephalus*). The Michigan Department of Natural Resources has documented a productive eagle's nest in the Heidemann Marsh. This area provides crucial habitat for this threatened species. As indicated in the Roscommon County Herald News on March 17, 2002, "Roscommon County eagle spotters noted twenty-five bald eagles, while twenty-six of the birds were reported in Crawford County during the Department of Natural Resources' annual winter bald eagle survey." As reported in the 2005 Midwest Eagle Survey, Roscommon County has 17 nesting pairs of eagles (Dale, 2005).



The *Appalachia arcana* is a rare species of secretive locust residing in the southern central wetlands area of the watershed. This region is known as Battin Swamp and is considered to be a Leatherleaf Jack Pine Bog. The Michigan Nature Association has designated a 40-acre area of this bog as a permanent nature preserve due to its population of the *Appalacia arcana*. This locust is found only in Michigan and prior to its discovery in the Higgins Lake Watershed in 1989 had not been seen since 1962.

The Houghton Lake Watershed, located just south of the Higgins Lake Watershed, has a large wetland area that serves as home for a variety of wetland birds and osprey. Currently, osprey (*Pandion haliaetus*) do not nest in the Higgins Lake Watershed, but according to the Michigan Department of Natural Resources Wildlife Division there is potential for these birds to expand into the wetland regions of the Higgins Lake Watershed. Protection of these wetlands is necessary to allow for the possible expansion of territory for wetland birds and osprey.

The Kirtland's Warbler (*Dendroica kirtlandii*) is one of the more rare members of the wood warbler (*Parulidae*) family. Even though it is a bird of unusual interest from many facets, this yellow-breasted songster's fame is largely due to its rarity. The Kirtland's Warbler has drawn more official interest and created more controversy than any other songbird in history. The entire breeding population of the Kirtland's Warbler, a federally endangered species, is found in the Jack Pine forest regions surrounding the Higgins Lake Watershed (Albert, 1995). Kirtland's Warblers do not currently reside within the watershed boundaries. However, as forest fires within the Jack Pine forest areas of the watershed occur, habitat could be more inviting and Kirtland's Warblers may

return. Management of the warbler consists of clearcutting, burning and replanting thousands of acres on a set rotation plan.

Loons have long been considered by many North Americans as beautiful and special, symbolizing wilderness and solitude. Many cottage-goers, campers, and vacationers feel their trip is complete after viewing a loon or listening to its haunting call. A pair of Common Loon (*Gavia immer*) have returned to the Higgins Lake Watershed for several years. Loons build their nests close to water, with the best sites being completely surrounded by water, such as on an island, muskrat house, half submerged log or sedge mat. Loon nesting sites are susceptible to the effects of pollution, development and disturbance. Physical interference with nests or young and increased boat wake on lakes, which may swamp or destroy nests, also cause loons to abandon nesting sites.

N. Recreation

The Higgins Lake Watershed supports a variety of outdoor recreational activities and has been a prime recreation and resort area since the early 1900s. Some of the most popular activities include: cross country skiing, snowmobiling, fishing, power boating, swimming, SCUBA diving, camping, sailing, trail exploration, birding and canoeing/kayaking.

Each of the three townships bordering the Higgins Lake shoreline maintains public parks. Gerrish Township offers a beach park located on the northeast shore of Higgins Lake and a park and recreation area located behind their township office building off County Road 100. Beaver Creek Township offers a park and recreation area directly behind their township office building located on Grayling Road. Lyon Township offers a beach park (Phoenix Park) located on the western shore of Higgins Lake as well as a park and recreation area along Old US-27 in the northern area of the township. Lyon Township also hosts an additional beach park in the Sam-O-Set subdivision area near the southern reaches of the township.

The MDNR Civilian Conservation Corps Museum located just north of Higgins Lake hosts many walking trails frequented by visitors and residents alike. North and South State Parks, the MacMullen Conference Center, and Camp Westminster also provide a variety of recreation opportunities for visitors in the region.

Many conflicts have arisen in past years due to the increasing recreational activities within the watershed. Most notable are the ongoing legal battles regarding the permitted uses of roads ending at Higgins Lake. These roads are often utilized for launching, mooring and docking boats with much controversy regarding these and other uses. Additional conflicts have arisen regarding the boat carrying capacity of Higgins Lake, ice fishing debris, snowmobile access, lake level maintenance and parasailing activities over the waters of Higgins Lake.

O. Fisheries Resources of Higgins Lake

Higgins Lake is one of the largest inland lakes in Michigan. It is just over 10,000 acres in size with a maximum depth of 135 feet. It is considered oligotrophic in trophic classification. Because it is deep and cold by nature, it is considered a two-story trout lake and is being managed as such by the Michigan Department of Natural Resources.

The fish community of Higgins Lake is composed of predominantly coldwater and coolwater species. Primary sport fish include rainbow smelt, yellow perch, rainbow trout, brown trout and lake trout. Lake whitefish, lake herring, northern pike and smallmouth bass also provide moderate fisheries.

Table 6: Trout and Salmon Stocking in Higgins Lake, 1978-2004 (Michigan DNR, 2004)						
Year	**Brown Trout**	**Rainbow Trout**	**Lake Trout**	**Splake**	**Atlantic Salmon**	**All Species**
1978	25,000		35,000			**60,000**
1979	17,000		50,000			**67,000**
1980	25,000		50,000			**75,000**
1981	25,000		25,000	22,000		**72,000**
1982	20,000		25,000	25,000	1,629	**71,629**
1983	26,900		25,000	25,000		**76,900**
1984	50,000		100,798	25,000		**175,798**
1985	20,330		25,000	50,000		**95,330**
1986	25,000	8,000		23,400		**56,400**
1987	23,274		21,880	34,975		**80,129**
1988	35,010	17,651	150,000	23,000		**225,661**
1989	35,000	83,727	600			**119,327**
1990	10,000	10,000	29,500	30,000	40,007	**119,507**
1991	65,000	33,000				**98,000**
1992	34,299	10,150	34,900			**79,349**
1993	34,700	10,000	34,900			**79,600**
1994		10,000	27,700	19,994		**57,694**
1995	34,981	116,624				**151,605**
1996	92,890	82,494	35,000			**210,384**
1997	33,602	138,979	28,448			**201,029**
1998	55,742	34,605	34,500			**124,847**
1999	34,980	34,780	35,000			**104,760**
2000	35,000	34,905	30,402			**100,307**
2001	35,000	30,750	35,000			**100,750**
2002	14,973	25,000	35,000			**74,973**
2003	15,000	25,001	35,000			**75,001**
2004	15,000	26,936	35,001			**76,937**

Angler use of the lake is substantial. The Department of Natural Resources performed a creel census between January 13 and March 31, 2001 and concluded that 34,906 angler trips were spent during this period. If the six-month open water fishery could be considered similar, this lake would receive over 100,000 angler trips annually. Anglers from nearly every county in Michigan and many nearby mid-western states fish on Higgins Lake every year.

In recent years the yellow perch, lake trout and lake whitefish catch has improved. The rainbow trout fishery has remained consistently good. Brown trout fishing seems to have declined in recent years. Rainbow smelt are very cyclic in nature with frequent upswings and downturns consistent with good and poor year-class fluctuations. Smelt fishing was excellent during the winter of 2002.

Lake trout have been stocked almost annually in Higgins Lake since 1941. Rainbow trout have been stocked consistently since then also. Brown trout have been regularly stocked since 1978. Splake were planted between 1981 and 1994 and Atlantic Salmon were stocked in 1982 and 1990. Kokanee Salmon were stocked on an experimental basis in the 1960s. (See Table 6 for trout and salmon stocking information.)

Higgins Lake continues to be one of the best fishing lakes in Michigan. The continuation of this condition depends upon suitable natural habitat. Human development activities along the shoreline of lakes directly influence natural habitat and tend to degrade it over time. For this reason, appropriate watershed management is necessary to sustain healthy biological communities, including fish, aquatic invertebrates, amphibians,

reptiles, birds and aquatic mammals. Important measures would include protecting water quality (particularly nutrient control), preservation of natural shorelines, natural vegetation, bottom contours and woody debris within the lake (Smith, 2002).

III. WATERSHED STAKEHOLDERS

Anyone who may have a stake in the Higgins Lake Watershed is encouraged to participate in watershed management, share their concerns and offer suggestions for possible solutions. By involving stakeholders in the initial stages of project development, we hope to ensure long-term success.

Updates to the Watershed Management Plan occurred in 2005 with input and approval of the Steering Committee.

A. Groups and Organizations

The following groups and organizations agree that maintaining the quality of life within the Higgins Lake Watershed is a major goal worth striving to accomplish. A thumbnail sketch for each group and their mission as an organization is listed below. Much of this information was printed in the 1992 issue of the *Higgins Lake Foundation News*.

The Higgins Lake Advisory Committee (HLAC) was organized in 1989 to provide a forum where its committee members could identify, discuss, recommend and coordinate action on issues regarding the quality of Higgins Lake and its watershed. Membership consisted of representatives from elected county and township boards, civic groups and appointed citizens. Meetings were open to the public and were often attended by interested citizens. Since the committee did not have legislative authority or funds, it operated in mutual cooperation with county and township boards, other groups and individuals in an effort to influence laws, ordinances and regulations pertinent to the lake and its watershed. In 2003 the HLAC elected to take a hiatus to reevaluate the mission of the group.

The Higgins Lake Civic Association (HLCA) is comprised of non-riparian property owners around the lake. The organization consists of several hundred families interested in protecting their right to use the lake for recreation purposes. The organization's major goal is to keep members informed of and in direct compliance with road end, boat and dock ordinances of the townships. The group monitors monthly governmental meetings and supports all local governmental agencies in an effort to promote equitable access to Higgins Lake by all area residents.

The Higgins Lake Foundation (HLF) was established in 1989 as a nonprofit corporation in response to a perceived need for leadership and coordination in assessing and protecting the quality of the lake. The mission of the Higgins Lake Foundation is to preserve the natural beauty of Higgins Lake and to enhance the quality of the lake and its watershed. The foundation sponsors a Higgins Lake Awareness Day each year and publishes a newsletter twice a year, in which details of lake studies and restoration projects are outlined.

The Higgins Lake Property Owners Association (HLPOA) was established in 1935 by a concerned group of lakefront property owners. The goal of the HLPOA is the preservation and improvement of the quality of Higgins Lake and its watershed. They participate with other community and governmental organizations and support an array of lake improvement activities. Members of the HLPOA are committed to safety on the lake, water quality, controlled and well planned development in the watershed, and preserving the integrity of the Higgins Lake ecological system. The HLPOA also publishes a newsletter three times annually.

In 2002 the Roscommon County Community Foundation (RCCF) became an independent community foundation serving Roscommon County. RCCF's mission is to enhance the quality of life for all citizens of Roscommon County, now and for generations to come, by attracting and holding permanent endowment funds from a wide variety of donors, by addressing community needs through awarding grants from the income of these endowment funds, and by providing leadership on key community issues.

The Crawford-Roscommon Conservation District is a locally-elected entity of state government whose purpose is to improve the quality of life in Crawford and Roscommon counties by conserving and improving our natural resources for the benefit of present and future residents and visitors. The conservation district provides services such as forestry assistance, a recycling program, agricultural programs, natural resource educational materials, and hosting of an annual tree sale program.

Huron Pines is a nonprofit organization working to conserve the forests, lakes and streams of Northeast Michigan. Since 1973 Huron Pines has worked closely with conservation groups, local, state and federal governments, and river and lake groups to identify resource concerns and implement strategies for these resources. Huron Pines continues to work closely with Higgins Lake organizations to promote watershed stewardship, control exotic species, reestablish greenbelts, and provide assistance to property owners and local officials.

B. Higgins Lake Watershed Partnership

The Higgins Lake Watershed Partnership (HLWP) is a community-based, voluntary initiative dedicated to preserving, protecting and improving the water quality of Higgins Lake. The HLWP was established in 2000 with a primary mission to provide a comprehensive watershed plan for reducing current and future nonpoint source pollution impacts in the Higgins Lake Watershed by thoroughly evaluating the physical, chemical and biological integrity for long-term protection and enhancement of the watershed. The partnership is a ten-year initiative to improve the ecological integrity of the Higgins Lake Watershed and will be renewed every two years to allow the partners to evaluate their role, address changing conditions, and assess progress in meeting their mission and goals. The members of the Higgins Lake Watershed Partnership have signed a partnership agreement (see Appendix A) as well as letters of commitment to the watershed management planning project.

The Steering Committee for the Higgins Lake Watershed Plan is comprised of the partners of the Higgins Lake Watershed Partnership and many concerned citizens. The Steering Committee meets on a bimonthly basis. During the years of 2000 and 2001 the Steering Committee focused its efforts largely on providing input for the overall planning efforts in the development of the Higgins Lake Watershed Plan.

During the years of 2004 and 2005 the Steering Committee worked closely with Huron Pines to complete the tasks defined in the Higgins Lake Watershed Transition/Implementation Project grant received through the Department of Environmental Quality 319 program. The main tasks included 1) update the Higgins Lake Watershed Management Plan to meet the criteria for the EPA 9 Elements, 2) conduct an Information and Education Program, and, 3) install greenbelt demonstration sites, utilizing native vegetation around Higgins Lake. In addition, partners have worked hard to control the spread of Eurasian watermilfoil and implement water treatment at the lake's highest-density developed area.

All meetings are open to the public and public participation is greatly encouraged.

C. Additional Public Input

1. Watershed Management Plan Survey

From July 2001 through September 2001 a Higgins Lake Watershed Partnership survey form was distributed to watershed stakeholders, residents, visitors and property owners to help determine their interests and concerns regarding watershed management. Methods of distribution ranged from annual organization meetings, township meetings, mailings and personal distribution. The survey questions were formatted after a similar survey developed by the Muskegon River Watershed Assembly.

A total of 124 survey forms were returned and compiled into a database to organize the responses. The survey form (see Appendix B) consisted of questions relating to watershed management priorities,

pollutant concerns, threats to designated uses, preferences for education tactics, uses of the watershed and obstacles and/or barriers to achieving improvements.

2. Public Hearing

The Higgins Lake Watershed Management Plan draft was reviewed at the August 13, 2002 Steering Committee Meeting held at the Beaver Creek Township Hall. The recommendations from that meeting were considered and revisions were made to the draft Plan. Members present were given a draft Plan to take with them for further review and instructed to return comments to the watershed planner by the end of the month.

On September 4, 2002 a public forum meeting was held at the Gerrish Township Hall to review the draft Watershed Management Plan. This meeting was publicized in the local newspapers including the *Houghton Lake Resorter* and the *Roscommon County Herald News.* Flyers for the public forum were placed throughout the watershed to inform residents and concerned citizens of this event. Additional publicity included a mass e-mail announcement to over 100 residents and local organizations. A meeting notice was also mailed to all Steering Committee members and watershed partners.

A summary of the Higgins Lake Watershed Management Plan was given to each participant including the Plan goals and objectives and copies of the complete draft Plan were also made available during the meeting. After a review of the watershed management planning process and explanation of expected implementation efforts, comments regarding the Plan were accepted and considered for final revisions. Particular comments included catastrophic event protocols and littoral drift in Higgins Lake. To address these comments the attendees were informed that each township within the watershed has a contingency plan that they will follow in the case of catastrophic events. Attendees were also informed that while littoral drift is a process occurring in all lakes, it does not contribute nonpoint source pollutants to the waterbody. Sediment that is introduced into a lake may then be relocated by this process, but the process itself does not cause sediment loading. It was generally agreed that study of the movement of sand in the lake may make for an interesting future project.

IV. PREVIOUS RESOURCE STUDIES

The Higgins Lake Watershed has many involved citizens and organizations that have sponsored multiple studies and have carried out water quality testing for over 30 years. Many efforts have been made previously to educate the community regarding watershed issues and concerns, direct policies toward prevention measures to protect land and water quality and to implement Best Management Practices regarding erosion, runoff, nutrient loading, etc.

Maintaining the High Water Quality of Higgins Lake was produced in 1969 by Willard E. Bosserman, County Extension Director for Roscommon and Crawford counties. The study focused on nonpoint source pollutant loading from drains into the lake and roads terminating at the lake. Best Management Practices to reduce nutrient loading were recommended. A follow-up to this study was completed ten years later entitled *Higgins Lake Water Quality – Plus 10*, in which the author addressed implementation of recommendations from the first study that had taken place as well as additional recommendations for further improvements.

Groundwater and surface water testing were completed by the Student Water Publications Club at Michigan State University in 1971 and 1972. Testing included *E. coli* bacteria, Chloride, Phosphate, and Nitrate. This testing was conducted to assist with the long-term, water-quality monitoring program for Higgins Lake.

Dr. G. Winfield Fairchild of the University of Michigan Biological Station and Richard Schultz of the Biology Department at Central Michigan University completed a *Water Quality Study of Higgins Lake, Michigan* in 1984. This was a very comprehensive study that includes physical characteristics of the lake and watershed, historical information regarding the area, biological characteristics of the lake and watershed, extensive limnological information, and land use patterns for the watershed. The main concentration of this study was to determine the sources of nutrient loading into Higgins Lake. The study indicated “nearshore areas of Higgins Lake have consistently high concentrations of phosphorus, and heavy accumulations of both marl and filamentous green alga.” It is estimated that 9% of the phosphorus loading is attributed to residential land use and up to 28% is contributed from on-site septic systems. Based on the results of the study, water quality management alternatives were suggested to reduce human sources of nutrient loading including banning fertilizer use within 100 yards of the lakeshore, increasing natural vegetation, and discussing septic system alternatives. In addition, the study recommends addressing residential development within the riparian zone and watershed to prevent future nutrient loading and continuing lake water quality monitoring programs.

Gosling-Czubak Associates, an engineering firm in Traverse City, conducted a *Higgins Lake Sewer Study* in 1988. This study provided recommendations for the implementation of a wastewater treatment and disposal system in the lakeshore area. It covers the types of systems that would be most productive as well as estimated costs for installation and maintenance. It also suggests potential funding options to assist with implementation costs.

Higgins Lake: Past-Present-Future was prepared by Terry E. Jones in cooperation with the Biology Department at Central Michigan University. This study has sections regarding the land, the water, the people, and the ecology of Higgins Lake and its watershed. Many recommendations are made in this publication as to Best Management Practices to improve water quality based on the data collected and sampling performed. While only some of these practices have been implemented, this publication does serve as an excellent reference source for the physical and economical structure of the watershed and its community.

In 1992 a *Higgins Lake Diagnostic and Feasibility Study* was conducted by Limno-Tech, Inc. of Ann Arbor, Michigan. This study included physical and demographic information for the entire watershed, historical land use information, land use change, limnological data and nonpoint source pollutant loading statistics. Studies determined that urban lands, while comprising only 12.6% of the land use, contributed an estimated 56% of all phosphorus from watershed runoff. Many Best Management Practices were recommended and include mitigating nutrient loading from on-site septic systems, reducing the amount of impervious surfaces, reducing erosion at road end sites, and encouraging landowners to reduce fertilizer use and maintain riparian vegetation. Many recommendations from this study were implemented; these include road end structural improvements, homeowner education and an ongoing water-quality monitoring program.

Septic System Phosphorus Loadings to Higgins Lake was another study conducted by Limno-Tech, Inc. in 1992. Modeling and household surveys were the means of data collection for this study. The outcome was a recommendation for a coordinated septic system management plan to significantly reduce phosphorus loading. Suggestions for the management plan included inspecting older systems to determine if they are of appropriate design and working efficiently, increasing the required minimum distance between septic systems and the lakeshore for all new and rebuilt septic systems, proper siting of new systems and homeowner education regarding phosphorus reduction practices. The first three recommendations from this study have proven to be an ongoing political challenge. However, the fourth recommendation has been addressed by the creation of the *Higgins Lake A*Syst Manual* for homeowners within the watershed.

Limno-Tech, Inc. also prepared a *Higgins Lake Clean Lakes Program Pollution Control Plan* in 1992. This plan estimated that 1208 pounds of phosphorus reaches Higgins Lake annually from near-lake septic systems. As a result of that, recommendations were prepared including inspection of older systems, increasing septic setback distances, installation of a sewer system for near-lake residences, practices to control phosphorus runoff from road ends, a lawn fertilizer program, lake level management and beaver dam management.

The *Higgins Lake Stormwater, Sedimentation, and Road End Erosion Inventory* was published in 1993 by Huron Pines through the Roscommon County Resource Conservation and Development Committee. This inventory provides a wealth of information regarding existing damage at roads terminating at Higgins Lake. Best Management Practices are identified to restore these sites and minimize further damage and pollutant loading. The resource committee identified 78 road end sites adding an estimated 507.2 tons of sediment to the lake annually. Since the inventory was completed at least 16 sites have been repaired, reducing the amount of sediment entering the lake annually by an estimated 297.5 tons. It also provides information regarding the major drains to the lake and proposed treatment options for these drainage systems.

Limno-Tech, Inc. was contracted in 1994 to complete a study entitled *Higgins Lake Septic System and Lawn Fertilizer Management Zones.* Field studies included an examination of the behavior of septic system effluent plumes in groundwater at two sites and an examination of nutrient concentrations in shallow groundwater as it flows into Higgins Lake downgradient from septic systems and fertilized lawns at numerous sites around the lake. The study indicated that concentrations of both nitrogen and phosphorus were significantly higher than background levels downgradient of septic systems absorption fields. Specific recommendations were made for both septic system management and fertilizer management practices, some of which were included in the *Higgins Lake A*Syst Manual* for homeowners.

Consulting Limnologists Wallace and Bene Fusilier completed a *Water Quality and Bottom Sediments Study* of Higgins Lake in 1998. Sampling of surface water and bottom sediment was completed and a lake water quality index value was averaged at 96 indicating very high water quality.

Numerous shoreline Cladophora surveys have been conducted by either consultants or volunteers throughout the last decade. Since 1990, there have been approximately six Cladophora surveys completed. The data collected is used to document locations of growth over an extended period of time and documents the trends of Cladophora presence in Higgins Lake.

The Cooperative Lakes Monitoring Program (CLMP) is an ongoing Citizen Volunteer Program in Michigan to help citizen volunteers monitor indicators of water quality in their lakes and document changes in lake quality over time. The CLMP provides sampling methods, training workshops, technical support, quality control and laboratory assistance for volunteers to monitor their lake for the basic indicators of lake productivity. Annual Summary Reports are printed consisting of the results of each indicator for all participating lakes. Results from the 2005 study indicate that Higgins Lake remains a very high quality oligotrophic lake. Some of the most recent reports can be viewed on the Internet at http://www.michigan.gov/deq.

The *Higgins Lake A*Syst Manual* was developed as a joint effort by Michigan State University Extension, Higgins Lake Foundation, Kirtland Community College and the Higgins Lake Advisory Council to provide property owners with a resource to help preserve and protect the quality and beauty of the lake and watershed. This manual is available at the Crawford-Roscommon Conservation District office and the Roscommon Michigan State University Extension

office, and is distributed to new riparian property owners through the Higgins Lake Property Owners Association as part of the ongoing riparian property owner education process within the Higgins Lake Watershed.

The most recent water quality data gathered and analyzed for the Higgins Lake Watershed was carried out from 1995-1999 by the United States Geological Survey. The results of the sampling were compiled into a report entitled *Effects of Residential Development on the Water Quality of Higgins Lake, Michigan* (See Appendix E). This study provided consistency of data due to the long-term data collection period that is most useful when making comparisons and tracking trends in water quality. Though replication of this study within the next 10 years is proposed as a method to better quantify the water quality changes happening in Higgins Lake there is clear correlation between increased development and declining water quality.

Some conclusions from the 1995-1999 USGS study include:

> *About 19 percent of the near-shore surface area of the lake is less than 4 ft. in depth. It is in this shallow zone that subtle changes in water quality are starting to occur. The concentration of most measured constituents in lake and ground water near shore increased with the increase of residential development. The dissolved chloride and turbidity in the lake water increase as building density becomes greater than 0.50 building per acre. The phosphorus concentration in near-shore lake water averaged about 1.5 times the concentration found in the deep basins. Nitrogen concentration in lake water off shore from areas where the building density was about 0.50 building per acre or greater was about twice as high as in water in the deep basins. Concentration of most constituents in near-shore lake water at site 20, with no residential development, generally was lower than at other near-shore sites with residential development.*

Throughout the years, a definite degradation of water quality has been documented and the stakeholders are eager to respond to this degradation by implementing further Best Management Practices to reduce this trend.

V. DESIGNATED AND DESIRED USES

A. Designated Uses

Pursuant to the Water Resources Commission Act (P.A. 451 of 1994, part 31, R323.1100 of Part 4), all surface waters of the State of Michigan are designated for and shall be protected for all of the following uses:

1. Agriculture
2. Navigation
3. Industrial water supply
4. Public water supply at the point of water intake
5. Warmwater fishery
6. Other indigenous aquatic life and wildlife
7. Partial body contact recreation
8. Total body contact recreation between May 1 and October 31
9. Coldwater fishery, if designated as such a waterbody
10. Fish consumption

1. Agriculture

Surface waters must consistently be a safe source for cropland irrigation and livestock watering. The watershed consists of mainly very well drained soils and irrigation could be necessary in certain types of agriculture. Producers rely on water free of harmful pathogens to keep their livestock healthy. Traditional agriculture is not a very extensive land use in the planning area. The tilled cropland is planted with potatoes and the remaining majority of agricultural land is pasture, fruit orchards, or Christmas tree plantations.

2. Navigation

Waterways that are large enough for canoes or kayaks must maintain navigable conditions. Obstructions that might prohibit passage or impede navigation are not permissible and may limit this designated use. An increasing problem in many area lakes is the invasion of exotic species, which could lead to impaired navigation.

