Evaluation of Mirror Lake Water Quality Conditions with Management Recommendations

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August 12, 2004

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1.0 Overview

The Mirror Lake Association authorized KIESER & ASSOCIATES (K&A) to initiate a study of Mirror Lake beginning in June 2003 and continuing through June 2004. The purpose of this effort was to examine current water quality conditions and identify management options to address Association concerns. This report summarizes field and modeling evaluations. It provides a range of lake and watershed management recommendations for current and long-term considerations.

Mirror Lake is located in Jackson County, Michigan just north of the Hillsdale County border (Figure 1). The lake was created in 1965 when the Grand River was dammed thus creating the upriver Lake LeAnn, Mirror Lake and the downriver Grand Lake. Mirror Lake has a surface area of approximately 71 acres based on the current investigation. The Mirror Lake watershed (lands draining directly into the lake and excluding Lake LeAnn) is located in a relatively rural setting with the dominant land cover types being forest, agriculture and low-density residential. The residences on Mirror Lake are all served by septic systems. Roadway stormwater runoff enters the lake through roadway ditches and culverts. An evaluation was undertaken by K&A to assess the current water quality conditions within Mirror Lake and to determine impacts to the lake from various inputs (septic systems, stormwater runoff, in-lake processes, and upstream Lake LeAnn). The Mirror Lake Association is interested in developing a management strategy for controlling excessive weed growth, maintaining/improving water quality and enhancing the Mirror Lake fishery.

This study consists of the following components:

- Watershed delineation and assessment of runoff contributions within the watershed
- Identification of stormwater pollutant sources and loading estimates
- Pollutant source estimation for shoreline areas and septic systems
- Hydraulic mass balance and morphometry
- Water quality monitoring over three seasons
- Aquatic plant survey
- Self-monitoring program for Mirror Lake Association
- Fisheries database
- Management plan recommendations as they relate to water quality, vegetation control and fisheries
- Cost estimates for recommended best management practices (BMPs)

2.0 Watershed Delineation and Assessment of Runoff Contributions

The contributing watershed of Mirror Lake was determined using a combination of topographic maps, satellite imagery, geographic information system (GIS) software and field surveys. A watershed is the land area which contributes runoff to a water body during storm events and is determined by topographic boundaries and storm sewer connections in urbanized areas. Field surveys of the watershed areas adjacent to Mirror Lake were conducted on July 14, 2003, October 13, 2003 and April 12, 2004. Accurate land cover data for the project area were generated from 1997 Landsat 5 Thematic Mapper satellite data. These satellite data were further refined based on field visits and knowledge of the watershed.

The Mirror Lake watershed was determined to be 213 acres (Figure 2) with approximately 128 acres forested, 47 acres agriculture, 30 acres of low-intensity residential, 7 acres open water, 1 acre of wetland and 0.5 acres of transportation (Table 1). The lake surface was determined to be 71.3 acres based on GIS data.

Using these land cover data, estimation techniques were utilized to determine the relative contributions of pollutants such as total suspended solids (TSS) and phosphorus in the runoff from these contributing areas. These contributions, or pollutant "loads", are discussed in Section 3.0 below.

3.0 Identification of Stormwater Pollutant Sources & Loading Estimates

3.1 Stormwater Sources

There are nine areas surrounding Mirror Lake to the north of Vicary Road that directly contribute roadway stormwater runoff to the lake (Figure 3). These drains/outfalls (Subdrainages 1-9) were located using a combination of maps obtained from the Jackson County Road Commission, a lakeshore tour via boat with Mr. Gale Cook of the Lake Association, and through various field visits. Table 1 identifies the size of these subdrainages which range in size from 36.9 acres (Subdrainage #2) to 3.8 acres (Subdrainage #6). The area to the south of Vicary Road is located in Hillsdale County. Maps obtained from the Hillsdale County Road Commission and field visits were used to determine roadway runoff draining to Mirror Lake from the south of Vicary Road (Figure 3). Watershed areas to the south of Vicary Road, covering approximately nine acres, are drained by paved open channels along Highland Hills Drive (to the west of Lake LeAnn) and along Killarny Circle (to the east of Lake LeAnn).

Overland lakeshore areas not directly drained by ditches or outfalls were also calculated using GIS and topographic information. These lakeshore areas total 74 acres and are also shown on Figure 3. All land cover designations in the Mirror Lake watershed are also presented in Table 1.

3.2 Stormwater Pollutant Loading

Using the identified land cover types and areas from Table 1, common pollutant load estimation techniques were applied to each subdrainage and the lakeshore area to determine annual pollutant loads to Mirror Lake from each area. The loading estimation technique is based on that used by the State of Michigan Draft Part 30-Water Quality Trading Rules (MDEQ, 2002).

Pollutant loads of total phosphorus and total suspended solids from stormwater runoff were calculated for the Mirror Lake watershed using the Event Mean Concentration (EMC) method. As a note, EMCs are estimated concentrations of non-point source pollution determined by the U.S. Environmental Protection Agency (USEPA) Nationwide Urban Runoff Program (NURP). While these EMC values do not correspond to water quality criteria, they do represent average pollutant concentrations observed in areas of similar land cover during wet weather events. EMCs used for the Mirror Lake study are displayed in Table 2. With this method, stormwater pollutant loads are also based on pollutant loading factors that vary by land use type and percent imperviousness (MDEQ, 2002). Loads can be computed using Equations 1 and 2 as follows.

$$M_L = EMC_L * R_L * K \qquad \text{Eq. 1}$$

Where:

M_L = Loading factor from land use L (pounds/acre/year)
EMC_L = Event mean concentration of runoff from land use L (mg/L)
R_L = Total average annual surface runoff from land use L computed from Eq. 2
K = Unit conversion factor of 0.2266

Runoff Equation:

$$R_L = [\, C_P + (\, C_I - C_P\,)DCIA_f * IMP_L\,] * AL * I \qquad \text{Eq. 2}$$

Where:

R_L = Total average annual surface runoff from land use L (acre-inches/year)
C_P = Pervious area runoff coefficient *(0.20)*
C_I = Impervious area runoff coefficient *(0.95)*
$DCIA_f$ = Fraction of impervious area that is directly contributing *(0.50)*
IMP_L = Fractional imperviousness of land use L
I = Long term average annual precipitation (inches/year)

Equation 1 shows that the loading factor (M_L) for land use L is the product of the event mean concentration for land use L, the annual runoff for land use L, and a unit conversion factor. The runoff calculation in Equation 2 provides the R_L value used in Equation 1 through the product of the annual rainfall depth [29.11 inches for the Jackson area from Michigan State University climatology data (MSU, 2004)] and the percent imperviousness of land use L, with the tuning coefficients C_P and C_I. The loading factor, M_L, is multiplied by the area of land use L to obtain a total annual loading for that land use. Loads for each land use within the watersheds were then totaled. Table 3 shows estimated annual total phosphorus (TP) and total suspended solids (TSS) loads corresponding to the Mirror Lake watershed.

Estimated annual loads to Mirror Lake from stormwater contributions are **56.3 pounds TP/year and 13,737 pounds TSS/year**. The largest estimated stormwater load of both TP and TSS is from the lakeshore area at 35.6 and 6,671.5 pounds TP and TSS, respectively. This is a function of the lakeshore area comprising the largest contributing area (74 acres) of any of the subdrainages. The columns in Table 4 displaying estimated 'load/acre' show that the lakeshore area is also contributing the largest load of TP and TSS on a per-acre basis with 0.48 pounds TP/acre-year and 90 pounds TSS/acre-year. This calculation aids in determining which areas to target for best management practices (BMPs) to maximize water quality improvements.

4.0 Pollutant Source Estimation for Shoreline Areas & Septic Systems

4.1 Shoreline Reconnaissance Survey

A shoreline reconnaissance survey was conducted by K&A on April 12, 2004 to identify shoreline areas where erosion or developed uses could be improved to minimize pollutant runoff entering the lake. The survey also examined these nearshore areas for the presence of heavy growths of the green alga, *Cladophora.* This filamentous algae grows under conditions of high light, cool water and high phosphorus inputs. This observational technique has been used to identify septic drain fields that have exceeded their useful life span and/or are no longer retaining phosphorus in the soils surrounding the drain field.

Cladophora

Results of the *Cladophora* survey are displayed in Figure 4. Lakeshore areas are designated as either "Poor Habitat" referring to areas where the algae was not found, but that also was not suitable for growth; "Low Density" referring to low productivity of the algae; "Medium Density" corresponding to medium growth; and "High Density" referring to relatively dense algal growth. The only area where significant algae were observed during this survey was in the northwest bay area of the lake. The remaining lake areas had minimal algae growth at the time of the study.

Erosion

Several potential erosion problem areas were identified during the Spring 2004 survey. Three of these areas are associated with stormwater outfalls #1, #2 and #7 and are shown in Figure 5. Outfall #1 had an exposed erosion area estimated at 200 ft^2, while outfall #2 had approximately 40 ft^2 of exposed soil. Outfall #7 has an exposed area of nearly 50 ft^2. Additionally, steep shoreline areas on the west side of the Mirror Lake channel are landscaped with a high potential for erosion. Along with an increase in solids entering the lake from erosion areas near the lakeshore, phosphorus attached to these particles, is added to the lake.

Using Michigan Department of Environmental Quality (MDEQ, 1999) methods it was estimated that the area near outfall #1 contributes **1.2 pounds TP/year**, outfall #2 adds **0.2 pounds TP/year** and outfall #7 contributes **0.3 pounds TP/year** to Mirror Lake. Estimates of TP and TSS additions from other lakeshore areas where specific erosion spots were not noted are included in the "lakeshore area" in section 3.2.

4.2 Septic System Survey/Questionnaire

A written septic system survey was prepared by K&A and forwarded to the Mirror Lake Association in November 2003 for their distribution to homeowners on Mirror Lake. The surveys were returned to K&A in January 2004 for analysis. A copy of the survey form is available in Appendix A. Respondents provided information on the number of residents (both year-round and seasonal); age of home; age of the septic system; septic maintenance schedule; and distance of drain field from the lake. Approximately 66 percent of the surveys were returned, leaving 17 households with no information provided (Flynn, personal correspondence, 2004). To best account for these incomplete data, the survey results that were available were calculated to obtain averages for: capita years (number of full time residents/dwelling); septic system age; maintenance schedule; and distance of drain field to lake. Overall results are displayed in Table 4. The average capita years is 2.01; septic system age is 14.78 years; distance of the drain field from lake is 106.4 feet; and maintenance schedule is 6.9 years. Average capita years (2.01) were then multiplied by 17 residences to obtain the estimated number of capita years for those residences not accounted for in the survey: 34.17 capita years. This number was then added to the 66.42 capita years obtained from the returned surveys, yielding an estimated total of 100.59 capita years for Mirror Lake. This number was used in the following equation (Reckhow, 1980):

$W_s = EC_{st} + C_t + AV$ *Eq. 3*

Where: W_s =Total phosphorus load to the lake from septic systems (pounds/year)
EC_{st} =Export coefficient to septic tank (pounds/(capita-year)/year)
C_t =Total # of capita-years/residence
AV =Sum of all variables influencing delivery of phosphorus to lake (dimensionless)

$AV=EV+SSV$ *Eq. 4*

$EV= 0.143[(1-SP)+(1-PA)+(1-DR)+(1-S)]$ *Eq. 5*

$SSV=0.143 [(1-A)+(1-DS)+(1-M)]$ *Eq. 6*

Where: EV =environmental variables (dimensionless)
SSV =septic system variables (dimensionless)
SP =soil permeability factor (dimensionless)
PA =phosphorus adsorption capacity factor (dimensionless)
DR =drainage factor (dimensionless)
S =slope factor (dimensionless)
A =age factor (dimensionless)
DS =distance factor (dimensionless)
M =maintenance factor (dimensionless)

Septic system variables (SSV) were obtained from survey averages (Table 5). Using these averages, the assigned factors for SSV could be determined for use in the above equation.

Environmental variables (EV) were determined from soils information obtained in the Soil Survey of Jackson County, Michigan (USDA, 1978). The soils within the Mirror Lake watershed are listed in Table 6. The Soil Survey provides specific information on soil permeability, drainage and slope for each soil type. These parameters were then used to determine EV factor ratings for the above equations (see Table 5). The mid-range of phosphorus adsorption capacity from Table 5 (1300-1600 pounds/acre per top 3 feet of soil) was used for the PA parameter.

The EC_{st} parameter was estimated to be 1.8 pounds/capita-year based on estimates used in Reckhow, 1989. This is considered a best estimate based on the number of survey respondents with dishwashers (75%). Unlike laundry detergents, dishwasher detergents contain phosphorus, and therefore, could be contributing substantial amounts of phosphorus to the lake. The estimated load from septic systems to Mirror Lake is **88.54 pounds phosphorus/year**.

5.0 Morphometry (Volume) and Hydraulic Mass Balance (Inflows and Outflows)

This section describes K&A efforts to calculate the volume of water in Mirror Lake (based on its water depths, or bathymetry) and the volumes of water flowing into and out of the lake. This important information is needed to assess the volume and/or quantity of water and pollutant flowing through or staying in Mirror Lake to determine the relative impacts of contributing sources. This information is then used to target management strategies which can be applied to most cost effectively and efficiently address identified problems.

5.1 Bathymetric Survey

A bathymetric survey of Mirror Lake was conducted by K&A on June 8, 2003 to aid in determining water depths throughout the lake and lake volume. The survey involved taking depth measurements along 12 different transects on Mirror Lake and recording the location of each measurement with a hand-held global positioning system (GPS) unit. These data were then entered into computer-aided design (CAD) software to create the bathymetric map in Figure 6. There is a deep hole (>3 feet) located in the mid-portion of the lake. The lake surface area was determined to be approximately 71.3 acres and the lake volume was calculated as approximately 864 acre-feet (38,955,567 ft^3).

5.2 Hydraulic Mass Balance

A rain gauge and simple level-monitoring device were installed by K&A at the Mirror Lake outfall during Summer 2003 and again during Spring 2004. These instruments recorded rainfall and lake outflow from July 14-November 19, 2003 and again from April 12-June 8, 2004. A plot of the collected data is provided in Figure 7. As shown in Table 7, during this study the greatest monthly rainfall was recorded for the months of August and September 2003 and May 2004 (4.4, 5.2 and 5.9 inches, respectively). During the 2003 monitoring period, the lowest monthly outflow volumes were recorded for August and September (7,825 and 120,016 ft^3, respectively). The highest outflow volumes from Mirror Lake were noted during April 2004 (1,727,192 ft^3) while the rainfall for that same time period was 0.6 inches.

A hydraulic mass balance was calculated for Mirror Lake (Table 8). A mass balance simply accounts for the volume of water flowing into the lake and the volume leaving the lake. Inputs to Mirror Lake are: direct rainfall (estimated from Michigan State University Climatology annual rainfall for the area); watershed runoff (MDEQ, 2002); and Lake LeAnn inflows estimated from outflow data (adjusted for groundwater and evaporation loss). Water exits Mirror Lake via: evaporation (estimated with MDEQ *Calculating a Water Budget*); groundwater losses (estimated using K&A monitored data for no-overflow period August 18 - September 22, 2003); and outfall volumes (determined with K&A lake level monitoring). Direct rainfall was determined to be the greatest contributor of water volume (7,531,632 ft^3) to Mirror Lake, though the relatively rapid drawdown of Lake LeAnn has a significant short-term influence on lake outflow, particularly during October and November.

During an October 2003 K&A monitoring event, inflow from Lake LeAnn was visibly entering the lake causing periodic "fountains" of water near the Mirror Lake boat launch where the Lake LeAnn inflow pipe is situated (Figure 8). Personal correspondence with Rob Londos (2003), the contractor responsible for Lake LeAnn weir operations, revealed that the Lake LeAnn Fall 2004 drawdown period was conducted between October 15 and October 25. This drawdown involves removing one to two 1/2-inch weir boards per week for a staged drawdown totaling six inches from Lake LeAnn. In the spring, May 15 was the targeted date for board replacement, which would explain the low outflow volume corresponding with the period of heavy May 2004 rainfall.

The hydraulic mass balance estimated that approximately 4,761,816 ft^3 of water were lost to groundwater recharge during this study period. This recharge phenomenon was further confirmed by examining the period from August 18 to September 22, 2003. K&A lake level data show no outflow from Mirror Lake during this monitoring period yet 685,888 ft^3 of rainfall was recorded at the lake during this time. Even accounting for limited evaporation during this brief period the importance of the large water volume exiting Lake LeAnn in maintaining Mirror Lake levels is evident.

Hydraulic residence time (HRT) was estimated for Mirror Lake based on the lake volume determined from the bathymetric survey and lake level monitoring at the Mirror Lake outfall. The HRT is an estimate of the average time it takes to completely renew a lake's water volume. The importance of this measure is that lakes with very short HRTs (10 days or less) are more immune to pollutant inputs than are lakes with long residence times. Pollutants tend to flush through systems with short HRTs before the nutrients can be assimilated into plant or algae biomass. In contrast, some aquatic herbicides may require a long HRT in order for the treatment to be effective. Based on available rainfall/outflow volume data, the HRT for Mirror Lake was determined to be 5.6 years, a relatively long residence time.

6.0 Water Quality Monitoring and Phosphorus Mass Balance

This section highlights the various monitoring activities completed by K&A and puts them in the context of lake management needs.

6.1 Water Quality Monitoring

Mirror Lake was monitored on four separate occasions during this study: July 14, 2003; October 13, 2003; December 1, 2003 and April 12, 2004. Water samples were collected from the following lake areas (Figure 5): the inlet area on the south channel of the lake near the Lake LeAnn inlet; within the lake near the >36 foot deep hole; and at the lake outlet. A sample was also collected in the channel, midway between the Lake LeAnn inlet and the main lake, during the October 13, 2003 sampling. The Upstate Freshwater Institute (UFI), in Syracuse, New York, analyzed samples for total phosphorus (TP), soluble reactive phosphorus (SRP), chlorides, total nitrogen (TN), chlorophyll a, and total dissolved solids (TDS). (Laboratory analytical results are available in Appendix B). In addition, field parameters of temperature, pH, specific conductance, dissolved oxygen and Secchi depth were recorded by K&A during each sampling. A discussion of the water quality parameters examined in this study is provided here to illustrate the value of these measures with respect to water quality characterization.

Phosphorus

Both algae and aquatic plants require a wide range of nutrients for growth. The nutrient that is typically in shortest supply with respect to aquatic plant and algal growth is termed the "limiting nutrient". This term implies that the relative unavailability of this particular nutrient will limit plant growth. In most freshwater ecosystems, phosphorus is typically the limiting nutrient. Therefore, increases in phosphorus will inevitably lead to increases in nuisance plant and algae growth. This is especially true for blue-green algal blooms.

The form of phosphorus most often used for general assessments of lake water quality is total phosphorus (TP). Measured concentrations of total phosphorus in lake water can be used to determine the trophic status of the lake based on scientific data compiled for other similar inland lakes. The term "trophic state" refers to the level of "primary productivity" (algal growth) in an aquatic system. The three trophic states include "oligotrophic", "mesotrophic" and "eutrophic", which correspond to low, medium and high levels of productivity, respectively. The ranges of total phosphorus concentrations in each trophic state, based on various scientific literature sources are presented in Appendix C. These can serve as a comparison to measurements of phosphorus in the lake samples documented in this report.

Soluble reactive phosphorus (SRP) is another measure of phosphorus within a lake system. This parameter is the faction of phosphorus in the dissolved form which is available to plants for biological uptake.

Chlorides

Chlorides can be used to determine potential pollutant sources. Normal groundwater chloride concentrations for this area are 10-20 mg/L chloride (Jude and Ervin, 1998). Sources of chloride can include septic systems (chloride values of 50 to 100 mg/l are common in septic tank effluent), animal waste, fertilizer, and drainage from road-salting chemicals. Increases in chloride, either seasonally or over time, can mean that one or more of these sources is affecting the water body. An increase in chloride from human or animal waste suggests that other nutrients are also entering the water body. Higher chloride concentrations from spring to fall may be the effect of lawn fertilizer runoff or septic systems during heavy use by summer residents. Higher values in spring after the snow melts may signify runoff from drainage basins or highways as a major source of chloride.

Nitrogen

Nitrogen is another essential nutrient necessary for plant and algae growth. Total nitrogen (TN) is the sum of inorganic nitrogen (nitrate, nitrite), ammonia and organic nitrogen. Like phosphorus, nitrogen can be a limiting nutrient. Nitrogen concentration can also aid in the determination of trophic state (Appendix C).

Chlorophyll a

Algae concentrations are often measured in terms of chlorophyll *a*, a pigment used by algae for photosynthesis. The more algae present within a lake system, the higher the measurable chlorophyll *a* content. Lakes with summer chlorophyll *a* concentrations less than 7 μg/l (parts per billion) are defined as oligotrophic. Lakes with chlorophyll *a* between 7 and 12 μg/l are mesotrophic, while lakes with concentrations greater than 12 μg/l are considered eutrophic (Thomann and Mueller, 1987).

Total Dissolved Solids (TDS)

The inorganic salts of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulfate and nitrate are the primary constituents of TDS. Concentrations vary depending on the geology of the region, but septic systems, road deicing and fertilizer runoff can contribute to elevated levels.

Dissolved Oxygen and Temperature

It is important to understand dissolved oxygen conditions in a lake as they provide a reliable indication of its health. A sufficient supply of dissolved oxygen in lake water is necessary for most forms of desirable aquatic life. Increased algal growth, (i.e., suspended microscopic plants in the water column), associated with nutrients added to the lake can lead to severe decreases in dissolved oxygen, especially in the cooler bottom waters of a lake during periods of temperature stratification. This drop in oxygen is due, in part, to dead algae and other organic matter (such as rooted plant material broken away from shoreline areas and leaves, grass and other plant debris washed in from storm drains) settling to the bottom of the lake and decaying. This decaying is a process that consumes oxygen. As materials accumulate at the bottom of a lake, these new sediments place a continuous demand on oxygen supplies in the overlying waters (referred to as “sediment oxygen demand”). Dissolved oxygen impacts are most often observed during periods of temperature stratification in warmer summer months, and to a lesser degree, under winter ice cover conditions. Measuring dissolved oxygen and temperature with depth and throughout various seasons of the year, therefore, provides for: 1) an assessment of the general physical conditions in the lake, and; 2) a characterization of habitat conditions.