3. Industrial Water Supply

Industrial water supplies must have cool temperatures and low turbidity for optimal use. No surface water intakes for industrial water supplies exist within the planning area.

4. Public Water Supply at the Point of Intake

Municipal water supplies must meet water quality standards and be safe for use in adequate amounts. There are no surface water intakes for public water supply in the planning area.

5. Warmwater Fishery

A warmwater fishery is generally considered to have summer temperatures between 60 and 70 degrees Fahrenheit and is capable of supporting warmwater aquatic species year-round. The watershed contains numerous lakes supporting a warmwater fishery.

6. Other Indigenous Aquatic Life and Wildlife

Aquatic life and other terrestrial wildlife in the ecosystem should be considered in all management strategies. Keeping individual components of the ecosystem healthy is paramount to keeping the entire ecosystem healthy.

7. Partial Body Contact Recreation

Partial Body Contact Recreation includes boating and other activities where the person's body is not totally submerged in the water but may come into contact with the water. Canoeing and kayaking are major activities in the watershed and are important factors to consider when planning for ecosystem health.

8. Total Body Contact Recreation

Total Body Contact Recreation includes swimming and other activities where a person's body comes into direct contact with the water. It is important to maintain water quality standards to avoid the absorption of pollutants through the skin or accidental ingestion.

9. Coldwater Fishery

A coldwater fishery is considered to have summer temperatures below 60 degrees Fahrenheit and to be able to support natural or stocked populations of brook trout. Healthy riparian and in-stream habitat is essential to provide the necessary requirements of a coldwater fishery.

10. Fish Consumption

Fish is recommended as part of a healthy diet, and consuming fish caught in Michigan's waters is common. The Michigan Department of Community Health (MDCH) issues regular advisories on which sizes and species may have unsafe levels of chemicals like PCBs, mercury, and others. Eating fish with these chemicals too often can cause them to build up in the body, resulting in illness.

Designated uses which apply to Higgins Lake include:

- Agriculture
- Navigation
- Industrial water supply
- Other indigenous aquatic life and wildlife
- Partial body contact recreation
- Total body contact recreation between May 1 and October 31
- Coldwater fishery
- Fish consumption

There are currently no water bodies listed on the 303 (d) list in the Higgins Lake Watershed. (However, all of the inland lakes in the State of Michigan are part of the mercury fish consumption advisory including Higgins Lake.)

B. Desired Uses

Desired uses are those that, in addition to the above-mentioned uses, are important to the watershed community. They help guide watershed restoration and protection efforts that go beyond the state list of designated uses. The desired uses listed below have been identified by the watershed Steering Committee as applicable for this watershed based upon the unique circumstances and conditions within the Higgins Lake Watershed. The Steering Committee would like to see the following desired uses:

1) More areas of natural shoreline to protect habitat and water quality
2) Protection of environmentally sensitive and undeveloped areas
3) Protection of high quality recreation opportunities

VI. NONPOINT SOURCE POLLUTANTS

A. Priority Method

As previously mentioned, the Higgins Lake Watershed Partnership conducted a survey of residents and property owners to determine the ways they used the watershed as well as their concerns regarding water quality. The survey also consisted of questions designed to determine the watershed management activities that would most likely be welcomed.

The survey form (see Appendix B) was distributed to members of the Higgins Lake Property Owners Association and Civic Association, which are the only property owner organizations within the watershed. The survey form was also distributed at township meetings throughout the watershed as well as many other meetings and activities attended by residents and property owners. In addition, many members of the Steering Committee randomly distributed survey forms to their neighbors and acquaintances. Approximately 500 survey forms were distributed in all.

A total of 124 survey forms were returned and the information from these forms was compiled into database format. Survey results along with results of field inventories and past water quality sampling were utilized in the compilation and prioritization process of the concerns and threats for the Higgins Lake Watershed. The survey results indicated a ranking of 1-10 with one indicating high priority and ten indicating low priority.

Based on the survey results and additional input by Steering Committee members, a prioritized listing of concerns and threats for the Higgins Lake Watershed was created. Those concerns and threats ranked as 1-5 by the survey participants were considered to receive one vote in the priority process. In addition, Steering Committee members were also given the opportunity to indicate five concerns or threats that they considered warranting priority. Each of the Steering Committee member's five priority threats and concerns received one vote as well. Thus the number of 'votes' each concern or threat received established its priority level.

Updates to the nonpoint source pollutant threats and concerns were conducted in 2005 with input and approval from the Steering Committee.

B. Known and Suspected Pollutants in the Higgins Lake Watershed

Nutrients, sediments, invasive exotic species, pathogens, oils & greases, salts, pesticides, metals, and debris were identified by the Steering Committee as main pollutants of concern that threaten the designated and desired uses of Higgins Lake. Below is a list of known and suspected pollutants (Tables 7 & 8).

Table 7: Known and Suspected Pollutants to Designated Uses

Threatened Use	Pollutants
Navigation	Invasive exotic species (K) Sediment (S)
Other indigenous aquatic life and wildlife	Nutrients (S) Sediment (S) Invasive exotic species (K) Pathogens (S) Oils & Greases (S) Salts (S) Pesticides (S) Metals (S) Debris (S)
Coldwater Fisheries	Sediment (S) Invasive exotic species (S) Pathogens (S) Oils & Greases (S) Salts (S) Pesticides (S) Metals (S) Debris (S)
Partial and total body contact recreation	Invasive exotic species (K) Pathogens (S) Debris (S)

Table 8: Known and Suspected Pollutants to Desired Uses

Threatened Use	Pollutants
More areas of natural shoreline to protect habitat and water quality	Sediment (S) Pesticides (S) Metals (S)
Protection of environmentally sensitive and undeveloped areas	Nutrients (S) Sediment (S) Invasive exotic species (S) Pathogens (S) Oils & Greases (S) Salts (S) Pesticides (S) Metals (S) Debris (S)
Protection of high quality recreation opportunities	Nutrients (S) Invasive exotic species (K) Pathogens (S) Debris (S)

Known (K) and Suspected (S)

C. Sources of Pollutants in the Higgins Lake Watershed

Land uses range from large tracts of state forest land to densely packed resort communities. To address pollutants within the watershed, it is important to understand their underlying causes. In some cases a cause such as large waves cannot be stopped. In other cases, however, a pollutant may be minimized.

The main sources of nonpoint source pollution identified for each primary pollutant of concern within the Higgins Lake Watershed are described in Table 9. The pollutants listed below were prioritized based on their potential to threaten and/or impair the designated uses of Higgins Lake. For a complete listing of typical nonpoint source pollutants please see Appendix C.

Table 9: Sources of Pollutants in the Higgins Lake Watershed

Pollutant	Source		Cause
Nutrients	Septic Systems		Lack of maintenance Poorly sited Undersized Density Age of System
	Shoreline practices by landowners		Lack of shoreline vegetation Lack of education Excessive development Poor shoreline setbacks Yard waste dumped in lake
	Stormwater		Lack of vegetation for roads/road end areas Excessive development Impervious surfaces Wetland loss
	Fertilizer use		Near shore fertilizer High phosphorus content Overuse Poor timing of application
Sediment	Shoreline erosion		Lack of shoreline vegetation Ice Natural waves Lack of adequate setbacks Seawalls Large boats High lake levels
	New construction		Lack of enforcement Parcel fragmentation Lack of effective regulation Lack of shoreline vegetation Poorly designated access
	Road end erosion		Lack of shoreline vegetation Poorly designed access
	Road/Stream Crossing		Poor design Lack of maintenance
	Stormwater		Wetland loss Impervious surface Lack of shoreline vegetation

Table 10: Sources of Pollutants in the Higgins Lake Watershed (cont.)			
Pollutant	**Source**		**Cause**
Invasive Exotic Species	Recreational boats and personal watercraft		Lack of education Apathy
	Waterfowl		Transportation of exotics
Pathogens	Septic Systems		Lack of maintenance Poorly sited Undersized Density Age of systems
	Stormwater		Lack of shoreline vegetation Wetland loss Poorly sites roads Impervious surfaces
	Human Waste		Lack of sanitary facilities for recreational users Lack of education
Oils and Greases	Stormwater		Lack of shoreline vegetation Wetland loss Road maintenance
	Watercraft engines		Fuel & oil spills Inefficient or poorly maintained watercraft motors
Salts	Stormwater		Lack of shoreline vegetation Wetland loss Poorly sites roads
Pesticides and Herbicides	Homeowner practices		Lack of proper methods for use and disposal Lack of facilities for disposal Lack of education
Metals	Airborne particles		Deposition from industry
	Paints		Painting of boats, docks, hoists, and seawalls
	Stormwater		Lack of shoreline vegetation
Debris	Recreational users		Lack of education Lack of disposal facilities Apathy

VII. CRITICAL AREA

A critical area is that portion of the watershed that is most sensitive to environmental impacts and has the greatest likelihood to affect water quality and aquatic habitat (See Figure 11). The critical area is defined to narrow the geographic scope in order to focus on areas that may be impacted from nonpoint sources of pollution.

Due to the dense residential development along the shoreline of Higgins Lake and its tributaries, the area within 1000 feet of surface water and/or wetland regions within the Higgins Lake Watershed were determined to be critical. The defined critical area encompasses the residential zoned land that is adjacent to the lakeshore, its tributaries and wetland regions. Management in the critical area is crucial due to the increasing development pressures within the watershed. (Road end priority sites are show with a red dot ●)

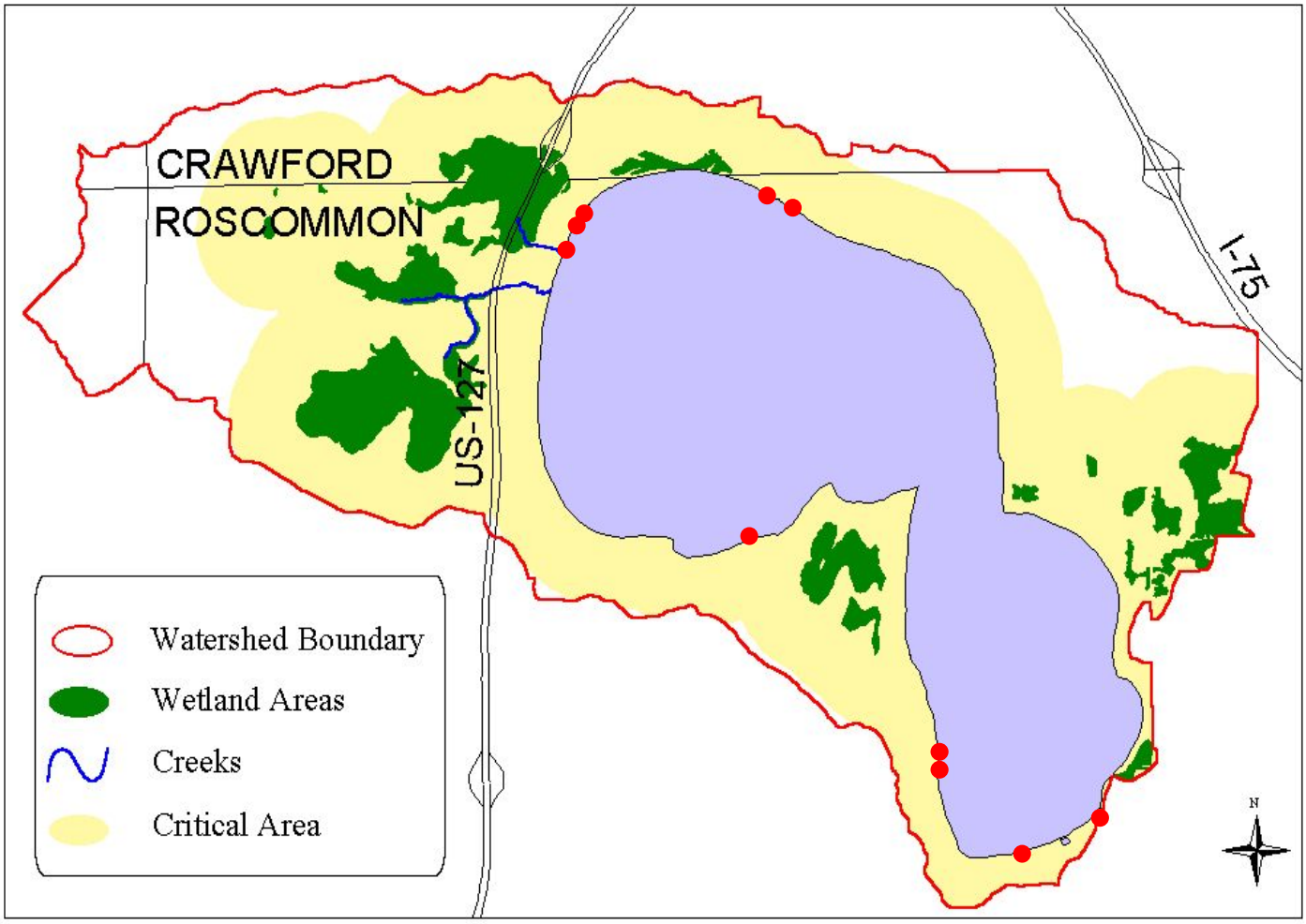


Figure 11: Higgins Lake Watershed Critical Area

VIII. WATER QUALITY REGULATIONS

Implementation of land use policies and regulations can be an important strategy used by local, state and federal units of government for protecting water quality. In addition to their benefits for aquatic resources, planning and zoning are tools used for ensuring the conservation of wildlife habitat, providing sustainable development, protecting property values and maintaining community character.

In the State of Michigan, planning and zoning are implemented at the township, municipal or county level. The enabling legislation for land use planning can be found under four State acts:

Public Act 285 of 1931 – Municipal Planning Act
Public Act 168 0f 1959 – Township Planning Act
Public Act 282 of 1945 – County Planning Act
Public Act 281 of 1945 –Regional Planning Act

The State also has three legislative zoning acts that enable local units of government to control land uses through regulation of activities on the land:

Public Act 184 of 1943 – the Township Rural Zoning Act
Public Act 183 of 1943 – the County Zoning Act
Public Act 207 of 1921 – the City and Village Zoning Act

In addition to planning and zoning standards, there are State regulations intended to help conserve natural resources. Relevant state laws for water resource protection include (this is only a brief summary, please see the respective law or contact MDEQ for more information):

Act 451, Part 91, Soil Erosion Control and Sedimentation Act
(for earth changes within 500 feet of the shoreline)

Act 451, Part 303, Wetland Protection
(covers the dredging, draining, or filling of regulated wetlands; however, non-contiguous wetlands in rural counties are generally not regulated wetlands)

Act 451, Part 301, Inland Lakes & Streams Act
(covers almost all work done below the ordinary high water mark)

Public Act 368 (1978), Aquatic Nuisance Control

This following review of local land use regulations is not intended to be the sole basis for determining the effectiveness of policies regarding water resource management although it may provide insight into how effective a local unit of government can be at protecting aquatic resources. For some resource issues, such as wetlands and soil erosion and sedimentation, the Michigan Department of Environmental Quality has the lead role in regulation and local government units have generally avoided addressing the issue. (It should be noted that legislation does give them the right to also handle those issues, should they choose to do so.) Likewise, regulations for septic systems are generally handled through the District Health Department, although a local government unit can enact certain policies within their own ordinance.

A. Analysis of Local Planning and Zoning Efforts

Townships located in a county with zoning have the option of having the county manage the entire planning and zoning program or administering their own. Roscommon and Crawford counties represent the majority of land in the Higgins Lake Watershed. Within Roscommon County, Lyon and Gerrish townships administer their own planning/zoning program. In Crawford County, Beaver Creek Township also administers its own planning/zoning program.

A small portion of the watershed is located in the southeast corner of Kalkaska County (Garfield Township) and the northeast corner of Missaukee County (Norwich Township). Considering that land within this minor area is owned by the State of Michigan, township policies were not analyzed for these areas.

Table 10: Planning and Zoning Jurisdictional Units Within the Higgins Lake Watershed

Township/City	Zoning Ordinance Last Date of Revision or Adoption	Comprehensive Master Plan Last Date of Revision or Adoption
Beaver Creek Township	2003	2003
Gerrish Township	2000	2004
Lyon Township	2006	2002

To help determine the adequacy of regulatory coverage for aquatic resources within the Higgins Lake Watershed, local zoning ordinances were reviewed to evaluate what, if any, "environmental provisions" were in place. The ordinances were specifically reviewed for the following:

- *Vegetative buffer zones* (Greenbelts): With regard to minimizing the impact of residential development along the waterfront, ensuring that vegetation is left along the shoreline is generally the most important action that can be taken. Greenbelts help to filter nutrients, reduce erosion and provide habitat. Much research has been done through the years to determine the effectiveness of different types of buffers (e.g., greenbelts 100 feet wide have been found to reduce runoff by more than 90%). Difficulties with having a "greenbelt ordinance" are that it can be hard to enforce, many local officials and residents are unaware of what an effective greenbelt consists of, historic patterns of development have already degraded the water in many areas (and these may be "grandfathered" in), zoning language is often poorly worded for proper enforcement, and citizens are often unaware that there is an ordinance in place. Even with the negatives, however, maintaining a greenbelt is essential to protecting water resources – even a 25-foot greenbelt is better than nothing. A mowed lawn to the water's edge is not a greenbelt.

- *Setbacks of structures* along the waterfront are an important means of reducing the amount of impervious surface near the water, helping to ensure that a greenbelt can be maintained and reducing the potential for serious resource problems. A structure that is setback only 30 or 40 feet is more likely to be associated with negative impacts to water resources than a structure 75 or 100 feet away from the water's edge. Unfortunately, many local units of government that do have an effective setback for homes will make many exceptions for large decks and boathouses. Such exemptions defeat the intent of the setback, as impervious surface cover will still be present near the water's edge. Furthermore, while many local units of government may have a greenbelt requirement of 50 or 75 feet width, they allow the structure setback to be less than the greenbelt restriction. Such a scenario significantly reduces the effectiveness of the greenbelt requirement. In addition, during the construction period, a structure being built less than 50 feet from the water will typically have a construction site that runs right down to the water. This leads to the unavoidable problem of the destruction of the greenbelt during construction. Maintaining the natural greenbelt in the first place is much easier than restoring a greenbelt. Setback requirements should be regarded as a key element for water resource protection.

- *Minimum lot width* is important for waterbodies because it ultimately determines the number of homes that will be built on the water. The more homes, the more septic systems, user conflicts, degraded shorelines, and the more impervious cover – all of which contribute to water resource problems. For most developed lakes, a 100+ foot width is necessary. Minnerick (2001) notes in the *Effects of Residential Development on*

the Water Quality of Higgins Lake, Michigan, that a decline in water quality can be linked to density of development.

- *Open space preservation* is used in communities to protect their rural character, as well as maintain prime recreational, farm or forest land. Unfortunately, most zoning ordinances, even if implemented correctly, are not written in such a way as to accomplish those goals. Many local units of government that have open space guidelines in this watershed typically state something to the effect of, "At least 40% of the total gross project shall be left as open space." Some require only 25%, which is not a way to accomplish their community goals.

  An improvement to the open space section of their ordinances would be to require the developer to increase the amount of open space to 50 or 60% and also make sure that some of the set aside acreage is from the developable portion of the site. Steep slopes, surface water, wetlands, etc., should be excluded from this calculation; otherwise only the most undesirable areas will be set aside as open space. Ordinance language should be something such as, "A minimum of 60% of the parent parcel's gross acreage shall be set aside as permanently protected open space. This area shall include at least half of the parcel's buildable land area."

- *Septic systems* are under the jurisdiction of the District Health Department. Typically, only severe problems are addressed, departments are understaffed, and there are poor/incomplete records of septic systems. Some local units of government have begun to adopt policies to initiate their own programs for inspections, maintenance or replacement requirements in cooperation with the health department.

- *Wetland protection* is handled through the state Department of Environmental Quality. For rural northern Michigan, the law generally does not regulate isolated wetlands. Some communities have addressed this oversight by adopting their own wetland regulatory program, which is authorized through the state wetland act.

- *Stormwater management* is recognized as critical for keeping oils, greases, organic debris, and trash from running directly into a waterbody. While stormwater control measures are often taken during construction, the post-construction runoff of stormwater is a problem that is often overlooked. Proper management should require that new developments handle their own stormwater on site, rather than get it off their site as quickly as possible (which has been the historic management practice).

- *Seawalls*, used for erosion control on the lake, are not often addressed by local units of government, although they are regulated in this watershed for both Gerrish and Lyon townships. The interface between land and water is an important transition zone; a vertical wall between these areas typically eliminates this zone.

Table 11: Assessment of Water Quality Regulations Within the Higgins Lake Watershed			
Water Quality Regulations	**Local Government Unit**		
	Beaver Creek Township (Crawford County)	Gerrish Township	Lyon Township
Vegetative Buffer Zones (greenbelts)	Regulations for "environmentally sensitive areas" (i.e., within 500 ft of surface water) Not more than 40% of tree coverage may be removed	Not addressed	25 feet from ordinary high water mark for new buildings.
Shoreline Setbacks	50 feet	50 feet	50 feet
Minimum Lot Width for Riparian Parcels	150 feet	65 feet	100 feet
Open Space	30% of lot must be left undeveloped for low density residential areas; 25% requirement for Planned Unit Development	75% of lot must be left undeveloped for residential (R1) district; 25% requirement for Planned Unit Development	50% of lot must be left undeveloped for residential; no Planned Unit Development or clustering options
Septic Systems	Not addressed	Not addressed	Not addressed
Wetland Protection	Not addressed	Not addressed	Not addressed
Stormwater Management	Not addressed	Not addressed	Mentioned, but not effectively regulated
Seawalls	Not addressed	Regulates seawalls & has specific design criteria	Regulates seawalls & has specific design criteria

B. Recommendations for Effectively Using Planning and Zoning Policies for Water Resource Protection

<u>Township Specific Recommendations</u>:

Beaver Creek Township

Beaver Creek Township updated their master plan in 2003. The plan incorporates socio-economic and natural resource information and makes specific recommendations for future land use management.

The current zoning regulations that are applicable for water resources generally fall under their "Environmental Conservation Provisions" section. While this section does make numerous references to applicable state laws, there is little specific zoning language that will ensure water resource protection at the local level. The ordinance does not adequately define the Environmentally Sensitive Areas.

One example of an area of confusion is the following statement for greenbelts. The ordinance prohibits more than 40% removal of trees in environmentally sensitive areas unless the approval of a forester is obtained. The 40% standard could certainly be taken to apply to areas along the waterfront (a sort of de facto greenbelt ordinance) but leaves a lot of loopholes. *Does 40% mean that such an amount can be removed at one time and that a property owner could come back next year (or next month) and remove 40% more? If 40% is cleared and the property sold, can the next property owner clear 40%? Can all other vegetation (besides trees) be removed?*

The minimum lot size for the waterfront is 150 feet and the setback requirement is 50 feet.

Gerrish Township

An update to the master plan was completed in 2004. The plan needs more background information and more concrete statements about what township residents want to have happen in the future.

Perhaps the most glaring weakness in the zoning ordinance is that there is no section on maintaining a vegetative buffer strip (greenbelt). It is extremely rare for a township with its own zoning and a high quality water resource to lack such a standard. Local organizations should push for the adoption of a greenbelt standard.

Minimum lot width is quite narrow (65 feet). While it may be too late to increase this, the township should never allow splits to occur that create lots less than this amount. Setbacks for the lake are only 50 feet; this could be increased. Even though much of the shoreline is developed, the next decade will see the trend of development of many of the small resort cabins. These will be torn down and much larger homes built on the same site.

Many township residents have stated they would like to maintain the rural character of their community. One of the sections of the zoning ordinance that would address this issue is in the Planned Unit Development (PUD) section. Unfortunately, adhering to the zoning ordinance would not accomplish the above goal. The wording states that 25% of the total PUD area must be left undeveloped. As mentioned earlier under the description of open space zoning, communities should require at least 50% of the developable portion of the property be left as open space. Such a provision will not reduce the total density (or profit) of the project, but will ensure that open space is preserved, infrastructure costs are less and, hopefully, a better plan is produced.

Gerrish Township could help improve the water quality of Higgins Lake by adopting (or working with the county to adopt) a septic system inspection/maintenance ordinance. Other counties, and in rare cases townships, have successfully accomplished this.

Lyon Township

Lyon Township recently adopted new zoning ordinances in 2006. Two new provisions were addressed that directly affect Higgins Lake. The first is the establishment of a Shoreline Protection Overlay (SPO) District that extends 500 feet from the ordinary high water mark and applies to all future development. As part of the overlay district, new development is required to maintain a 25 foot wide greenbelt that must be included as part of the site plan and provisions are set to limit the amount of impervious surfaces within 25 feet of the high water mark.

In addition to the SPO the building setback was increased to 50 feet, the minimum parcel width increased to 100 feet and new development sites are required to maintain at least 50% open space. Though these are improvements to the previous ordinances there is always room for further protection such as adopting a septic system inspection/maintenance ordinance.

General Recommendations:

- Data from the Michigan Society of Planning indicates that the average amount of time that a Planning Commissioner remains on a board is less than three years. Thus it is necessary to sponsor regular training

workshops for these officials. The Higgins Lake Watershed Partnership should ensure that these training workshops are made available (either freely or at a low cost) at least every other year.

- In the rural counties of northern Michigan (less than 100,000 people), the state wetland law does not regulate activities in wetlands that are non-contiguous, although the state law does provide for local government units to do so. It may be worthwhile for the Partnership to analyze past impacts on isolated wetlands and assess whether an ordinance is necessary.

- Recent changes in the State of Michigan's planning and zoning enabling legislation, such as requirements for open space and conservation planning, mandatory review of plans every five years, and involving adjacent units of government in planning process, should be incorporated by local government units. Local units of government may not be aware of these changes or how to incorporate them.

- Because local communities have different goals, resources and socio-economic status, local communities often differ in the types of regulations they utilize. Generally, within a given watershed (and within the Higgins Lake Watershed in particular) there are enough similarities that the same standards could be used throughout the watershed. Where one unit of government works to manage resources wisely and the adjoining unit does not, resources impacts cross the line on the map. Beaver Creek, Gerrish, and Lyon townships should all work to coordinate efforts on such items as shoreline setbacks, greenbelts, minimum lot size, etc.

- On-site management of post-construction stormwater runoff is generally accepted as the best means of handling stormwater and new development projects are in a good position to incorporate such design standards. The Higgins Lake Watershed Partnership should work with all local government units to adopt a single standard.

Even once local government units have "good" land use policies in place, there is still work that needs to be done – the governing body must make decisions regarding infrastructure and zoning in accordance with their up-to-date master plan.

The master plan should be reviewed every few years (and updated if necessary) to ensure that the plan reflects the evolving needs of the community. Zoning standards and decisions must be made with the guidelines of the comprehensive master plan in mind. Changes to the plan or decisions that are in conflict with the plan or zoning ordinance should not be made without the greatest of caution. In addition, zoning regulations need to be enforced and followed up. Without enforcement, the majority that make the effort to follow land use regulations are, in effect, penalized, as they have gone to greater effort and expense than those not following regulations. Such systems will eventually break down for local units of government – either most everyone will eventually give up on trying to follow the rules or the court system will not hold up the regulations.

It is important to note that an effective program of land use planning is only a tool of watershed protection. Even the best policies must be used in conjunction with educational outreach programs, land protection for critical habitat areas, and on-the-ground implementation of Best Management Practices.

C. Zoning

The estimated acreage for each zoning district within the watershed is listed in Table 13. It is important to keep in mind, however, that zoning district definitions often vary throughout the watershed by county or township. The restrictions of a residential district for one governmental unit can be quite different from the restrictions for the same district type in another governmental unit.

Table 12: General Zoning District Acreage

District	Acreage
Residential	9,315
Military	1,478
State Land	6,565
Commercial	459
Recreation	491
Agriculture	117
Utilities	108

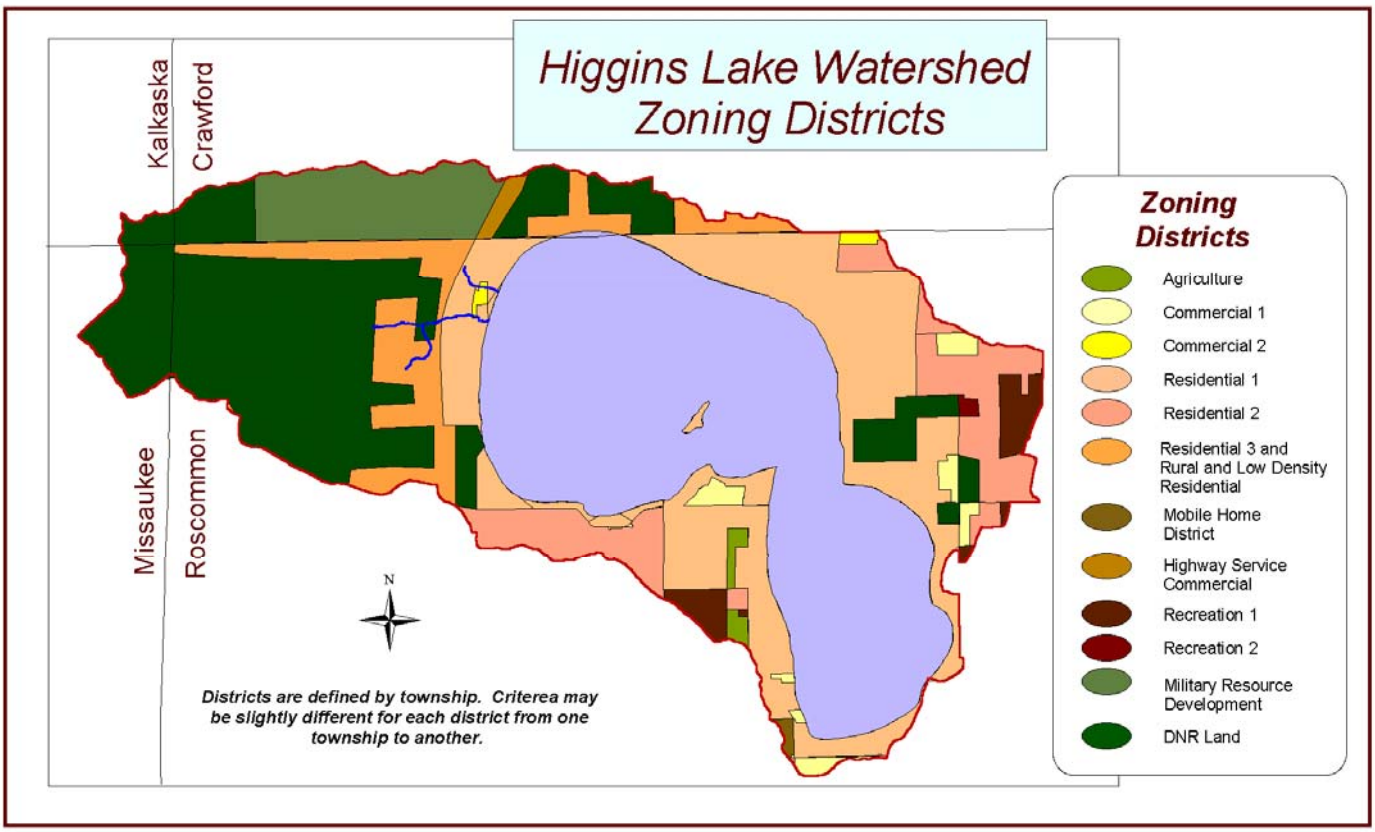


Figure 12: Higgins Lake Watershed General Zoning Districts

D. Build Out Analysis of the Higgins Lake Watershed

Local governments often use a build out analysis to test existing regulations and to estimate what the future might bring when all land is developed to the maximum extent allowed. A build out analysis can help jurisdictions see the future although the time frame for the future may be guesswork. A build out analysis helps to evaluate possible future development patterns.

The goals of a build out analysis is to estimate how much development potential a region has, given existing land use laws and regulations. A build out analysis will show where growth can occur on undeveloped land as well as on developed land that may not be developed to its fullest potential.

Within the Higgins Lake Watershed there are 18,533 acres of land. The zoning classifications for the Higgins Lake Watershed area include 9,882 acres for potential commercial and residential development (See Figure 13 and Table 13).

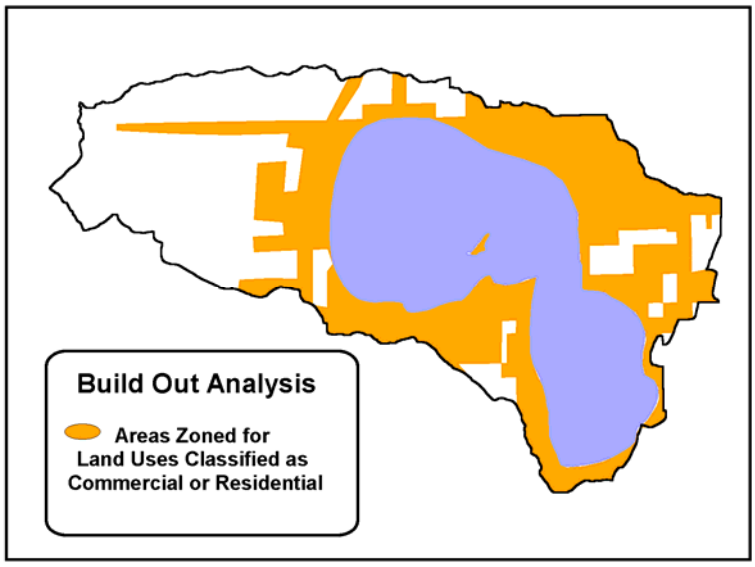


Figure 13:
Higgins Lake Watershed Build Out Analysis

Table 13: Higgins Lake Watershed Build Out Analysis

Land Use Classification	Year		
	1998	Future	% of Change
Commercial/Residential	3,629 (13%)	9,882 (34%)	+21%
Surface Water	10,198 (36%)	10,198 (36%)	0%
Wetland	690 (2%)	0 (0%)	-2%
Agricultural Land	53 (<1%)	117 (<1%)	0%
Rangeland/Barren	384 (1%)	0 (0%)	-1%
Forest Land (Includes military, recreation, and state land zoning classes)	13,777 (48%)	8,534 (30%)	-18%

This represents a trend for the Higgins Lake Watershed that indicates residential and commercial growth comes at the price of forest reduction. With increases in population in the Higgins Lake Watershed region, the need for structured land use planning and protection becomes evident.

E. Future Land Use

A future land use plan sets forth the desired pattern of land uses in the community for the next 20-30 years. It shows where agricultural and forest land should be retained and where new residences, commercial and industrial areas should be constructed. It creates the basis for planning for new roads, sewer and water infrastructure to meet the needs of the land uses displayed on the map. Future land use can work with natural landscape, or against it. Communities can plan to keep development out of floodplains and densities low along waterbodies. They can plan to preserve greenbelts for wildlife and vegetation along waterbodies to help filter stormwater runoff and provided space for trees to shade streams, keeping them cold enough for sportfish like trout. By planning with nature, they can preserve the characteristics that immeasurably add to our quality of life.

Following is a list of key strategies that communities can follow in the development of local future land use plans to help protect the environment and natural resources for use and enjoyment by both present and future generations.

- Prepare local future land use plans based on a comprehensive inventory of natural resources.
- Coordinate planning with adjoining jurisdictions.
- Keep density and intensity of land low near and along watercourses.
- Avoid developing in sensitive areas like floodplains, wetlands, environmental areas, and high risk erosion areas.
- Plan for greenbelts and buffers along watercourses.
- Provide for links between natural areas so wildlife have safe corridors to move within.
- Protect renewable natural resources like farm and forest land in large blocks.
- Set forth the specific zoning and other land use regulations that should be adopted to promote wise natural resource management and environmental protection.

The future land use plan provides the legal foundation for local land use regulations. If the community wishes to protect natural resources and the environment through local land use regulations, then it must have a basis for these regulations in the future land use plan and then adopt zoning and related regulations consistent with the plan (Ardizone & Wyckoff, 2003).

F. Impervious Surface

Impervious surfaces are mainly constructed surfaces – rooftops, sidewalks, roads, and parking lots – covered by impenetrable materials such as asphalt, concrete, brick and stone. These materials seal surfaces, repel water and prevent precipitation and melt water from infiltrating soils. Soils compacted by urban development are also highly impervious.

Impervious surfaces allow nonpoint source pollutants to accumulate upon them. Many of these pollutants are subsequently washed into water bodies by stormwater runoff, severely degrading water quality. Water quality problems increase with increased imperviousness and intensity of land use.

The environmental effects of impervious surfaces are varied and interconnected. These include impacts upon:

- Water Quality
- Water Quantity
- Habitat Degradation, Loss, and Fragmentation
- Water and Landscape Aesthetics

The Higgins Lake Watershed currently has a low percentage of impervious surfaces. Based on land use classification an estimated 0.3% of the watershed consists of impervious surfaces (see Table 14). However, utilizing the future land use predictions derived from the build out analysis of the Higgins Lake Watershed an estimated 7% (see Table 15) of the watershed could consist of impervious surfaces based on local zoning regulations.

Table 14: Higgins Lake Watershed
Impervious Surface Area Based on Current Land Use

Land Use	Acreage	*Calculation Factor	Impervious Area (Acres)	Percentage of Impervious Surface
Residential	3,556	15.4%	548	1.9
Commercial	73	72.2%	53	0.2
Barren/Open Land	384	1.9%	7	0.0
Agriculture	53	1.9%	1	0.0
Forest	13,777	1.9%	262	0.9
Wetland	690	0	0	0.0
Surface Water	10,198	0	0	0.0
Total	**28,731**		**871**	**0.3%**

*Indicates percentage of imperviousness based on land use (Cappiella & Brown, 2001)

Table 15: Higgins Lake Watershed
Impervious Surface Area Based on Future Land Use

Land Use	Acreage	*Calculation Factor	Impervious Area (Acres)	Percentage of Impervious Surface
Residential	9,315	15.4%	1,435	5.0
Commercial	567	72.2%	409	1.4
Barren/Open Land	0	1.9%	0	0.0
Agriculture	117	1.9%	2	0.0
Forest	8,534	1.9%	162	0.6
Wetland	0	0	0	0.0
Surface Water	10,198	0	0	0.0
Total	**28,731**		**2,006**	**7.0%**

*Indicates percentage of imperviousness based on land use (Cappiella & Brown, 2001)

IX. NONPOINT SOURCE POLLUTANT INVENTORIES

Higgins Lake is a high-quality, oligotrophic lake with a shoreline that is nearly all developed. On such a water body, research has shown that excessive nutrients, often attributable to the activities of homeowners, are a major pollutant. While nutrients are essential for life, excessive amounts can lead to accelerated eutrophication (premature aging) of the lake. Inventories of sites where nutrient enrichment is occurring make for a useful watershed management tool, although data generated by these inventories must be carefully interpreted and is intended only to help guide watershed management efforts.

Nonpoint source pollution is the primary threat facing the water resources of the Higgins Lake Watershed. An extensive nonpoint source inventory was conducted for the critical area within the watershed. This inventory includes an assessment of shoreline pollution, road/stream crossing impacts, road end erosion, septic systems, wells and contaminates, and Eurasian watermilfoil. The purpose of the nonpoint source management plan is to inventory pollution sources, determine the priority area of concern and develop management recommendations that can be implemented to enhance and protect the water resources of the Higgins Lake Watershed.

A. Shoreline Inventory

Because the riparian zone plays such an important role in water quality, an inventory of the shoreline can serve as a useful tool for understanding current and future water quality problems. While the owner of a small lakefront lot may feel insignificant in terms of the impact they may have, shoreline stewardship practices, one small parcel at a time, cumulatively equal a shoreline that will ultimately either help or hurt water resources.

This critical area can either be developed in such a way that it is in a near-natural state (working to filter nutrients, provide habitat and stabilize the shoreline) or be artificial (seawall with mowed, heavily fertilized grass to water's edge). While most parcels may fall somewhere in between, developed parcels generally have shorelines that resemble the second option. Loss of natural habitat and excess nutrients work together to drastically change the natural condition of the lake, and, while nearly everyone wants to improve water resources, few take the relatively easy steps to do so.

As part of the critical area inventory for the Higgins Lake Watershed Plan an inventory of the shoreline of Higgins Lake was conducted. The inventory began in September 2001 and was completed in July 2002. Through the collection of data on all parcels of property along the shore, and the subsequent sharing of information with property owners, improved shoreline stewardship practices are more likely to be implemented.

1. Methods

The shoreline inventory was conducted on a parcel by parcel basis. Shoreline property parcels included developed and undeveloped lots, access sites, road ends, etc. Parcel numbers were assigned to each shoreline property parcel identified (See Figure 14). Some of the categories of information collected for each shoreline property parcel included: substrate of parcel, aquatic plants observed in the nearshore area, turf management, erosion, structural setback, wetland regions, greenbelts, and cladophora. Methods for the shoreline inventory were based on similar studies conducted by the Tip of the Mitt Watershed Council. See the field data sheet in Reference A for more details regarding data collection categories.

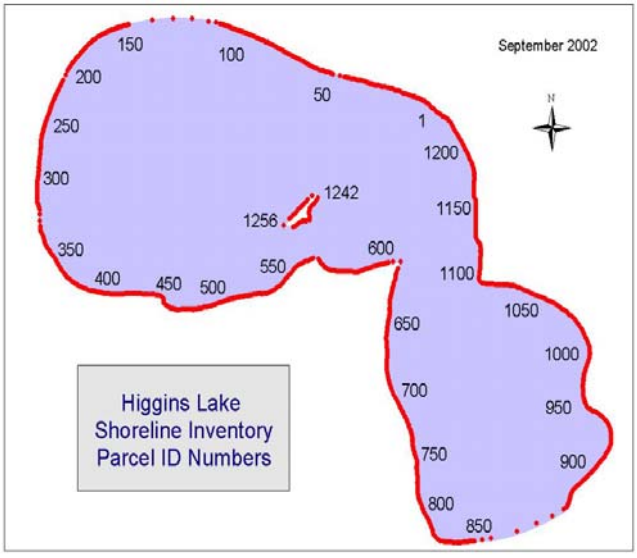


Figure 14: Shoreline Inventory Parcel Locations

In a lake such as Higgins, large growths of Cladophora can indicate areas of relatively high concentrations of nutrients. While these nutrients can originate from natural sources, the source is oftentimes attributable to such human influenced activities as excessive lawn fertilization and septic systems. The Higgins Lake substrate (mostly sand versus rock) may make Cladophora a less reliable indicator than it would be for some other oligotrophic lakes in northern Michigan but significant growths are still worth noting and can be helpful for watershed management activities. It should be emphasized that lack of Cladophora growth does not mean there is not a problem – the filamentous algae is simply an indicator that is subject to such variables as bottom substrate, wind current, wave action and time of year.

Turf management, erosion status and Cladophora presence were all given a level such as light, high, etc. versus just a yes/no status. Greenbelts (or vegetated buffer strips along the shoreline) were rated on a scale of zero to 3.0 with 3.0 being an undeveloped shoreline with no disturbance of the natural vegetation and zero being ascribed to a site entirely paved or devoid of vegetation.

While the shoreline survey does not replace the need for more detailed follow-up work at some locations, it is a good starting point and a useful management tool for future watershed protection efforts. Through a confidential follow-up with property owners and an on-site visit, practical recommendations can be offered that are often simple and relatively inexpensive. This sort of educational outreach targets an audience that can have a substantial impact on water quality. In 2002 Huron Pines utilized the information collected in the shoreline inventory to implement a shoreline stewardship project where a technician met individually with property owners to discuss ways to protect their shoreline.

2. Results

The entire shoreline of Higgins Lake was inventoried including the shoreline of Treasure Island. A total of 1265 shoreline property parcels were identified and inventoried. Listed in Table 16 below are some of the findings noted in this inventory.

By using a small watercraft, such as a kayak, the shoreline technician was able to be near enough to the shoreline to effectively collect data while also doing it in a timely manner.

Table 16: Shoreline Inventory Results

	Number	Percentage
Tributaries noted	5	
Parcels with Cladophora growth[1]	260	21%
Parcels with excellent greenbelts (2.5-3.0)	64	5%
Parcels with good greenbelts (2.0-2.4)	66	5%
Parcels with a setback distance of less than 50 feet	353	28%
Parcels with marly substrate	394	31%
Parcels with high turf management (lush, green lawn)[2]	448	35%
Parcels with a width of less than 100 feet	904	71%
Parcels with aquatic plants present[3]	311	24%

1. Breakdown of Cladophora growth:

	Number	Percent
Light growth	124	10%
Moderate growth	79	6%
High growth	57	5%
Total	**260**	**21%**

2. Breakdown of turf management status:

	Number	Percent
None	161	13%
Light	371	29%
Moderate	285	23%
High	448	35%
Total	**1265**	**100%**

3. Breakdown of aquatic plant growth:

	Number	Percent
Light	245	19%
Moderate	40	3%
Heavy	26	2%
Total	**311**	**24%**

See Reference A for more detailed results on a per parcel basis and maps indicating greenbelt status, erosion status and Cladophora status based on the Higgins Lake shoreline inventory.

B. Road/Stream Crossing Inventory

Where a road crosses a stream it provides access and a conduit for pollution. Sedimentation is an area of concern in flowing water systems as it directly affects the diverse fauna within such a system. As part of the critical area inventory for the Higgins Lake Watershed Plan an inventory of the road/stream crossing sites was conducted. The purpose of this inventory was to identify and document all the road crossing sites on the tributaries of the Higgins Lake Watershed. A total of 17 sites were located and documented during this inventory.

1. Methods

On-site field evaluations were performed to inventory each potential crossing. A Road/Stream Crossing Field Data Form (see Reference B) was completed at each site. A series of photographs were taken of each site to document existing conditions at each crossing. Each site was visited to assess potential problems that may contribute nonpoint source pollution and impact water quality. Data collected at the crossings included detailed information about the location, road characteristics (width, shoulder, drainage, surface), culvert condition, and erosion and runoff problems. Basic stream characteristics such as width, depth, current and substrate were also recorded.

At each crossing, soil erosion was evaluated in terms of existing and potential conditions; additionally, various physical measurements were made, and each site was documented with photographs. This information was compiled into a database for data evaluation. Locations of each site by township are listed in Table 17.

Table 17: Road/Stream Crossing Locations

Township	Number of Crossings
Beaver Creek	1
Gerrish	1*
Lyon	15

*Although the Gerrish Township road/stream crossing site (Cut River) lies just outside the watershed, this area was of concern to the Steering Committee and included in the inventory.

In order to help prioritize road/stream crossings for improvement, a severity ranking was given to each site. The severity ranking was determined using the scoring worksheet noted in Reference B. However, a

pretreatment site assessment will need to be conducted prior to Best Management Practice installation. See Reference B for specific site findings.

2. Results

The extent of erosion identified during the road/stream crossing inventory included one site noted to have extreme erosion, one site noted to have moderate erosion, six sites noted to have minor erosion, and nine sites noted to have no current erosion. The individual road/stream crossing site locations can be identified in Figure 15. Of the 17 road/stream crossing sites inventoried only one was noted to have extreme erosion. This site is identified as site 13 and is located on West Higgins Lake Drive where the road crosses Big Creek. Sites numbers 2, 5, 8 and 17 also warranted structural remedies due to current erosion or potential erosion factors. The remaining sites have minor or no erosion and are currently stable.

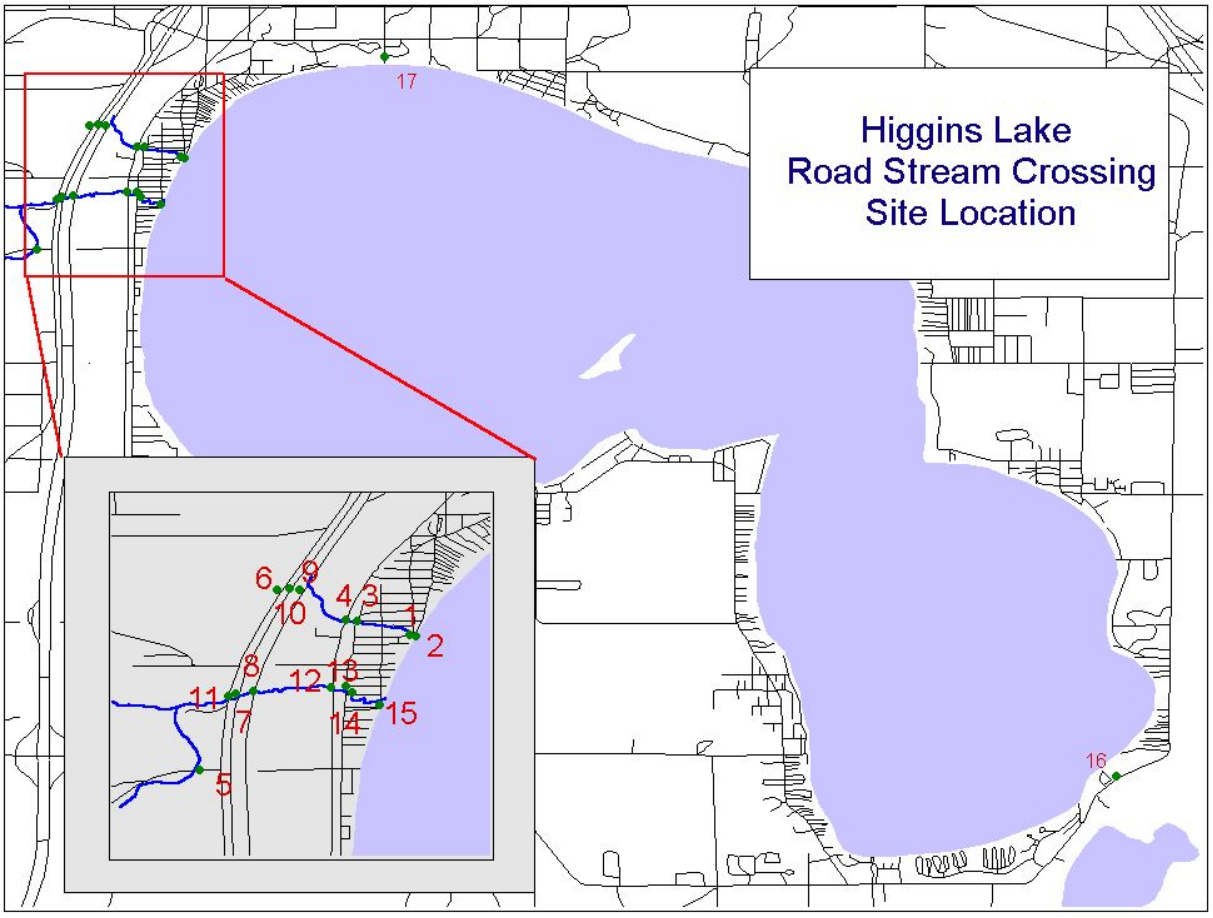


Figure 15: Road/Stream Crossing Location Sites

C. Road End Erosion Inventory

There are 78 roads that terminate at the shoreline of Higgins Lake providing a conduit for pollution and increased erosion potential (see Figure 16). Sediment loading is of particular concern at these sites due to the channeling of stormwater discharge into the lake that they provide and their potential for high recreational traffic and usage.