Dissolved oxygen levels and temperature were measured by K&A using a YSI 55 dissolved oxygen meter that was calibrated to saturated air conditions prior to use.

pH

The concentration of hydrogen ions in a particular sample is expressed as the pH value. Waters with a pH value below 7.0 are considered generally acidic while values over 7.0 are generally termed basic. Since pH is measured on a logarithmic scale, a change of one pH unit corresponds with a ten-fold change in concentration. Aquatic biota generally requires an environment with pH values between 5-9 (Allen, 1995). In addition to the direct effects on biota, low pH values can also result in the mobilization of toxic metals that may be bound to sediments under higher pH conditions. The pH level of lake water will also indicate the effectiveness and methods used for select lake restoration techniques such as alum treatment.

K&A measured pH using an Oakton pH Tester 3 probe. The probe was calibrated using appropriate standard solutions prior to use.

Conductivity

Conductivity, or specific conductance, is the measure of the flow of electrons through water. This value relates to the total dissolved ion level, which is basically a measure of dissolved salts present in a solution. Conductivity can serve as an indicator of septic system or road salt inputs.

K&A measured conductivity at the Mirror Lake sites with a YSI 30 conductivity meter. In this study, conductivity is reported as specific conductance, a temperature-compensated conductivity measurement.

Secchi Disc Transparency

The Secchi disc transparency is the depth at which a Secchi disc (a flat white or black and white platter approximately 20 centimeters in diameter) suspended into a lake disappears from the investigator's site. This measure has been correlated with total phosphorus and chlorophyll *a* values in classifying lakes according to their trophic state. In general, the greater the Secchi disc transparency, the lower the productivity of the water body.

6.2 Mirror Lake Water Quality Data

Water quality data from this study are presented in Table 9. The lake does stratify as evidenced by both the July 14, 2003 and October 13, 2003 temperature and dissolved oxygen data. The temperature measured 25.8 ^{o}C at the surface and 9.2 ^{o}C at the bottom on July 14, 2003 (Figure 9). Dissolved oxygen (DO) concentrations were recorded at 8.6 mg/L near the surface on July 14th and at 3.09 mg/L near the bottom on this same date. Mirror Lake temperatures during the October 13, 2003 sampling were 15.8 ^{o}C at the surface and 7.2 ^{o}C at the bottom (Figure 10). DO was recorded at 10.55 mg/L near the surface on October 13th and at 1.7 mg/L near the bottom. The lake had undergone fall turnover prior to the December 1, 2003 sampling, as illustrated both by the temperature and DO profile (Figure 11). Temperatures were near 5 ^{o}C and DO levels near 12 mg/L throughout the water column. The lake was just beginning to stratify following spring turnover as shown by the April 12, 2004 data (Figure 12). The surface temperature on this date was 9.2 ^{o}C and bottom temperature was 6 ^{o}C. Dissolved oxygen levels ranged from 12.5 at the surface to 8.8 at the lake bottom. The data reveal that Mirror Lake, like most other developed lakes, experiences dissolved oxygen depletion (low DO) during periods of temperature stratification.

TP and TN concentrations recorded during this study indicate nutrient enrichment is impacting the lake. TP levels were detected at 12.5 ug/L at the surface and at 132 ug/L at the bottom during the July 14, 2003 sampling. TP concentrations were recorded at 14.2 and 713 ug/L in the surface and bottom waters, respectively, during the October 13, 2003 monitoring. One mid-depth sample was collected during the December 1, 2003 sampling to represent the quality of the mixed water column. The TP concentration was 24.8 ug/L. TP levels measured at the inlet to Mirror Lake were greater than 27 ug/L on two separate occasions (July 14 and October 13, 2003). The concentration of TP detected in the channel sample was 22.7 during the October 2003 sampling. The inlet concentration recorded in the April 2004 sample was 16.9 ug/L. TP concentrations detected at the Mirror Lake outlet were generally less than those detected at the inlet, with concentrations of 16.8, 14.9, 24.8 and 16.5 ug/L TP for the July, October and December 2003 and April 2004 sampling events, respectively. This suggests that TP settling is occurring within the lake system. The TP levels seen in Mirror Lake are characteristic of lakes classified as mesotrophic (medium productivity) to eutrophic (high productivity) (See Appendix C for trophic state classifications).

Total nitrogen levels were detected at 479 ug/L near the surface and at 592 ug/L near the bottom during the July 14, 2003 monitoring. TN levels were at 277 ug/L and 2,136 ug/L during the October 13, 2003 monitoring for the surface and bottom waters, respectively. The TN concentration of the mid-water column sample recorded on December 1, 2003 was 324 ug/L. TN levels in the April 2004 samples were 204 ug/L at the surface and 245 ug/L in the bottom waters. TN concentrations in the inlet samples ranged from 162 (April 2004) to 456 ug/L (July 2003). The outlet samples were detected at 436, 337, 405 and 186 ug/L TN for the July, October and December 2003 and April 2004 samplings, respectively. Again, these concentrations of TN reflect mesotrophic to eutrophic lake conditions (Appendix C).

Chlorophyll *a* concentrations measured in Mirror Lake were characteristic of a mesotrophic system with all samples (inlet, channel, mid-lake, outlet) measuring below 10 ug/L but above 1.82 ug/L during this study. The Secchi depth, a measure of water transparency, was recorded at 5.3, 3.2, 3.4 and 3 meters on July 14, October 13 and December 1, 2003, and April 12, 2004 respectively. These values represent a system classified as mesotrophic to oligotrophic (low productivity).

Chloride and total dissolved solids (TDS) concentrations were not detected at significant levels during this study. Levels of chloride were recorded in the 40 mg/L range with the exception of the December 2003 sample collected at 18 feet of depth which was 22.5 mg/L chloride. TDS values were between 238 to 296 mg/L in all samples in this study.

6.3 Sediment Sampling

One bottom sediment sample was collected in Mirror Lake during the July 14, 2003 sampling. The sample was collected at the deepest point in the lake near the 40 feet deep hole (Figure 6). This deep spot should represent 'worst-case' conditions where suspended solids in the water column settle over time. A Ponar dredge was used to collect the bottom sample, which was sent to UFI for analysis of TP and TN. The results are presented in Table 10. Bottom sediment TP levels were detected at 5,100 mg/kg dry weight and TN levels were 1,200 mg/kg dry weight. The levels detected for TP are in the range of 'moderately polluted' sediments based on USEPA guidance (USEPA, 1982). The high levels of TP and TN detected in the bottom water samples as compared to surface samples show that the bottom sediments are releasing nutrients to the water column during anoxic (oxygen-limited) conditions.

6.4 Phosphorus Mass Balance

K&A estimated the inputs and outputs of phosphorus to the Mirror Lake system to determine the relative magnitude of TP sources and sinks (losses) and to identify those inputs which are the most cost-effective to treat. These sources and sinks are presented in Table 10 and the accompanying graphic.

Phosphorus inputs to Mirror Lake include: atmospheric deposition (estimated from Reckhow, 1980); stormwater runoff; Lake LeAnn inflow; septic systems; and shoreline erosion contributions.

As shown in Figure 13, the largest estimated load from this study is from septic systems at **88 pounds TP/year**. Stormwater sources are estimated to contribute **56 pounds TP/year**. An additional **20 pounds TP/year** is added from atmospheric deposition while Lake LeAnn contributes only approximately **11 pounds TP/year** to Mirror Lake. Erosion from the three eroding shoreline areas contributes approximately **1.7 pounds TP/year**. An estimated **7.9 pounds TP/year** exits Mirror Lake via the outflow structure. Subtracting the outflow from source loads suggests that an estimated 169 pounds of TP is added to the bottom sediments of Mirror Lake annually. The negative impact of this trap or sink is the release of TP back to the water column during anoxic (oxygen depleted) conditions which are observed during stratification. During this monitoring period, lake bottom TP levels were detected at 713 ug/L. During spring and fall turnover, this phosphorus is remixed with surface waters and becomes available for biological uptake.

An estimate of the TP contained in the hypolimnion of Mirror Lake was determined by multiplying the average of the two bottom water TP concentrations (132 and 713 ug/L) by the hypolimnetic volume (1,766,509). Approximately 47 pounds TP is present in the Mirror Lake hypolimnion during times of stratification. The importance of this estimate is that if Mirror lake outflow was from bottom rather that surface waters, a large internal source of TP could be released from the system annually. Alternately, in-lake restoration techniques such as alum treatment could bind this phosphorus and essentially bury it on the lake bottom.

7.0 Aquatic Plant Survey

An aquatic plant survey was conducted on Mirror Lake by K&A on July 14, 2003. This date was selected for the survey because the Mirror Lake Association had an herbicide application scheduled for late July 2003. One herbicide treatment had been applied to the lake earlier in the growing season of 2003. The survey design was based on the Michigan Department of Environmental Quality (MDEQ) "Procedures for Aquatic Plant Surveys".

K&A sampled 14 different sites (Figure 14) in the littoral (shallow) zone of Mirror Lake. At each site, a weighted plant sampling rake was thrown in a north, south, east and west direction from an anchored boat. Aquatic plants attached to the sampling device were removed after each toss and collected in a sampling pan for identification and a relative density rating of: present (a); sparse (b); common (c); or dense (d). Visual observations of emergent plant species were recorded at each site, as well. Table 11 lists aquatic plant species found at each of the 14 sites and the corresponding density rating of each species. Relative density, based on the MDEQ procedures, of both submergent and emergent plant species observed in Mirror Lake are provided in Table 12.

Based on this survey, *Ceratophyllum demersum* (coontail) was present at the highest cumulative percent cover of the submergent species (71.4) with *Vallisneria americana* (wild celery) at 60.7. *Lythrum salicaria* (purple loosestrife) had the highest emergent species cumulative percent coverage during this survey at 24.4 with *Nymphaea odorata* (white water lily) at 20%. The 1999 MDEQ aquatic vegetation survey of Mirror Lake showed *Vallisneria americana* and *Chara sp*. (Table 13) as the most common submergents (73.04 and 70.65%, respectively) and *Nymphaea sp.* and *Lythrum salicaria* as the most common emergent species (18.11 and 17.3%, respectively).

Three exotic species were found in Mirror Lake during this survey: *Myriophyllum spicatum* (Eurasian water milfoil); *Potamogeton crispus* (Curly-leaf pondweed); and *Lythrum salicaria* (purple loosestrife). Purple loosestrife was observed during the 1999 MDEQ aquatic vegetation survey conducted on Mirror Lake, but Eurasian water milfoil and curly-leaf pondweed were not noted at that time. Purple loosestrife was observed at ten of the 14 survey sites during the 2003 K&A survey and was abundant during the 1999 MDEQ survey as well, noted at all but one survey site. Eurasian water milfoil was observed at only two survey sites (sites 6 and 7) during this 2003 study but it was present at levels rated as ‘dense’ at one of these sites (site 6). This species has the potential to spread through a lake system rapidly and dominate the submergent plant population. Eurasian water milfoil can outcompete native plants with its ability to grow when spring water temperatures are still cool. This head start over the native vegetation can allow the Eurasian water milfoil to develop a canopy, shading out other submergent plants. In addition, Eurasian water milfoil can reproduce easily from plant fragments that can float to new locations and take root. Curly-leaf pondweed was found at one location (site 9) in Mirror Lake during the 2003 K&A survey at a density level rated as ‘present’. While this species is not as invasive as Eurasian water milfoil, it can grow in cool water while native vegetation remains dormant. Winter foliage can be produced under a cover of ice and die back in mid-summer releasing nutrients into the water column. The plant is also tolerant of turbid water conditions. An additional plant to watch for in Mirror Lake is *Hydrilla verticillata*. This plant has the potential to cause serious alteration the lakes surface waters. Like other exotic species, Hydrilla can outcompete native vegetation and dominate a waterway. (See Appendix D for more information on exotic vegetation in Mirror Lake.)

Exotics can enter Mirror Lake a number of ways. Boats can carry plant fragments from an infected lake into Mirror Lake. In addition, any exotic vegetation present in upstream Lake LeAnn has the potential to enter Mirror Lake via their discharge. Transient wildlife may also serve as carriers of plant parts from one lake to another.

8.0 Self-Monitoring Program

Consistent, frequent monitoring of Mirror Lake would provide a long-term database to document changes over time. These data are also necessary to compare conditions both before and after a specific treatment/management change to determine success. Also, consistent monitoring depicts water quality trends that would not be apparent from infrequent, sporadic sampling efforts.

Mirror Lake Association volunteers have been conducting Secchi disk transparency readings since the summer of 2003. Consistent weekly or semi-monthly readings of transparency would provide a useful long-term database to observe any emerging trends. Annual surface and bottom phosphorus samples at the lake's deepest area should also be monitored during spring, summer and fall periods.

The MDEQ along with the Michigan Lakes and Streams Association (MLSA) oversee the Cooperative Lakes Monitoring Program (CLMP). The CLMP is a program aimed at assisting lake associations in collecting and compiling water quality data collected by lake association volunteers. Interested lake associations must send in an application form to the MLSA providing basic contact information as well as a list of parameters the association is interested in monitoring for the sampling year. Current monitoring projects include: Secchi disk transparency, spring total phosphorus, summer total phosphorus, chlorophyll, and dissolved oxygen. There is a separate cost associated with each program an association is enrolled in. Additional information on CLMP is provided in Appendix E.

9.0 Fisheries

A compilation of Mirror Lake fisheries data was reviewed in Jude and Ervin (1998). The MDEQ and Michigan Department of Natural Resources (MDNR) were contacted, but did not have additional data to contribute to this current K&A study. These management agencies generally do not collect information on private lakes. However, the fisheries division is currently producing a Grand River Fisheries Assessment. The Jude and Ervin (1998) report would likely be useful for the MDNR to review for the Fisheries Assessment. The Mirror Lake Committee should consider providing a copy to the MDNR, as Mirror Lake is a Grand River headwater impoundment and management of the lake fishery affects waters downstream.

9.1 Tracking the Fishery

A standardized creel survey was provided to the Association in early 2004 and distributed to Mirror Lake anglers (Appendix F). The survey did not generate new information to update fishery investigations by Jude and Ervin (1998). K&A recommends that the Association encourage use of the standardized form to track long-term fishery dynamics. Ideally, information contained on the forms, compiled over multiple seasons, can provide information about lake angling pressure, fish capture rate, habitat specific capture success, species-specific health parameters, and stocked species growth and survival.

9.2 Angling Pressure

The Mirror Lake Committee has indicated that there are relatively few regular Mirror Lake anglers. Anglers generally know one another and communicate regularly. Given the low amount of angling pressure on the lake and the lack of a public access, angler removal of fish will not likely impact the fish community structure. Thus, it is not recommended that Mirror Lake anglers consider any self-imposed limits beyond State of Michigan regulations.

9.3 Review of Previous Mirror Lake Plan

Previous work by Jude and Ervin (1998) included fisheries sampling information. A brief review of findings and recommendations include the following:

1998 Findings –

- ♦ Bluegill were successfully reproducing and growth was above state average, perhaps boosted by a strong zooplankton forage base and removal of small bluegill by predators
- ♦ Largemouth bass were successfully reproducing but growth was below state average, perhaps due to limited available forage
- ♦ Deep, coolwater, oxygenated habitat was limited due to a habitat squeeze between warm surface waters and deoxygenated bottom waters below 20 feet during summer stratification
- ♦ Fish species were considered diverse with 18 species identified
- ♦ Diverse fish habitat exists within the lake with shallow bays, sand/gravel shoals, shoreline woody debris, and diverse weed beds

1998 Recommendations –

- ♦ Salmonid and/or walleye stocking was not recommended due to the habitat squeeze and inappropriate temperature regime, especially for salmonids
- ♦ Northern pike stocking was recommended at 1-2 per acre despite expected slow growth due to coolwater habitat limitations
- ♦ Channel catfish stocking was recommended, despite the fact that they were considered to be exotic species in Mirror Lake
- ♦ Deepwater habitat (deoxygenated) is the only habitat that needs improvement, but costs were considered to be too high to be feasible

9.4 Additional 2004 Considerations

Ultimately, Mirror Lake angler desires will drive future stocking plans. To the average bluegill angler, Mirror Lake would likely be considered an excellent fishery. Bass anglers, on the other hand, would likely be disappointed with smaller than average largemouth size. The MDNR generally discourages or denies permits for bluegill, bass, or yellow perch stocking, instead preferring to let these species develop a natural balance. The combination of large bluegill and small bass is not common in Michigan and may be the result of a lack of abundant forage fish. Essentially, predators eat young bluegill until their numbers are severely reduced. Remaining bluegill then share abundant food supply, grow fast, and become less vulnerable to predators due to their large size.

Adding top predators (e.g., channel catfish, northern pike, walleye) to the lake could increase competition for forage fish and further strain the stunted bass population, thereby precluding the success of stocked predators (Kregg Smith, MDNR, personal communication, 2004). This may also help explain the failure of previously stocked predators to fully establish in the lake, though habitat limitation is also a likely factor. DNR fisheries biologists rarely recommend forage fish stocking; however, if Mirror Lake anglers are interested in forage stocking, the DNR considers fathead minnows to be the preferred general forage species.

Mirror Lake anglers have expressed specific interest in walleye stocking. K&A agrees with previous walleye stocking assessments in that deep coolwater habitat is lacking in the summer months due to warm surface waters and deoxygenated waters below 20 feet, effectively limiting walleye to shallower, warm habitat. Walleye prefer water with a maximum temperature of 25 ºC (77 ºC) (Baker et al., 1993). Available habitat temperatures measured in this study in July slightly exceeded 25 ºC. In addition, the previous fisheries report indicated that past stocking may have resulted in at least some walleye growth and survival over multiple seasons. Thus, even though habitat would not be considered ideal, it is only slightly out of temperature range.

It is also important to consider how changes to Mirror Lake phosphorus loading will potentially reduce walleye habitat squeeze. Nutrient management options undertaken by the Association should reduce the deoxygenated zone in the deep waters of the lake and open up more deep coolwater habitat for walleye. Though an ideal deepwater habitat can never be fully achieved, there are no overarching reasons why walleye stocking should be delayed, especially if minnow stocking occurs simultaneously.

The MDNR typically stocks walleye fingerlings (< 2 inches; also called "spring fingerlings) at a rate of 50 – 100 per acre; yearlings (3 - 6 inches; also called "fall fingerlings) are stocked at a density of about 15 per acre (MDNR personal communication).

In the past, fisheries professionals rarely considered or had much opportunity to select local broodstock for stocking operations. Advanced genetic techniques have been refined in the past decade and applied to fish stock identification. The result is that fisheries professionals and the aquaculture community increasingly recognize that unique genetic fish stocks exist in different drainages. For example, the lake Erie walleye population is unique and identifiable from the Ohio River walleye population. Mixing the two populations will produce young, but long-term population health will decline. The bottom line for the Association is that the best and most responsible broodstock selection that they can make for purchase of walleye would be from a producer using broodstock from local populations. In addition, stocked walleye from local broodstock will be better adapted to regional conditions. The use of local strains is recommended for any fish species stocked in Mirror Lake, and is consistent with MDNR preferences.

The MDNR suggested a name of a grower in the Mirror Lake area named Dan Laggis of Laggis Fish Farm. In the past, Dan had selected broodstock of walleye from Iowa, however, MDNR biologists have encouraged him to develop local broodstock instead of, or in addition to, his Iowa stock. We recommend that the Lake Committee contact Dan specifically to discuss the status of his walleye operation and the projected availability of locally produced walleye.

Selection of proper broodstock is particularly important given the Mirror Lake is actually an onstream impoundment of the Grand River. Though it may seem unlikely, walleye escapement is possible over the outflow weir, especially during high flows. Walleye species routinely pass through hydropower and flood controls dams in the Midwest and are considered one of the most highly migratory riverine fish species.

It is important to recognize that the upstream Lake LeAnn fishery is directly connected to Mirror Lake through its outlet structure. Previous fishery investigations indicated that at least one surprisingly strong northern pike year-class occurred in Mirror Lake in the recent past. It is possible that the population came from upstream Lake LeAnn, where pike may have more available spawning habitat. Fostering communication with Lake LeAnn anglers is recommended to stay current on the status of their fish community. Additional information can be gleaned from Lake LeAnn about aquatic nuisances such as zebra mussels, carp, milfoil, and hydrilla.

10.0 Lake Improvement/Management Options and Estimated Costs

Based on the findings of this study, a list of options are offered as potential approaches for the Mirror Lake Association to consider for both short and long-term management of Mirror Lake. In addition, cost estimates are provided to assist the Association with assessing the feasibility of each approach. These recommendations address expressed concerns by the Association as well as specific findings of K&A efforts.

A. Stabilize erosion problem areas

Three significant erosion areas where identified near stormwater outfalls (#1, #3 and #7) during this study (Figure 5). These areas should be stabilized using a combination of rock rip-rap and bioengineering (deep-rooted plants) where appropriate to minimize sediment and phosphorus entering the lake from these exposed soils. Approximately 1.7 pounds of TP are added annually to Mirror Lake. It is a general rule of thumb that one pound of phosphorus in a lake can equate to 500 pounds of plant and algal material (Minnesota Lakes Association, 2004). In addition, steep riparian areas along the channel may also be contributing to the sediment and phosphorus loads to the lake. Alternative landscaping, incorporating deeply-rooted native vegetation near the lakeshore, would serve to stabilize the shoreline, slow runoff along the steep gradient and discourage waterfowl from congregating along the shore.

Cost estimate: $30-$50/linear foot of shoreline ($1,500-$2,500 total for the three identified sites)

B. Increase vegetation "filter" in park area along East Shore Drive

During a rain event in 2003, K&A observed a significant sediment load entering the wetland area in the park on the east bay of Mirror Lake. The wetland is serving to filter out some of this sediment load before it enters Mirror Lake. Increasing the density of native wetland vegetation in this park area would provide increased sediment trapping capabilities, enhancing water quality in both the wetland and Mirror Lake.

Cost estimate: $50-$100

C. Implement a regular street sweeping program in area south of Vicary Road

Regular removal of accumulated debris in the paved channels along Highland Hills Drive and Killarney Circle would result in less pollutants entering Mirror Lake. Debris collects in these channels during dry weather and is washed into Mirror Lake during rain events. This contributes to both the sediment and phosphorus load to the lake. Requests should be made to the township or county road commissions, depending on which authority is currently responsible for these activities at the local level. Since the remaining roadway areas around Mirror Lake do not have curbs and gutters, street sweeping would not be effective. Homeowner removal of litter, debris and yard waste from curb and gutter systems, culverts or existing roadways should be stressed through educational efforts.