1. Prior Inventory

In 1991 an inventory was completed of stormwater, sedimentation and road end erosion for Higgins Lake. This inventory was sponsored by the Roscommon County Resource Conservation and

Development Committee and a comprehensive booklet was printed in 1993 with the results of that inventory. A severity rating for each site was recorded and many structural improvements were made to the most severely degraded road ends as a result of the inventory.

2. Methods

As part of the critical area inventory for the Higgins Lake Watershed Plan an update to this original inventory was completed. Only the information subject to change was recollected for each site such as characteristics of erosion problems and recommended treatments versus a comprehensive re-inventorying process.

Each road end was evaluated as to the severity of erosion or erosion potential by gathering various data at each site (See Inventory Data Collection Sheet in Reference C). Categories such as watershed information and some road characteristics were taken from the 1991 inventory records if the data was unchanged. Photos were taken at each site and compared to the site photos from the 1991 inventory to assist in estimating problem trends.

See Figure 16 below for locations of the roads ending at Higgins Lake that were identified in this inventory. For a map indicating site numbers in relationship to location please see Reference C.

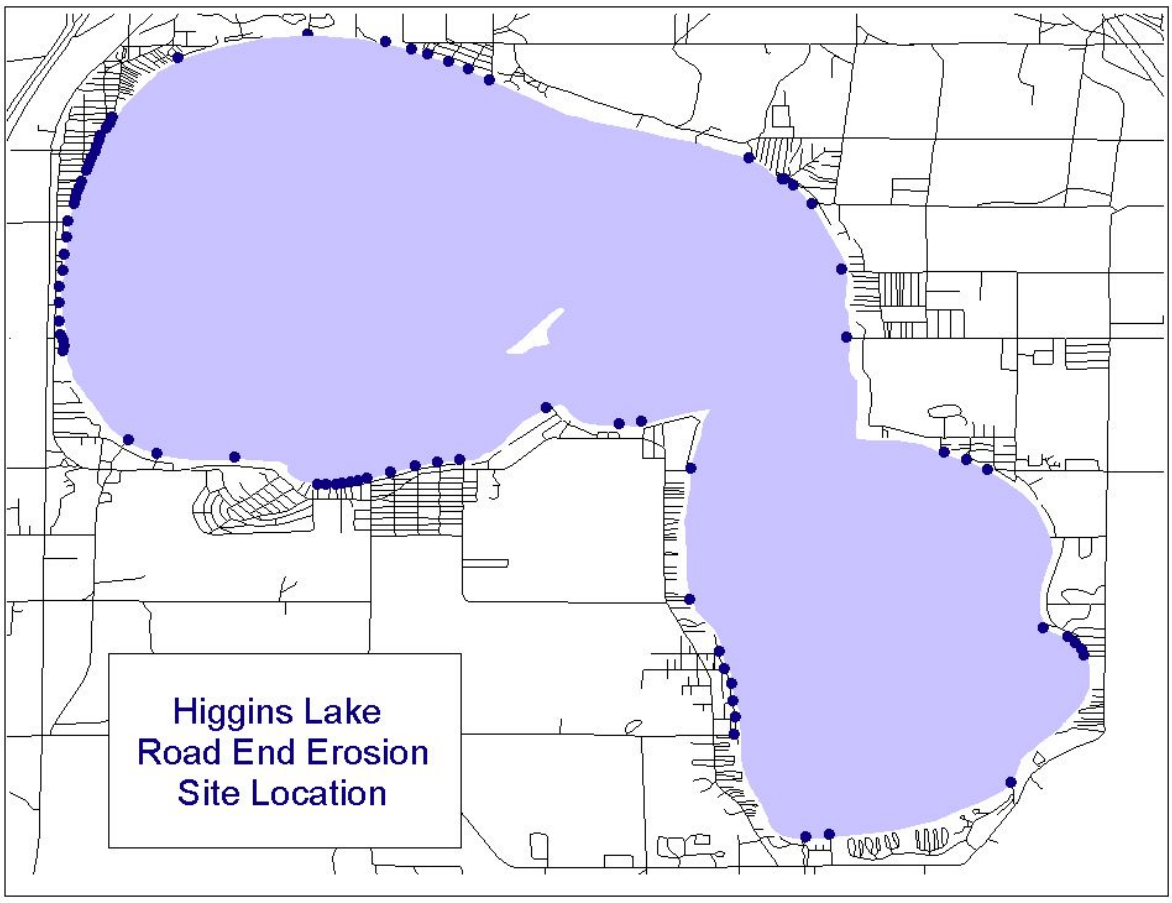


Figure 16: Road End Erosion Site Locations

Best professional judgment was used in determining the remedial measures recommended for each site. These remedial measure recommendations should not be considered the only solution to the problem at a particular road end. Alternative treatments may be equally effective in solving the erosion problem for a particular site. Treatment recommendations can be used to estimate cost; measurements and slope data will aid in design of treatment measures and consideration of alternatives. Eventual treatment will entail

returning to most sites for follow-up measurements, elevations, etc. to accommodate design preparation, material specifications and cost estimates.

3. Results

Measurements recorded during the field survey were later used in the Universal Soil Loss Equation and/or the gully erosion formula (see Reference C) to calculate annual erosion estimates. Resulting erosion rate data facilitated ranking each site as to severity. The sites have been ranked from most to least severe based upon sediment delivery. This rating system allows for scheduling of control measures whereby the most critical road ends can be treated first. Detailed inventory data for each road end site is listed in Reference C.

The ranking of the most severe road end erosion sites is as follows:

Table 18: Road End Erosion Ranking

Road Name	Township	Sediment Load (Tons) per year	Severity Ranking
Lincoln	Gerrish	20.74	1
St. Lawrence	Gerrish	16.45	2
Michigan Central Park Blvd.	Lyon	12.94	3
Cooke	Lyon	9.58	4
Muskegon	Gerrish	7.13	5
Mason	Lyon	6.26	6
Ironwood	Lyon	6.24	7
Bismark	Lyon	6.18	8
Forest Avenue	Lyon	6.06	9

D. Storm Sewers and Drains

Storm sewers and drains that discharge into a waterbody have the potential to carry nutrients and sediment with them. Higgins Lake has one major storm sewer and two major storm drains discharging directly into the lake. In 1991 an inventory of these drainageways was sponsored by the Roscommon County Resource Conservation and Development Committee. Since there have been no major changes in the status of these drainageways since the prior inventory, a re-inventory was not warranted. The information regarding the storm sewers and drains discharging to Higgins Lake was taken from the 1991 inventory results and a preliminary evaluation conducted by Christopher Johnson, area engineer.

1. County Road 202 Storm Sewer

This is an underground storm sewer serving the northern end of County Road 202, the intersection of County Road 202 and West Higgins Lake Drive, and William Street. The outlet of the sewer is on the beach just north of the intersection of Williams Street and Sam-O-Set Boulevard. The area drained by this storm sewer is partially paved and partially gravel-surfaced and is rather densely developed (both residential and commercial).

Nutrients (nitrogen and phosphorus), sediment, trace amounts of oils, street litter, and chlorides from road salting are contributed to the lake during storm and snowmelt events. This drain normally flows only during storm and snowmelt events. The turbid discharges that occur during these events are objectionable to local residents based on comments made to MDEQ.

All runoff from the road is directed toward the shoreline, due to an inverted crown, where it flows to storm drains and down a pipe approximately 3000 feet to Higgins Lake. While solving the erosion problem, this method directs sand, salts and oils off the road directly into the lake. Following an

engineering survey and analysis, it may be possible to cut into the storm drain and divert the water to constructed basins and allow the runoff to infiltrate. The last 600 feet down to the lake poses a particular problem due to the concentration of houses and the difficulty in placing a basin off the side of the road. A possible location could be next to the lake on the shoreline. Inlets with infiltration tiles could also be used to increase both capacity and infiltration rates. Detailed engineering surveys and calculations, as well as land rights and property surveys, will be required to determine the feasibility of these alternatives. Other alternatives may become apparent with more information.

2. Battin Drain

This is an open ditch storm drain except for short sections in Old Point Comfort Marine property, under West Higgins Lake Drive, and approximately the last 300 feet between Magnolia Avenue and Higgins Lake. These sections consist of underground culverts. The outlet is a 24-inch concrete pipe exiting through a concrete seawall. The drain flows most of the year except winter.

There is some nutrient contribution to the lake from this drain. Leaves and other litter may be flushed down this drain and into the lake during heavy flows. The main problem is aesthetics, local residents find its tannin (tea)-colored water objectionable. The tannin color is due to the vegetation in Battin Swamp, which is where a major portion of the flow originates.

The Battin Drain appears to be the only outlet of a 200-acre swamp. Tannin-colored water with considerable suspended solids flows steadily thorough the outlet. The marina is located directly over the outlet (the pipe runs through the staging area between the main buildings). The potential of an accident and point source pollution is high. Soaps, antifreeze, gasoline and oils all have the potential of being spilled and could enter Higgins Lake within minutes, before action could be taken. A heavy-duty concrete pipe should be installed to replace the existing, damaged corrugated metal pipe. Fill could then be placed over the pipe for protection. All runoff from the marina should then be diverted to constructed basins for infiltration. The high water table could pose a construction problem. An in-depth inventory and evaluation of the site is required to determine the feasibility of these alternatives.

A berm could be placed along the north edge of the swamp to meter the water into the pipe. Slowing the flow will allow settling and infiltration of the suspended solids. The pipe could be extended beyond the marina directly to the lake. This would prevent leaves and trash from being flushed into the lake. Detailed engineering surveys and calculations, as well as land rights property surveys are required to determine the feasibility of these alternatives. Also, other alternatives may become apparent with more information.

3. Kennedy Drain

This is an open ditch storm drain except for approximately the last 200 feet, which consists of an underground 18-inch corrugated pipe. The outlet is at the top edge of the beach on Higgins Lake between two residences. The area drained by this ditch is manly wooded and very lightly developed.

Nutrients (nitrogen and phosphorus) and suspended solids are contributed to the lake when the drain flows. This drain only flows during heavy snowmelt and heavy rain events. Due to the nature of the drainage area, the water is a tannin color, which local residents find objectionable.

The Kennedy Drain drains from approximately ¼ mile east of County Road 100, through a culvert and wooded wetland and across private property into Higgins Lake. It may be possible to either fill the drain or eliminate the culvert. Possible alternatives west of the road may include infiltration basins. A detailed engineering survey is needed to determine drainage characteristics of the drain. A detailed property rights survey will also be required. Preliminary calculations estimate that a 330 ft. x 150 ft. x 5 ft. basin is needed to contain a 25-year storm event. Note that this is an estimate and that a detailed investigation and site evaluation will be required for final design. Other alternatives may become apparent with more information.

E. Septic Systems

The Central Michigan District Health Department covers the Roscommon County portion of the Higgins Lake Watershed while the District Health Department #10 has jurisdiction over Crawford County, Kalkaska County, and Missaukee County. The vast majority of the critical area of the watershed falls within Roscommon County so the information regarding septic systems was gathered from the Central Michigan District Health Department only.

The health department began the inspection of and permitting process for new septic systems in 1971. Prior to that time the local townships conducted this process. Over the years, the individual townships yielded their permitting powers to the health department. When these duties were transferred from the townships to the health department, all prior records were also transferred. However, site plans were not always available or were sometimes incomplete for each septic system. The health department is the permitting agency for new residential septic systems as well as new septic systems for small commercial operations. Large commercial operations are permitted through the Department of Environmental Quality. As part of the health department's permitting process a site plan indicating the location of the septic system and drain field is completed and these records are maintained. Site plans are also completed when the health department evaluates a current system. Evaluations are done upon the request of the property owner or when the local township requires it due to addition or remodeling projects. There is no evaluation requirement of existing systems mandated by the Central Michigan District Health Department.

When a new septic system is requested the Health Department evaluates the site to ensure 50-foot isolation distances are maintained from water wells, suction lines, lakes and streams. If this isolation distance cannot be met at a particular location, a dry well may be indicated to reduce the amount of space needed for the system. If the placement of a dry well still does not meet the isolation distance requirements, then a holding tank is allowed. Holding tanks are often the only possibility for homeowners in the American Legion grounds area at the northwestern shore of Higgins Lake. Holding tanks must be pumped at regular intervals. They have a built-in alarm that sounds when the tank reaches ¾ capacity. If the alarm sounds the tank must be pumped.

If a site does not meet the drainage requirements mandated by the health department then an elevated "mound" drain system may be required. These mounds systems must still meet all isolation distance requirements. Alternative systems such as "sand filter" systems are also available to the property owner. However, the significant cost and additional maintenance of alternative systems has impeded the placement of these systems to date.

The Higgins Lake Advisory Committee is currently working with the townships and county commissioners to develop a program to inspect septic systems at the point of property transfer. This type of program is followed in many other counties throughout Michigan and the nation and has proven to be quite effective. The proposed program recommends that all septic systems within 500 feet of the Higgins lakeshore be required to be inspected at the point of sale or within a 10-year period, whichever occurs first. It also recommends pumping records to be secured, reviewed and maintained for systems within this area (see Appendix D for an example pumping log). Site plans indicating the location of systems and drain fields would also be documented during the inspection and kept on file for future reference.

F. Wells and Contaminates

The locations of oil and gas wells, injection wells and dry holes were received from the Department of Natural Resources. Additionally, location sites of hydrocarbon production and groundwater contaminates were also received. Activity of pumping at well locations varies. Merit Energy Company in Morristown, Michigan currently controls the active wells in this region. See Figure 17 for a map of these sites.

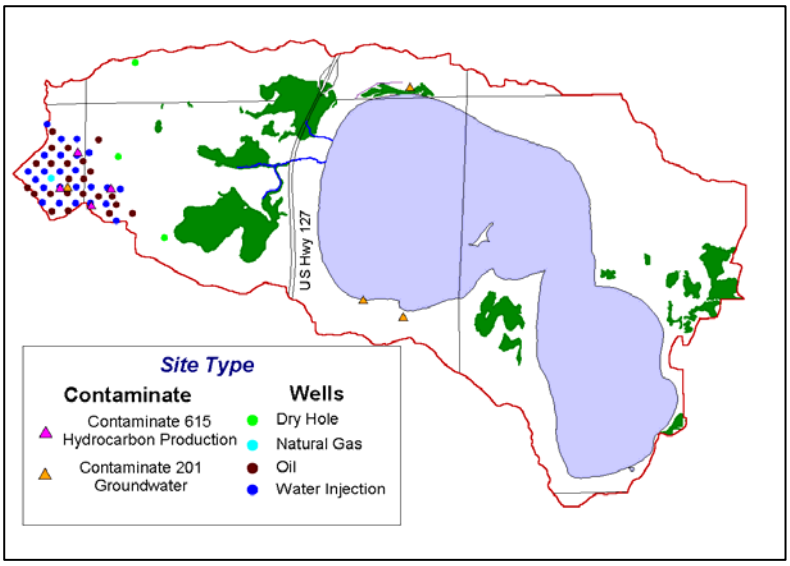


Figure 17: Higgins Lake Watershed Well and Contaminate Sites, 1995-1998

G. Eurasian Watermilfoil Survey

Eurasian watermilfoil (*Myriophyllum spicatum*) is an invasive exotic species with the potential to disrupt a lake's ecological system and interfere with recreation. It is generally thought to have first entered lakes in North America in the 1940s. Eurasian watermilfoil is a concern because it can rapidly colonize lakes and spreads easily by fragmentation. This plant can grow up to the surface of the water and form extremely dense mats, inhibiting boating and swimming. Once established, it is very difficult to remove and can be spread from lake to lake by boat traffic.

In late June/early July of 2002, Huron Pines staff conducted an inventory of Eurasian watermilfoil in Higgins Lake. The study (see Reference D) was conducted in order to identify areas of Eurasian watermilfoil growth in the lake and provide baseline information for analysis of future management options. Additional studies were conducted in 2003 and 2005; the following is an excerpt from the report *Eurasian Watermilfoil in Higgins Lake:Status Report for 2005.*

> *In general, we were surprised by how effective the bottom barrier treatment seemed to be working. The effectiveness is in large part due to the volunteer efforts of the SCUBA team which is handling the installation and maintenance of these structures. In addition, we saw quite a variation in the effectiveness of the chemical treatment at the three DNR Launch Sites on the lake. We were somewhat disappointed with the impact of the weevil treatment at the two test locations, although further study and more time are certainly needed to determine whether that method is a viable treatment for Higgins Lake. The integrated management approach, where specific treatments are tailored to the needs of each site within Higgins Lake, should be continued and closely monitored. Some growth may be slowly occurring along several of the drop-off areas in the lake. The open water sites which have not received treatment may also be slightly increasing in size; however, in both cases the growth was happening extremely slowly. The priority sites in Higgins Lake have recognized a net decrease in size from 2003 to 2005. This is due to the impact of the benthic barriers at a couple of locations and the effectiveness of the chemical treatment at the South State Park DNR Boat Launch.*

Higgins is an oligotrophic lake, meaning it lacks the nutrients necessary to support large communities of aquatic plants. The lake is very deep and much of the bottom is not a potential area for plant growth, due to lack of sunlight. In total, 77 distinct locations of Eurasian watermilfoil were identified within Higgins Lake. These range in size from a grouping of two or more plants to several sites with an acre or more. Eurasian watermilfoil is present on approximately 12 acres of the lake bottom. To put it into perspective, this represents about one-tenth of one percent of the lake.

Many of the small plant clusters were found along the shoreline. Some large weed beds were found between he shore and the drop-off. For the most part, however, large areas of Eurasian watermilfoil were generally in long, narrow bands along the drop-off. Three notable areas of growth in shallow water are the South Higgins Lake State Park boat basin, the North Higgins Lake State Park launch site, and the Department of Natural Resources boat launch. Plant growth in all three areas was dense and numerous floating plant fragments were found near these areas.

Eurasian watermilfoil ‘hotspots’ within Higgins Lake and recommendations for treatment can be reviewed in Reference D.

X. POLLUTANT LOADING and LOAD REDUCTION

Pollutant loading estimates focus on the top two sources of pollutants to the Higgins Lake Watershed. These two sources include sediment and nutrients. Aquatic algae and plants require nutrients to live and grow, with the two most important nutrients typically being phosphorus and nitrogen. Thus three pollutant loading categories will be addressed: phosphorus, nitrogen and sediment.

Pollutants are contributed to a waterbody in several ways. To determine pollutant loading in the Higgins Lake Watershed the following sources will be addressed:

- Stormwater Runoff
- Shoreline
- Road/Stream Crossing Erosion
- Road End Erosion
- Septic Systems
- Fertilizers
- New Construction

A. Total Watershed Runoff and Pollutant Loading Based on Land Use

An overall watershed runoff analysis was completed using the Long-Term Hydrologic Impact Assessment (L-THIA) model (www.ecn.purdue.edu/runoff). The model was designed by Purdue University with cooperation from the U.S. EPA. Based on average annual runoff, soil conditions, land use type and impervious cover, the L-THIA model estimates runoff volume and depths, and expected nonpoint source pollution loadings to water bodies. The model was also used to determine the pollutant loading if maximum development occurred according to existing zoning regulations.

To determine runoff and pollutant loading for current conditions the land use figures (circa 1998) within the critical area were used. To estimate potential future loads existing zoning ordinances within the critical area were utilized, providing estimates for maximum development based on current zoning conditions. The following tables depict estimated runoff amounts and pollutant loading for phosphorus, nitrogen and sediment for current conditions and future building conditions and include the runoff amounts expected to discharge from the storm drains.

Table 19: Average Annual Runoff Results (acre-ft*)

Land Use	Current conditions (based on existing land use)		Future runoff (maximum development based on current zoning regulations)		Percent increase of runoff
	Acres	Runoff (acre-ft)	Acres	Runoff (acre-ft)	
Residential	3,556	635	9,315	1,662	162%
Commercial	73	40	567	306	665%
Agriculture	53	3	117	7	133%
Grass/pasture	384	3	0	0	-100%
Forest	13,777	34	8,534	21	-38%
Wetlands	690	0	0	0	0%
Water	10,198	0	10,198	0	0%
Total acres	**28,731**		**28,731**		
Total annual volume		**715**		**1,996**	179%

*Acre-feet=volume of water necessary to cover one acre to a depth of one foot (1 acre-ft=43,560 cu ft)

Tables 20 and 21 show the estimated phosphorus and nitrogen loading on a watershed scale. This information was derived from the existing land use types and projected increase in development based on current zoning conditions. The Higgins Lake Watershed Partnership prioritized nutrient loading as the highest pollutant of concern to the watershed.

Table 20: Estimate of phosphorus (P) loading to water bodies (lbs/year)

Land Use	Current conditions (based on existing land use)		Future loading (maximum development based on current zoning regulations)		Percent increase of pollutant loading
	Acres	Runoff (lbs.)	Acres	Runoff (lbs.)	
Residential	3,556	985	9,315	2,581	162%
Commercial	73	34	567	266	682%
Agriculture	53	11	117	24	118%
Grass/pasture	384	1	0	0	-100%
Forest	13,777	1	8,534	1	-40%
Wetlands	690	0	0	0	0%
Water	10,198	0	10,198	0	0%
Total acres	**28,731**		**28,731**		
Total P annual loading (lbs)		**1,032**		**2,872**	178%

Table 21: Estimate of nitrogen (N) loading to water bodies (lbs/year)

Land Use	Current conditions (based on existing land use)		Future loading (maximum development based on current zoning regulations)		Percent increase of pollutant loading
	Acres	Runoff (lbs.)	Acres	Runoff (lbs.)	
Residential	3,556	3,146	9315	8,242	162%
Commercial	73	143	567	1,115	680%
Agriculture	53	37	117	82	122%
Grass/pasture	384	5	0	0	-100%
Forest	13,777	65	8534	40	-38%
Wetlands	690	0	0	0	0%
Water	10,198	0	10198	0	0%
Total acres	**28,731**		**28,731**		
Total N annual loading (lbs)		**3,396**		**9,479**	**179%**

Sediment was identified as the second highest pollutant of concern for the Higgins Lake Watershed. Table 22 depicts sediment loading on a watershed scale based on existing land use and potential future development. Common sources of sediment include road/stream erosion, access sites/road ends, construction, stormwater runoff and shoreline erosion.

Table 22: Estimate of sediment loading to water bodies (lbs/year)					
Land Use	Current conditions (based on existing land use)		Future loading (maximum development based on current zoning regulations)		Percent increase of pollutant loading
	Acres	Runoff (lbs.)	Acres	Runoff (lbs.)	
Residential	3,556	70,888	9,315	185,692	162%
Commercial	73	5,946	567	46,185	677%
Agriculture	53	910	117	2010	121%
Grass/pasture	384	7	0	0	-100%
Forest	13,777	93	8,534	57	-39%
Wetlands	690	0	0	0	0%
Water	10,198	0	10,198	0	0%
Total acres	**28,731**		**28,731**		
Total annual loading (lbs)		**77,844**		**233,944**	**201%**

B. Shoreline Erosion

A shoreline erosion inventory was completed in 2002 and identified parcels around the lake exhibiting erosion. Of the 1265 parcels inventoried, 25 had heavy erosion, 111 exhibited moderate erosion and 272 parcels had light erosion problems. The majority of erosion sites were caused by excessive use, failing seawalls, removal of vegetation and wave action.

The channel erosion equation or CEE (MDEQ, 1999) was utilized to estimate the amount of sediment entering Higgins Lake from the heavy and moderate erosion sites.

CEE=Length (ft) * Height (ft) * Lateral Recession Rate (ft/yr) * Soil Weight

The amount of phosphorus and nitrogen attached to the sediment is calculated using information collected by USDA-ARS researchers. The estimate starts with an overall phosphorus concentration of 0.0005 pounds of phosphorus per pound of soil and a nitrogen concentration of 0.001 pounds of nitrogen per pound of soil. Then a general soil texture is determined, and a correction factor is used to better estimate nutrient holding capacity of the soil (MDEQ, 1999). Sand is the dominant soil texture for the Higgins Lake Watershed, thus a correction factor of 0.85 was utilized.

Table 23: Shoreline Erosion Pollutant Loading			
Erosion Status	**Sediment (tons/year)**	**Phosphorus (lb/yr)**	**Nitrogen (lb/yr)**
Heavy (25 sites)	55	47	93
Moderate (111 sites)	39	33	65
Total	**94**	**80**	**158**

In the original 2002 shoreline inventory site specific information was not collected at each erosion site. Prior to implementation of specific shoreline Best Management Practices, each site should be visited by a technician to develop the most appropriate erosion control plan. According to the shoreline inventory we know many of the erosion sites were created by access, lack of shoreline vegetation and dilapidated seawalls.

Load reduction estimates for shoreline erosion contributing sediment were based on the severity of the erosion sites. A value of .75 was used in the Load Reduction Spreadsheet (MDEQ, 1999) for the BMP efficiency. Vegetative buffers remove 75% of sediment and resemble the suggested BMP for controlling shoreline erosion.

In addition, construction of steps, toe stabilization and, in some cases, removal or reconstruction of a seawall may also take place. Costs associated with the treatment of each site are estimated at approximately $2,800 for the moderate sites, which includes planting native vegetation and installing minor shoreline stabilization BMP's. The heavily eroded sites will require higher costs and include BMP's such as revegetation, installation of bio-logs or rock, creation of stairs and seawall removal or reconstruction. An average heavily eroded site will cost approximately $7,500. It is important to remember each site will need to be evaluated by a qualified technician prior to actual BMP recommendations and cost evaluation.

Table 24: Shoreline Erosion Pollutant Load Reductions

Erosion Status	Sediment (tons/year) reduced	Phosphorus (lb/yr) reduced	Nitrogen (lb/yr) reduced	Cost
Heavy (25 sites)	41	35	70	$187,500
Moderate (111 sites)	29	24	49	$310,800
Total Reduction	**70**	**59**	**119**	**$498,300**

C. Road/Stream Crossing Erosion

In 2002, a road/stream crossing erosion inventory was completed for the 17 sites located on the tributaries of the Higgins Lake Watershed. When a road crosses a stream it provides access and a direct conduit for pollution. Erosion at road/stream crossings causes sediment loading into tributaries, eventually ending in the lake. In addition, nutrients attach themselves to sediment and are deposited into a waterbody through erosion. The road/stream crossing erosion inventory for Higgins Lake estimated a total of 33 tons of sediment is delivered to Higgins Lake annually through erosion at these sites. This amount was derived utilizing the universal soil loss equation for each road/stream crossing site. See Reference B for more information.

The amount of phosphorus and nitrogen attached to the sediment is calculated using information collected by USDA-ARS researchers. The estimate starts with an overall phosphorus concentration of 0.0005 pounds of phosphorus per pound of soil and a nitrogen concentration of 0.001 pounds of nitrogen per pound of soil. Then a general soil texture is determined, and a correction factor is used to better estimate nutrient holding capacity of the soil (MDEQ, 1999). Sand is the dominant soil texture for the Higgins Lake Watershed, thus a correction factor of 0.85 was utilized.

Road/stream erosion phosphorus loading calculation:

33 tons/yr * 0.0005 lb P/lb soil * 2000 lb/ton * 0.85 = 28 lb/yr

Road/stream erosion nitrogen loading calculation:

33 tons/yr * 0.001 lb N/lb soil * 2000 lb/ton * 0.85 = 56 lb/yr

Load reduction estimates were determined based on individual BMP's installed at each site. A total value of 88% reduction was used for BMP efficiency. This value was determined by combining revegetation (75% efficiency) with a combination of road surface BMP's including hardening approaches and installing diversion outlets (88% efficiency). By installing BMP's on 4 of the 17 sites (25% of sites) we estimate an overall load reduction of 65% resulting in the most load reduction for the cost.

Table 25: Road/Stream Crossing Pollutant Reductions										
Site Information		**Pollutant Loading**			**Best Management Practice**			**Pollutant Load Reduction**		
Site ID	**Road Name / Stream Name**	**TSS (tons)**	**TP (lbs)**	**TN (lbs)**	**Suggested BMP**		**Cost**	**TSS (tons)**	**TP (lbs)**	**TN (lbs)**
17	King Road Unnamed Tributary	9	7	15	Diversion outlets Revegetation Pave approaches	6 .25 acre 1000’	$20,000	8	6	13
13	W. Higgins Lake Dr. Big Creek	8	7	14	Diversion outlets Revegetation Replace structure	4 .5 acre 70’x20’	$120,000	7	6	12
5	Heidmann Big Creek	5	4	8	Diversion outlets Revegetate Install culvert Pave approaches	4 .25 acre 30’x6’ 1000’	$50,000	4	4	7
11	Dead Stream Road Big Creek	2	2	4	Diversion outlet Revegetate	2 .25 acre	$6,000	1.75	1.75	3.5
Totals		**24**	**20**	**41**	**Diversion outlets Revegetation Pave approaches Replace culvert**	**16 1.25 acre 2000’ 2**	**$196,000**	**20.75**	**17.75**	**35.50**

D. Road End Erosion

A road end erosion inventory was completed in 2002 for the 78 roads that terminate at the shoreline of Higgins Lake. Erosion is of particular concern at these sites due to their potential for high recreational traffic and usage. Erosion at road ends causes sediment and nutrient loading in the lake.

The road end erosion inventory for Higgins Lake estimated a total of 123 tons of sediment is delivered to Higgins Lake annually through erosion at these sites. This amount was derived utilizing the universal soil loss equation for each road end site. See Reference C for more information.

The amount of phosphorus and nitrogen attached to the sediment is calculated using information collected by USDA-ARS researchers. The estimate starts with an overall phosphorus concentration of 0.0005 pounds of phosphorus per pound of soil and a nitrogen concentration of 0.001 pounds of nitrogen per pound of soil. Then a general soil texture is determined, and a correction factor is used to better estimate nutrient holding capacity of the soil (MDEQ, 1999). Sand is the dominant soil texture for the Higgins Lake Watershed, thus a correction factor of 0.85 was utilized.

Road end erosion phosphorus loading calculation:

123 tons/yr * 0.0005 lb P/lb soil * 2000 lb/ton * 0.85 = 105 lb/yr

Road end erosion nitrogen loading calculation:

123 tons/yr * 0.001 lb N/lb soil * 2000 lb/ton * 0.85 = 209 lb/yr

Load reduction estimates were determined based on individual BMP’s installed at each site and are the same as the estimates applied to road/stream BMP’s. A total value of 88% reduction was used for BMP efficiency. This value was determined by combining revegetation (75% efficiency) with a combination of road surface BMP’s including hardening approaches and installing diversion outlets (88% efficiency).

Table 26: Road End Erosion Sites											
Site Information			**Pollutant Loading**			**Best Management Practice**			**Pollutant Load Reduction**		
Severity Code	**Site ID**	**Road Name**	**TSS tons**	**TP lbs**	**TN lbs**	**Suggested BMP**		**Cost**	**TSS tons**	**TP lbs**	**TN lbs**
1	1	Lincoln	21	18	35	Access mgnt. Revegetation Road hardening Diversion outlets Sediment basin Rock chute Stairway	40' .25 acre 1880 sq ft 4 1 25 ft 25 ft	$7,500	18	16	31
2	3	St. Lawrence	17	14	28	Revegetation Diversion outlets Sediment basin	.25 acre 4 1	$6,900	15	12	25
3	55	Michigan Central Park	13	11	22	Revegetate Erosion control Stairs (2 sets) Bank sloping	1 acre 350 ft 30 ft 700 ft	$32,100	11	10	19
4	50	Cooke	10	8	16	Access mgnt. Revegetation Stairway Rock chute Erosion control	200 ft .25 acre 10 ft 50 ft 30 ft	$7,800	9	7	14
5	8	Muskegon	7	6	12	Revegetation Stairway Road hardening Diversion outlet Sediment basin	.25 acre 25 ft 3,300 sq ft 4 1	$9,100	6	5	11
6	69	Mason	6	5	11	Revegetation Rock chute	.25 acre 30 ft	$2,800	5	4	10
7	54	Ironwood	6	5	11	Access mgnt. Revegetate Erosion control	60 ft .25 acre 20 ft	$2,200	5	4	10
8	19	Bismark	6	5	10	Access mgnt. Revegetation Stairway Rock chute	40 ft .25 acre 10 ft 20 ft	$2,700	5	4	9
9	65	Forest Avenue	6	5	10	Revegetate Road hardening Rock chute	.5 acre 900 sq ft 30 ft	$4,400	5	4	9
Totals			**92**	**77**	**155**	**Access mgnt.** **Revegetation** **Stairway** **Rock chute** **Erosion control** **Road hardening** **Diversion outlets** **Sediment basin** **Bank sloping**	**340 ft** **3.25 acre** **100 ft** **155 ft** **400 ft** **6080 sq ft** **12** **3** **700 ft**	**$75,500**	**81**	**68**	**136**

E. Septic Systems

As more development occurs within rural areas that do not have centralized water management systems, the reliance for on-site wastewater treatment (septic systems) becomes greater. There is a greater demand to build vacation and retirement homes along water bodies or convert existing waterfront part-time dwellings to permanent residences. Septic systems can be very efficient at treating wastewater if they are properly sited,

installed correctly and maintained regularly. However, the cumulative impact of hundreds or thousands of individual septic systems within a watershed can lead to increased eutrophication (aging) of the lakes.

Septic systems typically consist of two components: a septic tank designed to intercept and hold partially treated solids and a drainfield that disperses wastewater to surrounding soils. Septic effluent is the substance that passes through the tank to the drainfield and eventually filters through the soils. The major water quality pollutants from septic effluent are phosphorus, nitrogen and pathogenic bacteria. The soil type will greatly affect the amount of nutrients a soil can absorb from septic tank effluents and/or lawn fertilizer. Though phosphorus has a tendency to rapidly adhere to soil particles, studies indicate that areas with sandy soils are ineffective at removing phosphorus (Michigan Water Resources Commission, 1973). In addition, once soils become saturated the ability for phosphorus and nitrogen to move to ground or surface water becomes greater.

The most common shortcoming of septic systems is their inability to remove significant amounts of nutrients. Approximately only 20% of nitrogen that passes through conventional septic systems is effectively removed, although this number may be influenced by several factors including maintenance and frequency of use (Siegrist and Janssen, 1989; Gold *et al*., 1990). Once in the drainage field, organic nitrogen is easily converted into nitrates, which are quite soluble and easily mobilized, thus increasing the potential for ground and surface water contamination (WIDILHR, 1991). Pathogenic bacteria, parasites and viruses are also found in septic effluent. Improperly treated wastewater from septic systems can contain unhealthy concentrations of bacteria and viruses harmful to many organisms, including humans.

Pollutants not removed by septic systems can migrate into groundwater by leaching through the soils. The majority of the Higgins Lake Watershed exhibits either large areas of sandy soils that may not have adequate filtering capacity before pollutants reach ground or surface water or soils with restricted permeability and are at risk for ponding. Surface water may eventually be affected as groundwater seeps into adjacent streams, lakes, rivers and wetlands. Water bodies may also be directly affected if a nearby system fails and the effluent ponds on or just below the soil surface.

It is difficult to estimate pollutant loading from septic systems. Many factors need to be considered including soil type, age, condition, use of system, and proximity of system to ground and surface water. However, numerous studies have been conducted sampling effluent from identified septic systems. The following table was documented in the *Onsite Wastewater Treatment Systems Manual* published by the US Environmental Protection Agency in 2002 depicting several septic effluent studies and their associated pollutant levels. All of the studies in Table 27 documented septic effluent from residential homes.

Table 27: Characteristics of Domestic Septic Tank Effluent

Parameter	University of Wis. (1978)	Harkin, et al. (1979)	Ronayne, et al. (1982)	Ayres Associates (1993)	Ayres Associates (1996)
# tanks sampled	7	33	8	8	1
Location	Wisconsin	Wisconsin	Oregon	Florida	Florida
# samples	150	140-215	56	36	3
BOD mg/L[a]	138	132	217	141	179
COD mg/L[b]	327	445	-	-	-
TSS mg/L[c]	49	87	146	161	59
TN mgN/L[d]	45	82	57.1	39	66
TP mgP/L[e]	13	21.8	-	11	17
Oil/grease mg/L	-	-	-	36	37
Fecal coliforms log/L	4.6	6.5	6.4	5.1-8.2	7.0

[a]Biological Oxygen Demand (BOD) is used to determine how much oxygen is being used by aerobic microorganisms in the water to decompose organic matter. If aerobic bacteria are using too much of the dissolved oxygen in the water, there may not be enough left over for other aquatic organisms.

[b]Chemical Oxygen Demand (COD) is the quantity of oxygen used in biological and non-biological oxidation of materials in water. The higher the concentration the more oxygen the discharges demand from water bodies.
[c]Total Suspended Solids (TSS) is the amount of filterable solids in a water sample.
[d]Total Nitrogen (TN) is the organically bound nitrogen and ammonia in a water sample.
[e]Total Phosphorus (TP)

Utilizing geographic information systems (GIS) and the current parcel data from the Roscommon County Equalization Department, a query of all parcels located within 1000 feet of the Higgins Lake shoreline arrived at a parce; amount of 4,328. Parcel data for Crawford County were not available, but residential area is limited within 1000 feet of the shoreline in Crawford County. Assuming only 95% of the parcels have a septic system located on them the parcel amount utilized for this calculation is 4,111. The American Legion property at the north shore of Higgins Lake is listed in the GIS parcel data as 1 parcel. There are currently 418 home sites on this parcel. Therefore an adjustment to the parcel amount utilized for this calculation is as follows:

4,111 (parcels within 1000 ft. of shoreline) + 417 (American Legion parcels) = 4,528 parcels.

For the purpose of the Higgins Lake Management Plan, the figures from the Harkin et al. study *Evaluation of Mound Systems for Purification of Septic Tank Effluent* were utilized. As documented by the resource inventory 4,528 septic systems are located with 1000 feet of Higgins Lake. For the purpose of this study estimates will be calculated for the nutrients nitrogen and phosphorus (the number one pollutant).

Table 28: Septic System Pollutant Load Estimates-Residential Conventional System

Parameter	Sample pollutant load	# of septic systems	Estimate effluent load
TN mg/L	82	4,528	371,296
TP mg/L	21.8	4,528	98,710

Note: These estimates are for 1 liter/day. In most cases septic effluent going to the drain field is much more than 1 liter/day, though specific estimates were not found.

Since model estimates represent sources potentially generated, the actual amount that ultimately reaches groundwater, well or surface water is likely to be less. If the on-site treatment facility is properly sited and maintained the surrounding soils should effectively filter much of the effluent. In addition, the opportunity for nutrient uptake is greater in large watersheds with abundant wetlands, where shoreline buffers have high nutrient removal potential, and where septic system setbacks are farther from adjacent waterbodies (e.g. 75 foot setback from water compared to 50 foot setback).

Numerous studies have been conducted researching the effectiveness of conventional septic systems and alternative on-site waste treatment from reducing pollutant loads. The following table compares effectiveness of different waste treatment practices and was provided by the U.S. EPA document *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*.

Table 29: Conventional and Selected Alternative Septic System Effectiveness

On-site wastewater disposal practice	Average Effectiveness (total system reductions)				
	TSS (%)	BOD (%)	TN (%)	TP (%)	Pathogens (logs)
Conventional Septic System	72	45	28	57	3.5
Mound System	NA	NA	44	NA	NA
Anaerobic Upflow Filter	42	62	59	NA	NA
Intermittent Sand Filter	92	92	55	80	3.2
Recirculating Sand Filter	90	92	64	80	2.9
Water Separation System	60	42	83	30	3.0
Constructed Wetlands	80	81	90	NA	4.0

* an average household of 4 occupants was assumed

The following table estimates load reductions for septic effluent in Higgins Lake for conventional septic systems, intermittent sand filters, recirculating sand filters and water separation systems. Again, these figures are based on septic tank effluent, not discharge to ground or surface water. It is important to remember that the selection of septic BMP's are site specific. In addition, existing septic systems may be effective at treating effluent.

Table 30: Septic Effluent Load Reduction

Parameter	Total septic effluent loading	Conventional Septic System		Intermittent Sand Filter		Recirculating Sand Filter		Water Separation System	
		% reduced	amount	% reduced	amount	% reduced	amount	% reduced	amount
TN mg/L	515,688	28	144,393	55	283,628	64	330,040	83	428,021
TP mg/L	229,558	57	130,848	80	183,646	80	183,646	30	68,867
		$Per system	Overall costs (millions)	$Per system	Overall costs (millions)	$Per system	Overall costs (millions)	$Per system	Overall costs (millions)
Costs		$2,700-$6,700	$12.2-$30.3	$5,360-$10,720	$24.3-$48.5	$6,000-$10,700	$27.2-$48.4	$4,000-$10,000	$18.1 $45.3

F. Fertilizer Usage

The Higgins Lake Shoreline Inventory completed in 2002 revealed the following statistic regarding turf management. Turf management was ranked from none, which indicated a natural shoreline, to high, indicating a manicured, lush, green lawn, most likely utilizing fertilizer.

Breakdown of turf management status:

	Number	Percent
None	161	13%
Light	371	29%
Moderate	285	23%
High	448	35%
Total	**1265**	**100%**

Average setback of structure from shore:

	Number	Percent
No structure	99	8%
0-25 feet	117	10%
26-50 feet	590	48%
51-75 feet	222	18%
76-100 feet	151	12%
100 feet or more	51	4%
Total	**1230**	**100%**

There were 448 shoreline properties identified as most likely utilizing fertilizer. Utilizing geographic information systems (GIS), an average lake frontage per property of 88 feet is deduced. The shoreline inventory revealed that the most common setback of structure on Higgins Lake is 26-50 feet, thus an average setback of 38 feet is assumed.

Calculation for area of lawn fertilized at the lakeshore:

$448 * 88 \text{ ft} * 38 \text{ ft} = 1{,}498{,}112 \text{ ft}^2$

Fertilizer applications to home lawns are usually based on applying approximately 1 pound of nitrogen per

1000 square feet per application (EPA, 2001). Based on the 1 lbN/1000 ft^2 application if the 28:3 (Low Phosphorus Fertilizer; 28 Nitrogen: 3 Phosphorus) fertilizer is used, there would be 1lbN and 0.05 lbP/1000 ft^2 of lawn.

Fertilizer phosphorus application calculation:
0.05 lb P * 1,498,112 ft^2/1000 ft^2 = 75 lb P/application
Assuming three applications per year 75 lb P * 3 = 225 lb P/yr

Fertilizer nitrogen application calculation:
1 lb N * 1,498,112 ft^2/1000 ft^2 = 1498 lb N/application
Assuming three applications per year 1498 lb N * 3 = 4494 lb N/yr

If a fertilizer ban was enacted by the local townships requiring residents to use a "no-phosphorus" fertilizer on their lawns it is possible to eliminate all phosphorus from this source resulting in a 225 lb P/yr reduction.

G. New Construction

New construction practices along Higgins Lake are a source of excess sediment loading and are characterized by clearing vegetation, compacting and grading soils, or filling low areas. Avoiding erosion in the first place by preserving vegetation and using proper site design is always the best choice for protecting water quality. However, in some cases it is difficult to prevent erosion; under these circumstances, erosion control practices that trap sediment before it is carried off site are used. Although many of these practices are effective for trapping coarse sediment, most fine, suspended sediment oftentimes enters the waterbody.

In addition to causing turbid conditions, fine sediment carries a significant load of nutrients and other pollutants that can harm water quality. That is why it is important to stabilize construction sites and prevent erosion as much as possible. Virtually all construction sites will affect water quality; however, proper erosion and sediment control can minimize these problems.

Though data were not obtained for the potential occurrence of new construction or redevelopment sites along Higgins Lake, based on current zoning there is the potential for a 21% increase in residential or commercial development in the watershed. It will be important to mitigate the effects of future construction, particularly along the shoreline, to protect the integrity of Higgins Lake.

H. Total Pollutant Loading and Reduction

Table 31 lists the total pollutant loading and Table 33 shows load reduction for shoreline erosion, road/stream crossings, road end erosion, septic system, and fertilizer use.

Table 31: Higgins Lake Watershed Pollutant Loading Estimates

Nutrient Source	Sediment *Tons Per Year*	Phosphorus *Lbs. Per Year*	Nitrogen *Lbs. Per Year*
Shoreline Erosion	94	80	158
Road/Stream Crossing Erosion	33	28	56
Road End Erosion	123	105	209
Septic Systems (Conventional System)	N/A	98,710	371,296
Fertilizer Usage	N/A	225	4494
Totals	**250**	**99,148**	**376,213**

Table 32: Higgins Lake Watershed Sediment and Nutrient Load Reduction Estimates				
Nutrient Source	**Sediment** *Tons Per Year*	**Phosphorus** *Lbs. Per Year*	**Nitrogen** *Lbs. Per Year*	**Cost**
Shoreline Erosion	70	59	119	$498,300
Road/Stream Crossing Erosion	21	18	36	$196,000
Road End Erosion	92	77	155	$75,500
Fertilizer Usage	N/A	225	4494	$5,000
Totals	**183**	**379**	**4804**	**$774,800**

Pollutant load reductions for septic effluent were not included in the preceding table because load reduction is highly dependent on the system of BMP's implemented (see Table 30).

XI. WATERSHED GOALS AND OBJECTIVES

The goals for the Higgins Lake 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 identified indicating the steps needed to reach the objective. Implementing most objectives requires a combination of four types of activities, each with associated tasks. These include 1) implementing Best Management Practices, 2) reviewing and modifying existing projects, programs and ordinances 3) designating and implementing education and information activities, and 4) evaluating the effectiveness of planned activities.

For each objective the Steering Committee has identified the organizations that are best suited to implement the tasks, estimated timeline for completion, estimated pollutant load reduction should this objective be achieved, estimated costs for implementation, potential funding sources and signs of success to evaluate the status of implementation efforts.

Many of the objectives, especially those related to education, will be an ongoing effort. Once the objective is achieved it may be prudent to begin the tasks again.

A. Priority Method

Prioritization of the goals for the Higgins Lake Watershed was completed by the Steering Committee. Each of the 20 Steering Committee members present for the May, 2002 meeting was given a “voting sheet” to allow them the opportunity to prioritize the goals as they deemed appropriate. The voting sheets consisted of a listing of the goals and priority stickers numbered first through fifth. Upon collection of the voting sheets each goal given the priority level of first was granted five points. Goals given the priority level of second were given four points. Goals given the priority level of third were given three points. Goals given the priority level of fourth were given two points. Goals given the priority level of fifth were given one point. The points for each goal were tallied and the goals were prioritized based on the highest number of points received.

Prioritization of the objectives was also completed by the Steering Committee in a similar manner. Each Steering Committee member present for the May, 2002 meeting was given twenty stickers that they could place next to the objectives they deemed a priority. They could use all their stickers for one objective, place one sticker on twenty different objectives or place multiple stickers on multiple objectives as they saw fit. Each sticker represented a one-point value. The objectives were prioritized based on the highest number of points received. The objectives for each goal were prioritized individually. Thus there is a first, second, third, etc. objective for each individual goal.

In 2005, these goals were reviewed and presented in greater detail. Though no formal voting process took place minor updates to the goals and objectives were made. The goals are presented in priority order, the objectives under each goal is also listed in priority order.

Under each objective are the following categories:

- Lead Organization(s) for ensuring this project is implemented: Group(s) responsible for each strategy
- Partners Involved: Other organizations whose assistance will ensure completion
- Tasks needed to execute this strategy: Sub-tasks to ensure the overall strategy is being implemented (signs of success)
- Level of Effort: Specific details related to each strategy
- Timeline: The schedule for completion of each objective or individual task
- Water Quality Benefits: Load reduction figures where applicable, other water quality or habitat benefits that can not be quantified
- Technical Assistance: Support from experts other than the lead organization needed to properly implement the strategy
- Costs: Funding needed to implement each strategy
- Funding Sources: The partners, programs, foundations and grants where funding might be sought

- Milestones: Methods to determine if the tasks are being implemented and whether they are effective at reducing nonpoint pollution
- Evaluation Methods: Methods to determine if the tasks are being implemented and whether they are effective at reducing nonpoint source pollution
- 2006 status: Review of projects completed during 2004-2006

B. Goals and Objectives

Goal 1. Reduce the amount of nutrients and contaminants from sources within the critical areas of the watershed.

Goal I: Objective 1.	Distribute material to property owners on nutrient reduction, closing of abandoned wells, Lake*A*Syst assessments, fertilizer sources, soil testing, septic system maintenance, and greenbelts.
Lead Organization:	Higgins Lake Property Owners Association
Partners Involved:	MSU Extension Service, Michigan Groundwater Stewardship Program, Natural Resources Conservation Service, Michigan Department of Environmental Quality, Health Departments, Huron Pines, Higgins Lake Foundation, Higgins Lake Civic Association, Subdivision Associations, Local Newspapers, Roscommon County Community Foundation, and Local Townships.
Tasks:	Conduct seminars for property owners. Distribute water quality information packets to homeowners. Develop a system to track new property owners and ensure they receive water quality information. Continue Conservation Corner column in local newspapers. Involve real-estate agencies in distribution process. Conduct survey to determine the existing level of awareness and perception about basic watershed issues among property owners.
Level of Effort:	Approximately 1,200 riparian property owners
Timeline:	Bi-Annually
Water Quality Benefits:	225 lbs. phosphorus reduced annually if residents stopped using phosphorus fertilizers.
Technical Assistance:	N/A
Costs:	$10,000
Funding Sources:	EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones:	One seminar completed each summer. Initial information packet mailing. Conduct one "nonpoint" mailing each summer. Establish an ongoing process for distribution of materials for new homeowners.
Evaluation Method:	Evaluate survey results for increased awareness.
2006 Status:	In 2003 a shoreline greenbelt information card was produced and distributed. In 2005 a shoreline greenbelt information brochure was produced and distributed. In 2005 a survey of Higgins Lake riparian property owners was conducted to gauge the level of awareness regarding nonpoint source pollutants and Best Management Practices for pollutant reduction. Based on the information gained from this survey an initial information packet was mailed to over 1,000 riparian property owners. This packet contained a general contact sheet and information regarding recycling, aquatic nuisance species, septic system management, shoreline greenbelts, landscape maintenance, and stormwater management. These information packets were also distributed to the local real estate agencies to give to new Higgins Lake riparian property owners. A follow-up survey occurred 2006 to document increased awareness from this education effort.
Goal I: Objective 2.	Develop sewer system/community septic systems in densely populated areas.
Lead Organization:	Lyon Township
Partners Involved:	Gerrish Township, Beaver Creek Township, and Health Departments.
Tasks:	Evaluate sites to determine need and feasibility. Conduct onsite engineering visits. Secure sources of funding. Implement program.
Level of Effort:	418 residential units at the American Legion Property.
Timeline:	1-10 years
Water Quality Benefits:	Reduction of nutrient loads between 55% and 83% depending on system installed.