Cost estimate: $500-$1,000 (annual County costs)

D. Septic system considerations

It is estimated in this study that over 88 pounds of phosphorus enter Mirror Lake annually via septic systems. This accounts for 50% of the predicted annual TP load. Strategies to reduce this phosphorus load entering via septic systems may include:

1. Increase clean-out/maintenance frequency of septic systems. On average, septic tank clean-out should be conducted every 2-5 years depending on the number of individuals residing in the

home and the size of the system. Faulty or improperly maintained systems can result in increased leaching of nutrients from the drainfields to the lake. A group rate might be negotiable with one septic hauler if the Association could agree to pursue this option.
Cost estimate: $200-$500 per cleanout

2. Replace old or failing systems. For older homes with older septic systems (>25 years) that have drain fields within 100 feet of the lake, a septic system and drainfield replacement should be considered, especially if there has been infrequent maintenance. Drainfield soils can become saturated with phosphorus and thereby directly transport phosphorus from wastewater to the lake. (The soils are the "treatment" whereby soil particles bind phosphorus molecules until they are saturated and then lose this binding capacity). The Mirror Lake Association should also work closely with the County Health Departments to ensure that with each new property transaction, existing systems for homes on the lake are inspected prior to new owner occupancy. If systems are outdated, the Health Departments should be asked to implement or enforce a policy requiring system replacement. Areas in the northwest corner of the lake where *Cladophora* growths were noted in the spring of 2004 might be an area to focus initial voluntary efforts to encourage homeowners to consider updating their systems. Concerns over adequate setbacks from the lake may be present in this area given steeply sloping shorelines.
Cost estimate: $2,000-$5,000 per new system
3. Use dishwashing detergent containing low or no phosphorus levels. Available brands include: Shaklee; Bi-O-Kleen; Earth Friendly Products; Ecover; Enviro-Rite; Life Tree; President's Choice; Seventh Generation; and Ultra Citra-Dish.
4. Eliminate septic systems by sewering lake properties. Local initiatives for sewering other lake communities are underway. Capacity will be available to connect Mirror Lake area homes to this system. Costs per connection in 2003 were estimated at $10,000 per household.
Cost estimate: $500,000 (for all lake front homes)

E. Eliminate exotic plant species

Three exotic plant species (Eurasian water milfoil, curly-leaf pondweed and purple loosestrife) were found during the 2003 vegetation survey on Mirror Lake. Efforts to eliminate these species should be undertaken. Whole lake Fluridone (Sonar) treatment for Eurasian water milfoil is not recommended at this time. This approach will be costly as the entire lake would require treatment to maintain a minimum dosage level through all areas for an extended period of time. Though the hydraulic retention time is more than adequate to accommodate this treatment approach, spot treatment with Diquat is recommended approach based on the limited area of observed milfoil. A weed treatment applicator can address appropriate chemical treatments for the curly-leaf pondweed. Purple loosestrife presents a greater treatment challenge as it will require individual efforts to control and eradicate this exotic by direct removal and spot treatment with Roundup. A broader effort could be undertaken with "biocontrols". A beetle that feeds exclusively on loosestrife can be purchased and broadly distributed amongst various stands of loosestrife around the lake. Additional details on each the nuisance exotic species are provided in Appendix D. In addition, informational signs should be posted at the boat launch area to educate boaters on the potential of spreading exotic species from lake to lake on boat trailers, motors, etc.
Cost estimate: $15,000-$35,000 (existing annual weed treatment costs)

F. Maintain a buffer of native vegetation along the lakeshore

A zone of native vegetation between a residence and the lakeshore is important in providing a buffer to slow stormwater runoff, allowing particles to filter out prior to reaching the lake. In addition, this vegetation can trap grass clippings, leaf litter and other debris that can serve as a nutrient source for nuisance algae and other aquatic plants. Tall vegetation along the lakeshore has also been shown to

discourage waterfowl from using these areas. (See Appendix G for more information on native vegetation.) While a large portion of the Mirror Lake shoreline remains relatively natural, several areas around the lake have closely mowed turf-grass or mulched areas that can result in erosive conditions or conditions favorable for heavy waterfowl use. Deep-rooted plants growing between the septic drainfield and the lakeshore can also intercept phosphorus and nitrogen leaching from the drainfield before it reaches the lake. Thus, a naturalized shoreline buffer can provide multiple environmental benefits. K&A has worked with other lake associations that are voluntarily attempting to naturalize their individual shorelines with mixed success. Participation will depend on the successful outreach and education by the Association to their members. By examining combinations and costs of buffers, septic system cleanouts or replacements vs. the costs of worsening water quality, (or more directly, public sewers), the level of voluntary participation should increase.
Cost estimate: $50-$200/homeowner

G. Implement good lake stewardship practices

1. Use lawn fertilizer containing zero-phosphorus to avoid fertilizing the lake.
2. Keep leaf litter, grass clippings and ashes out of lake. Leaves and other lawn debris can decay in the lake and act as a nutrient source for nuisance algae and other aquatic plants. During spring 2004 sampling, ash piles were observed within 10 feet of the lake at several sites along the lakeshore.
3. Wash cars in lawn areas away from lake to allow wash water to infiltrate into the ground instead of running off pavement into storm drains entering lake.

H. Implement a citizen lake monitoring program

The MLA would benefit from a consistent, long-term lake monitoring program to track any emerging trends in water quality. The Association could choose a simple self-monitoring program consisting of Secchi depth and phosphorus monitoring or a more intensive monitoring plan as a part of the MDEQ Citizen Lake Monitoring Project.
Cost estimate: $100-200/year

I. Establish partnership with the Lake LeAnn Association

Mirror Lake and Lake LeAnn are directly connected via the Lake LeAnn dam at Vicary Road. Lake level and rainfall monitoring during this study suggest that Mirror Lake outflow is dependent on flow from upstream Lake LeAnn. Therefore, it is important that the two lake associations work together to improve water quality in both lakes. A better understanding of Lake LeAnn discharge schedules, chemical treatments, etc. is vital in managing Mirror Lake issues. Exotic species in Lake LeAnn can also enter Mirror Lake via the inflow area. In addition, the hydraulic residence time of Mirror Lake will be seasonally dependent on the Lake LeAnn discharge rate. This might be critical during periods of weed treatment where an upstream discharge could impact chemical applications.

In order to ensure the high quality of water entering Mirror Lake via Lake LeAnn, discharge from the upstream lake must continue to be from surface waters with a consistent discharge schedule.
Cost estimate: $0

J. Eliminate directly contributing stormwater outfall areas

Nine stormwater outfalls are located around Mirror Lake with an additional input from areas south of

Vicary Road. Where possible, stormwater should be diverted into retention/detention areas to allow settling of pollutants prior to entering Mirror Lake. County road or drain commissions should be contacted and a dialogue started regarding these inputs to Mirror Lake. Thus, as new road projects are planned, design considerations can more readily be integrated into improvements. Gravel roadways and direct erosion into culverts or drains leading to the lake should be periodically checked by the Lake Association and erosion problems reported to the appropriate agencies.
Cost estimate: $2,000-$10,000/outfall (County costs)

K. Fisheries considerations

Mirror Lake anglers have expressed a desire to stock walleye. There are no reasons not to stock as long as it is recognized that habitat limitation may preclude strong growth and survival unless there are deepwater habitat improvements. In the short term, the returns of stocking a top predator may be low but should improve over time.

- To maintain the current bluegill fishery –
    - ♦ Stock nothing
- To maintain the current bluegill fishery, and increase bass size –
    - ♦ Stock fathead minnows
- To develop an additional top predator fishery (e.g., walleye, channel cat, northern pike) –
    - ♦ Stock predator and
    - ♦ Stock fathead minnows

The State of Michigan regulates fish stocking in "public waters". This designation includes waters with permanent inflow and outflow structures such as Mirror Lake, which is an on-stream impoundment of the Grand River. The Department of Natural Resources Stocking Permit is included in Appendix F. The Lake Committee must follow these MDNR guidelines prior to undertaking stocking activities.
Cost estimate: Varies depending on fish size, stocking density, and vendor

L. Communication with government entities to oversee future management

The Mirror Lake Association should seek partnerships with the townships, and Hillsdale and Jackson County road and drain commissions to ensure future management plans for the watershed incorporate sound management options for Mirror Lake. Township zoning for future development will affect both drainage patterns and pollutant loads to Mirror Lake and therefore, stormwater retention should be required in areas of future development. Also, road maintenance should be conducted with appropriate sediment control measures in areas surrounding Mirror Lake. Communication with county drain commissions is also pertinent to managing lake levels.
Cost estimate: $0

M. Alum treatment to eliminate sediment phosphorus release

Hypolimnetic waters of Mirror Lake are highly enriched with nutrients based on July and October 2003 monitoring. This phosphorus becomes available after spring and fall turnover. Alum treatment is a method of binding phosphorus in sediments that can inactivate this source of phosphorus to the lake. The effectiveness of this treatment is dependent on minimizing other sources of phosphorus to the system to ensure that new phosphorus and sediment loads do not cover this alum "blanket". This technique has been shown to be an effective treatment, with an estimated life-span of 5-15 years, depending on the lake dynamics. Inactivation of phosphorus in

bottom sediments may also help diminish the potential for blue-green algal blooms that have been noted recently in Mirror Lake. These opportunistic, noxious algae can bloom rapidly under the right conditions of high sunlight, calm water and high phosphorus loading.
Cost estimate: $33,000

<u>N. Hypolimnetic discharge</u>
By releasing bottom waters from the Mirror Lake outflow structure instead of releasing higher quality surface water, an estimated **47 pounds of TP** could be removed from the system annually. While this is a significant reduction in TP from Mirror Lake, implementation challenges will include high cost for engineering, legal assistance, permitting and construction associated with reconfiguring the outflow structure. Moreover, the potential negative effects of discharging this enriched water to downstream Grand Lake may preclude regulatory approval.
Cost estimate: $50,000-100,000 (one time costs)

<u>O. Hypolimnetic discharge with alum addition prior to Grand Lake</u>
This option would incorporate alum addition to the hypolimnetic withdrawal noted above prior to discharging to Grand Lake. A small “treatment system” would be located on the north end of Mirror Lake to precipitate out the phosphorus before discharging the overflow to Grand Lake, thus minimizing downstream detrimental effects of the hypolimnetic discharge. This treatment technique is now being used more frequently to treat stormwater with growing success. Some method to capture the precipitated phosphorus (which will be in a flocculent state) may be necessary. Bench scale (treatability) testing will be needed as well as additional permitting.
Cost estimate: $70,000-120,000 (one time capital plus $500-1,500/year treatment) (these are in addition to the outlet structure costs)

<u>P. Hypolimnetic Aeration or Artificial Circulation</u>

Many eutrophic lakes throughout the world that experience low oxygen conditions in bottom waters (resulting in lost habitat and increased phosphorus recycling from sediments) have installed bottom water aeration systems or circulation pumps. Both techniques have met with mixed success in achieving water quality improvement goals. Installation and maintenance, as well as electrical costs to operate mechanical systems (oxygen delivery or circulation pumps) are quite high. There are many other factors that also need to be considered in the design and engineering of these systems. Ecological impacts must also be addressed as part of the permitting process required for these systems to be installed. A long-term commitment to a maintenance contractor or by Association volunteers will be necessary to ensure that such systems are operating during critical periods of the year.
Costs Estimate: ($120,000-$200,000)(one time costs for engineering, permitting, equipment and installation plus $3,000-$6,000 per year for operation and maintenance)

At this time, K&A would not recommend either of these strategies before consideration of in-lake alum treatment and implementation of other less-expensive management strategies. A note of caution should be expressed here based on past experiences. Lake Associations are frequently solicited by vendors attempting to sell systems based simply on product brochures and limited scientific support. Strategic assessments of engineering and environmental issues need to be made prior to committing to such techniques.

Lake management requires a holistic approach. So long as all integral and complex environmental factors and implementation efforts are strategically considered, hypolimnetic aeration or artificial circulation could become a part of these broader management efforts.

Q. Pursue outside funding for implementation of management options

Mirror Lake may have limited opportunities to receive grant funds from the state of Michigan because there is no public access on the lake. This is typically an unwritten requisite where taxpayer dollars will be expended. As such, it would be useful for the Association to consider partnering with other area lake associations to increase their chances to obtain state funds. Such funds might be somewhat limited with several partners, however, there could be opportunities to further develop management strategies such as working on policy, ordinance and operational practices with local agencies. State support could also fund ongoing sampling efforts as well as some additional design of structural improvements (erosion and stormwater sites). Other partnerships with local conservation agencies could provide opportunities to share resources and obtain additional information and services at no or low costs to the Association. One opportunity, for example, might be to team with local groups that are specifically targeting the eradication of purple loosestrife. In addition, many local communities are required to address water quality impacts from stormwater and have generated a wealth of educational information that could be used by the Association. Formation of a Lake Board could be considered if one of the larger efforts involving significant construction costs is desired. The Lake Board would be singularly focused on that issue and would have the assessment authority over riparians.

Recommendations noted above for working directly with township planners, and county road and drain commissions will be necessary to ensure that management needs that are good for the lake can be integrated early in their planning processes. K&A has successfully worked with lake associations that initiated these efforts, thus achieving at no cost to them, their desired improvements (e.g., stormwater controls) with this strategy. Other associations have successfully developed cost share opportunities with local agencies. Still others have maintained an active affiliation with state (e.g., Michigan Lakes & Streams) and national (North American Lake Management Society) organizations so that they remain aware of unique opportunities. Armed with information about the pertinent issues and needs for the lake, Mirror Lake is now in a better position to attract the interests of others seeking to institute new programs, develop new equipment or monitoring protocols, or wishing to partner on innovative projects. These can lead to additional funding or technical support for the lake.

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Figure 1. Mirror Lake and Surrounding Area.

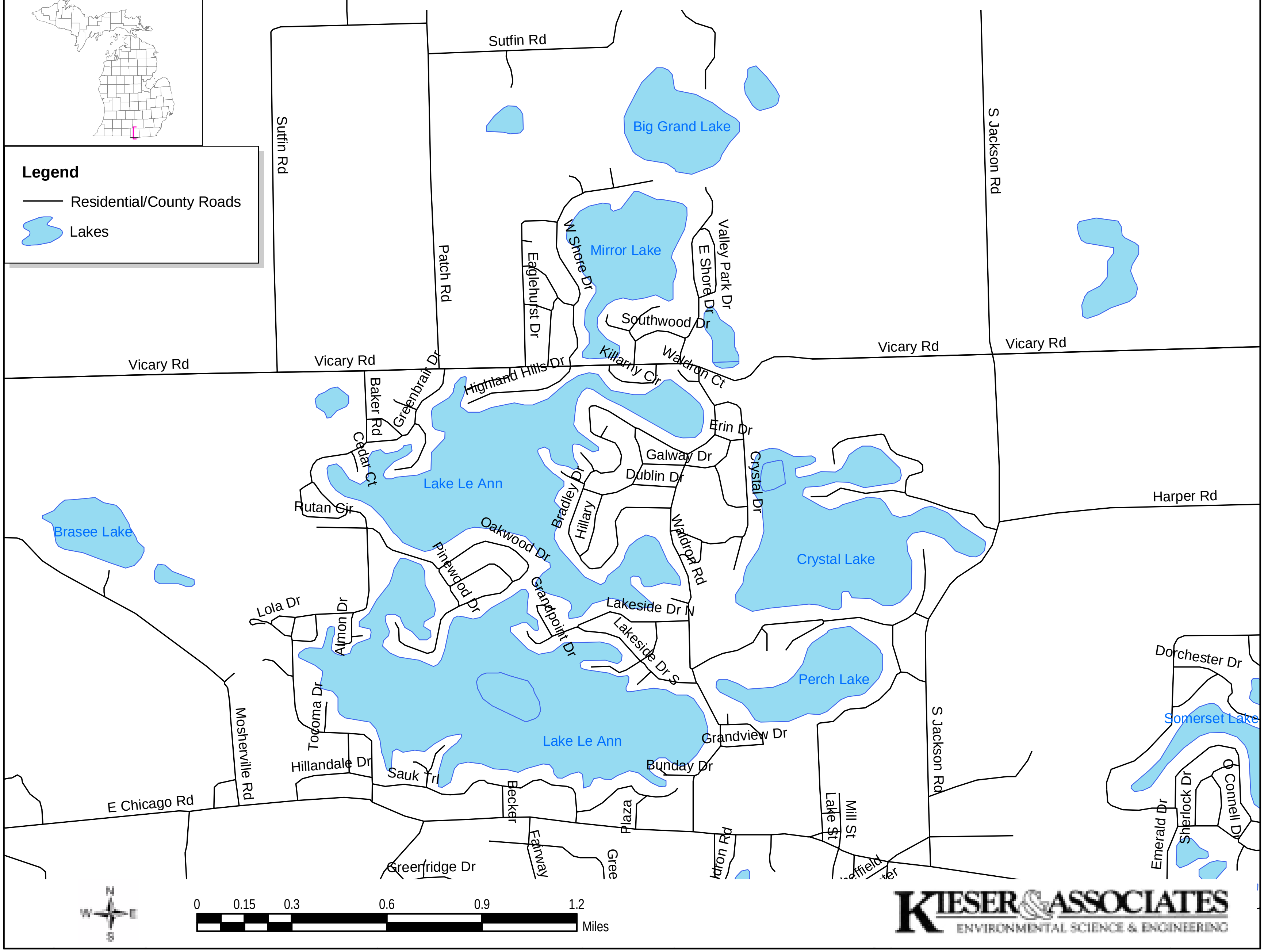

Figure 2. Mirror Lake Watershed.

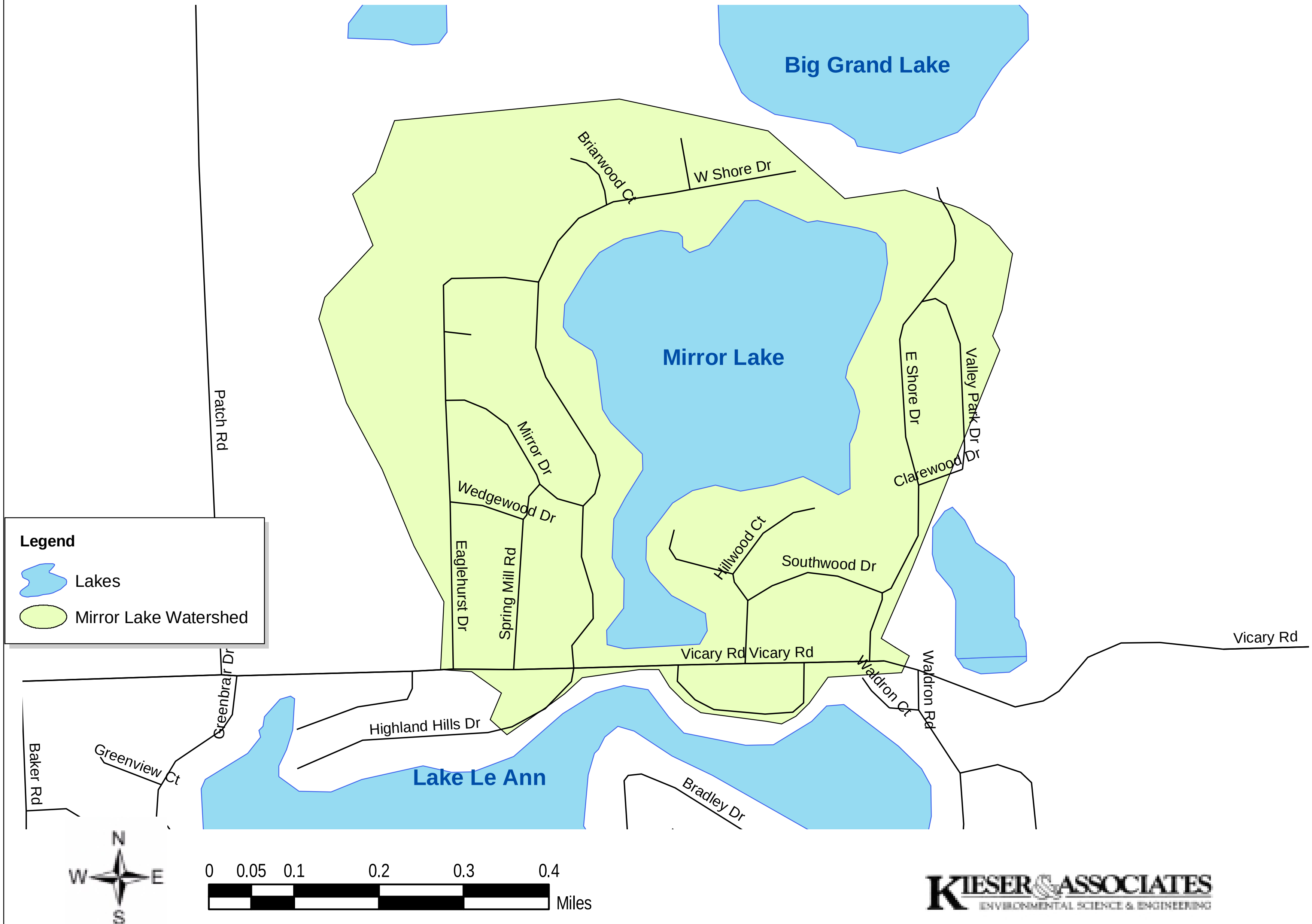

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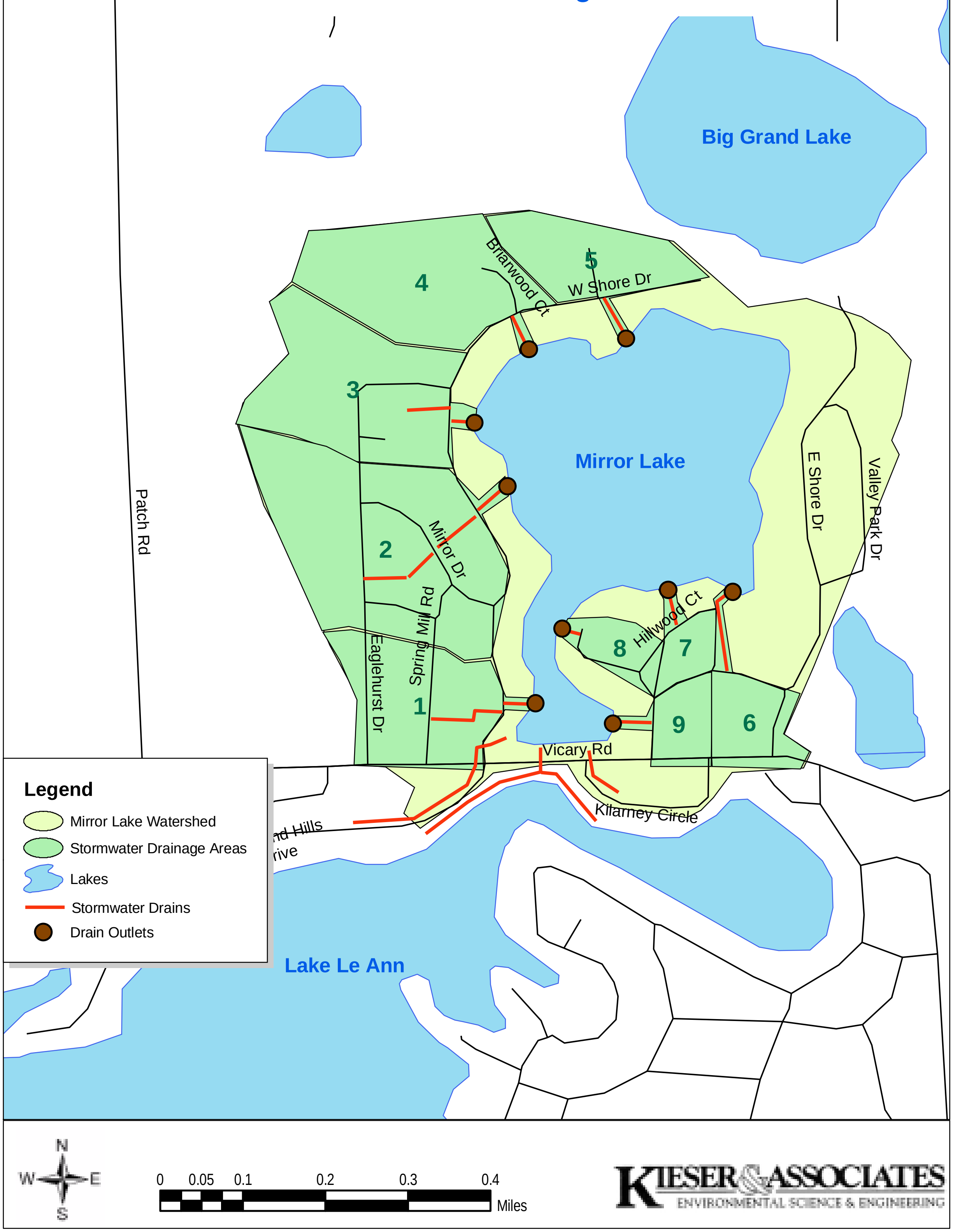
Figure 3. Mirror Lake Stormwater Outfalls and Associated Drainge Areas.