Technical Assistance: Engineering services, MDEQ
Costs: $6,000,000-$11,000,000
Funding Sources: State Revolving Fund, Special Assessment, and Private Foundations.
Milestones: Implement System at American Legion property.
Identify additional areas of need.
Evaluation Method: Sewer system installed, E-Coli monitoring in nearshore area.
2006 Status: Implementation of a sewage treatment system for the American Legion Property at the North shore of Higgins Lake is underway. Approval for State Revolving Funds has been received for the project. A special tax assessment of the legion ground residents will begin in 2006. Lyon Township is working with MDNR to acquire the land for the sewage treatment facility. Engineering plans will be complete in 2006 and construction will begin in 2008.

Goal I: Objective 3. Address concerns and options related to mandate septic system maintenance, inspection, mapping, and replacement.

Lead Organization: Local Townships
Partners Involved: Health Departments, County Commissioners, Higgins Lake Property Owners Association, and Higgins Lake Civic Association.
Tasks: Receive endorsement from County Commissioners.
Develop a self-funded working system for inspection.
Level of Effort: Three townships.
Timeline: 1-3 years
Water Quality Benefits: Decreased nutrient and bacteria loading to Higgins Lake
Technical Assistance: Groundwater Stewardship Program
Costs: $5,000
Funding Sources: Local Townships, County Commission, District Health Department, and Private Foundations.
Milestones: Inspection system in place.
Evaluation Method: Document number of inspections conducted each year.
2006 Status: Proposed mandatory inspection program at state level.

Goal I: Objective 4. Arrange for a shoreline technician to meet one on one with property owners to voluntarily re-establish shoreline wetland areas and shoreline greenbelts.

Lead Organization: Huron Pines
Partners Involved: Crawford-Roscommon Conservation District, MSU Extension Service, Natural Resources Conservation Service, Kirtland Community College, and Higgins Lake Property Owners Association.
Tasks: Identify potential sites for revegetation.
One-on-one meetings with property owners and technicians.
Involve local landscapers interested in assisting.
Secure funding for staff technician.
Find sources for native plant purchasing.
Level of Effort: Fifty individual site visits annually.
Timeline: Every 3 years
Water Quality Benefits: Decreased runoff, reduced erosion, improved riparian habitat.
Technical Assistance: N/A
Costs: $45,000 ($15,000 every 3 years)
Funding Sources: EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones: Five sites reestablished with shoreline greenbelts.
Part-time technician hired.
Fifty on site visits.
Conducted survey of property owners visited for response to program.
Evaluation Method: Track number of visits and greenbelts reestablished, document load reduction at reestablished sites.
2006 Status: The Higgins Lake Shoreline Stewardship Project took place during the months of April through November, 2003. A shoreline technician was hired who completed one-on-one consultations with 31 property owners around Higgins Lake. Consultations consisted of shoreline management issues including the use of shoreline greenbelts and the use of bio-technical erosion control methods.

Goal I: Objective 5. Develop shoreline greenbelt demonstration sites.

Lead Organization: Huron Pines

Partners Involved: Crawford-Roscommon Conservation District, Master Gardeners, MSU Extension Service, Natural Resources Conservation Service, Higgins Lake Watershed Council, Local Landscapers, Higgins Lake Foundation, and Higgins Lake Property Owners Association.

Tasks: Evaluate potential locations for demonstration site.
Site evaluation to determine appropriate Best Management Practices.
Secure funding for implementation.
Find sources for native plant purchasing.
Work with local landscapers in construction.
Publicize project to promote active participation of erosion control methods.
Organize group visits to the site for local officials, homeowners, etc.

Level of Effort: Reestablish 200 linear feet of native vegetation annually.

Timeline: 5 years.

Water Quality Benefits: Decreased runoff, reduced erosion, improved riparian habitat, increase public awareness.

Technical Assistance: N/A

Costs: $40,000

Funding Sources: EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.

Milestones: Twenty demonstration sites completed.

Evaluation Method: Document sites completed, take before and after photos, calculate load reduction at each site.

2006 Status: Five Higgins Lake shoreline sites were selected for greenbelt installations that begin in spring 2006. The property owners with matching funds secured from an EPA section 319 grant will cover implementation costs. Huron Pines is administering the project, Higgins Lake Landscaping constructed the greenbelts, and the Higgins Lake Foundation will be responsible for ongoing site tours of the demonstration sites. The Foundation has also begun a program where flags will be given to riparian property owners exhibiting good stewardship practices.

Goal I: Objective 6. Coordinate with businesses and property owners on the management and disposal of hazardous waste and promote hazardous waste collection locations and times.

Lead Organization: Crawford-Roscommon Conservation District

Partners Involved: Crawford-Roscommon Conservation Districts, Local Townships, Chambers of Commerce, Michigan Groundwater Stewardship Program, Township Fire Departments, and County Commissioners.

Tasks: Conduct site visits for businesses to determine needs.
Provide information through mailings, etc. regarding collection dates.
Promote hazardous waste collection at local events.

Level of Effort: Collect 50 lbs. of hazardous waster materials annually.

Timeline: Annually

Water Quality Benefits: Reduction in hazardous materials reaching the ground and surface water.

Technical Assistance: N/A

Costs: $40,000

Funding Sources: Local Townships, County Commission, and Private Foundations.

Milestones: On site visits for businesses/industry.
One collection event completed per year.

Evaluation Method: Document number of clean up events, track amount/type of hazardous waste that was collected.

2006 Status: Household hazardous waste collection is conducted yearly in September. Advertisement of the collection date is conducted through townships and local news publications.

Goal I: Objective 7. Develop stormwater management regulations.

Lead Organization: Higgins Lake Watershed Council

Partners Involved: Road Commissions, Local Townships, Tri-Lakes Building Association, Drain Commissioners, Zoning Boards, Michigan Department of Environmental Quality, County Commissioners, and Huron Pines.

Tasks: Develop a model ordinance.
Institute Best Management Practices for stormwater runoff areas.
Improve communication with local townships on implementation of stormwater runoff Best Management Practices along with road resurfacing schedules.
Develop consistent standards of implementation of Best Management Practices.

Level of Effort: Three townships

Timeline: 1-5 years

Water Quality Benefits: If all new development treated stormwater on site it is estimated that 1,840 P lb/yr; 6,083 N lb/yr; 156,100 sediment lb/year will be prevented from entering the watershed at maximum buildout.

Technical Assistance: Land use planning expert

Costs: $20,000

Funding Sources: EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.

Milestones: Implementation of stormwater runoff Best Management Practices at problem sites.
Implementation of stormwater management ordinance.
On site treatment practices implemented.

Evaluation Method: Adoption of ordinance, conduct on site evaluations of stormwater runoff areas.

2006 Status: No progress.

Goal I: Objective 8. Replicate the United States Geological Survey's study.

Lead Organization: Higgins Lake Watershed Council

Partners Involved: United States Geological Survey, Higgins Lake Foundation, Higgins Lake Property Owners Association, and Local Townships.

Tasks: Secure sources of funding for study.
Organize volunteers to assist with monitoring efforts.
Coordinate study area and sampling activities.

Level of Effort: Lake wide survey.

Timeline: 5-10 years

Water Quality Benefits: Provide trend data to evaluate changes in Higgins Lake. Enable partners to know if BMP's are reducing pollution.

Technical Assistance: N/A

Costs: $40,000

Funding Sources: Local Townships, County Commission, and Private Foundations.

Milestones: Printing of study results.

Evaluation Method: Follow-up study was completed, compare results to use as an indicator of overall watershed improvement.

2006 Status: The Higgins Lake Watershed Council has organized volunteer water quality monitoring efforts beginning in 2005 in conjunction with the Cooperative Lakes Monitoring Program (CLMP). They met with USGS representative, Russ Minnerick, to discuss sampling techniques to ensure results would correlate with future USGS sampling. In 2006 the local townships, Huron Pines, Higgins Lake Foundation and the Higgins Lake Property Owner Association are working with USGS to develop an in-depth study of the impact of septic systems on groundwater.

Goal I: Objective 9. Implement methods to reduce the amount of road salts, sediment, debris, etc. from entering the lake.

Lead Organization: Higgins Lake Watershed Council

Partners Involved: Road Commissions, Higgins Lake Property Owners Association, and Local Townships.

Tasks: Evaluate current maintenance methods at road ends and revise if necessary.
Evaluate current salt calibration methods and revise if necessary.
Develop guidelines for instituting catch basins, sediment traps, etc. in problem areas.

Level of Effort: 78 road ends, 17 road stream crossings.

Timeline: 1-5 years

Water Quality Benefits: Decreased pollutants from road runoff

Technical Assistance: Better Backroads Guidebook

Costs: $5,000

Funding Sources: Local Townships, County Commission, Road Commission, and Private Foundations.

Milestones: Conduct awareness survey.

Evaluation Method: Document number of structural BMP's installed, survey road commission to see if they are using recommended guidelines.

2006 Status: No progress.

Goal I: Objective 10. Continue water quality monitoring activities.

Lead Organization: Higgins Lake Watershed Council

Partners Involved: Higgins Lake Foundation, and Local Townships.

Tasks: Collection of sampling data.
Submission of sampling data.

	Develop a QAPP if necessary.
Level of Effort:	Lake wide, at identified "hot spots", track phosphorus levels.
Timeline:	Annually
Water Quality Benefits:	Provides trend data used to make management decisions.
Technical Assistance:	USGS, Huron Pines
Costs:	$10,000
Funding Sources:	Local Townships, County Commission, and Private Foundations.
Milestones:	Sampling data printed and distributed regularly for analysis.
Evaluation Method:	Evaluate sampling procedures to ensure protocol is being followed. This information will also be used to track changes in the watershed.
2006 Status:	The Higgins Lake Watershed Council has organized volunteer water quality monitoring efforts beginning in 2005 in conjunction with the Cooperative Lakes Monitoring Program (CLMP).

Goal 2. Institute responsible land use practices within the watershed.

Goal II: Objective 1.	Review and comment on land use/zoning decisions.
Lead Organization:	Higgins Lake Watershed Council
Partners Involved:	Local Townships, County Soil Erosion Officers, and County Commissioners.
Tasks:	Establish a committee to monitor resource management decisions. Address items of concern in written format to agency in charge. Develop potential alternatives to improve water quality.
Level of Effort:	Three townships.
Timeline:	Annually
Water Quality Benefits:	Decreased polluted runoff
Technical Assistance:	Land use planning expert
Costs:	$5,000
Funding Sources:	Local Townships, County Commission, and Private Foundations.
Milestones:	Working committee established.
Evaluation Method:	Determine if the committee is actively addressing land use/zoning decisions.
2006 Status:	No progress.

Goal II: Objective 2.	Publicize local regulations and ensure that information on adopted standards is clear, concise, and available to the public.
Lead Organization:	Higgins Lake Property Owners Association
Partners Involved:	Higgins Lake Foundation, Local Newspapers, Local Townships, Huron Pines, and Crawford-Roscommon Conservation District.
Tasks:	Revise water quality regulation pamphlet as needed. Printing of pamphlet. Dissemination of pamphlet to property owners. Publicize changes as they occur.
Level of Effort:	Approximately 1,200 riparian property owners.
Timeline:	Bi-annually
Water Quality Benefits:	Increased understanding of local regulations leading to decreased polluted runoff
Technical Assistance:	N/A
Costs:	$5,000
Funding Sources:	Local Townships, County Commission, and Private Foundations.
Milestones:	Awareness surveys.
Evaluation Method:	Survey landowners to gauge level of awareness.
2006 Status:	No progress.

Goal II: Objective 3.	Develop and propose a model ordinance to local governmental units for an effective, consistent standard for shoreline greenbelts.
Lead Organization:	Higgins Lake Watershed Council
Partners Involved:	Local Townships, Huron Pines, and Higgins Lake Property Owners Association.
Tasks:	Develop a model ordinance. Present model ordinance to all townships and counties within the watershed.

Level of Effort: Three townships
Timeline: 1 year
Water Quality Benefits: Reduce polluted runoff , decrease shoreline erosion and provide wildlife habitat.
Technical Assistance: N/A
Costs: $5,000
Funding Sources: Local Townships, County Commission, and Private Foundations.
Milestones: Model ordinance applied at township level.
Evaluation Method: Document number of new developments with greenbelts constructed before and after the ordinance takes effect.
2006 Status: Huron Pines met with Lyon Township Planning Commission members and provided shoreline greenbelt information. As a result, Lyon Township developed a Shoreline Overlay District in their zoning ordinance that restricts removal of shoreline vegetation. Huron Pines also provided Gerrish and Lyon Township with sample ordinances to protect water quality.

Goal II: Objective 4. Coordinate master planning efforts among local units of government.

Lead Organization: County Planning Commission.
Partners Involved: Local Planning Commissions, Local Zoning Boards, and MSU Extension Service.
Tasks: Address watershed management practices within master plans for all townships.
Update and/or revise master plans for all townships.
Promote consistency for master plans for all townships.
Level of Effort: Three townships.
Timeline: Annually
Water Quality Benefits: Managing development will help decrease negative water quality impacts.
Technical Assistance: N/A
Costs: $20,000
Funding Sources: MSU Extension Service, Local Townships, County Commission, and Private Foundations.
Milestones: All master plans updated.
All townships provide input on every master plan within the watershed.
Evaluation Method: Track pre and post ordinance building and construction practices.
2006 Status: Lyon Township has updated their zoning ordinance and Gerrish Township is currently updating their plan however the final copy was unavailable at the time of this publication.

Goal II: Objective 5. Provide training for planning and zoning commissioners.

Lead Organization: MSU Extension Service
Partners Involved: Local Townships, Planning Commissions, and Michigan Association of Planning Officials.
Tasks: Coordinate training seminars for local planning and zoning personnel.
Conduct follow-up seminars regarding new planning issues.
Level of Effort: Three townships.
Timeline: Bi-Annually
Water Quality Benefits: Increase awareness about land use impacts on water quality leading to reduction in polluted runoff.
Technical Assistance: Land use planning expert.
Costs: $10,000
Funding Sources: MSU Extension Service, Local Townships, County Commission, and Private Foundations.
Milestones: Completion of "Citizen Planner" program for Roscommon County.
Establish an ongoing training program.
Evaluation Method: Pre and post survey of participants.
2006 Status: In March 2005, Huron Pines organized a free workshop regarding land use planning was conducted. Local officials from throughout the watershed were invited and over 50 people attended the workshop. The speaker was Mark A. Wyckoff, president of the Planning and Zoning Center, Inc. Topics included laws related to zoning, zoning functions and responsibilities, site plan review, lot size and shape regulations, overlay districts, master planning process, natural resources protection zoning techniques, and decision making methods.

Goal II: Objective 6. Identify and map environmentally sensitive parcels and ecological corridors throughout the watershed and track development and conservation trends in these areas.

Lead Organization: County Equalization/GIS Departments

Partners Involved:	Huron Pines, Northeast Michigan Council of Governments, and East Central Michigan Planning & Development Regional Commission.
Tasks:	Identify environmentally sensitive parcels. Utilize GIS to map these parcels. Track development in these areas. Track conservation trends in these areas.
Level of Effort:	Watershed scale (29,000 acres).
Timeline:	3-5 years
Water Quality Benefits:	Protection of sensitive lands and reduced polluted runoff.
Technical Assistance:	Huron Pines
Costs:	$20,000
Funding Sources:	Local Townships, County Commission, and Private Foundations.
Milestones:	Development of maps. Distribution of maps. Tracking process in place.
Evaluation Method:	Completion of database and track if the information is being used by land conservation organizations.
2006 Status:	No progress.

Goal II: Objective 7.	Assist landowners of environmentally sensitive parcels with the voluntary protection/easement of their property.
Lead Organization:	Headwaters Land Conservancy, Higgins Lake Foundation
Partners Involved:	Higgins Lake Watershed Council, Higgins Lake Property Owners Association, Crawford-Roscommon Conservation District, Natural Resources Conservation Service, and Huron Pines.
Tasks:	Identify environmentally sensitive parcels. Promote conservation easements. Work with property owners to secure easements.
Level of Effort:	Watershed scale (29,000 acres).
Timeline:	1-5 years
Water Quality Benefits:	Protection of sensitive lands and reduced polluted runoff.
Technical Assistance:	N/A
Costs:	$15,000
Funding Sources:	EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones:	Three conservation easements established within the watershed.
Evaluation Method:	Document number of acres, lake shore, sensitive areas protected. Calculate runoff load reductions.
2006 Status:	The Higgins Lake Property Owners Association conducted an information meeting in 2005 with Headwaters Land Conservancy and Higgins Lake Property Owners to discuss issues of land use Easements.

Goal II: Objective 8.	Produce and distribute GIS maps to local governments.
Lead Organization:	County Equalization/GIS Departments
Partners Involved:	Huron Pines, Northeast Michigan Council of Governments, and East Central Michigan Planning & Development Regional Commission.
Tasks:	Secure funding for implementation. Produce GIS maps of watershed. Distribute maps to local governments.
Level of Effort:	Watershed scale (29,000 acres).
Timeline:	3-5 years
Water Quality Benefits:	Informative tool to assist with management practices
Technical Assistance:	N/A
Costs:	$10,000
Funding Sources:	Local Townships, County Commission, and Private Foundations.
Milestones:	Development of maps. Distribution of maps.
Evaluation Method:	Use of maps and inventories in local decision making and prioritizing land protection options.
2006 Status:	Local townships received a portfolio of GIS land use information including maps and analytical data. This information was produced by the Annis Water Institute at Grand Valley State University as part of the Muskegon River Watershed land use update for 1998.

Goal 3. Protect habitat diversity within the watershed by monitoring and reducing aquatic nuisance species.

Goal III: Objective 1.	Educate the public on steps they can take to help manage aquatic nuisance species.
Lead Organization:	Higgins Lake Property Owners Association
Partners Involved:	Higgins Lake Civic Association, Huron Pines, Subdivision Associations, State Parks, Higgins Lake Foundation, and Michigan Sea Grant.
Tasks:	Obtain and/or print informational cards and/or pamphlets. Distribute information through mailings and/or on site delivery. Secure funding for implementation.
Level of Effort:	Watershed scale (23,000 summer residents, 673,000 visitors).
Timeline:	Annually
Water Quality Benefits:	Protection of aquatic habitat, fishery, and navigation by preventing the influx of invasive species.
Technical Assistance:	N/A
Costs:	$20,000
Funding Sources:	EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones:	Completion of awareness surveys.
Evaluation Method:	Survey residents and ask boaters if the information was useful.
2006 Status:	In 2002 an informational card indicating ways to prevent the spread Eurasian watermilfoil was produced and distributed. In 2005 an information card indicating ways to prevent the spread Zebra mussels and Eurasian watermilfoil was produced and distributed. In 2005 an information packet was mailed to over 1,000 riparian property owners. This packet contained a general contact sheet and information regarding recycling, aquatic nuisance species, septic system management, shoreline greenbelts, landscape maintenance, and stormwater management. These information packets were also distributed to the local real estate agencies to give to new Higgins Lake riparian property owners.
Goal III: Objective 2.	Continue Eurasian Watermilfoil management program.
Lead Organization:	Higgins Lake Property Owners Association
Partners Involved:	Higgins Lake Foundation and Huron Pines.
Tasks:	Secure funding for implementation. Conduct inspections for aquatic nuisance species at likely "hotspots" (i.e. boat launches, marinas etc.). Coordinate treatment as needed. Inform public on treatment options.
Level of Effort:	Lake basin, approximately 12 acres have EWM growth at 77 locations.
Timeline:	Annually
Water Quality Benefits:	Protects designated uses including navigation, fishery and aquatic habitat by managing the impacts of EWM on the lake's ecosystem.
Technical Assistance:	Divers, EnviroScience.
Costs:	$50,000
Funding Sources:	EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones:	Survey results received and analyzed.
Evaluation Method:	Document increase or decrease in EWM occurrence.
2006 Status:	In 2002 the Higgins Lake Property Owners Association implemented a multifaceted approach to Eurasian watermilfoil management included the use of benthic barriers, hand pulling, chemical treatment and, in 2004, the introduction of the milfoil eating weevil. The Department of Natural Resources is also treating milfoil at three MDNR owned access sites. The Higgins Lake Property Owners Association is implementing a boat wash program to reduce the spread of invasive species. Over the past 4 years there has been a slight reduction of Eurasian watermilfoil. In addition the Higgins Lake Foundation is coordinating with MDEQ to participate in the "Clean Boats, Clean Waters" Program.
Goal III: Objective 3.	Work with riparian property owners to conduct yearly monitoring programs of aquatic nuisance species as needed (i.e. Zebra Mussels).
Lead Organization:	Higgins Lake Property Owners Association
Partners Involved:	Higgins Lake Foundation.

Tasks:	Record and summarize findings. Track trends. Keep abreast of new methods of treatment.
Level of Effort:	1,200 riparian landowners
Timeline:	Annually
Water Quality Benefits:	Protection of aquatic habitat, fishery, and navigation by preventing the influx of invasive species.
Technical Assistance:	N/A
Costs:	Volunteer
Funding Sources:	No cost
Milestones:	Implementation of tracking system.
Evaluation Method:	Number of landowners monitoring invasive species, track changes over time.
2006 Status:	Eurasian watermilfoil is being monitored by volunteers.

Goal 4. Protect shoreline habitats by reducing erosion.

Goal IV: Objective 1.	Maintain legal summer and winter water levels for Higgins Lake.
Lead Organization:	Higgins Lake Watershed Council
Partners Involved:	County Commissioners and Local Townships
Tasks:	Develop standards of procedure for dam operations. Organize volunteers to assist with dam operations. Monitor lake levels consistently. Track trends in precipitation. Install rain gage within the watershed. Institute method for obtaining lake level information in a user friendly format.
Level of Effort:	Lake basin (10,198 acres).
Timeline:	Annually
Water Quality Benefits:	Reduction in erosion from fluctuating lake levels.
Technical Assistance:	Department of Natural Resources.
Costs:	$20,000
Funding Sources:	Local Townships, County Commission, and Private Foundations.
Milestones:	Consistent lake level maintenance throughout the year.
Evaluation Method:	Measure and track the lake fluctuations after standards are in place.
2006 Status:	The Higgins Lake Watershed Council works closely with the County Commissions to monitor the lake level on an on-going basis and particularly after rainstorm events.

Goal IV: Objective 2.	Implement Best Management Practices at road ends where erosion and runoff is a problem.
Lead Organization:	Huron Pines
Partners Involved:	Road Commissions, Crawford-Roscommon Conservation District, Higgins Lake Foundation, Natural Resource Conservation Service, Local Townships, Higgins Lake Civic association, Subdivision Associations, and Michigan Department of Environmental Quality.
Tasks:	Secure funding for implementation. Determine sites for implementation. Conduct analysis of sites for appropriate treatment. Develop engineering designs for approval. Install structural improvements. Develop a schedule for future maintenance of sites. Institute signage on road ends regarding safe boat launching practices.
Level of Effort:	Access management 340 feet, revegetation 3.25 acres, stairway 100 feet, rock chute 155 feet, erosion control 400 feet, road hardening 6080 square feet, diversion outlets 12, sediment basins 3, bank sloping 700 feet.
Timeline:	1-5 years
Water Quality Benefits:	Annual reduction: 81 tons of sediment, 68 lbs. phosphorus and 136 lbs. nitrogen.
Technical Assistance:	Engineering services.
Costs:	$75,500
Funding Sources:	EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones:	Best Management Practices implemented at severe road ends.
Evaluation Method:	Before and after photos, calculate BMP load reduction.

2006 Status: No progress.

Goal IV: Objective 3. Promote shoreline bio-technical erosion control methods.

Lead Organization: Huron Pines
Partners Involved: Crawford-Roscommon Conservation District, MSU Extension Service, Natural Resources Conservation Service, Kirtland Community College, Local Townships, State Parks, Department of Natural Resources, Road Commissions, Master Gardeners, Local Landscapers, and Higgins Lake Property Owners Association.
Tasks: Find a source of matching funds as an incentive.
Conduct seminars for property owners regarding methods.
Conduct workshops for local service providers.
Publicize "lake friendly" service providers.
Distribute educational materials.
Develop shoreline erosion control demonstration sites.
Encourage the use of native plants.
Level of Effort: 25 "heavy" sites and 111 "moderate" sites approximately 2,300 linear feet.
Timeline: 1-5 years
Water Quality Benefits: Annual reduction: 70 tons of sediment, 59 lbs. phosphorus and 119 lbs. nitrogen.
Technical Assistance: Engineering services.
Costs: $498,300
Funding Sources: EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones: Completion of two seminars.
Matching funds source secured.
Development of three demonstration sites.
Two workshops held with completion of attendance surveys.
Evaluation Method: Before and after photos, calculate BMP load reductions.
2006 Status: In 2002 Huron Pines conducted a free workshop for local contractors entitled "LakeScaping to Protect Water Quality". Speakers included Howard Wandell, MSU Department of Fisheries and Wildlife, Jeff Silagy, MDEQ Land and Management Division, and Doug Fuller, Tip of the Mitt Watershed Council. In 2003 Huron Pines in conjunction with the Crawford-Roscommon Conservation District and Gerrish Township implemented an erosion control demonstration project at the Gerrish Township Park on Higgins Lake. The project included reshaping the slope of the shoreline and placement of riprap and vegetation to better resist erosion at this site. In 2006 five greenbelts were planted along Higgins Lake. Interested property owners applied to be part of the program and funding for the sites were in part supplied by the MDEQ Section 319 grant, the remaining amount was provided by the property owner as match.

Goal IV: Objective 4. Update shoreline inventory as needed.

Lead Organization: Higgins Lake Property Owners Association
Partners Involved: Higgins Lake Watershed Council, Higgins Lake Foundation, and Higgins Lake Civic Association.
Tasks: Review past inventory.
Duplicate method.
Conduct inventory.
Print results.
Level of Effort: 21.8 shoreline miles.
Timeline: Every 5 years
Water Quality Benefits: Assist with monitoring and prioritizing erosion sites contributing pollution to Higgins Lake. Will serves as an evaluation tool for sites already improved.
Technical Assistance: N/A
Costs: $5,000
Funding Sources: EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones: Shoreline inventory updated.
Evaluation Method: Documentation of new erosion sites, removal of repaired sites.
2006 Status: No progress.