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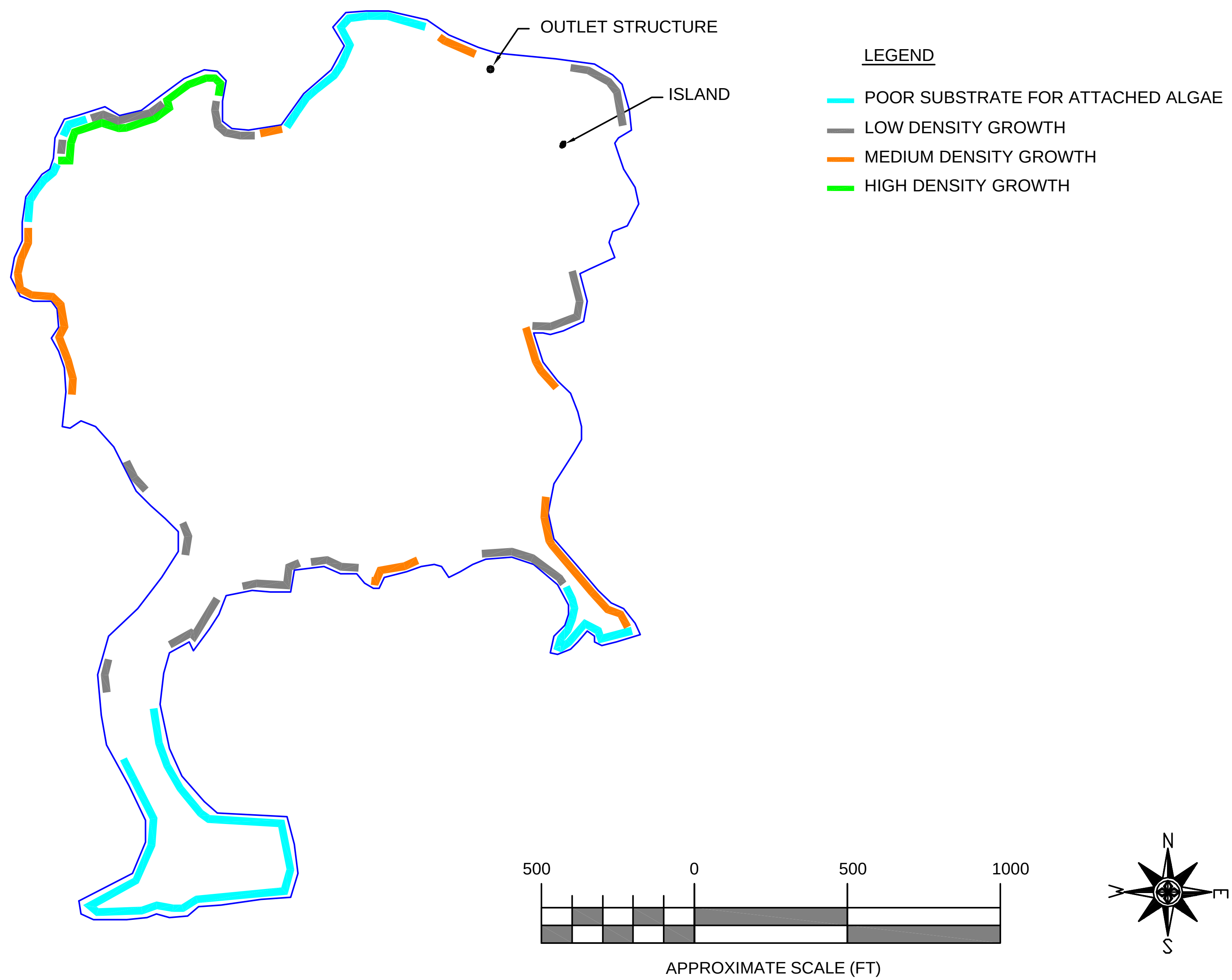

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FIGURE 4.
MIRROR LAKE SHORELINE CLADOPHORA SURVEY
APRIL 12, 2004.

FIGURE

4

Figure 5. Mirror Lake Lakeshore Erosion Sites (See Figure 3 for locations).

Outfall #1

Outfall #2

Outfall #7

DRAWN BY: KBB CHECKED BY: MSK REVISED:

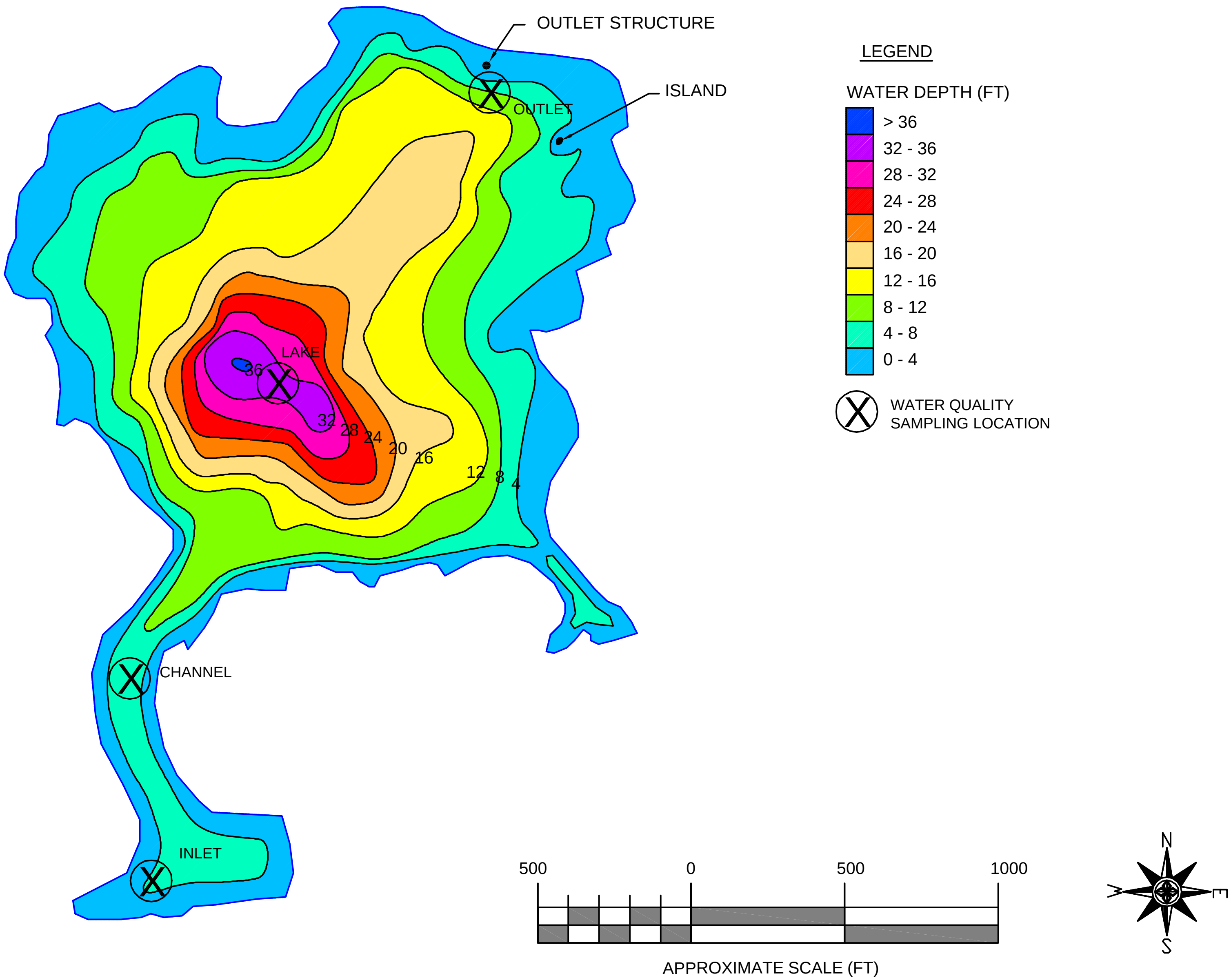

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FIGURE 6.
MIRROR LAKE BATHYMETRY MAP (JUNE 8, 2003) AND WATER QUALITY SAMPLING LOCATIONS.

FIGURE
6

Figure 7. Mirror Lake Hourly Level and Hourly Rainfall Total.

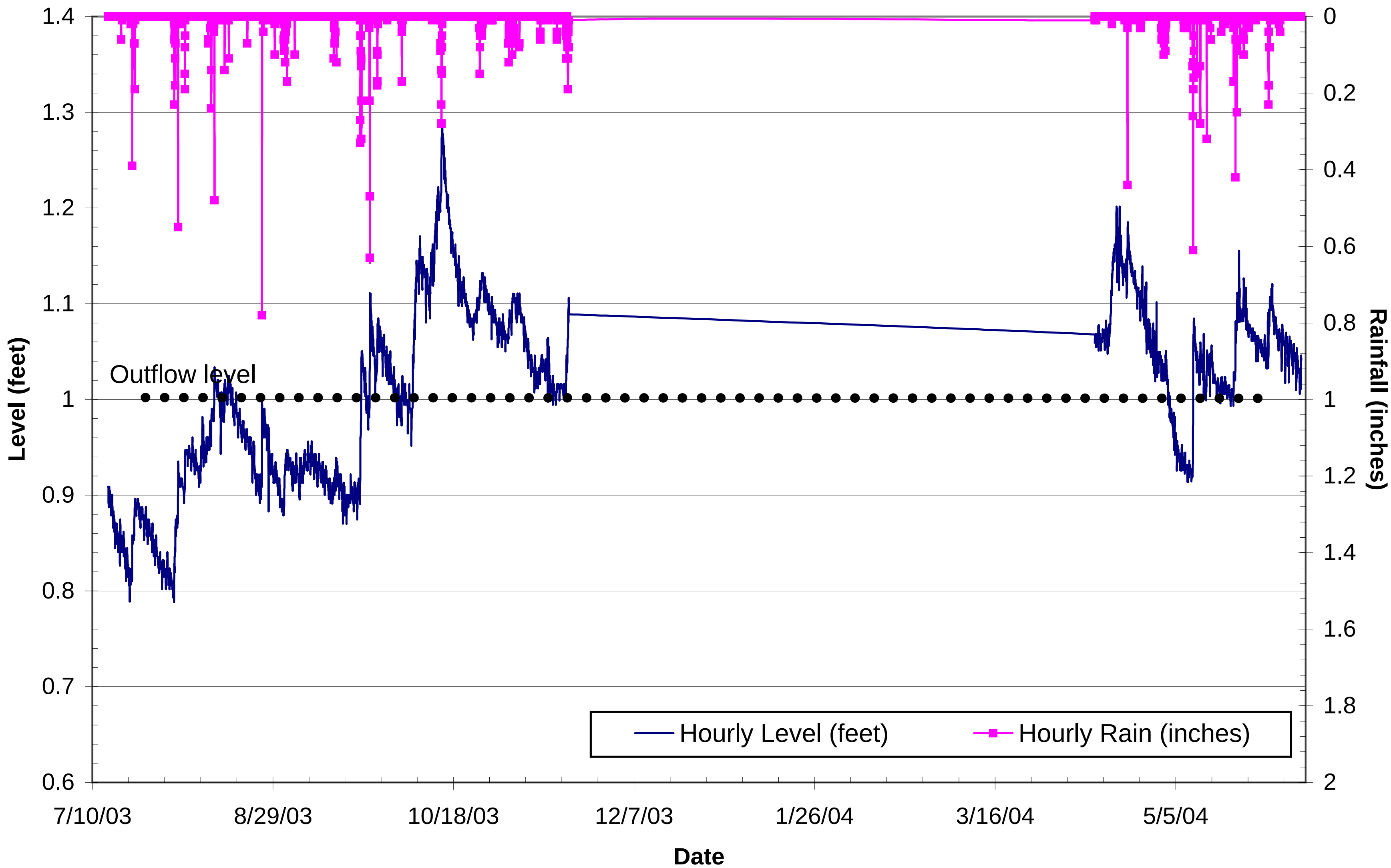


Figure 8. Lake LeAnn Inflow October 13, 2003.

Figure 9. Mirror Lake Dissolved Oxygen and Temperature July 14, 2003.

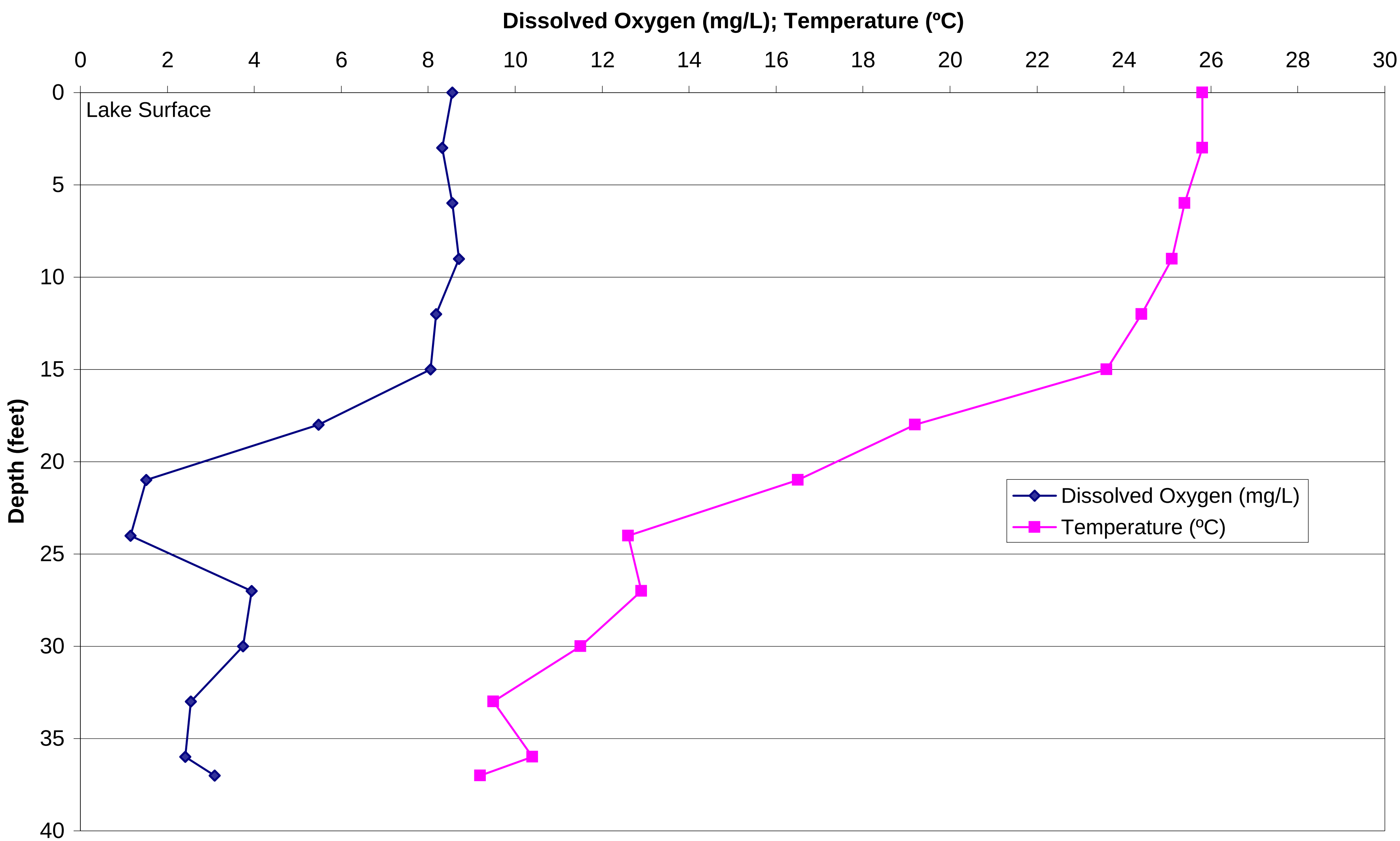


Figure 10. Mirror Lake Dissolved Oxygen and Temperature October 13, 2003.

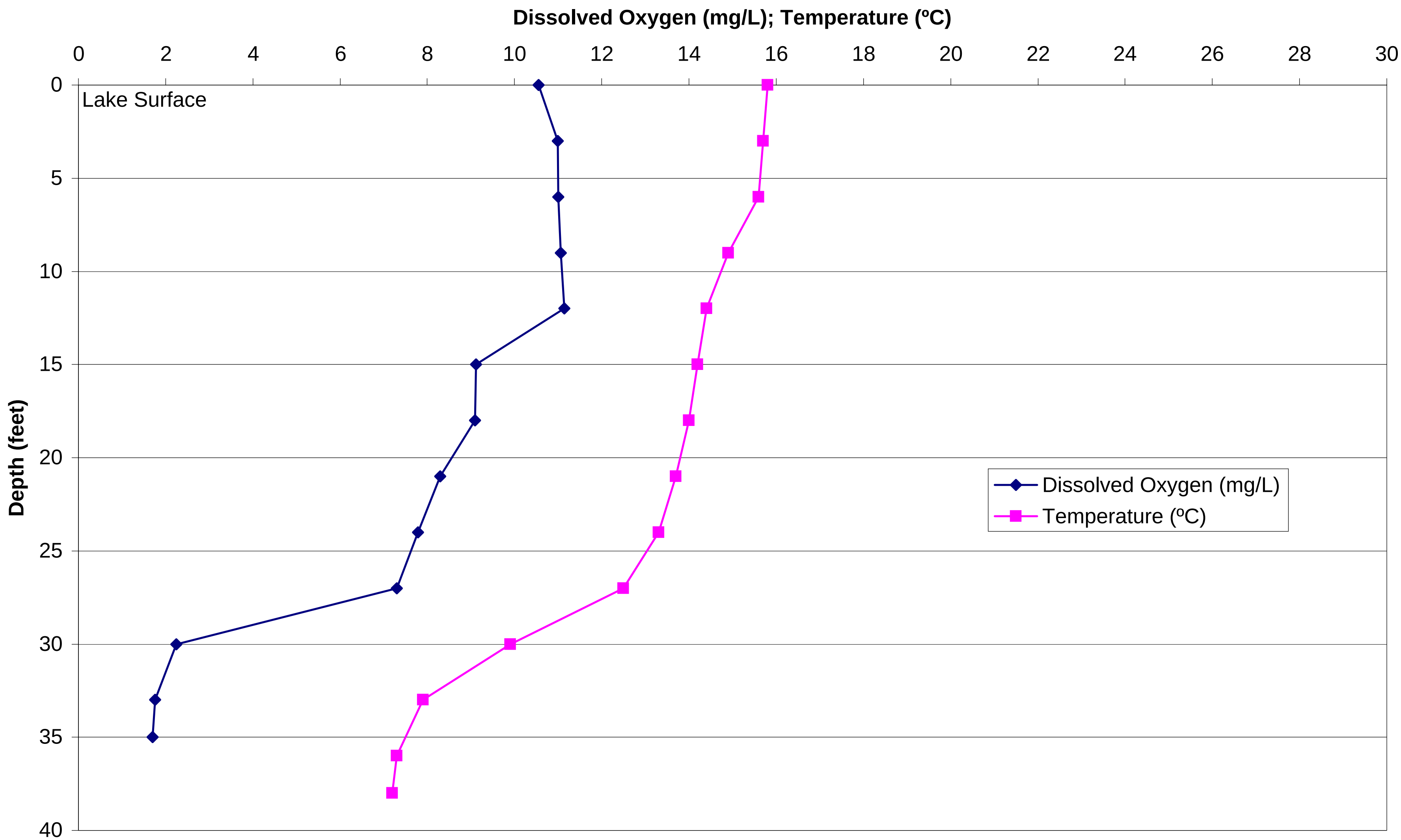


Figure 11. Mirror Lake Dissolved Oxygen and Temperature December 1, 2003.

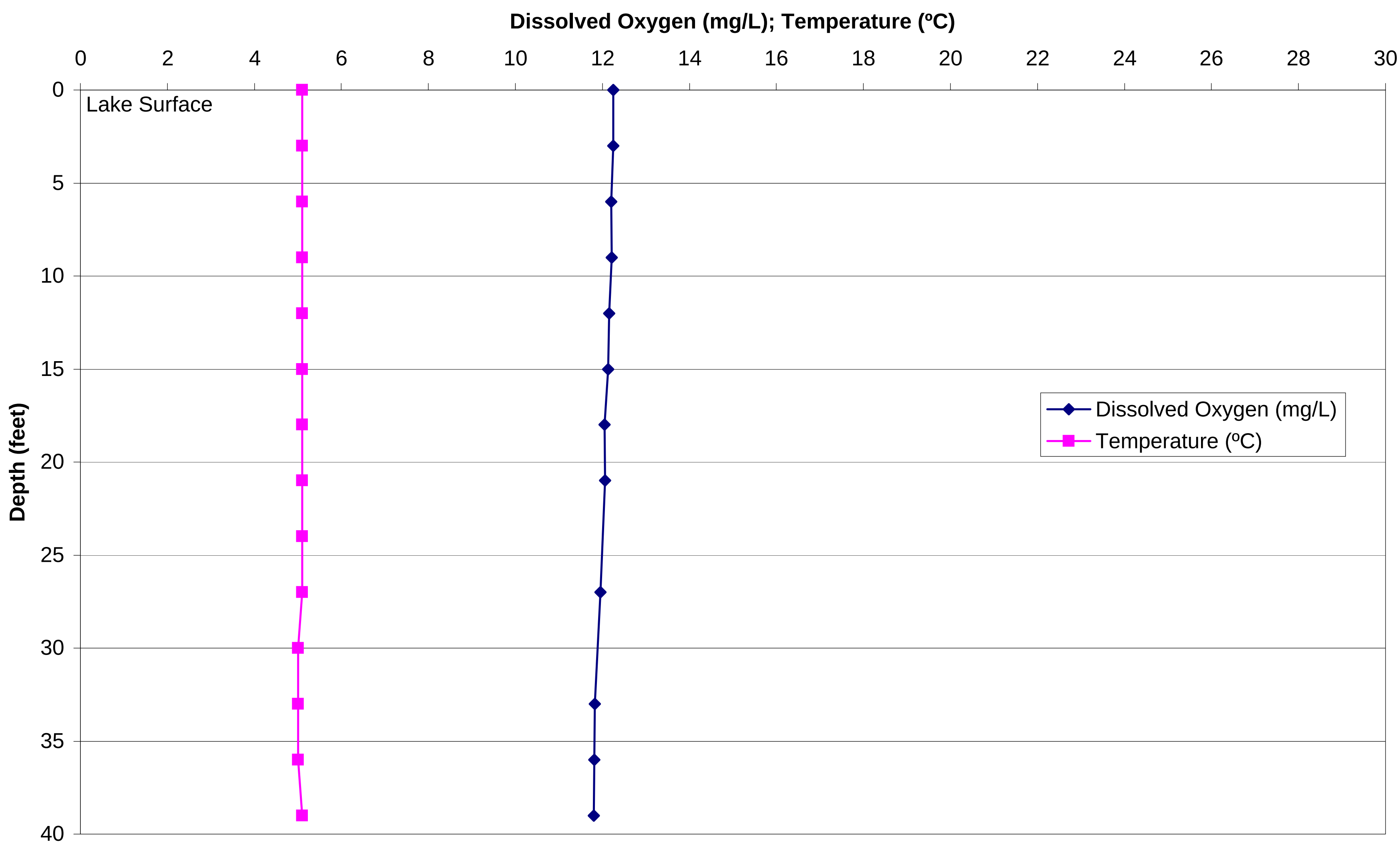


Figure 12. Mirror Lake Dissolved Oxygen and Temperature April 12, 2004.

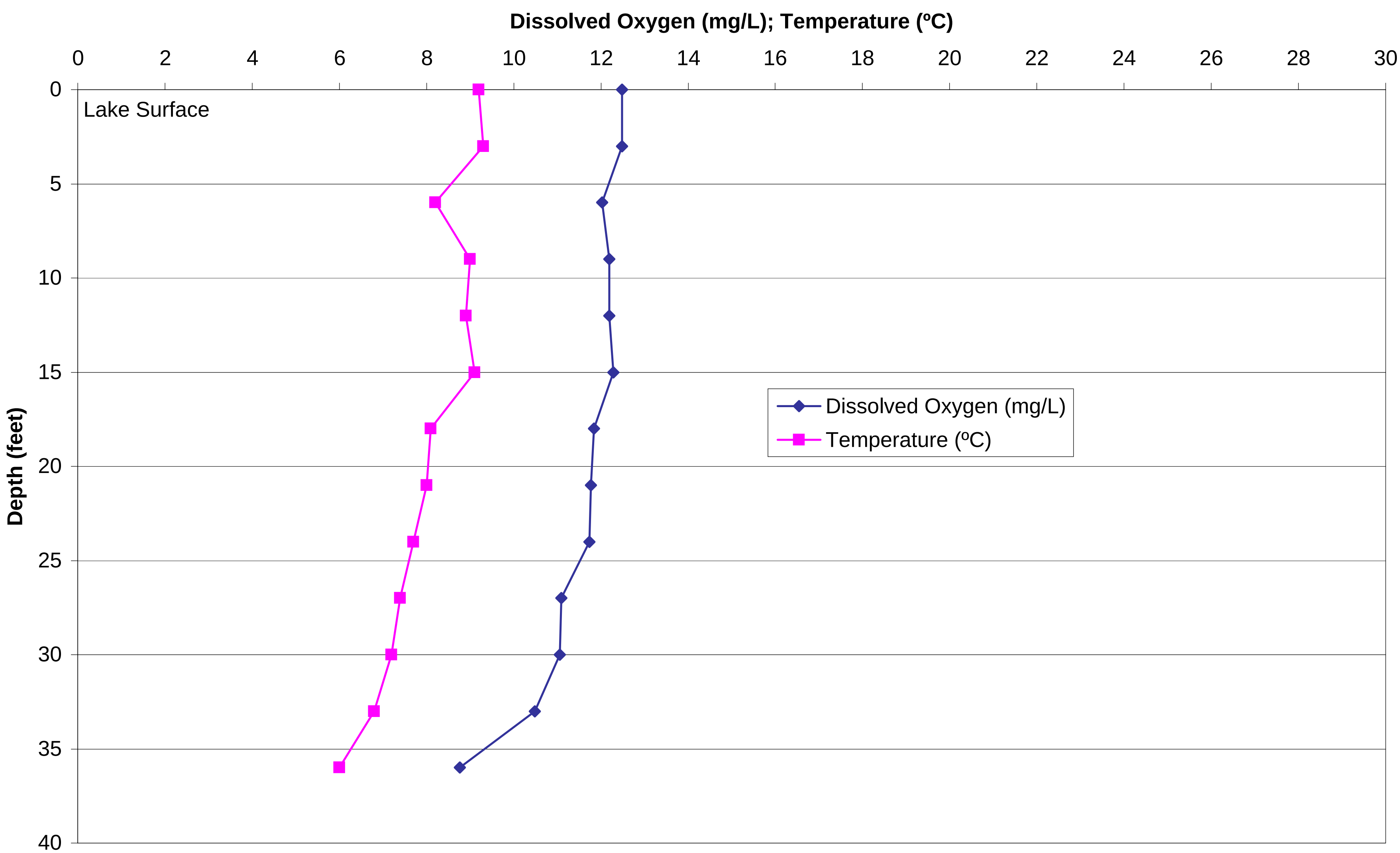
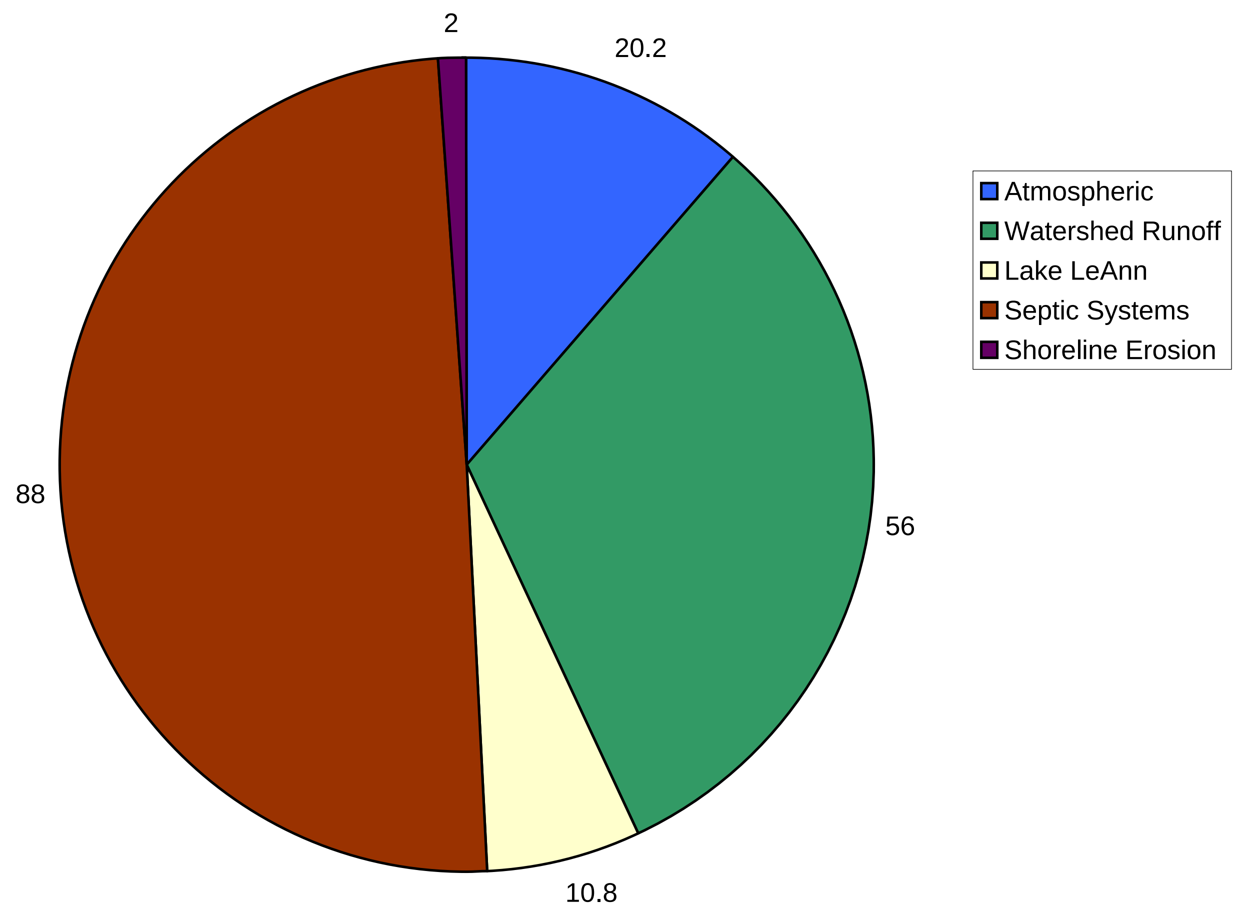


Figure 13. Mirror Lake Estimated External Phosphorus Loads (pounds/year).



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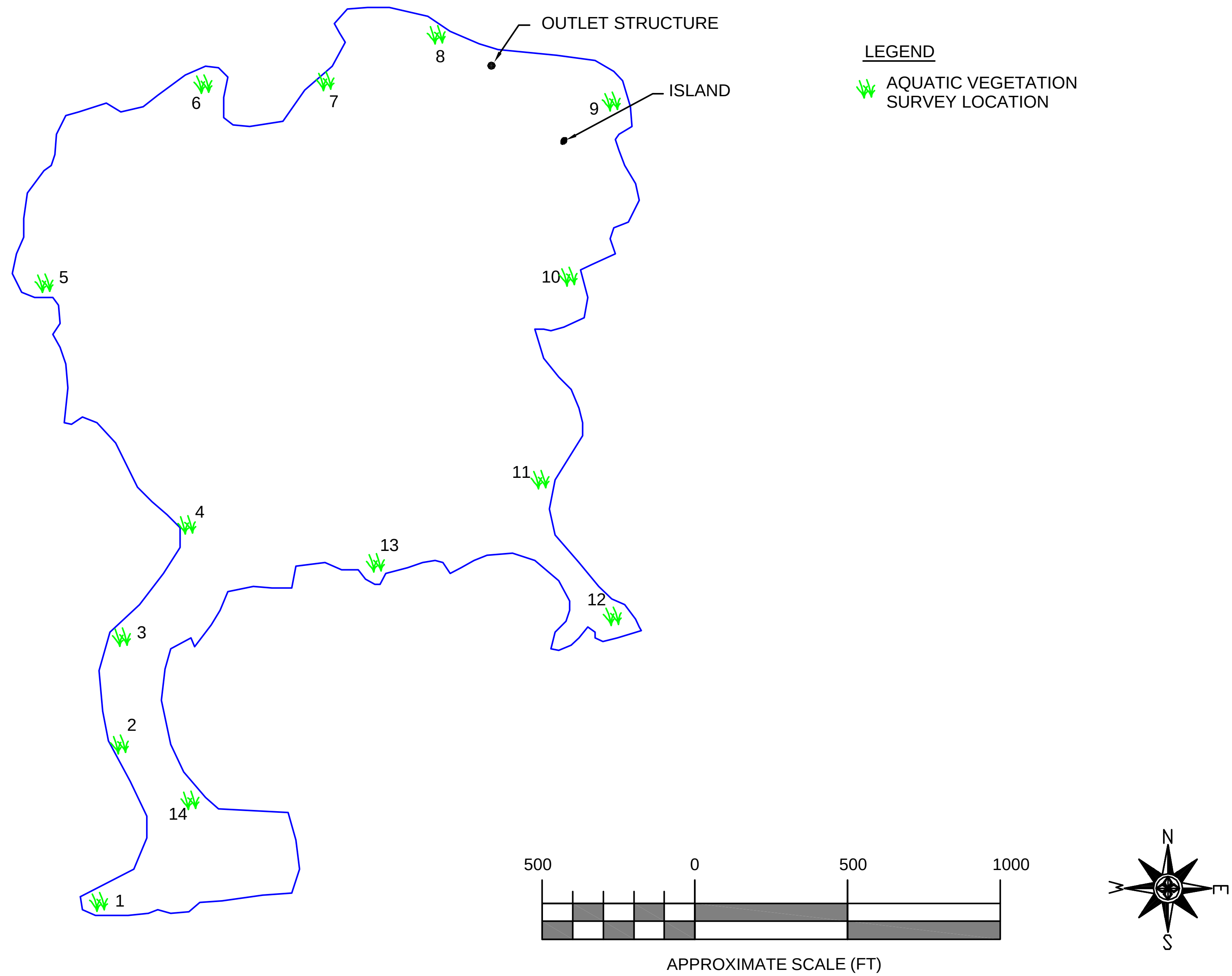

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FIGURE 14.
MIRROR LAKE VEGETATION SURVEY SAMPLING LOCATIONS
JULY 14, 2003. REFER TO TABLE 11 FOR DETAILS.

FIGURE
14

Table 1. Mirror Lake Subdrainage Areas and Land Cover Designations (Refer to Figure 3 for locations).

Watershed Drainage	Area (acres)						
Area Number	Water	Residential	Industrial/Transportation	Forest	Agricultural	Wetland	Total
1	0.00	2.00	0.22	4.22	10.67	0.00	**17.12**
2	0.22	0.22	0.00	21.34	15.12	0.00	**36.90**
3	0.44	0.22	0.00	14.67	8.45	0.22	**24.01**
4	0.00	0.00	0.00	20.45	1.11	0.00	**21.56**
5	0.00	0.00	0.00	8.45	2.89	0.00	**11.34**
6	0.22	0.00	0.00	2.89	0.67	0.00	**3.78**
7	0.22	0.00	0.00	3.11	1.11	0.00	**4.45**
8	0.00	0.00	0.22	2.67	1.56	0.00	**4.45**
9	0.00	0.00	0.00	2.22	4.22	0.00	**6.45**
Lakeshore	6.22	25.56	0.00	41.57	0.00	0.67	**74.03**
Vicary South	0.00	2.22	0.00	6.00	0.89	0.00	**9.11**
TOTALS	**7.34**	**30.23**	**0.44**	**127.60**	**46.68**	**0.89**	**213.19**

Table 2. Event Mean Concentration (EMCs) Used for Mirror Lake.

	Land Cover Type					
EMCs (mg/L)	**Open Water**	**Low Intensity Residential**	**Transportation**	**Forest**	**Agriculture**	**Wetland**
Total Phosphorus	0.08	0.52	0.43	0.11	0.37	0.08
Total Suspended Solids	6	70	141	51	145	6

From: State of Michigan Office of Regulatory Reform (MI-ORR). 1999. Draft Part 30 - Water Quality Trading Rules. **ORR#00-036EQ.**

Table 3. Mirror Lake Annual Pollutant Loads from Identified Subdrainages.

Subdrainage	Total TP loads (lbs)	TP load/acre	Total TSS load (lbs)	TSS load/acre
1	3.02	0.18	686.95	40.12
2	4.39	0.12	1,618.39	43.84
3	3.66	0.15	1,190.87	49.58
4	3.00	0.14	1,389.50	64.41
5	1.24	0.11	573.92	50.60
6	0.53	0.14	207.20	54.80
7	0.59	0.13	226.16	50.85
8	0.65	0.15	292.42	65.74
9	0.33	0.05	151.03	23.42
Lakeshore Area	35.60	0.48	6,671.51	90.09
Vicary South	3.26	0.36	728.68	79.92
Totals	56.27		13,737	

Table 4. Mirror Lake Septic System Survey.

Survey #	Plat #	Residents		# of days/yr	Total # capita-yrs	Septic Age (yr)	Distance from lake (ft)	Maintenance (yr)
		Permanent	Seasonal					
1	194	7	8	2	7.04	12	125	5
2	198	2	7	8	2.15	9	55	9
3	199	5	3	4	5.03	18	150	**18**
4	203	2	4	3	2.03	14	55	**14**
5	205		2	30	0.16	15	100	7
6	207		2	180	0.99	13	100	**13**
7	210	2			2.00	16	150	3
8	213	2	2	2	2.01	14	120	
9	217	2			2.00	12	100	7
10	222	2	20	1	2.05	28	60	**10**
11	223	3	6	2	3.03	5	40	
12	226	3	10	3	3.08	2	250	2
13	227	2			2.00	7	40	1
14	232	1	4	8	1.09	25	100	4
15	234	2			2.00	20	60	1
16	242		4	30	0.33	31		
			4	2	0.02			
17	245	2	4	10	2.11	9	60	3
18	248	3			3.00	4	100	1
19	249		4	3	0.03	35	200	5
			2	3	0.02			
20	250	1	2	3	1.02	2	75	
21	253	2	15	2	2.08	12	100	3
22	257	2	2	3	2.02	11	70	6
23	272	2	25	2	2.14	14	75	2
24	273	2	3	7	2.06	14	50	3
25	277		4	30	0.33	25	100	
			20	2	0.11			
26	293	2	6	1	2.02	22	98	2
27	302	2	4	3	2.03	31	120	31
28	305	2	10	2	2.05	10	150	2
29	306	4	6	3	4.05	20	120	5
30	309	2	4	10	2.11	6	125	
31	311				0.00			18
32	312	2			2.00	1	150	
33	315		2	30	0.16	16	200	3
			10	2	0.05			
				Total	66.42	473	3298	178
				Average	**2.01**	**14.78**	**106.39**	**6.85**

Table 5. Variable Considered in Calculating AV (Sum of all variables influencing phosphorus delivery to the lake) and Assigned Factors (From: Reckhow, 1980).

Parameter	Range	Assigned Factors
Soil Permeability	>10	0.75
(in/hr)	1-10	0.5
	0-1	0.25
Phosphorus Adsorption Capacity	1600-2000	.75
(lbs/ac/top 3 feet of soil)	1300-1600	.5
	1000-1300	.25
Soil Drainage	6	.75
(depth to water table)	0.5-1.8	.15
	0	.05
Slope	0	1
(%)	>0-6	1
	>6-12	.75
	>12-18	.75
	>18-25	.5
	>25	.25
Age	0-2.5	1
(years)	>2.5-5	.75
	>5-8	.5
	>8-11	.25
	>11	.05
Maintenance Frequency	0-2	1
(years)	>2-5	.75
	>5-8	.5
	>8-11	.25
	>11	.05
Distance to Lake	<50	.05
(ft)	>50-75	.25
	>75-100	.5
	>100-200	.75
	>200	1

Table 6. Mirror Lake Soils (from USDA, 1978).

Soil Types	Code	Estimated % at shore	Permeability (in/hr)	Drainage (feet to water table)	Slope (%)
Ormas-Spinks	13B	3	2-6	>6	0-6
Riddles	42C	5	2-6	>6	0-2
Hillsdale-Riddles	49E	80	2-6	>6	18-30
Gilford-Colwood	18	1	2-6	0.5-1.5	na
Brady	16A	1	2-6	1-3	0-3
Udorthents/Udipsamments	51	10	na	na	0

(From: Jackson County Soil Survey, USDA. 1978)

Table 7. Mirror Lake Outflow Volume and Rainfall Monitored During 2003-2004 Period.

Year	Month	Monthly Volume (gallons)	Monthly Rainfall (inches)	Number of Hours Monitored
2003	July	0	0.9	422
2003	August	58,536	4.4	744
2003	September	897,781	5.2	720
2003	October	30,321,679	2.2	744
2003	November	2,985,622	2.4	433
2004	April	12,920,295	0.6	442
2004	May	3,720,179	5.9	744
2004	June	938,951	0.1	188

Table 8. Mirror Lake Hydraulic Mass Balance.