Goal IV: Objective 5. Educate planners and local officials on using soil survey information.

Lead Organization: Natural Resources Conservation Service

Partners Involved:	Crawford-Roscommon Conservation District and Michigan State University Extension.
Tasks:	Conduct training sessions on information and usage of soil survey manuals for local officials. Roscommon County Soil Survey manuals made available.
Level of Effort:	Three townships.
Timeline:	1-5 years
Water Quality Benefits:	Aids in making sounds land use decisions that will reduce polluted runoff.
Technical Assistance:	N/A
Costs:	$1,000
Funding Sources:	EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones:	Provide Soil Survey Manuals to local officials.
Evaluation Method:	Survey participants of workshop.
2006 Status:	Soil survey manuals are provided by the Crawford-Roscommon Conservation District.

Goal IV: Objective 6.	Implement Best Management Practices at priority road/stream crossings where erosion and runoff is a problem.
Lead Organization:	Huron Pines
Partners Involved:	Road Commissions, Higgins Lake Foundation, Crawford-Roscommon Conservation District, Local Townships, Michigan Department of Environmental Quality, and Natural Resources Conservation Service.
Tasks:	Determine sites for implementation. Conduct analysis of sites for appropriate treatment. Secure funding for implementation. Develop a schedule for future maintenance of sites.
Level of Effort:	Diversion outlets 16, revegetation 1,25 acres, harden approaches 2000 feet, replace culvert 2.
Timeline:	1-5 years
Water Quality Benefits:	Annual reduction: 21 tons of sediment, 18 lbs. phosphorus and 36 lbs. nitrogen.
Technical Assistance:	Engineering services.
Costs:	$196,000
Funding Sources:	EPA Section 319 of the Clean Water Act, Clean Michigan Initiative, and Private Foundations.
Milestones:	Best Management Practices implemented at severe road/stream crossings.
Evaluation Method:	Before and after photos, stream assessment, calculate BMP load reductions.
2006 Status:	No progress.

Goal 5. Work to ensure the availability of high-quality recreational activities within the watershed and that they are conducted in such a way so as to not degrade the integrity of the watershed.

Goal V: Objective 1.	Educate recreational users on environmentally safe methods (including education on aquatic nuisance species) for practicing recreational activities.
Lead Organization:	Crawford-Roscommon Conservation District
Partners Involved:	Michigan Department of Natural Resources, Local Marinas, Marine Patrol, Higgins Lake Foundation, Local Townships, Higgins Lake Watershed Council, and Coast Guard Auxiliary.
Tasks:	Distribute information to recreational users. Hold training sessions for recreational users. Publicize environmentally safe methods in local newspapers.
Level of Effort:	Watershed scale (23,000 summer residents, 673,000 visitors).
Timeline:	Annually
Water Quality Benefits:	Increase water awareness, foster appreciation for Higgins Lake.
Technical Assistance:	N/A
Costs:	$10,000
Funding Sources:	Private Foundations, Local Townships, County Commissioners.
Milestones:	Completion of awareness surveys.
Evaluation Method:	Survey residents and ask boaters if the information was useful, survey training session participants.
2006 Status:	In 2002 an informational card indicating ways to prevent the spread Eurasian watermilfoil was produced and distributed. In 2005 an information card indicating ways to prevent the spread Zebra mussels and Eurasian watermilfoil was produced and distributed.

Goal V: Objective 2. Identify recreation concerns and make recommendations.

Lead Organization: Roscommon County Recreation Committee
Partners Involved: MSU Extension Service, Local Townships, and Higgins Lake Watershed Council.
Tasks: Determine stewardship needs for existing parks.
Organize methods of debris disposal for recreational users (i.e. ice fisherman.)
Address appropriate snowmobile access locations for Higgins Lake.
Address personal watercraft pollution concerns for Higgins Lake.
Address restroom facility needs for recreational users.
Level of Effort: Watershed scale (29,000 acres).
Timeline: 1-2 years
Water Quality Benefits: Decreased debris and pollution from watercraft users.
Technical Assistance: N/A
Costs: $10,000
Funding Sources: Private Foundations, Local Townships, County Commissioners.
Milestones: Implementation of management practices.
Evaluation Method: Development of a Higgins Lake recreation plan.
2006 Status: No progress.

Goal V: Objective 3. Establish a boat carrying capacity standard for Higgins Lake.

Lead Organization: Higgins Lake Property Owners Association
Partners Involved: Department of Environmental Quality, MSU Extension, and Department of Natural Resources.
Tasks: Research methods for determining boat carrying capacity.
Secure funding for possible study.
Level of Effort: Lake basin (10,198 acres).
Timeline: 1-3 years
Water Quality Benefits: Decreased debris and pollution from watercraft users.
Technical Assistance: N/A
Costs: $2,000
Funding Sources: Private Foundations.
Milestones: Development of a boat carrying capacity.
Evaluation Method: Creation of a boat carrying capacity, regulation of boat volume on the lake.
2006 Status: No progress.

Goal V: Objective 4. Monitor and improve fisheries and aquatic habitat.

Lead Organization: Michigan Department of Natural Resources
Partners Involved: Local Bait Shops, Huron Pines, Higgins Lake Property Owners Association, Higgins Lake Civic Association, and Subdivision Associations.
Tasks: Habitat improvement.
Continuation of fish planting program.
Work with property owners on steps they can take to improve habitat.
Level of Effort: Continue stocking program (approximately 15,000 brown trout, 26,000 rainbow trout, 35,000 lake trout).
Timeline: Annually
Water Quality Benefits: Increase the fishery and recreation designated uses.
Technical Assistance: N/A
Costs: $50,000
Funding Sources: Michigan Department of Natural Resources.
Milestones: Productive fishery maintained.
Evaluation Method: Track angler hours annually.
2006 Status: A total of 76,937 fish stocked in Higgins Lake in 2004.

Goal 6. Facilitate continued efforts by the Higgins Lake Watershed Partnership to review and update Plan progress and coordinate funding proposals.

Goal VI: Objective 1.	Facilitate implementation of Watershed Management Plan.
Lead Organization:	Higgins Lake Watershed Partnership
Partners Involved:	Local Townships, Higgins Lake Property Owners Association, Higgins Lake Watershed Council, Higgins Lake Civic Association, Huron Pines, Crawford-Roscommon Conservation District, Michigan Department of Natural Resources, MSU Extension, Michigan Department of Environmental Quality, Higgins Lake Foundation, Road Commissions, Natural Resources Conservation Service, County Commissioners, Health Departments.
Tasks:	Find sources of funding for carrying out the objectives of the Watershed Management Plan. Conduct ongoing meeting of the Higgins Lake Watershed Partnership Steering Committee.
Level of Effort:	Higgins Lake Watershed Partnership.
Timeline:	Biannually
Water Quality Benefits:	Sustainability and evaluation of management practices.
Technical Assistance:	Huron Pines
Costs:	$20,000 per year
Funding Sources:	Department of Environmental Quality, Clean Michigan Initiative and Section 319 Programs, Higgins Lake Foundation, Roscommon County Community Foundation, Schroeder Foundation, Wege Foundation and others.
Milestones:	Commitment of the Watershed Partnership to meet regularly to discuss progress. Completion of projects listed in the Management Plan; revision of the goals and objectives as necessary.
Evaluation Method:	Document number of tasks implemented set forth in the plan, increased meeting attendance and dollars raised.
2006 Status:	Management Plan has been updated to reflect current conditions of the watershed and has met the EPA required nine elements.

C. Costs by Implementation Method

Each estimated cost was classified into the following management categories: Structural and Vegetative BMPs, Education, Land Protection, and Managerial Practices. Table 33 lists each management category, number of strategies to implement and the estimated costs.

Table 33: Costs by Implementation Method

Managerial Strategy	Implementation Cost	Number of Objectives
Structural and Vegetative BMP's	$6,814,800	6
Education	$ 301,000	14
Land Protection	$ 45,000	3
Managerial	$ 132,000	9
TOTAL for 10 years	**$7,292,800**	**32**

C. Implementation Schedule

One question of watershed management is "Are the strategies being implemented in a timely fashion?" Each objective and sub-task shows milestones and the expected years in which they will be implemented. Due to unforeseen circumstances, such as the availability of funding, increased project needs, the capacity of the lead organization to implement the project, the years may vary from the timeline. In order to evaluate the effectiveness of implementation the Higgins Lake Partnership should meet once a year to review the management plan and determine whether the objectives are being implemented in a timely manner.

In order to mitigate the pollutants degrading Higgins Lake, Best Management Practices need to be in place. BMPs can be educational, vegetative, structural or managerial. Table 34 is categorized by strategy highlighting the potential BMP, number of sites or years to completion and the estimated costs of implementation.

Table 34: Potential Systems of BMPs and Estimated Costs, by Objective

Objective	BMP or Managerial tool	Number of priority sites or # of years	Estimated cost (averaged for all the sites in a category)
1.1	*E-Distribute material to property owners on nutrient reduction	Bi-annually	$10,000
1.2	BMP-Develop sewer system in densely populated areas	Single event	$6,000,000
1.3	M-Mandate septic maintenance, inspection, replacement	4,528 systems	$5,000
1.4	E-Shoreline technician	Every 3 years	$45,000
1.5	BMP-Shoreline greenbelt demonstration sites	20 sites	$40,000
1.6	E-Promote hazardous waste collection	Annually	$40,000
1.7	M-Develop stormwater regulations	Single event	$20,000
1.8	E-Replicate USGS water quality survey	Single event	$40,000
1.9	M-Reduce amount of road salt, etc. by proper road management	Every 5 years	$5,000
1.10	E-Continue water quality monitoring activities	Annually	$10,000
2.1	M-Review and comment on land use/zoning decisions	Annually	$5,000
2.2	E-Publicize local regulations	Bi-annually	$5,000
2.3	M-Develop model shoreline greenbelt ordinance	Single event	$5,000
2.4	M-Coordinate planning efforts between townships	Annually	$20,000
2.5	E-Provide training for planning and zoning officials	Bi-annually	$10,000
2.6	LP-Identify and map sensitive parcels	Single event	$20,000
2.7	LP-Assist landowners with voluntary land protection	Annually	$15,000
2.8	LP-Produce and distribute GIS maps to local governments	Single event	$10,000
3.1	E-Manage aquatic nuisance species	Annually	$20,000
3.2	E-Continue Eurasian watermilfoil management program	Annually	$50,000
3.3	E-Nuisance species monitoring program	Annually	Volunteers
4.1	M-Maintain legal lake levels	Annually	$20,000
4.2	BMP-Implement BMPs at road ends	9 sites	$75,500
4.3	BMP-Promote shoreline bio-technical erosion control methods	136 sites	$498,300
4.4	BMP-Update shoreline inventory	Every 5 years	$5,000
4.5	E-Educate planners on using soil survey information	Single event	$1,000
4.6	BMP-Implement BMPs at road stream crossings	4 sites	$196,000
5.1	E-Educate recreational users on environmentally safe methods	Annually	$10,000
5.2	E-Identify recreation concerns	Annually	$10,000
5.3	M-Establish boat carrying capacity	Single event	$2,000
5.4	M-Monitor and improve fishery and aquatic habitat	Annually	$50,000
6.1	E-Facilitate implementation of watershed plan	Annually	$20,000

*BMP=structural or vegetative, M=Managerial, E=Educational, LP=Land Protection

Once objectives to reduce nonpoint source pollutants have been identified, funding sources must be sought to ensure implementation of the management plan and a timeline must be established. Table 35 highlights several different funding sources based on specific management practices. Funding sources include the Clean Michigan Initiative (CMI), EPA's 319 Clean Waters Program, Foundations, Local Communities and others.

Table 35: Estimate Costs, Potential Funding Source and Implementation Timeline

Objective	Estimated cost for the next 10 years	Potential sources of funding	Implementation Timeline
1.1	$10,000	Foundations, CMI, 319	Annually
1.2	$6,000,000	State Revolving Fund, Special Assessment, Foundations	10 years
1.3	$5,000	Townships, County, Health Department, Foundations	1-3 years
1.4	$45,000	Foundations, 319, CMI	Every 3 years
1.5	$40,000	Foundations, 319, CMI	5 years
1.6	$40,000	Townships, County, Foundations	Annually
1.7	$20,000	Foundations, 319, CMI	2-3 years
1.8	$40,000	Townships, County, Foundations	2-6 years
1.9	$5,000	Great Lakes Commission, Road Commission, Foundations	1-5 years
1.10	$10,000	Townships, County, Foundations	Annually
2.1	$5,000	Townships, County, Foundations	Annually
2.2	$5,000	Townships, County, Foundations	Bi-annually
2.3	$5,000	Townships, County, Foundations	1 year
2.4	$20,000	MSUE, Townships, County, Foundations	Annually
2.5	$10,000	MSUE, Townships, County, Foundations	Bi-annually
2.6	$20,000	Townships, County, Foundations	2-4 years
2.7	$15,000	Foundations, 319, CMI	Annually
2.8	$10,000	Townships, County, Foundations	3-5 years
3.1	$20,000	Foundations, 319, CMI	Annually
3.2	$50,000	Foundations, 319, CMI	Annually
3.3	Volunteers	No cost	Annually
4.1	$20,000	Townships, County, Foundations	Annually
4.2	$75,500	Foundations, 319, CMI	1-5 years
4.3	$498,300	Foundations, 319, CMI	1-5 years
4.4	$5,000	Foundations, 319, CMI	Every 5 years
4.5	$1,000	Foundations, 319, CMI	Biennial
4.6	$196,000	Foundations, 319, CMI	3-7 years
5.1	$10,000	Townships, County, Foundations	Annually
5.2	$10,000	Townships, County, Foundations	1-2 years
5.3	$2,000	Foundations	1-3 years
5.4	$50,000	Michigan Department of Natural Resources	Annually
6.1	$20,000	Foundations, 319, CMI	Bi-annual

XII. INFORMATION AND EDUCATION STRATEGY

The long-term protection of Higgins Lake's water quality will depend on the values and actions of future generations. Educating the residents and property owners of the Higgins Lake Watershed about how their actions impact water quality is a high priority. Increasing awareness and ultimately changing behaviors is a long-term strategy for protecting water quality.

An information and education (I & E) strategy is a tool that informs the public and motivates them to take action. It is a coordinated strategy tailored to both the specific water quality concerns and the people who live in the watershed.

An I & E strategy is effective because most behavioral changes that are required to minimize or eliminate pollution in the watershed will be voluntary -- rather than required by law. Before individuals will consider changing their behavior, they need to understand the concerns for the watershed and how their individual activities can help protect the quality of water in the region (Brown et al., 2000, pg. 31).

The (I & E) activities will involve a variety of approaches including installing demonstration sites, building partnerships, sponsoring seminars and distributing education materials.

A. Community Education

The identification of groups or individuals whose support or action will be needed to achieve the watershed project's goals is one of the first steps needed to develop the (I & E) strategy. Listed in Table 36 are some of the target audiences identified for specific pollutant problems along with particular messages and delivery mechanisms for each audience.

Table 36: Information and Education Strategy					
Pollutant	**Source/ Cause**	**Target Audience**	**Messages**	**Delivery Mechanism**	**Potential Evaluation**
Sediment	Shoreline erosion	Homeowners, riparian property owners	Protect your investment and water quality for children and grandchildren	Use newsletter, brochures, and a model biotechnical erosion control site to demonstrate restoration. Meet one-on-one with property owners.	Photographic and survey to homeowners with erosion
	Road/Stream crossings	Road Commissions	Protect/improve fishing; reduce sediment loading	Meet with road commissions to discuss standard designs that reduce pollution and are cost effective. Train road crews through the "Better Back Roads" program.	Photographic and interviews
	Lakeshore development-construction	Contractors, Realtors, Local Government Officials, Homeowners	Increase economic return	Sponsor contractor workshop on BMP's, work with local governments to standardize requirements. Use print media to educate riparians about the importance of setbacks. Meet one-on-one with property owners.	Focus group and evaluation forms
	Road end erosion	Road Commissions	Protect/improve fishing; Reduce sediment loading	Meet with road commissions to discuss standard designs that reduce pollution and are cost effective.	Photographic and interviews
	Stormwater	Local townships officials	Protect/improve fishing; Reduce sediment loading	Meet with local township officials to discuss stormwater management techniques.	Photographic and interviews
Nutrients	Lawn maintenance	Landscaping and lawn care companies, homeowners, riparian property owners	Marketing for lawn care companies, save money, and enhance property appearance and values	Sponsor seminars for landscaping companies to learn more about "lake friendly" property practices. Sponsor workshops for homeowners. Use print media to reach residents. Meet one-on-one with property owners.	Survey and evaluation forms
	Lack of Greenbelts	Riparian property owners	Keep the water safe for swimming, reduce aquatic plant growth	Sponsor seminars for riparian homeowners to learn more about developing a natural shoreline. Use print media to reach riparians.	Survey and evaluation forms

Table 36: Information and Education Strategy					
Pollutant	**Source/ Cause**	**Target Audience**	**Messages**	**Delivery Mechanism**	**Potential Evaluation**
	Septic systems	Riparian property owners	Keep the water safe for swimming, reduce aquatic plant growth	Meet one-on-one with property owners that may have potential septic system problems. Provide assistance to address problems. Use print media to reach riparians.	Interview and survey
	Stormwater	Local townships officials	Reduce aquatic plant growth, reduce nutrient loading	Meet with local township officials to discuss stormwater management techniques.	Photographic and interviews
Toxins	Stormwater	Homeowners	We are all lakefront property owners (via drains)	Media campaign with local newspapers, radio, and TV. Mail residents information on reducing nonpoint source pollution.	Survey
	Lawn maintenance	Homeowners, riparian property owners	Don't harm fisheries and aquatic life	Sponsor seminars for landscaping companies to learn more about "lake friendly" property practices. Sponsor workshops for homeowners. Use print media to reach residents. Meet one-on-one with property owners.	Focus group and survey
	Lack of Greenbelts	Riparian property owners	Keep the water safe for swimming	Sponsor seminars for riparian homeowners to learn more about developing a natural shoreline. Use print media to reach riparians.	Survey and evaluation forms
	Car care	Urban residents, riparian residents	Don't harm fisheries and aquatic life	Use print media to reach residents.	Survey
Pathogens	Stormwater	Pet owners	Keep the water safe for swimming	Implement media campaign about proper disposal of pet waste.	Survey
	Septic systems	Riparian property owners	Keep the water safe for swimming	Meet one-on-one with property owners that may have potential septic system problems. Provide assistance to address problems. Use print media to reach riparians.	Interview and survey

B. Recent Outreach Activities

Some of the information and education activities that have already taken place as part of the watershed planning efforts include:

1) Presentation of a *Lakeshore and Streambank Workshop* focusing on erosion control, landscaping waterfront property, local resources, laws and ordinances, nuisance control and lakeshore habitat. This workshop was designed for property owners. About 75 people attended this successful workshop.
2) Construction of a web site to inform people about watershed planning activities and to promote sound watershed management practices.
3) Development of a watershed management brochure that explains watershed management, nonpoint source pollution and addresses why watershed management is important.
4) Publication of a Conservation Corner column in the Roscommon County Herald News and the Houghton Lake Resorter to promote watershed management practices and provide education regarding a variety of environmental issues.
5) Presentation of a Lakescaping Workshop geared toward landscapers, lawn care professionals, contractors and excavators to provide information regarding lakescaping concepts and practices. About 45 people attended the workshop.
6) A guide was developed for homeowners to assist them in understanding state and local regulations for protecting water quality. The Higgins Lake Foundation printed and distributed this guide to over 3000 homeowners.
7) Bimonthly publication of the Higgins Lake Watershed Partnership newsletter entitled Ripple Effects. This newsletter focuses on current management activities taking place within the watershed.
8) Produced and distributed a brochure titled “Shoreline Greenbelts: Our Lakes’ and Streams’ Best Friends” detailing the importance of native greenbelts.
9) Conducted a riparian landowner pre and post survey to first determine the level of watershed awareness and second select appropriate literature to send. The response rate of the pre survey was 53% while the response rate of the post survey was 40%. According to the post survey, 83% of the respondents felt the educational materials were useful.
10) Direct-mailed educational packets to over 1,000 riparian landowners with discussion topics such as shoreline erosion, septic maintenance, fertilizer use and native greenbelt planting.
11) Created a “Look Before You Launch” card and “Eurasian watermilfoil” card describing the effects of invasive species to northern Michigan lakes and how to reduce the spread of species from lake to lake.
12) A Naturalization Workshop held July 29, 2005 in Roscommon County was sponsored by Huron Pines, the Roscommon County Community Foundation, and the Higgins Lake Foundation. Mr. Robert Karner, Lake Biologist from Leelenau County gave a visual presentation regarding the benefits of planting native vegetation, known as a greenbelt, along the lakeshore.
13) In 2005 the Higgins Lake Partnership and Huron Pines, with funding from the MDEQ's Section 319 Fund, sponsored a free seminar for local officials and anyone else interested in community development. Mark Wyckoff from the Planning and Zoning Center presented land use planning and zoning information with emphasis placed on preserving high-quality water resources. Some of the areas discussed were the laws related to zoning, zoning functions and responsibilities, site plan review, lot size and shape regulations, overlay districts, master planning process, natural resources protection zoning techniques and decision making methods.
14) Produced two 30-second Public Service Announcements (PSA’s) to raise awareness regarding nonpoint source pollution in Higgins Lake. The PSA’s were funded through the Section 319 Program and the Higgins Lake Foundation.
15) An educational kiosk was constructed at the South State Park boat launch. The two-sided 24” x 36” kiosk discusses the causes and effects of nonpoint source pollution and what recreational users and riparian landowners can do to protect water quality.

XIII. EVALUATION PROCESS

The true test of the efficacy of the Higgins Lake Watershed Management Plan will be the implementation of the Plan goals and objectives. Implementation of Watershed Plan goals and objectives for site specific activities will require an evaluation to determine the progress and effectiveness of the proposed activities. Because there is a large diversity of tasks, a variety of evaluation methods will be necessary.

Documenting changes with photographs will be used to evaluate the effectiveness and improvements for any components of the project that modify physical features (road/stream crossings, shoreline erosion, stormwater management improvements, recreational access sites, etc.). Pollutant reduction estimates will also be documented for structural BMP's.

Because protecting the quality of the resources is a focus of this project, information and education components are very important. A variety of techniques will be used. A written evaluation form will be used for workshops, seminars or other events where people are gathered for a specific event. For riparian homeowners, interviews and surveys will be conducted after a certain number of the objectives have been implemented to see what tools were most effective (personal visits, news articles, booklets, presentations).

Evaluating the effectiveness of programs directed towards improving land use management will require a different approach. Focus groups would be most effective in learning how helpful the ordinance, programs, materials, maps and other tools created helped with changing policy and protecting water resources. Surveys may also be used to assess the progress as the land use tasks are being implemented. Photographic evidence, particularly documenting the design of new construction, will be used to evaluate the progress of specific tasks.

It is not only important to evaluate whether the goals are being implemented but determine whether or not they are protecting the water quality of Higgins Lake. Though Higgins Lake is a high-quality resource, impacts associated with development and recreational uses are beginning to show. Many water quality studies have been completed over the past 30 years measuring the conditions of the lake. As discussed earlier phosphorus is the limiting nutrient in the lake, therefore the amount of phosphorus available determines the magnitude of growth of plants and algae. In order to determine if the recommended goals of the management plan are actually protecting Higgins Lake the levels of phosphorus over the years will be used as a watershed indicator. There are ongoing volunteer monitoring programs that will track fluctuations in phosphorus levels. It is the goal of the Watershed Partnership to ensure phosphorus levels do not increase from where they are today and ideally will decrease over the years as BMP's are implemented.

Although there have been numerous water quality studies in Higgins Lake, differences in sampling procedures and reporting make it difficult to analyze changing trends in phosphorous levels. However, previous studies conducted by MDEQ, EPA and Limno-Tech found low levels of phosphorous throughout the lake. The 1991 studies conducted by Limno-Tech found very low levels of phosphorous in the surface levels with concentrations ranging from 0.003 to 0.006 mg/L for both the spring and summer samples. There was some evidence of phosphorous release from bottom sediment, with the deepest concentrations of 0.008 mg/L in the south basin and 0.023 mg/L in the north basin (Limno-Tech, 1992).

Implementing various watershed goals will be effective if phosphorous levels do not increase in the coming years. Table 37 compares phosphorous loading from three different studies (Limno-Tech, 1992).

Table 37: Historical Total Phosphorous Comparisons (mg/L)

Spring Data				
Source	**National Eutrophication Survey (EPA)**		**STORET**	**Limno-Tech**
Date	**6-15-1972**		**4-23-1985**	**5-8-1991**
Surface Water	0.004-0.008		0.005-0.018	0.001-0.004
Thermocline	0.009		0.006-0.010	0.003-0.005
Bottom Water	0.010		0.006-0.005	0.003-0.004
# of Stations	2		2	2
Late Summer Data	**National Eutrophication Survey (EPA)**	**STORET**	**STORET**	**Limno-Tech**
Source				
Date	**9-16-1972**	**8-29-1977**	**8-26-1985**	**8-19-1991**
Surface Water	<0.002-0.008	0.003, 0.003, 0.014	0.012-0.003	0.003-0.005
Thermocline	0.002-0.013	0.004, 0.006, 0.030	0.005-0.003	0.005-0.007
Bottom Water	0.004-0.007	0.049, 0.022, 0.074	0.015-0.012	0.006-0.023
# of Stations	3	3	2	2

Performing dissolved oxygen (DO) studies in addition to tracking phosphorous levels is another way to determine if the watershed goals are effective in protecting water quality. Higgins Lake currently supports a cold-water fishery and this fishery is dependent on adequate levels of dissolved oxygen in the lake. In the 1991 study conducted by Limno-Tech results showed that DO levels were maintained throughout the water column, although bottom water DO depletion reduces the concentrations near the sediments to very low levels. Dissolved oxygen levels were fairly uniform during the spring sample and ranged from 11.2-12.4 mg/L. The study also found the bottom water dissolved oxygen generally decreased over the summer and the lowest concentrations were found in the deepest basin (northwest basin) with levels consistently below 5mg/L (Limno-Tech, 1991).

Decreasing dissolved oxygen levels is a good indicator of increased nutrient inputs to the lake. As nutrients increase in a lake the presence of algae and other aquatic plants increase as well. When plant material dies it sinks to the bottom of the lake where it decomposes. Decomposition uses oxygen and thus decreases the amount of DO in the water. In order to determine if watershed goals are protecting the high water quality of Higgins Lake, dissolved oxygen levels should be monitored and should not decrease from the levels found in the 1991 survey.

In addition to the studies conducted by Limno-Tech, the US Geological Survey completed a survey titled the *Effects of Residential Development on the Water Quality of Higgins Lake, Michigan 1995-1999*. Results from this study indicated that the quality of lake water near shore has been affected by residential development. The concentration of chloride and turbidity near the shore increases with increased building and road density. Nitrogen concentrations have increased in near shore waters while groundwater showed higher concentrations of phosphorus, nitrogen, chloride, boron and *Escherichia Coliform (E. coli)* bacteria. A second study scheduled for 2007 will build upon the previous survey with more focus on the quantity and quality of groundwater input to the lake.

A. Monitoring Effectiveness of Implementation Activities

In 1992 Limno-Tech prepared a report titled *Higgins Lake Clean Lakes Program Pollution Control Plan* which presented water quality objectives necessary for maintaining Higgins Lake as an oligotrophic lake. Those objectives are:

- Maintain average lake total phosphorous concentrations less than 0.010 mg/L, the concentration generally considered an upper boundary for high quality lakes.
- Maintain dissolved oxygen in the bottom waters of the lake during late summer
- Maintain or increase water clarity as measured by Secchi disk depth as compared to a long-term average of 26 feet.
- Reduce near-shore algal growth as much as feasibly possible.

In addition to these recommendations it would be prudent to establish permanent shallow well sampling sites in order to monitor the levels of phosphorous and *E. coli* bacteria in the groundwater. It has been shown that residential septic use is having an impact on the lake and continuous monitoring along with implementing septic BMPs will be fundamental to preserving the health of the lake.

It is recommended that monitoring programs continue to ensure water quality is not declining. Higgins Lake is a large deep lake with two distinct basins, two inlets and one outflow. Regular monitoring of the inlets is important however the amount of water they contribute to Higgins Lake is relatively insignificant (less than 6%). Since groundwater accounts for half of Higgins Lake water budget it is very important to regularly monitor this flow. If contaminant levels from groundwater increase the Watershed Partnership will be able to modify and adapt programs to address this concern.

Table 38 shows a breakdown of water monitoring protocol recommended for Higgins Lake. Sampling locations, parameters tested and environmental targets are listed. Meeting the environmental targets will help show that implementation efforts are effective at protecting water quality.

Table 38: Water Quality Monitoring Protocol				
Type of Analysis	**Monitoring Site(s)**	**Parameters**	**Frequency**	**Environmental Target(s)**
Replicate USGS water quality study	• Near-shore groundwater (15 sites) • Epilimnion & Hypolimnion in North and South Basin during lake stratification (16 sites)	Phosphorous Nitrogen	3 year study	• Phosphorous levels at or below 0.010 mg/L • Nitrogen levels well-below 10 mg/L in groundwater (Note: 10mg/L is level when drinking water becomes a health concern)
Water Chemistry	• Epilimnion & Hypolimnion in North and South Basin during lake stratification • Big Creek • Little Creek • Cut River	Chlorophyll *a* Total suspended Solids (TSS) Dissolved Oxygen Phosphorous Nitrogen	Twice a year	• No statistical increase in nutrients levels tested from grab samples at all testing locations including the Cut River • Dissolved oxygen levels 3 mg/l or above in summer sampling of bottom layer • TSS levels should not exceed 80 mg/l (levels over 150mg/l and water clarity drastically decreases) • Chlorophyll *a* levels should not exceed 1.5 parts/billion • Maintain Lake Water Quality Index above 85 (Higgins Lake is at 96 as sampled in 1998)
Fecal Coliform	• Near-shore groundwater • Near-shore surface water	*E. coli*	Yearly	• *E. coli* not to exceed 1 unit/100 mL for drinking water • *E. coli* not to exceed 130 units/100 mL over a 30 day average for surface water • Note: Levels above 300 units/100 ml impair total body contact
Hydrogen Ion Concentration	4 surface locations in each basin	pH	Yearly	• Maintain pH levels between 8.0 and 8.7
Fish Community	Lake-wide	Cold-water species	Yearly	• Maintain current cold-water fish levels
Secchi Disk	4 surface locations in each basin	Water clarity	Monthly	• Maintain Secchi disk levels above 25 feet
Temperature	Hypolimnion of North and South basin	Water Temperature	Yearly	• Temperature should not exceed 50 degrees Fahrenheit

GLOSSARY OF TERMS

Anoxic: Deprivation of oxygen.

Best Management Practices (BMP): Structural, vegetative and managerial practices implemented to control nonpoint source pollution.

Carlson's Trophic Status Index: Classification system used to classify lakes based on degree of enrichment. Carlson's Trophic-State Index (TSI) is used to evaluate nutrient concentration and its effects on biological productivity. The TSI is a numerical scale ranging from 0-100. Lakes with index values less than 40 are classified as oligotrophic (low productivity).

Chlorophyll *a*: A pigment in all plants that is necessary for photosynthesis.

Critical Area: That part of the watershed that is contributing a majority of the pollutants and is having the most significant impacts on the waterbody.

Cultural Eutrophication: An accelerated input of plant nutrients and sediment into a waterbody that promote excessive plant growth and results in diminished or detrimental changes in water quality.

Designated Uses: Recognized uses of surface water established by state and federal water quality programs.

Erosion: Detachment and movement of rocks and soil particles by gravity, wind, and water.

Eutrophic: Designation of a body of water rich in nutrients which cause excessive growth of aquatic plants.

Eutrophication: A natural aging process where lakes begin to fill in with sediment and nutrient materials.

Fauna: The animals of a specified region or time.

Groundwater: The subsurface water supply in the saturated zone below the water table.

Impervious: A surface through which little or no water will move. Impervious areas include paved parking lots and roof tops.

Marl: A mixture of clay, sand, and limestone in varying proportions that is soft and crumbly. Any loose, earthy, crumbly deposit.

Mesotrophic: Trophic state between oligotrophic (nutrient poor) and eutrophic (nutrient rich) systems.

Nonpoint Source Pollution: Pollution caused when rain, snowmelt, or wind carry pollutants off the land and into the waterbodies.

Nutrient Pollution: Excess nitrogen and phosphates in streams, rivers and estuaries.

Oligotrophic: Designation of a body of water poor in plant nutrient minerals and organisms and usually rich in oxygen at all depths.

Pathogens: Human disease causing bacteria or viruses.

Pollutant: Any substance of such character and in such quantities that when it reaches a body of water, soil, or air, it contributes to the degradation or impairment of its usefulness or renders it offensive.

Phosphorus: A plant nutrient that is needed for processes such as growth and photosynthesis. Increased levels can cause excessive growth of aquatic plants.

Riparian: Person who lives along or hold title to the shore area of a lake or bank of a river or stream.

Riparian corridor: Area bordering streams, lakes, rivers, and other water courses. These areas have high water tables and support plants requiring saturated soils during all or part of the year.

Runoff: That portion of the precipitation or irrigation water that travels over the land surface and ends up in surface streams or water bodies.

Secchi disk: A circular disk that can be lowered into the water to obtain an estimate of light penetration.

Sediment: Soil, sand, and minerals which can take the form of bedload, suspended, or dissolved material.

Slope: Ground that is not flat or level; measured as deviation from the horizontal.

Soil Erosion: The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices related to farming, residential or industrial development, road building, or timber cutting.

Stakeholder: Any organization, governmental entity, or individual that has a stake in or may be affected by a given approach to environmental regulation, pollution prevention, or energy conservation.

Storm Drain (Storm Sewer): A slotted opening leading to an underground pipe or an open ditch that carries surface runoff.

Stormwater: Runoff from a storm, snow melt runoff, and surface runoff and drainage.

Succession: The slow, regular sequence of changes in the regional development of communities of plants and associated animals.

Surface Water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, wetlands, impoundment, and seas).

Topographic Map: Land map that display elevation along with natural and man-made features.

Topography: The physical features of a surface area including relative elevations and the position of natural and man-made features.

Tributary: A river or stream that flows into a larger river or stream.

Water Quality: The biological, chemical, and physical conditions of a waterbody, often measured by its ability to support life.

Watershed: The geographic region within which water drains into a particular river, stream or body of water. Watershed boundaries are defined by the ridges separating watersheds.

Wetland: An area that is regularly saturated by surface or groundwater and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

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APPENDIX A

Higgins Lake Watershed Partnership Agreement

Higgins Lake Watershed Partnership Agreement

This document serves as a partnership agreement between various units of government, local citizens, riparians, associations, businesses, and other groups interested in the future of the Higgins Lake watershed. The Higgins Lake Partnership is a community-based, nonprofit, voluntary initiative dedicated to preserving, protecting and improving the water quality of Higgins Lake.

This agreement is not a contract. It is a statement of intent, support, and willingness to participate at a level appropriate to the respective interest. A partnership agreement is an effective way to unite organizations, sometimes with competing and conflicting interests, to work together for a common goal. The agreement is a statement of the vision and or mission of the partnership. It articulates the unifying theme.

The individuals and organizations committed to this partnership are united by a mutual concern for the quality of our natural resources. The parties recognize that the ecological health of the Higgins Lake watershed is important to the economic prosperity and quality of life in the region, and that understanding, flexibility, cooperation, and action on a long-term, ecosystem basis are keys to making improvements and solving problems.

Background:

The Higgins Lake watershed is located primarily in northwest Roscommon County. The northern portion of the watershed extends into southwestern Crawford County. The surface area of the lake is approximately 10,317 acres. Two small streams, Big Creek and Little Creek, flow into Higgins Lake on the northwest side, but the majority of water inflow into Higgins Lake is from groundwater (springs). The two creeks contribute only 6-7% of the total outflow measured at the Cut River dam, the lake's only outlet.

This cold-water lake provides diverse recreational opportunities including fishing, swimming, SCUBA diving, sailing, and boating. Water-related activities, such as camping and picnicking are also very popular. The lake is ringed with seasonal and year-round homes. Higgins Lake adds significant recreation, aesthetic, and economic value to the region.

Higgins Lake, along with Houghton Lake, probably receive the highest usage by the public of any of the lakes within a 50-100 mile radius. Both lakes are located between two major freeways and thus are within a 2-3 hour drive of major population centers in Michigan. Of the two, Higgins Lake has the greatest public access. There are two major state parks, North and South Higgins Lake State Parks. South Higgins Lake State Park consistently ranks in the top three parks in the state in terms of the annual number of users. There are also one state public access site and three township parks (one in Lyon and two in Gerrish). Seventy-seven roads ending at the lake are also public access points.

The high quality of the lake is a driving force behind the recreation/resort-related economy of the area. Higgins Lake is one of the few 'clear water lakes' in Michigan. A high level of

transparency is maintained in the water column throughout the year. Currently, Higgins Lake is oligotrophic. However, the near shore shallow areas, which comprise one–third of the lake's area, are showing signs of increasing nutrient enrichment. Controllable sources of nutrients responsible for enrichment (septic system seepage, runoff, and soil erosion) are increasing as more people move into the area and more part-time residents become full-time. Complaints of algae, weeds, and other natural phenomenon associated with nutrient enrichment are increasing every year. More cases of swimmer's itch are documented each year. Also on the increase are complaints to the Michigan Department of Environmental Quality regarding turbid or discolored water discharging into the lake from three storm drains.

Vision Statement:

Together, as the Higgins Lake Partnership, we value our shared, unique resources, and through community involvement and education we will balance economic, environmental, and social priorities to restore and preserve our water resources for today and future generations.

Mission Statement:

To provide a comprehensive watershed plan for reducing current and future non-point source pollution impacts in the Higgins Lake Watershed by thoroughly evaluating the physical, chemical, and biological integrity for long-term protection and enhancement of the watershed.

Action:

This partnership launches a ten-year initiative to improve the ecological integrity of the Higgins Lake Watershed. This partnership will be renewed every two years to allow the partners to evaluated their role, address changing conditions, and assess progress in meeting our mission and goals.

We, the undersigned, mutually agree to fully cooperate and participate in this Partnership, and to provide assistance, as available.

Bob Stauffer — August 10, 2000
Crawford-Roscommon Conservation District — Date

Herbert Wakeley — August 11, 2000
Gerrish Township — Date

Paul Fatta — August 16, 2000
Lyon Township — Date

Glori L. Burns — August 14, 2000
Roscommon County Road Commission — Date

August 10, 2000
Higgins Lake Property Owners Association — Date

District Health Department — August 10, 2000 — Date

Michigan Department of Environmental Quality — Date

Higgins Lake Civic Association — August 14, 2000 — Date

MSU Extension — August 18, 2000 — Date

Michigan Groundwater Stewardship Program — August 11, 2000 — Date

Road Commission for Crawford County — August 8, 2000 — Date

Village of Roscommon — August 15, 00 — Date

Huron Pines Resource Conservation and Development — August 14,2000 — Date

Higgins Lake Foundation — August 11, 2000 — Date

USDA Natural Resources Conservation Service — August 14, 2000 — Date

Higgins Lake Advisory Committee — August 11, 2000 — Date

Beaver Creek Township — August 15, 2000 — Date

HeadWaters Land Conservancy — August 15, 2000 — Date

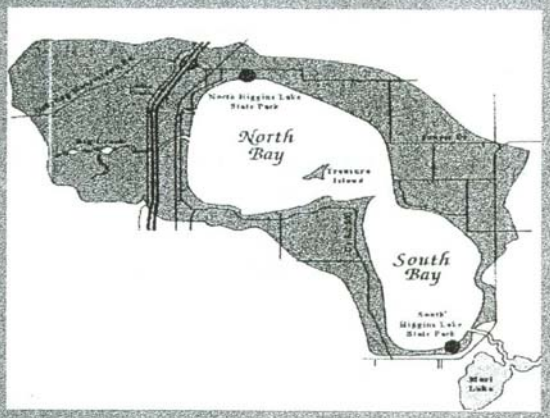
East Central Michigan Planning & Dev. Commission — August 15, 2000 — Date

Tip Of The Mitt Watershed Council — August 17, 2000 — Date

SEE-NORTH	8/15/00 Date
Sierra Club - Mackinac Chapter	8/15/00 Date
Northeast Michigan Council of Governments	8/15/00 Date
Higgins Lake State Park and Recreation	8/14/00 Date
Michigan's Golden Triangle	8/1/00 Date
AuSable River Committee	8/18/00 Date
Ralph A. MacMullen Conference Center-DNR	8/15/00 Date
North Central Michigan Community Foundation	8/17/00 Date
Kirtland Community College	8/22/00 Date
Roscommon County Board of Commissioners	8/24/00 Date
	Date
	Date
	Date
	Date
	Date
	Date

APPENDIX B

Watershed Survey Form



To our Higgins Lake watershed neighbors,

The Higgins Lake Partnership has recently been given approval for its "319" watershed planning grant. To help determine your interests and concerns we are gathering data, conducting analyses, initiating a program of public information and education, and creating a watershed management plan for the Higgins Lake Watershed. This information will also help the "319" planners for the Muskegon River Watershed for which we are the headwaters. By working together, we will develop a plan which will work to improve and to sustain the quality of both watersheds for many years to come.

Thank you very much for taking time to share your thoughts.

Members of the HLP Steering Committee

Fold line

Higgins Lake Partnership
115 Earl Avenue
Roscommon, MI 48653-9532

Contact Information (Optional)

Name: _____

Address: _____

City: _____ State: _____ ZIP: _____

Phone: _____ E-mail: _____

Fax: _____

_____ I would like to receive regular mailings. My conservation - related areas of interest are:

_____

_____ I would like you to contact me about: _____. _____ I would like information about _____.

Fold line

1. **In what township do you reside?**
   _____

2. **Are you in the Higgins Lake Watershed (see above map)?** ____ **Yes** _____ **No**

3. **To which primary audience do you belong?**
   (Please check no more than 3.)
   _____ Riparian
   _____ Non-riparian
   _____ Retiree
   _____ Veteran
   _____ Educator
   _____ Farmer
   _____ Building/construction
   _____ Recreational User (ex. boating, fishing, etc.)
   _____ Local Decision Maker

4 **To which specific audience and/or affiliation do you belong (i.e. local elected official, Trout Unlimited, Farm Bureau, etc.)**

   _____

5 **How do you use Higgins Lake or its watershed?**

   _____ Wading/swimming
   _____ Swimming
   _____ Wildlife watching
   _____ Tubing, skiing
   _____ Cross Country ski
   _____ Hiking
   _____ Camping
   _____ Other (list): _____
   _____
   _____ Boating (power)
   _____ Hunting
   _____ Fishing/ice fish
   _____ Irrigation
   _____ Canoe/kayak
   _____ Sailing
   _____ Snowmobile

6 **Through which media source would you prefer to receive information about natural resources?**

_____ Website _____ Newspaper _____ Meetings
_____ Newsletters _____ Radio _____ Fact Sheets
_____ Local Cable TV _____ TV News _____ Library
_____ Other: _____

7 **Please rank (1-high to 10-low) the priorities in your area regarding the Higgins Lake watershed?**

_____ Surface Water Quality _____ Wildlife Habitat/Natural Area Enjoyment
_____ Ground Water Quality _____ Wildlife Habitat/Hunting
_____ Fisheries _____ Wetland Preservation/Creation
_____ Recreational Uses _____ Farmland/Open Space Preservation
_____ Cultural Heritage Preservation _____ Other: _____

8 **What pollutants concern you most?** (Please rank 1-most to 7-least)

_____ Nutrients/fertilizer _____ Stormwater runoff/erosion sediments _____ *E. coli* Bacteria
_____ Oil, Grease, and Gasoline _____ Airborne pollutants _____ Septic wastewater
_____ Road salt/brine

9 Please rank the top 10 issues and concerns that need to be addressed in our community:

_____ Land Use Changes _____ Population Growth
_____ Runoff (Stormwater) _____ Erosion Control
_____ Failing Septic Systems _____ Loss of Agriculture
_____ Dumping of Trash _____ Degradation of Lakes and Streams
_____ Loss of Open Space _____ Uncontrolled Use of Recreational Vehicles
_____ Poor Forest Management _____ Residential Fertilizer Entering Lakes/Streams
_____ Loss of Habitat _____ Lake level
_____ Other: _____

10 What are the major obstacles/barriers to achieving improvements with these issues and concerns?

_____

11 **What improvements would you most like to see in the watershed? Please rank 1(high)-12(low).**

_____ Restored cold water fishery _____ Enhanced natural areas for habitat or public use
_____ Restored warm water fishery _____ Locally produced/marketed food
_____ Land preservation/conservation easements _____ Increased protection of groundwater
_____ Increased recreation _____ Reduced sedimentation from eroding shoreline
_____ Reduced sedmentation from roads _____ Improvements to septic/wastewater treatments
_____ Reduced sedimentation at eroding road-stream crossings
_____ Other:_____

12 **What strategies would you support to address some of these issues? Please rank 1(high)-10(low).**

_____ Educational Programs _____ Wetlands Protection Ordinance ____ Zoning
_____ Voluntary Stormwater Management _____ Watershed-based Land Use Planning ____ Monitoring
_____ Stormwater Management Ordinance _____ Grass Roots/Local initiating solutions
_____ Community Cleanups _____ Regional/State Programmed initiation of Solutions
_____ Other: _____

13 **What are you willing to do to improve the water quality in the watershed?**

_____ Implement conservation practices at your household.
_____ Water quality monitoring
_____ Volunteer on stewardship teams? (such as cleanup campaigns, volunteer studies, educating, etc.)
_____ Attend education workshops/ training
_____ Attend watershed meetings?
_____ Contribute money to Higgins Lake Partnership for newsletters and projects
_____ Other: _____

APPENDIX C

Typical Nonpoint Source Pollutants Impacting Michigan Waters

Nonpoint source pollutants are any of the substances listed below that can degrade the water quality by impairing the designated uses(s) of the water.

Animal manure –Manure is a source of nutrients, salts, and organic matter that can degrade water quality.

Depressed dissolved oxygen – When the oxygen dissolved in water and readily available to aquatic organisms (mg/1) is below optimal levels.

Hydrologic flow fluctuation – When the natural hydrology of the watershed changes due to increases in storms water runoff.

Metals – Toxic substances, such as mercury and lead that come from urban runoff or atmospheric deposition.

Nitrogen – An element that at certain levels can cause excessive algae and aquatic weed growth.

Organic matter – Residue from plant and animal origin (including leaves and grass clippings). In excessive amounts organic matter can lower dissolved oxygen levels.

Pathogens – Human disease causing bacteria or viruses.

Pesticides – Chemical substances used to kill pests such as weeds, insets, algae, rodents, and other undesirable agents.

Petroleum and petroleum by-products (oil and grease) – Urban pollutants that are transported by rainfall from roads, parking lots, and improper storm drains.

Phosphorus – An element that at certain levels can cause excessive algae and aquatic weed growth.

Salts – Chemical compounds from winter road deicing, septic systems, and water softener outwash.

Sediment – Soil that is transported by air and water and deposited on the stream bottom

Temperature – An elevation in water temperature that stresses fish and aquatic insects.

APPENDIX D

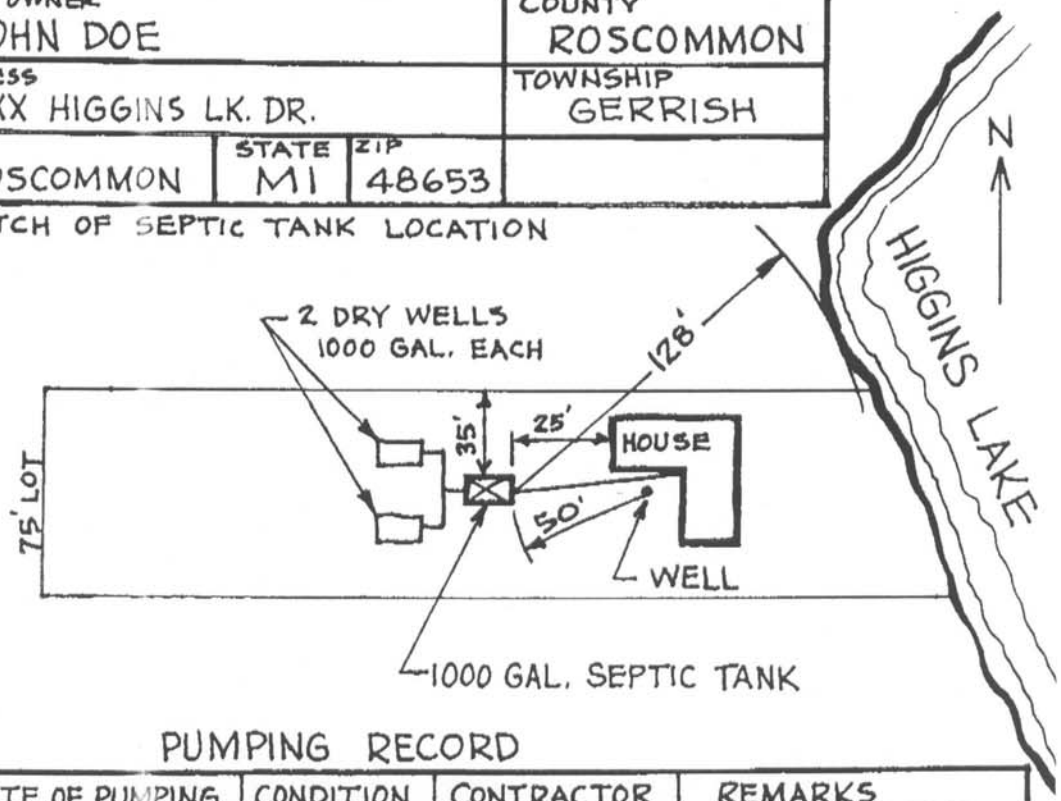
Example Pumping Log

Format Developed by Casmir Snabes

SEPTIC SYSTEM RECORD

HOME OWNER			COUNTY
JOHN DOE			ROSCOMMON
ADDRESS			TOWNSHIP
XXX HIGGINS LK. DR.			GERRISH
CITY	STATE	ZIP	
ROSCOMMON	MI	48653	

SKETCH OF SEPTIC TANK LOCATION



PUMPING RECORD

DATE OF PUMPING	CONDITION	CONTRACTOR	REMARKS
7-86	GOOD	S CO.	
7-91	"	Y CO.	
7-95	"	X CO.	
7-98	"	Z CO.	
7-2000	"	S CO.	

APPENDIX E

Minnerick, Russel J., *Effects of Residential Development on the Water Quality of Higgins Lake, Michigan 1995-1999.* U.S. Geological Survey. Lansing, Michigan. 2001.