Parameters

Inputs	Volume (gallons)
Direct Rainfall	56,340,520
Watershed Runoff	39,888,830
Lake LeAnn	46,813,944
Outputs	
Outfall	51,843,045
Evaporation	55,579,392
Groundwater	35,620,857

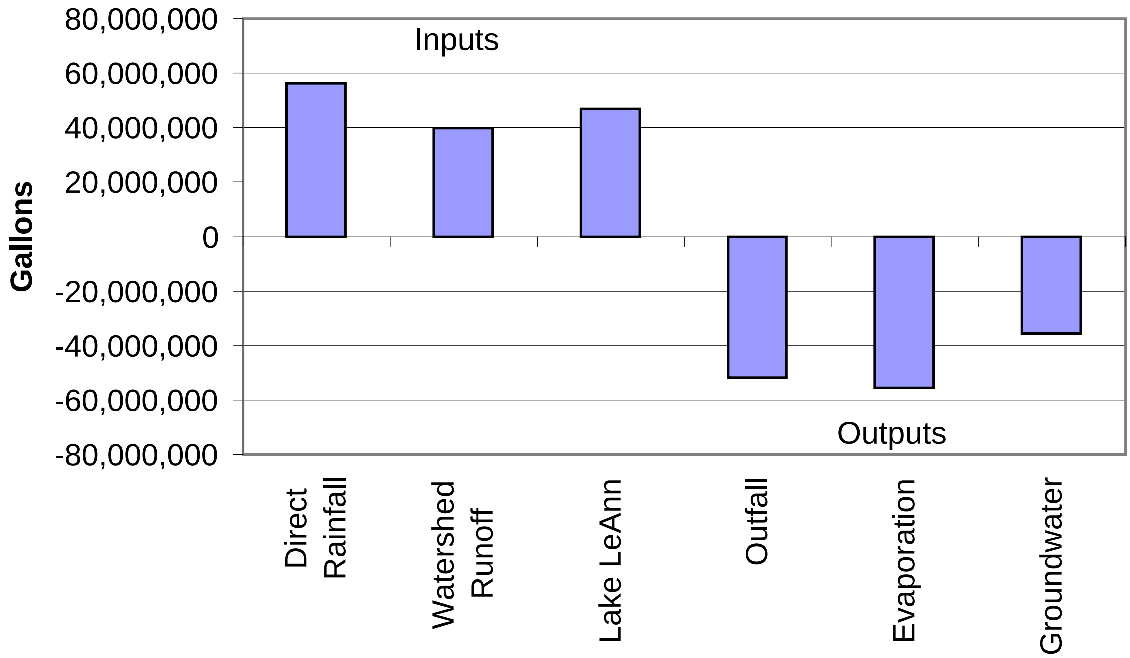

Table 9. Mirror Lake Water Quality Data.

Station	Depth (feet)	Date	Time	Cloud Cover	Air Temp (°F)	Water Temp (°C)	pH (S.U.)	Conductivity (uS)	Dissolved Oxygen (mg/L)	TP (ug/L)	SRP (ug/L)	Chlorides (mg/L)	TN (ug/L)	Chl a (ug/L)	TDS (mg/L)	Secchi Depth (feet)
INLET	na	7/14/2003	14:30	sunny	85	26	8.61	461	10.3	30	<0.3	45	456	9.72	260	
	na	10/13/2003	10:50	sunny	60	15.4	8.7	347.1	10.34	27.8	0.61	44	309	6.91	244	
	na	12/1/2003	10:00	windy	35	5.3	6.8	280	12.53							
	na	4/12/2004	9:30	sunny	40	9.4	8.51	154	11.64	16.9	0.6	47.5	162	5.2	251	
OUTLET	na	7/14/2003	14:30	sunny	85	27.1	8.44	457	8.84	16.8	<0.3	45	436	1.82	245	
	na	10/13/2003	13:15	sunny	60	16.1	8.68	277.7	11.10	14.9	**<0.3**	42.5	337	5.23	254	
	na	12/1/2003	11:35	windy	35	5.1	6.73	295	12.35	24.8	0.58	42.5	405	9.6	243	
	na	4/12/2004	10:50	sunny	40	9.5	8.73	103.4	12.59	16.5	0.6	46	186	7.3	257	
CHANNEL	na	10/13/2003	12:15	sunny	60	15.7	8.7	257.2	11.00	22.7	0.43	44	307	7.28	248	
CENTER LAKE																
	0	7/14/2003	9:30	sunny	85	25.8	8.45	458	8.55	12.5	<0.3	46.6	479	1.96	255	17.5
	0	10/13/2003	11:40	sunny	60	15.8	8.63	286.5	10.55	14.2	0.61	43	277	4.91	238	10.5
	0	12/1/2003	10:25	windy	35	5.1	6.85	286	12.25							
	0	4/12/2004		sunny	40	9.2	8.74	147.8	12.48	16.5	0.8	46	204	BROKEN	254	9
	3	7/14/2003	9:30	sunny	85	25.8	na	na	8.32	---	---					
	3	10/13/2003	11:40	sunny	60	15.7	na	282.7	10.99							
	3	12/1/2003	10:25	windy	35	5.1		285	12.25							
	3	4/12/2004		sunny	40	9.3			12.3							
	6	7/14/2003	9:30	sunny	85	25.4	na	na	8.55	---	---					
	6	10/13/2003	11:40	sunny	60	15.6	na	279.7	11.00							
	6	12/1/2003	10:25	windy	35	5.1		284	12.20							
	6	4/12/2004		sunny	40	8.2	8.78	145.3	12.03							
	9	7/14/2003	9:30	sunny	85	25.1	na	na	8.71	---	---					
	9	10/13/2003	11:40	sunny	60	14.9	na	275.5	11.06							
	9	12/1/2003	10:25	windy	35	5.1		271	12.21							
	9	4/12/2004		sunny	40	9			12.19							
	12	7/14/2003	9:30	sunny	85	24.4	na	na	8.18	---	---					
	12	7/14/2003	9:30	sunny	85	24.4	na	na	8.18	---	---					
	12	12/1/2003	10:25	windy	35	5.1		270	12.15							
	12	4/12/2004		sunny	40	8.9			12.19							
	15	7/14/2003	9:30	sunny	85	23.6	7.99	na	8.05	---	---					
	15	10/13/2003	11:40	sunny	60	14.2	8.51	269.8	9.12							
	15	12/1/2003	10:25	windy	35	5.1		269	12.13							
	15	4/12/2004		sunny	40	9.1	8.75	147	12.28							
	18	7/14/2003	9:30	sunny	85	19.2	na	na	5.48	---	---					
	18	10/13/2003	11:40	sunny	60	14	na	267.7	9.09							
	18	12/1/2003	10:25	windy	35	5.1	6.54	263	12.05	24.8	0.41	22.5	324		246	11
	18	4/12/2004		sunny	40	8.1			11.84							
	21	7/14/2003	9:30	sunny	85	16.5	na	na	1.52	---	---					
	21	10/13/2003	11:40	sunny	60	13.7	na	266	8.30							
	21	12/1/2003	10:25	windy	35	5.1		260	12.06							
	21	4/12/2004		sunny	40	8			11.77							
	24	7/14/2003	9:30	sunny	85	12.6	na	na	1.15	---	---					
	24	10/13/2003	11:40	sunny	60	13.3	na	265.5	7.79							
	24	12/1/2003	10:25	windy	35	5.1		258								
	24	4/12/2004		sunny	40	7.7			11.74							
	27	7/14/2003	9:30	sunny	85	12.9	na	na	3.94	---	---					
	27	10/13/2003	11:40	sunny	60	12.5	na	268.3	7.30							
	27	12/1/2003	10:25	windy	35	5.1		258	11.95							
	27	4/12/2004		sunny	40	7.4			11.09							
	30	7/14/2003	9:30	sunny	85	11.5	na	na	3.74	---	---					
	30	10/13/2003	11:40	sunny	60	9.9	na	285.5	2.25							
	30	12/1/2003	10:25	windy	35	5		255								
	30	4/12/2004		sunny	40	7.2			11.06							
	33	7/14/2003	9:30	sunny	85	9.5	na	na	2.54	---	---					
	33	10/13/2003	11:40	sunny	60	7.9	7.54	298.3	1.76							
	33	12/1/2003	10:25	windy	35	5		253	11.83							
	33	4/12/2004		sunny	40	7.2	8.36	146.1	11.06							
	35	10/13/2003	11:40	sunny	60		7.3	na	1.70							
	36	7/14/2003	9:30	sunny	85	10.4	7.55	na	2.41	---	---					
	36	10/13/2003	11:40	sunny	60	7.3	na	313.8	na							
	36	12/1/2003	10:25	windy	35	5		254	11.81							
	36	4/12/2004		sunny	40	6	8.19	95.6	8.76	20.8	0.6	45	245		251	
	37	7/14/2003	9:30	sunny	85	9.2	7.34	501	3.09	132	56.1	45	592	9.82	275	
	38	10/13/2003	11:40	sunny	60	7.2	na	327.9	na	713	559	36.5	2136		296	
	39	12/1/2003	10:25	windy	35	5.1	6.3	256	11.80							
Sediment Sample	**37**	**7/14/2003**	**9:30**	**sunny**	**85**					**5,100 mg/kg**			**1,200 mg/kg**			

Table 10. Mirror Lake
Total Phosphorus Balance.

Source	Load (lbs/yr)
Atmospheric	20.2
Watershed Runoff	56
Lake LeAnn	10.8
Septic Systems	88
Shoreline Erosion	2
Mirror Lake Outflow	7.9
Settling (Trapped TP)	169

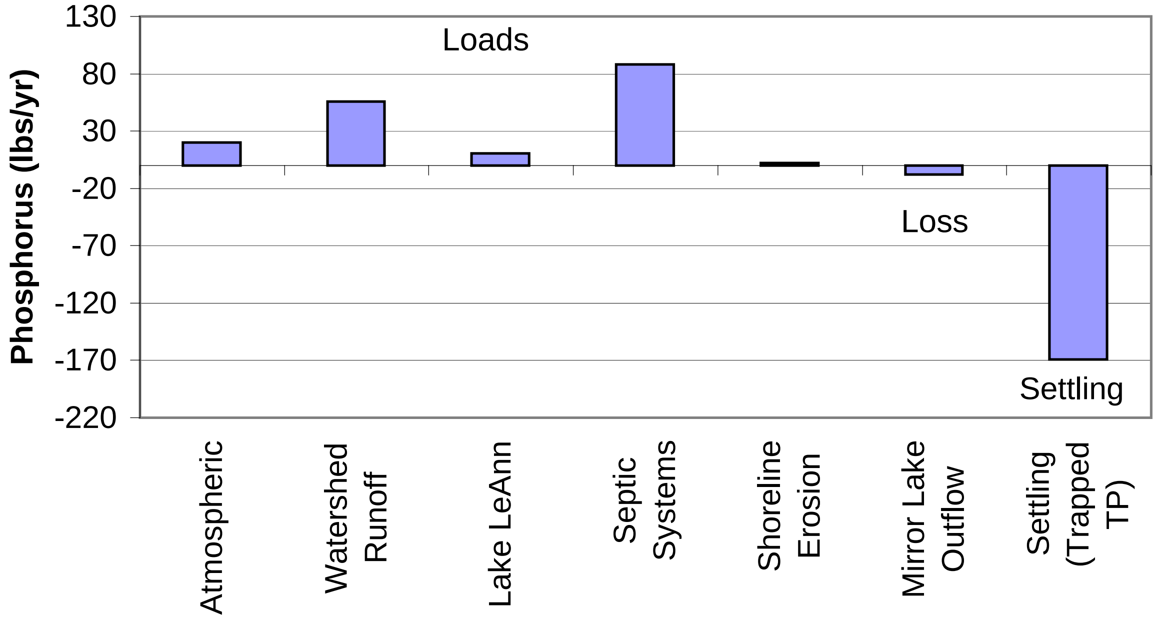

Table 11. Mirror Lake Vegetation Survey.
July 14, 2003 Surveyors: PHM, JAS

	Site Number (See Figure 8)													
Plant Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mypriophyllum spicatum (Eurasian water milfoil)						d	b							
Potamogeton crispus (Curly leaf pondweed)									a					
Chara (Muskgrass)			c		d		c		c			b	d	
Potamogeton spp. (Thinleaf pondweed)		c	b	b		c	b		b	c	c		b	b
Potamogeton amplifolius (Large leaf pondweed)								c		c	d	d	c	
Vallisneria americana (Wild celery)	c	d	c	c	d	d	d	b	d	d	c	d	d	c
Myriophyllum verticillatum (Whorled water milfoil)	d						c	b		a				
Myriophyllum heterphyllum (Various leaf water milfoil)														
Ceratophyllum demersum (Coontail)	d	d	d	d	d	d		d	d	d	d	c	d	d
Urtricularia spp. (Bladderwort-mini)								a			b		a	
Najas spp. (Southern naiad)				b	c	c			b	b	c	d		
Nymphea (White water lily)	c			c	b	b	b		c	c		c		c
Nuphar (Yellow water lily)	a													
Pontederia cordata (Pickerel weed)	b													
Typha latifolia (Cattails)	s								b			b		
Scirpus (Bulrushes)	a										b			
Decodon verticillatus (Swamp loosestrife)						b	b						b	
Lythrum salicaria (Purple loosestrife)	d	a	a		b	c	b	d	c			c		c
Filamentous algae	d													d

a=present
b=sparse
c=common
d=dense

Table 12. Mirror Lake Standard Aquatic Vegetation Summary Sheet.

July 14, 2003 Surveyors: PHM, JAS

Plant species	# of a.v.a.s per density category				density calculations				sum of previous four columns	Cumulative cover % (column 9/# of a.v.a.s.'s)
	a 1	b 2	c 3	d 4	(ax1) 5	(bx10) 6	(cx40) 7	(dx80) 8	9	10
Submergent										
Ceratophyllum demersum (Coontail)	0	0	1	12	0	0	40	960	1000	71.43
Vallisneria americana (Wild celery)	0	1	5	8	0	10	200	640	850	60.71
Chara spp. (Muskgrass)	0	1	3	2	0	10	120	160	290	20.71
Potamogeton amplifolius (Large-leaf pondweed)	0	0	3	2	0	0	120	160	280	20.00
Najas spp. (Naiad)	0	3	3	1	0	30	120	80	230	16.43
Potamogeton spp. (Thin-leaf pondweed)	0	6	4	0	0	60	160	0	220	15.71
Myriophyllum spp. (Native milfoil)	1	1	1	1	1	10	40	80	131	9.36
Myriophyllum spicatum (Eurasian water milfoil)	0	1	0	1	0	10	0	80	90	6.43
Urtricularia spp. (Bladderwort)	2	1	0	0	2	10	0	0	12	0.86
Potamogeton crispus (Curled leaf pondweed)	1	0	0	0	1	0	0	0	1	0.07
Emergent										
Lythrum salicaria (Purple loosestrife)	2	2	4	2	2	20	160	160	342	24.43
Nymphea odorata (White water lily)	0	4	6	0	0	40	240	0	280	20.00
Typha latifolia (Cattail)	0	3	0	0	0	30	0	0	30	2.14
Decodon verticillatus (Swamp loosestrife)	0	3	0	0	0	30	0	0	30	2.14
Scirpus spp. (Bulrush)	1	1	0	0	1	10	0	0	11	0.79
Pontederia cordata (Pickerel weed)	0	1	0	0	0	10	0	0	10	0.71
Nuphar spp. (Yellow pond lily`	1	0	0	0	1	0	0	0	1	0.07

a.v.a.s. - aquatic vegetation assessment site

Table 13. Mirror Lake Standard Aquatic Vegetation Summary Sheet. August 23, 1999 Surveyors: MDEQ

Plant species	# of a.v.a.s per density category				density calculations				sum of previous four columns	Cumulative cover % (column 9/# of a.v.a.s.'s)
	a 1	b 2	c 3	d 4	(ax1) 5	(bx10) 6	(cx40) 7	(dx80) 8	9	10
Submergent										
Vallisneria americana (Wild celery)	0	0	10	37	0	0	400	2960	3360	73.04
Chara spp. (Muskgrass)	0	1	3	39	0	10	120	3120	3250	70.65
Ceratophyllum demersum (Coontail)	10	13	4	5	10	130	160	400	700	15.22
Potamogeton amplifolius (Large-leaf pondweed)	8	5	8	0	8	50	320	0	378	8.22
Najas spp. (Naiad)	2	3	3	1	2	30	120	80	232	5.04
Myriophyllum spp. (Native milfoil)	4	5	2	0	4	50	80	0	134	2.91
Potamogeton spp. (Thin-leaf pondweed)	2	0	0	0	2	0	0	0	2	0.04
Urticularia spp. (Bladderwort)	1	0	0	0	1	0	0	0	1	0.02
Emergent										
Nymphea spp.	13	18	12	2	13	180	480	160	833	18.11
Lythrum salicaria (Purple loosestrife)	6	27	11	1	6	270	440	80	796	17.30
Nuphar spp. (Yellow pond lily)	3	5	1	0	3	50	40	0	93	2.02
Scirpus spp. (Bulrush)	0	1	1	0	0	10	40	0	50	1.09
Typha latifolia (Cattail)	6	1	0	0	6	10	0	0	16	0.35
Decodon verticillatus (Swamp loosestrife)	2	1	0	0	2	10	0	0	12	0.26
Iris spp.	3	0	0	0	3	0	0	0	3	0.07
Pontederia cordata (Pickerel weed)	1	0	0	0	1	0	0	0	1	0.02

a.v.a.s. - aquatic vegetation assessment site

(From: MDEQ, August 23, 1999.)

APPENDIX A

SEPTIC SYSTEM SURVEY

Mirror Lake Shoreline Septic Systems
~ A Survey for Lake Residents ~

Optional Information:

Date you completed this form: ___________________

Resident of home: ____

Owner of home (if different than above): _____________________________________

Address: ____

Necessary Information:

IF YOU ARE PERMANENT YEAR-ROUND RESIDENT, number of permanent residents: _____.

-OR-

IF YOU ARE SEASONAL RESIDENT, number of seasonal residents: _____, approximate length of stay _____ days

If you are seasonal residents, how many people plan to become permanent residents? _____ people in _____ years?

OTHER INFORMATION:

Typical number of annual guests: _____, approximate length of stay _____ days

Age of home: ______ years

Age of septic system: ______ years

Distance of drain field from the lake: _____ feet

Is the septic tank routinely pumped (circle)? Yes or No.
How often? Every _____ years

Additional Optional Information:

_____ years since septic tank last pumped. Reason for pumping (for example, routine maintenance, system filled to capacity, system backed up, etc.) ______________________

____.

_____ years since major septic system repairs. (Describe the repair.)_________________

____.

Please enter the number of each water-using fixture (Please note "w.c." if designed to conserve water):

___Shower head	___Kitchen sink	___Laundry machine
___Bathtubs	___Garbage disposal	___Water softener
___Bathroom sink	___Dishwasher	___Utility sink
___Toilets	___Other kitchen	___Other utilities

Are there any plans for changes to the household water fixtures? ___________________

____

Are there any known problems with the septic system? __________________________

____

____

Are there any plans to replace your septic system and if so, when?

____

Thank you for your cooperation. Please return completed surveys to your Mirror Lake Members, Richard Flynn or Gale Cook.

Mirror Lake Association
P.O. Box 127
Somerset Center, MI 49282

APPENDIX B

LABORATORY ANALYTICAL DATA

UPSTATE FRESHWATER INSTITUTE

P.O. Box 506
Syracuse, New York 13214

ELAP ID 11462

UPSTATE FRESHWATER INSTITUTE LABORATORY REPORT

315-431-4962

FOR:
Kieser & Assoc.
310 East Michigan Ave. Suite 505
Kalamazoo, MI 49007

December 11, 2003
Report Number: CHEM03126

Table I

Sample ID/Lab # Mirror Lake 7/14/03	Total Phosphorus (mg/l) Method: SM18 4500 P.B.5	Soluble Reactive Phosphorous (ug/l) Method: SM18 4500 P.E	Chlorides (mg/l) SM18 4500-Cl⁻ C.	Conductivity (mS) SM18 2510B	Chlorophyll (ug/l) EPA Method 445	Total Nitrogen (ug/l) SM18 4500-N_{org} C.	Total Dissolved Solids mg/L SM18 2540 C
Inlet, Lab #:3198019	--	--	45	461	9.72	456	260
Surface, Lab#:3198020	--	--	46.6	458	1.96	479	255
Bottom, Lab#:3198021	--	--	45	501	9.82	592	275
Outlet, Lab#:3198022	--	--	45	457	1.82	436	245
Bottom Soil, Lab#3198023	5.1(1)					1.2(2)	

(1): Soil Sample- Results express as mg Phosphate per gram dry weight.
(2): Soil Sample- Results express as mg Nitrogen per gram dry weight

UPSTATE FRESHWATER INSTITUTE

P.O. Box 506
Syracuse, New York 13214

ELAP ID 11462

UPSTATE FRESHWATER INSTITUTE LABORATORY REPORT

315-431-4962

FOR:

Kieser & Assoc.
310 East Michigan Ave. Suite 505
Kalamazoo, MI 49007

January 6, 2004
Report Number: CHEM03129

Sample ID	Total Phosphorus (ug/l) Method: SM18 4500 P.B. 5	Soluble Reactive Phosphates(ug/l) Method: SM18 4500 P.E.
Mirror Lake- IN 10/13/03	27.8	0.61
Mirror Lake- Surface 10/13/03	14.2	0.61
Mirror Lake- Bottom 10/13/03	713	559
Mirror Lake- Out 10/13/03	14.9	>0.3
Mirror Lake –Channel 10/13/03	22.7	0.43

Douglas F. Gillard, Laboratory Director

Table II

Sample ID/Lab# Mirror Lake 10/13/03	Total Phosphorus (ug/l) Method: SM18 4500 P.B. 5	Soluble Reactive Phosphorous (ug/l) Method: SM18 4500 P.E.	Chlorides (mg/l) SM18 4500-Cl⁻ C.	Conductivity (mS) SM18 2510B	Chlorophyll (ug/l) EPA Method 445	Total Nitrogen (ug/l) SM18 4500-N_{org} C.	Total Dissolved Solids mg/L SM18 2540 C
Inlet, Lab#:3289002	–	–	44	449	6.91	309	244
Channel, Lab#:3289003	--	–	44	444	7.28	307	248
Surface, Lab#:3289004	–	–	43	424	4.91	277	238
Bottom, Lab#:3289005	--	--	36.5	515	–	2136	296
Outlet, Lab#:3289006	–	--	42.5	435	5.23	337	254

Table III

Sample ID/Lab ID Mirror Lake 12/01/03	Total Phosphorus (ug/l) Method: SM18 4500 P.B. 5	Soluble Reactive Phosphorous (ug/l) Method: SM18 4500 P.E.	Chlorides (mg/l) SM18 4500-Cl⁻ C.	pH EPA Method 150.1	Chlorophyll (ug/l) EPA Method 445	Total Nitrogen xx/yy SM18 4500-N_{org} C.	Total Dissolved Solids mg/L SM18 2540 C
Center Mid, Lab#: 3337001	24.8	.041	--	--	--	–	–
Mirror Lake Out, Lab#: 3337002	24.8	.058	--	--	–	–	–
Center Mid, Lab#: 3337005	--	--	42.5	8.06	--	324	246
Mirror Lake Out, Lab#: 3337006	–	--	22.5	8.11	9.6	405	243

Douglas F. Gillard 12-11-03
Douglas F. Gillard, Laboratory Director
12/11/03 Page 2 of 2

UPSTATE FRESHWATER INSTITUTE

P.O. Box 506
Syracuse, New York 13214

ELAP ID 11462

UPSTATE FRESHWATER INSTITUTE LABORATORY REPORT

315-431-4962

FOR:
Kieser & Assoc.
536 East Michigan Ave. Suite 300
Kalamazoo, MI 49007

May 24, 2004
Report Number: CHM4016
Contract Number: 116

Table 1

Sample ID/Lab # Mirror Lake 4/12/04	Total Phosphorus (mg/l) Method: SM18 4500 P.B.5	Soluble Reactive Phosphorous (ug/l) Method: SM18 4500 P.E.	Chlorides (mg/l) SM18 4500-Cl⁻ C.	Chlorophyll (ug/l) EPA Method 445	Total Nitrogen (ug/l) SM18 4500-N_{org} C.	Total Dissolved Solids mg/L SM18 2540 C
Inlet, Lab #:4104005	16.9	0.6	47.5	5.2*	162	251
Surface, Lab#:4104006	16.5	0.8	46	--	204	254
Bottom, Lab#:4104007	20.9	0.6	45	--	245	251
Outlet, Lab#:4104008	16.5	0.6	46	7.3*	186	257

Jennifer Aicher, Laboratory Director
* data amended 6/15/04

9a

APPENDIX C

LAKE TROPHIC STATE TABLE

Total Phosphorus Concentrations for Trophic Status Categories from Various Scientific Literature Sources (modified from Effler, 1996)

Trophic State	Total Phosphorus (ìg/l) (by source)			
Category	*(1)*	*(2)*	*(3)*	*(4)*
Oligotrophic	4.3-11.5	<10	<10	<9
Mesotrophic	11.5-37.5	10-21.7	10-20	9-35
Eutrophic	>37.5	>21.7	>20	>35

(1) Auer et al., 1986
(2) Chapra and Dobson, 1981
(3) Vollenweider, 1975
(4) Vollenweider, 1982

Total Nitrogen Concentrations for Trophic State Categories (From University of Florida Extension, 2004)

Trophic State	**Total Nitrogen (*u*g/l)**
Oligotrophic	<400
Mesotrophic	401-600
Eutrophic	601-1500
Hypereutrophic	>1500

APPENDIX D

EXOTIC VEGETATION INFORMATION

To view the aquatic invasive “eurasian water milfoil” see:
http://www.seagrant.umn.edu/exotics/eurasian.html

To view the aquatic invasive “purple loosestrife” see:
http://www.seagrant.umn.edu/exotics/purpleid.html

To view the aquatic invasive “hydrilla” see:
http://www.miseagrant.umich.edu/ans/hydrilla.htm

To view the aquatic invasive “curly-leaf pondweed” see:
http://www.dnr.state.wi.us/org/water/wm/GLWSP/exotics/curly.html

APPENDIX E

CITIZEN LAKE MONITORING PROGRAM
(CLMP FORMS)

MICHIGAN LAKE AND STREAM ASSOCIATIONS, INC.
8511 Kokosing Rd, PO Box 303, Long Lake, MI 48743
Phone 989.257.3583 Fax 989.257.2073 Email info@mlswa.org
Website www.mlswa.org ML&SA Volunter Web Site http://www.mi-water-cmp.org

CLMP 2004

A cooperative monitoring program between lake associations, Michigan Department of Environmental Quality, and Michigan Lake and Stream Associations, Inc.

Registration Information

Michigan has 11,000 lakes larger than 5 acres. At this time most of these water resources have no available water quality data to guide management. This condition exists despite the fact that many of Michigan's lakes are excellent to above average quality and have substantial economic and recreational value. As development and use demands increase, lakes will be increasingly susceptible to overuse and environmental degradation. Rehabilitation of these resources will be significantly more difficult and costly than protective management would have been. Consequently, there is a significant need to collect water quality data on Michigan's inland lakes.

To meet this need, the Department of Environmental Quality (DEQ) and Michigan Lake and Stream Associations, Inc. (ML&SA) have partnered to implement the Cooperative Lakes Monitoring Program (CLMP). The purpose of this effort is to help citizen volunteers monitor the water quality in their lake and document changes. The CLMP provides sampling methods, training, workshops, technical support, quality control, and laboratory analysis to the volunteer samplers. Michigan State University's Department of Fisheries and Wildlife supports the partnership with technical assistance.

All of the CLMP partners and volunteer samplers are committed to a quality program, which produces quality data. There is a motto that says, "bad data is worse than no data". Therefore any new lake communities or volunteer samplers joining the CLMP program need to commit to taking the necessary training and perform all sampling activities exactly as outlined in the monitoring procedures. Additionally, each volunteer sampler must demonstrate that they can collect consistent quality data before they can participate in the more complicated monitoring projects. Consequently, first year lake communities and volunteer samplers may only register for the Secchi disk transparency, spring total phosphorus and summer total phosphorus monitoring projects. After they have demonstrated a proficiency in these projects in following years they may register for chlorophyll, dissolved oxygen/temperature and pilot projects.

To further assure quality data new monitoring projects are field tested in limited pilot efforts before being incorporated into the regular program. In 2004, pilot projects are being conducted for Aquatic Plant Mapping and Fish Age and Growth. Lake communities participating in these pilots need to make an extra commitment to assure an effective evaluation. If the pilot projects demonstrate that quality data can be collected the projects they will be expanded to full monitoring projects in 2005.

During 2004 CLMP monitoring projects are available for Secchi disk transparency, spring total phosphorus, summer total phosphorus, chlorophyll and oxygen/temperature. Except for Secchi disk transparency, all monitoring projects have a limited enrollment because of available equipment or laboratory capacity. **Register early to insure your lake community's participation in the projects you are interested in.** Recently, enrollment limits have been reached 20 to 30 days before the registration cutoff dates.

To register for the 2004 CLMP complete the enclosed APPLICATION and WAIVER forms and return to ML&SA, PO Box 303, Long Lake, MI 48743. To learn more about each of the monitoring projects see the reverse side of this page. If you would like more information about any of the monitoring projects you may contact ML&SA and request a copy of the project's Monitoring Procedure.

INSTRUCTIONS
for completing the
Cooperative Lakes Monitoring Program 2004
APPLICATION

The Cooperative Lakes Monitoring Program 2004 - Application should be completed and submitted along with appropriate fees to ML&SA, PO Box 303, Long Lake, MI 48743. Most CLMP monitoring projects have limited enrollment. Once the enrollment limit is reached for each project it will be closed to all later applications. Therefore, you will want to submit your APPLICATION form and fees as soon as possible to assure your lakes place in the CLMP -2004 monitoring projects.

LAKE LOCATION - Identify the township(s) and county(s) in which the lake is located.

NAME OF APPLICANT - Provide the name of your association or corporation or your name if you are submitting the application as an individual.

APPLICANT ADDRESS - The address provided in this space should be the association's or corporation's address, unless the application is from an individual. All initial communications with your organization will be to this address. Additionally, the final report for the CLMP 2004 program will be mailed to this address. Once a volunteer sampler - coordinator has been identified on the WAIVER -2004 form all subsequent communications will be directed to that individual.

CLMP MONITORING PROJECT ENROLLMENT - In this section of the application you will enroll in all the CLMP monitoring projects you wish to conduct on your lake. For basic information about each of the monitoring projects consult the Registration Information page included in this application packet. If you would like more detailed information about any of the monitoring projects you may write to ML&SA and acquire the Monitoring Procedures for each of the monitoring projects you have an interest in. The Monitoring Procedure describes the value of the project's parameter to be measured, equipment needed, sampling procedures used, when and where samples are delivered, training requirements needed to participate in the project, quality control procedures and sources of assistance.

LAKE NAME - Identify the name of the lake to be sampled. If your association or corporate property includes more than one lake, all lakes may be included on one application form but a separate fee will be required for each lake.

EQUIPMENT - If participating in the chlorophyll monitoring project for the first time it will be necessary to purchase chlorophyll testing equipment. In following years sampling and filtering equipment may be reused but replacement filters and vials will be needed. A Secchi disk may be built or purchased from ML&SA. The disk will last for many years.

TOTAL ENCLOSED - Add the fee for enrollment in each desired monitoring project and the cost of any equipment purchased and enter the amount.

APPLICATION SIGNATURE - The individual signing the application indicates by their signature that they have been authorized by their association or corporation to submit the application and that the organization will complete the WAIVER form and return it to ML&SA. If the application is submitted by an individual he/she will sign and return the WAIVER form.

INSTRUCTIONS
for completing the WAIVER - 2004 form

All individuals participating in all 2004 CLMP monitoring projects need to provide the requested information, sign and date the waiver - 2004 form. The waiver - 2004 form does **not** need to be completed and returned with the APPLICATION form. It may take some time to lineup all the necessary samplers and acquire their signatures. Since many CLMP monitoring projects have limited enrollment you do not want to wait to submit your APPLICATION form and fees to secure your lake's place in the monitoring projects. **However, the waiver - 2004 form must be completed and returned to ML&SA before sampling begins.**

<u>The first box on the waiver - 2004 form is for your monitoring coordinator</u>. With over two hundred lakes, and maybe as many as 400 to 500 samplers involved in the CLMP each year, it is not possible for ML&SA to communicate with each sampler. Therefore each lake association and corporation is asked to assign one volunteer sampler as coordinator. This individual will be ML&SA and the MDEQ's primary contact at your lake. When necessary this person will be responsible for providing local information to ML&SA and MDEQ, scheduling side-by-side sampling with the MDEQ, receiving sampling materials, assuring that volunteer samplers have received the necessary training and distributing written information.

If more spaces for volunteer sampler information and signatures are needed than provide by the form, please duplicate the form and submit both. The completed waiver - 2004 form(s) should be submitted to **ML&SA, PO Box 303, Long Lake, MI 48743.**

Appl 03 CLMP Revised 8/6/03

APPLICATION

Cooperative Lakes Monitoring Program 2004

NAME OF LAKE ASSOCIATION ____**ASN #**_________

(Please note that the program is open to all lakes. Associations, corporations, or private individual are welcome to join in the CLMP)

ADDRESS (**The address to which all correspondences and reports will be mailed):**

____

P.O. BOX/ STREET CITY STATE

LAKE LOCATION: TOWNSHIP(s)____________________________________COUNTY(s)__________________________

APPLICANT'S NAME____________________________LAKE Association/Corporation ____________________________________

Position____

Phone # (______) ____________________________Email address:____

APPLICATION SIGNATURE: ____

It is the responsibility of the applicant association, corporation or individual to secure the signatures of all volunteer samplers on the enclosed WAIVER FORM and return to ML&SA before sampling starts.

~~~~~~

CLMP MONITORING PROJECT ENROLLMENT

LAKE NAME *1____

◆ SECCHI DISK TRANSPARENCY	$35.00 per lake	$ ________________
◆ SPRING TOTAL PHOSPHORUS	$15.00 per lake	$________________
◆ SUMMER TOTAL PHOSPHORUS	$15.00 per lake	$________________
◆ CHLOROPHYLL	$50.00 per lake	$________________
◆ DISSOLVED OXYGEN	$35.00 per lake	$________________
◆ AQUATIC PLANT MAPPING	$200.00 per lake	$________________
◆ FISH AGE AND GROWTH	$600.00 per lake	$________________
EQUIPMENT:		
◆ CHLOROPHYLL TESTING EQUIPMENT - Needed for first year in Chlorophyll project (Distributed at required training sessions)	$40.00 per lake	$________________
◆ CHLOROPHYLL REPLACEMENT FILTERS AND VIALS	$7.00 per set	$________________
Available at the ML&SA training sessions for those who have been in the Chlorophyll project previously. If you wish them shipped, please add $1.50	$1.50 mailing	$________________
◆ SECCHI DISK sold to lakes, individuals registered in the CLMP program	$40.00 per disk	$________________
Total due for lake #1	**$**____________________________	

LAKE NAME *2____

◆ SECCHI DISK TRANSPARENCY	$35.00 per lake	$________________
◆ SPRING TOTAL PHOSPHORUS	$15.00 per lake	$________________
◆ SUMMER TOTAL PHOSPHORUS	$15.00 per lake	$________________
◆ CHLOROPHYLL	$50.00 per lake	$________________
◆ DISSOLVED OXYGEN	$35.00 per lake	$________________
◆ AQUATIC PLANT MAPPING	$200.00 per lake	$________________
◆ FISH AGE AND GROWTH	$600.00 per lake	$________________
EQUIPMENT:		
◆ CHLOROPHYLL TESTING EQUIPMENT - Needed for first year in Chlorophyll project (Distributed at required training sessions)	$40.00 per lake	$_______________
◆ CHLOROPHYLL REPLACEMENT FILTERS AND VIALS $	7.00 per set	$_______________
Available at the ML&SA training sessions for those who have been in the Chlorophyll project previously. If you wish them shipped, please add $1.50	$1.50 mailing	$_______________
~~~~~~

COOPERATIVE LAKES MONITORING PROGRAM

WAIVER --- 2004

(Instructions for completing the form are on the reverse side.)

When form is completed mail to: ML&SA, PO Box 303, Long Lake, MI 48743

RELEASE OF ALL CLAIMS

The person signing below, hereinafter referred to as Volunteer Sampler, hereby understands and acknowledges that:

1. *The Volunteer Sampler has agreed to sample a body of water as designated by Michigan Lake and Stream Associations (hereinafter ML&SA) pursuant to the Cooperative Lakes Monitoring Program (hereinafter "Program").*
2. *The Volunteer Sampler is not an employee or agent of the Michigan Lake and Stream Associations nor of the State of Michigan while performing these activities.*
3. *The Volunteer Sampler understands and assumes that he/she may encounter hazards from the presence of individuals using the body of water or from natural occurrences.*

I, the below named person, having read and fully understanding this document, and in consideration of being accepted as a Volunteer Sampler, do hereby waive any and all claims against Michigan Lake and Stream Associations and/or the Department of Environmental Quality, State of Michigan, or any agent or employee of Michigan Lake and Stream Associations and or the Department of Environmental Quality State of Michigan, acting lawfully and within the scope of his/her official duties arising during the course of my participation in the program. This includes but is not limited to, (1) claims by Volunteer Sampler, his estate, executor, administrator, heirs and assigns for wrongful death, personal injury, or property damage arising during the course of sampling, or while traveling to and from sampling locations(s), and (2) claims for fines or other civil or criminal penalties or damages imposed upon Volunteer Sampler by a court of law arising in any way from Volunteer Sampler participation in the program.

Please print the following information: ____________ **Volunteer Sampler - COORDINATOR**

Lake name ______________________ **Asn #** ____________

County(s) ______________________

Coordinator Name ______________________

Phone ______________________ **Email** ______________________

____

Summer Address: Street, PO Box State Zip

____

Winter Address: Street, PO Box State Zip

____

Signature **Date**

Please print the following information: ____________ **Volunteer Sampler - COORDINATOR**

Lake name ______________________ **Asn #** ____________

County(s) ______________________

Coordinator Name ______________________

Phone ______________________ **Email** ______________________

____

Summer Address: Street, PO Box State Zip

____

Winter Address: Street, PO Box State Zip

____

Signature **Date**

Please print the following information: Volunteer Sampler - **COORDINATOR**

Lake name____________________ **Asn #** ____________

County(s) ____________________

Coordinator Name ____________________

Phone ____________________ **Email**____________________

____

Summer Address: Street, PO Box State Zip

____

Winter Address: Street, PO Box State Zip

____

Signature **Date**

Please print the following information: Volunteer Sampler - **COORDINATOR**

Lake name____________________ **Asn #** ____________

County(s) ____________________

Coordinator Name ____________________

Phone ____________________ **Email**____________________

____

Summer Address: Street, PO Box State Zip

____

Winter Address: Street, PO Box State Zip

____

Signature **Date**

Please print the following information: Volunteer Sampler - **COORDINATOR**

Lake name____________________ **Asn #** ____________

County(s) ____________________

Coordinator Name ____________________

Phone ____________________ **Email**____________________

____

Summer Address: Street, PO Box State Zip

____

Winter Address: Street, PO Box State Zip

____

Signature **Date**

◆ SECCHI DISK sold to lakes, individuals registered in the CLMP program $ 40.00 per disk $______________

Total due for lake #2 **$________________________**

LAKE NAME *3____

◆ SECCHI DISK TRANSPARENCY	$35.00 per lake	$_______________
◆ SPRING TOTAL PHOSPHORUS	$15.00 per lake	$_______________
◆ SUMMER TOTAL PHOSPHORUS	$15.00 per lake	$_______________
◆ CHLOROPHYLL	$50.00 per lake	$_______________
◆ DISSOLVED OXYGEN	$35.00 per lake	$_______________
◆ AQUATIC PLANT MAPPING	$200.00 per lake	$_______________
◆ FISH AGE AND GROWTH	$600.00 per lake	$_______________

EQUIPMENT:

◆ CHLOROPHYLL TESTING EQUIPMENT - Needed for first year in Chlorophyll project (Distributed at required training sessions)	$40.00 per lake	$_______________
◆ CHLOROPHYLL REPLACEMENT FILTERS AND VIALS	$7.00 per set	$_______________
Available at the ML&SA training sessions for those who have been in the Chlorophyll project previously. If you wish them shipped, please add $1.50	$1.50 mailing	$_______________
◆ SECCHI DISK sold to lakes, individuals registered in the CLMP program	$ 40.00 per disk	$_______________

Total due for lake #3 **$____________________________**

FINAL TOTAL DUE FOR ONE OR MORE LAKES REGISTERED IN PROGRAM **$____________________**

Make checks payable to ML&SA and mail to: ML&SA, PO Box 303, Long Lake, MI 48743

ML&SA # ________________ **Rec'd**__________________________________**Check NO.** _____________**Amt.Rec'd**________________

Date ________________________ **By**_____________________**Date Rpt sent**____________________**By**__________________________

APPENDIX F

FISHERIES INFORMATION

To view a selection of Michigan fish species see:
http://www.michigan.gov/dnr/0,1607,7-153-10364_18958---,00.html

To view additional fish species (from Ohio) see:
http://www.dnr.state.oh.us/wildlife/Fishing/aquanotes-fishid/fishtips.htm

To view fish stocking records in lakes upstream from Mirror Lake search:
http://www.michigandnr.com/fishstock/

Known Mirror Lake Fish Species - from previous collections and angler/resident input:
Bluegill
Largemouth bass
Walleye
Northern Pike
Grass Pickerel
Warmouth
Blackstriped topminnow
Bluntnose minnow
Pumpkinseed
Redear sunfish
Green sunfish
Sand shiner
Spotfin shiner
Brook silversides
Brown bullhead
Black crappie
Channel catfish
Yellow perch

Mirror Lake Creel Survey

The Mirror Lake Association asks that you complete one creel survey following each fishing trip on the lake. The Association will contact you during Spring 2004 to collect the surveys. Information gathered in this survey will be compared with historical data and used to make recommendations for fishery protection and management.

Angler initial(s):____
Date____________ Time ____________
Fished from (check one): Bank________ Boat ________ Through Ice _______

Did you and any guest(s) fish with more than one rod at a time? If yes,
how many rods per person?_________________

What time of day did your fishing trip begin?___________________AM/PM
What time of day did your fishing trip end? ___________________AM/PM

Please indicate approximately how many hours were spent fishing in each lake section (for example, 0.25 hours, 2 hours, etc.):

Lake shoreline over visible weedbeds or sandbars __________hours
Shallow, narrow channels on south end of the lake __________hours
Along the dam over visible weed or gravel beds __________hours
Open, deepwater, where the bottom could not be seen __________hours

What kind(s) of fish were you fishing for?_________________________________

Please record the lengths and weights of fish captured as accurately as possible. Additional fish species, lengths, and weights as well as any general observations of concern about the fish community can be recorded on the back of this sheet. An expected species catch list is also included on the other side of this form.

Bluegill		Other Species		
Length (inches)	Weight (lbs)	Species	Length (inches)	Weight (lbs)

Please circle the length/weight entries of the fish that were removed from the lake.

Dear Interested Citizen:

The Departments of Natural Resources and Agriculture welcome your interest in improving fishing opportunities in public waters of Michigan. Both departments are directly involved in managing and regulating the stocking of fish by private parties into waters of the state. Department of Natural Resources (DNR) is the agency responsible for protection and management of fisheries resources throughout the state. Department of Agriculture (MDA) is the agency responsible for oversight of the private aquaculture industry in Michigan, a source from which you can obtain fish for stocking. We have worked together to develop a stocking permit process that provides you with opportunities to stock fish as a private party, yet maintains protection of the state's fisheries resources.

As a private party, you may wish to stock fish into public waters of the state. To do so requires a permit from DNR. This permit is required to ensure that fish to be stocked are:

1) healthy and will not pose a disease risk to populations in the wild;
2) a species that currently exists in the watershed and do not pose long term management problems; and
3) a species that is compatible with the overall fishery management goals in a watershed.

The permit process ensures protection of the state's fisheries resources by preventing potential long range and expensive problems before they occur, thus improving fishing opportunities for all.

The permit process is detailed in the attached materials. It requires a purchaser or their agent to first determine if the water body to be stocked is public or private. Water bodies that have permanent inlets or outlets will require a permit, as fish will escape from these waters into public waters. Waters with no permanent inlets or outlets do not require a permit. Waters that have been stocked in the past by the state require a permit along with those that have public access. If you are unsure about the status of the water body you wish to stock, please contact any of our Fisheries Management Unit offices for assistance (see Table 1).

If the water body to be stocked is public, you will need to fill out an application (attached) and specify what species and how many fish you intend to stock. This allows

DNR to determine if the species is permitted for stocking, and if it is compatible with management goals established for the watershed. It is also important for you to determine if the source from which you intend to obtain the fish is free of certain fish diseases (see Table 2), so be sure to enquire about the fish disease certification status of the source you intend to use. DNR recommends that any applicant obtain a copy of the disease certification from the source, as fish must be certified disease-free for stocking in waters of the state. Although providing a copy of the disease certification with your application will speed the processing of the permit, it is not a necessary step.

After you fill out the application form, submit it to the Fisheries Management Unit (see Table 1) responsible for the watershed in which you wish to stock fish. If you need help determining the right office, feel free to contact any Fisheries Management Unit Office. It is a good idea to send copies of your application form to multiple individuals in the Fisheries Management Unit to ensure that it gets processed promptly. The same is also true for follow up emails and other inquiries as our staff is frequently in the field and may not see your message. By sending emails to multiple staff, you will get a response back much quicker. Our fisheries staff will review the permit and provide you with either an approved permit or a letter detailing why the permit was denied.

Once you have an approved permit, you can stock your fish. Please be sure to contact our Fisheries Management Unit Office about the stocking at least two calendar days before it occurs. Also be sure that either an original or a copy of the Public Waters Fish Stocking Permit is on site during the stocking. After stocking, be sure to submit the Public Waters Fish Stocking Report to DNR. This data will be input into our databases and will become a permanent part of the fisheries management record for the watershed.

Both DNR and MDA are appreciative of your interest in the state's fisheries resource. We hope this process will meet your needs.

Good Fishing to All,

Kelley D. Smith, Ph.D.
Chief
Department of Natural Resources
FISHERIES DIVISION

Joan M. Arnoldi, D.V.M.
Chief
Department of Agriculture
ANIMAL INDUSTRY DIVISION

Michigan Department of Natural Resources
Fisheries Division

PUBLIC WATERS STOCKING PERMIT PROCESS
January 1, 2004 through December 31, 2004

1) It is the responsibility of the purchaser or their agent to determine if a permit is required to stock fish into a water body. If a Public Waters Stocking Permit is necessary, the purchaser or their agent must obtain the permit prior to any stocking event. A copy of the Public Waters Stocking Permit Application is in Attachment 1.
   a) If the water body to be stocked is permanently connected to public water bodies via an inlet or outlet, the purchaser or their agent must obtain a Public Waters Stocking Permit.
   b) If the water body to be stocked is not permanently connected to any other water body, it is does not require a Public Waters Stocking Permit unless it meets one of the two following conditions.
      i. If the water body has public access, the purchaser or their agent must obtain a Public Waters Stocking Permit.
      ii. If the water body has been stocked at anytime in the past by the state, the purchaser or their agent must obtain a Public Waters Stocking Permit.
   c) If unsure of the need for a permit to stock a water body, the purchaser or their agent may request assistance from any Department of Natural Resources (DNR) Fisheries Management Unit Office. The offices and fisheries biologists are listed in Table 1.

2) The purchaser or their agent can obtain an application for a Public Waters Stocking Permit from any DNR Fisheries Management Unit Office, from the DNR Internet site (www.michigan.gov/dnr) or from any private aquaculture facility.

3) The purchaser or their agent must return the completed Public Waters Stocking Permit Application to the DNR Fisheries Management Unit Office responsible for the watershed that is to be stocked. See attached Table 1 to determine which office is the appropriate location.

4) DNR Fisheries Management Unit staff will employ the following guidelines in its review of the permit application:
   a) Disease status of the private aquaculture facility. Lists of emergency fish, reportable and diseases of concern are in attached Table 2.
      i) Emergency Fish Diseases - If the facility has a valid disease free certification for emergency fish diseases, the fish can be stocked in public waters. If the facility does not have a current or valid disease-free certification for emergency fish diseases, the permit shall be denied.
      ii) Reportable Disease - If the facility has a known reportable disease, additional review shall be conducted before approving any stocking. The existence of

reportable diseases at a facility will not automatically cause the denial of the permit but will require additional consultation with fish health experts from DNR and MDA prior to the issuance of the permit to determine if there are potential resource impacts from stocking the fish. If there is no potential for resource impacts then the fish can be stocked in public waters. If there is the potential for resource impacts then the permit will be denied.

iii) Diseases of concern - If the facility has a known disease of concern, additional review shall be conducted before approving any stocking. The existence of diseases of concern at a facility will not automatically cause the denial of the permit but will require additional consultation with fish health experts from DNR and MDA prior to the issuance of the permit to determine if there are potential resource impacts from stocking the fish. If there is little or no potential for resource impacts then the fish can be stocked in public waters. If there is the potential for resource impacts then the permit will be denied.

b) Species analysis – If the species has been approved for stocking in waters of the state, the fish can be stocked in public waters. If the species has not been approved for stocking in waters of the state, the permit shall be denied. The list of approved species for fish stocked can be found in Table 3.

c) Management implications of the stocking – If the stocking action is consistent with DNR's management objectives for the water body and watershed to be stocked, the fish can be stocked in public waters. If the stocking action is not consistent with DNR's management objectives for the water body and watershed to be stocked, the permit shall be denied.

5) After review of the application, the Fisheries Management Unit will determine if the permit is to be approved or denied based on Sections 4 a, b and c above, taken in their entirety.

6) Within seven (7) calendar days of receipt of the permit application, the Fisheries Management Unit shall provide either an approved permit to the purchaser or their agent, or a letter of permit denial designating the rationale for denial based on Sections 4 a, b, and c above, taken in their entirety (see Attachment 2).

7) Purchaser or their agent must notify the appropriate Fisheries Management Unit of the actual date of stocking at least two (2) calendar days prior to occurrence of the stocking event. This notification can be done via letter, telephone, or e-mail. Upon receipt of notification, the Fisheries Management Unit shall provide a response to the purchaser or their agent that notification of the actual stocking date has been received.

8) The permit must be available on site when fish are stocked into public waters.

a) If a private aquaculture operation is to do the stocking, they must have the original or a copy of the valid Public Waters Stocking Permit on site during stocking.

b) If the purchaser or their agent is to do the stocking, they must have the original valid Public Waters Stocking Permit on site during stocking.

9) Within 14 days calendar days of the actual public waters stocking event, a signed Public Waters Stocking Report (see Attachment 2) shall be sent to the Fisheries Management Unit that issued the permit.

10) Upon receipt of the report, the Fisheries Management Unit shall:
    a) Record receiving the report.
    b) Enter the data into the DNR's Fish Stocking Information System database.
    c) Provide a response to the party that the report was received and processed.

Table 1. DNR Fisheries Management Unit Offices.

Basin/Watersheds	Staff	Office location	Telephone	E-mail
Lake Superior Basin Coordinator	Steve Scott	Newberry	906-293-5131	scottsj@michigan.gov
Western Lake Superior West of the Chocolay River to Ironwood	George Madison Biologist - Vacant	Baraga Baraga	906-353-6651 906-353-6651	madisong@michigan.gov TBA
Eastern Lake Superior Chocolay River to Sault Ste. Marie	Robert Moody Jim Waybrant	Newberry Newberry	906-293-5131 906-293-5131	moodyr@michigan.gov waybranj@michigan.gov
Lake Michigan Basin Coordinator	James Dexter	Plainwell	616-685-6851	dexterjx@michigan.gov
Northern Lake Michigan All Upper Peninsula - Lake Michigan watersheds	Michael Herman Darren Kramer Bill Ziegler	Escanaba Escanaba Crystal Falls	906-786-2351 906-786-2351 906-875-6622	hermanm@michigan.gov kramerd@michigan.gov zieglerw@michigan.gov
Central Lake Michigan Mackinac Bridge to Muskegon River	Thomas Rozich Mark Tonello Todd Kalish Rich O'Neal	Cadillac Cadillac Traverse City Twin Lake	231-775-9727 231-775-9727 231-922-5280 231-788-6798	rozicht@michigan.gov tonellom@michigan.gov kalisht@michigan.gov onealr@michigan.gov
Southern Lake Michigan South of Muskegon River to Indiana Border	Jay Wesley Gregg Smith Scott Hanshue Amy Harrington	Plainwell Plainwell Plainwell Comstock Park	616-685-6851 616-685-6851 616-685-6851 616-784-1808	wesleyjk@michigan.gov smithkrm@michigan.gov hanshusk@michigan.gov harringa@michigan.gov
Lake Huron Basin Coordinator	Tammy Newcomb	Lansing	517-373-3960	newcombt@michigan.gov
Northern Lake Huron St. Marys River to Au Sable River	David Borgeson Tim Cwalinski Neal Godby Steve Sendek	Gaylord Gaylord Gaylord Grayling	989-732-3541 989-732-3541 989-732-3541 989-348-6371	borgesd1@michigan.gov cwalinst@michigan.gov godbyn@michigan.gov sendeks@michigan.gov
Southern Lake Huron South of Au Sable River to Port Huron	James Baker Kathrin Schrouder Joe Leonardi	Bay City Bay City Lapeer	989-684-9141 989-684-9141 810-664-8355	bakerjp@michigan.gov schroudk@michigan.gov leonardi@michigan.gov
Lake Erie Basin Coordinator	Kurt Newman	Lansing	517-241-3623	newmankr@michigan.gov
Lake Erie South of Port Huron to Ohio border	Gary Towns Jim Francis Jeff Braunscheidel	Livonia Livonia Livonia	734-953-0241 734-953-0241 734-953-0241	townsg@michigan.gov francisj@michigan.gov braunscj@michigan.gov

Baraga DNR Office 427 US 41 North Baraga, MI 49908	Crystal Falls DNR Office 1420 US 2 West Crystal Falls, MI 49920	Lapeer State Game Area DNR Office 3116 Vernon Road Lapeer, MI 48446	Traverse City DNR Office 970 Emerson Traverse City, MI 49686
Bay City DNR Office 503 N. Euclid Ave., Suite 1 Bay City, MI 48706	Escanaba DNR office 6833 Hwy. 2, 41 & M-35 Gladstone, MI 49837	Livonia DNR Office 38980 Seven Mile Road Livonia, MI 48152	Twin Lake DNR Office 7550 E. Messenger Road Twin Lake, MI 49457
Cadillac DNR Office 8015 Mackinaw Trail Cadillac, MI 49601	Gaylord DNR Office 1732 M-32 West Gaylord, MI 49735	Newberry DNR Office 5100 State Highway M-123 Newberry, MI 49868	
Comstock Park DNR Office 195 6-Mile Rd. NE Comstock Park, MI 49321	Grayling DNR Office R#3, 1955 N. I-75 BL Grayling, MI 49738	Plainwell DNR Office 621 N. 10th Street Plainwell, MI 49080	

Table 2. Emergency fish diseases, reportable fish diseases (Michigan Department of Agriculture Reportable Animal Diseases August 2003 – July 2004) and fish diseases of concern in the State of Michigan.

Reportable Fish Diseases

Disease Agent	**Disease Name**	**Approved Fish Species Affected**
Aeromonas salmonicida	Furunculosis	Atlantic Salmon, brook trout, brown trout, rainbow trout
Ceratomyxosis shastal	Ceratomyxosis	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
EED Virus	Epizootic Epitheliotropic Disease	Lake trout
EHN Virus	Epizootic Hematopoietic Necrosis	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
IHN Virus*	Infectious Hematapoietic Necrosis	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
IPN Virus*	Infectious Pancreatic Necrosis Virus	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
*Myxobolus cerebralis**	Whirling Disease	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
Myxosporean agent PKD	Proliferative Kidney Disease	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
Onchorhynchus masou Virus	Onchorhynchus masou Virus Disease	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
Renibacterium salmoninarum	Bacteria Kidney Disease	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
Rhabdovirus – Spring Viremia of Carp Agent	Spring Viremia of Carp	
VHS Virus*	Viral Hemorrhagic Septicaemia	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout
Yersinia ruckeri	Enteric Redmouth	Atlantic Salmon, brook trout, brown trout, lake trout, rainbow trout

* - These shaded diseases are considered emergency fish diseases. Fish must have certified free of these diseases to be permitted for stocking in public waters.

Fish Diseases of Concern – These are emerging diseases on the watch list for future action.

Disease Agent	**Disease Name**	**Fish Species Affected**
Ranavirus	Largemouth Bass Virus	Largemouth bass
Heterosporsis	Heterosporis	Yellow perch
Iridovirus	Sturgeon Virus	Lake sturgeon

Table 3. Approved list of species that can be stocked into public waters of the State of Michigan.

SPECIES
ATLANTIC SALMON
BLACK BULLHEAD
BLACK CRAPPIE
BLUEGILL
BLUNTNOSE MINNOW
BROOK TROUT
BROWN BULLHEAD
BROWN TROUT
CHANNEL CATFISH
COMMON SHINER
EMERALD SHINER
FATHEAD MINNOW
FLATHEAD CATFISH
GOLDEN SHINER
GREEN SUNFISH
HYBRID SUNFISH
LAKE HERRING
LAKE TROUT
LAKE WHITEFISH
LARGEMOUTH BASS
MUSKELLUNGE
NORTHERN PIKE
NORTHERN REDBELLY DACE
PUMPKINSEED
RAINBOW TROUT
REDEAR SUNFISH
ROCK BASS
SMALLMOUTH BASS
WALLEYE
WARMOUTH
WHITE BASS
WHITE CRAPPIE
YELLOW BULLHEAD
YELLOW PERCH

Attachment 1. Public Waters Stocking Permit Application

DNR **Michigan Department of Natural Resources - Fisheries Division**

APPLICATION TO STOCK FISH INTO MICHIGAN PUBLIC WATERS

*Under authority of Section 48735 of Part 487, Sport Fishing, of Act 451, P.A. 1994, as amended, **stocking fish into the public waters of the State of Michigan is prohibited without an approved permit**. Failure to comply with the conditions of this Act and permit shall be cause for revocation of this permit. The penalty for stocking fish into public waters of the state without a permit is a misdemeanor, punishable by imprisonment for not more than 90 days, or a fine of not more than $500.00, or both.*

PERMITTEE INFORMATION

Applicant's Name	Telephone Number ( ) -
Street Address	City, State and Zip Code

WATER TO BE STOCKED

Waterbody Name	Size (Acres)	County	Township	Range	Section(s)	Approximate Stocking Date

Name of Inlets and/or Outlets	Is Water to be Stocked Open to Public Fishing? ☐ Yes ☐ No
Purpose of Stocking	

SOURCE OF FISH

MDA Facility Registration Number	Telephone Number ( ) -	Facility Manager's Name	Telephone Number ( ) -
Street Address		Street Address	
City, State and Zip Code		City, State and Zip Code	

FISH TO BE STOCKED

Species	Stock or Strain	Size (Inches) or Age	Number

FOR TROUT AND SALMON ONLY

The trout and salmon for stocking must come from a facility with a certificate or report of fish health designating disease free status that includes all facilities through which said fish have passed.

Aquaculture Facility has a Current Fish Health Certificate(s) or Report(s) of Fish Health? Yes ☐ No ☐

I hereby certify that all information provided above is true to the best of my knowledge.

Signature of Purchaser or Agent_______________________________________ Date ____________________________

For Department Use Only

APPLICATION IS: ☐ **APPROVED** ☐ **DENIED** (see attached denial letter)

Permit Number: ____________________________

Issue Date: ____________________________

Expiration Date:

Approved Action:

Attachment 2. Public Waters Fish Stocking Permit and Report Form

DNR **Michigan Department of Natural Resources - Fisheries Division**

PERMIT TO STOCK FISH INTO MICHIGAN PUBLIC WATERS

This permit is issued under the authority of Section 48735 of Part 487, Sport Fishing, of Act 451, P.A. 1994, as amended. Failure to comply with the conditions of this Act and permit shall be cause for revocation of this permit. The penalty for stocking fish into public waters of the state without a permit is a misdemeanor, punishable by imprisonment for not more than 90 days, or a fine of not more than $500.00, or both.

PERMIT TO STOCK FISH INTO PUBLIC WATERS OF THE STATE OF MICHIGAN

APPLICATION IS: ☐ **APPROVED** ☐ **DENIED** (see attached denial letter)

Permit Number: ____________________

Issue Date: ____________________

Expiration Date: ____________________

Approved Action:

By: ______________________________ ______________ ______________

Department Signature | Title | Date

LAWS, CODES AND PERMITS. Permittee recognizes that this permit does not obviate other requirements of federal, state, or local law. Permittee agrees to comply with all applicable laws, regulations, and codes, and shall obtain any necessary permits in connection with the activities that are the subject of this permit.

INDEMNIFICATION. Permittee shall indemnify and hold harmless the State of Michigan and all its departments, agencies, commissions, officers, employees, and agents from and against all claims, liabilities, damages, losses, penalties, and fines, and all related costs and expenses, including reasonable attorney fees, for personal injury, death, or property damage of any kind or nature, including environmental contamination, that arise in any manner from Permittee's use of the property that is the subject of this permit or from the exercise of any rights or privileges granted under this permit.

I have read the terms and conditions contained in this permit. I agree to abide by same and assume all the obligations contained herein. Approved applicants or their agent will be required to submit a report detailing the number and size of each species stocked.

______________________________ ______________

Purchaser or Agent's Signature | Date

Return completed application to: FISHERIES MANAGEMENT UNIT OFFICE RESPONSIBLE FOR THE WATERSHED TO BE STOCKED (see Table 1)

Detach and Submit Private Fish Stocking Report within 14 days of Stocking

MDNR FISHERIES DIVISION – PUBLIC WATERS STOCKING REPORT

This report is required under the authority of Section 48735 of Part 487, Sport Fishing, of Act 451, P.A. 1994, as amended.

PERMIT INFORMATION

Purchaser or Agent's Name	Telephone Number ( ) -
Permit Number	

WATER STOCKED

Waterbody Name	County	Township	Range	Section(s)	Stocking Date

FISH STOCKED

Species	Stock or Strain	Size (Inches) or Age	Number

I hereby certify that all information reported by me is true to the best of my knowledge.

Signature of Purchaser or Agent______________________________ Date ____________________

Return completed application to: FISHERIES MANAGEMENT UNIT OFFICE RESPONSIBLE FOR THE WATERSHED TO BE STOCKED WITHIN 14 DAYS OF STOCKING (see Table 1)

APPENDIX G

NATIVE VEGETATION INFORMATION SOURCES

Publications:

1) ***Landscaping for Wildlife and Water Quality.*** Minnesota Department of Natural Resources. 1999. Available from the Minnesota Bookstore. Phone: 800-657-3757. Excellent information including before/after landscaping photos and sketches; plant species listings and habitat requirements

2) ***Through the Looking Glass-A Field Guide to Aquatic Plants***. Wisconsin Lakes Partnership. 1997. Available through the Wisconsin Extension for $20 + shipping. Phone: 715-346-2116. One of the user-friendliest taxonomic books available. Provides drawings, habitat requirements, wildlife value for aquatic plants.

3) ***The Water's Edge-Helping fish and wildlife on your waterfront property***. Wisconsin Department of Natural Resources. 2000. General overview of benefits of maintaining a shoreline buffer on your property.

4) ***Michigan Native Plant Producers Association, 2002 Source Guide, Michigan Genotype Seeds & Plants***. Contains a list of members with addresses and phone numbers, as well as a listing of plant materials available.

5) ***Restore Your Shore***. Minnesota Department of Natural Resources. Available from the Minnesota Bookstore. Phone: 800-657-3757. Interactive CD Rom which contains step-by-step how to of restoring native lakeshore vegetation, worksheets, example projects and an index of over 400 plant species.

Web Sites:

1) **http://www.macd.org/native plants/npproducts.html**
Michigan Conservation Districts. Contact names and numbers for Michigan Conservation Districts with services and products they provide.

2) **http://www.agnr.umd.edu/MCE/Publications/Publications.cfm?ID=13**
University of Maryland, Department of Agriculture and Natural Resources. *Riparian Forest Buffer Design, Establishment and Maintenance*. How-to guide for streambank restoration including planting zones, suggestions for plant species and maintenance.

3) **http://www.epa.gov/glnpo/greenacres/toolkit/chap4.html**
U.S. Environmental Protection Agency. *Natural Landscaping for Public Officials*. Provides how-to information for various habitats including site-preparation, plant selection and maintenance.

4) **http://www.npwrc.usgs.gov/resource/othrdata/plntguid/plntguid.htm**
U.S. Department of Agriculture. *Midwestern Wetland Flora Field Office Guide to Plant Species*. Provides photos, distribution and detailed species information for midwestern wetland plant species.

5) **http://www.gvsu.edu/wri/isc/bear/ripguide/lawncare.htm**
Annis Water Resources Institute. Grand Valley State University.

Web Sites cont.

6) **http://plants.usda.gov/**
U.S. Department of Agriculture. PLANTS database. Allows a search for plant species by common or scientific name. Provides photos, distribution, plant tolerances, and species characteristics.

7) **http://www.dnr.state.mn.us/fwt/back_issues/1996/Lakescap.pdf**
Minnesota Department of Natural Resources. Brief page on benefits of native landscaping.

8) **http://www.crjc.org/riparianbuffers.htm**
Connecticut River Joint Commission. Guidance and general information on stream and riverbank plantings and maintenance.

9) **http://www.seagrant.umn.edu/exotics/purple.html**
Minnesota Sea Grant. Detailed information on purple loosestrife including history, identification, and control measures.

10) **http://www.lakegeorgeassociation.org/**
Lake George Association, New York. Example of a large-scale lake association and projects and activities implemented.

11) **http://lakewhatcom.wsu.edu/gardenkit/Lakescaping/RiparianPlanting.htm**
Washington State University. Example of a Washington State model, but is an excellent listing of the necessary process of lakescaping. Some adaptations are possible if you work with a knowledgeable Michigan landscape expert.

Web Sites cont.

12) **http://www.shorelandmanagement.org/quick/w.html**
Minnesota Shoreland Management. Contains an extensive library of on-line publications and links pertaining to owners of shoreline properties. A great resource.

13) **http://www.for-wild.org/index.htm**
Wild Ones Natural Landscapers, Ltd. This is a non-profit organization with a mission to educate and share information with members and community at the “plant-roots” level and to promote biodiversity and environmentally sound practices. Local and regional chapters exist in the Midwest.

14) **http://www.chesapeakebay.net/pubs/subcommittee/nsc/forest/handbook.htm**
Chesapeake Bay Riparian Handbook. A Guide for Establishing and Maintaining Riparian Forest Buffers. A 481 page downloadable document extensively detailing all aspects of riparian buffers.

15) **http://www.treelink.org/woodnotes/vol1/no1/rrres.htm**
Riparian Restoration Roundtable. An extensive listing of links citing techniques and examples of riparian restoration projects.

Native Plant Nurseries:

1) **See list of Michigan Native Plant Producers Association** (publications) available as a handout (http://www.for-wild.org/michigan/MNPPA.pdf)

2) **Prairie Nursery**. Westfield, WI. Phone: 800-476-9453. www.prairienursery.com.

3) **J&J Transplant Aquatic Nursery**. Wild Rose, WI. Phone: 800-622-5055. www.tranzplant.com.

4) **Kester's Wild Game Food Nurseries, Inc**. Omro, WI. Phone: 800-558-6727. www.kestersnursery.com

5) **Spence Restoration Nursery.** Muncie, IN. Phone: 765-286-7154. www.spencenursery.com.

6) **Heartland Restoration Services, Inc**. Fort Wayne, IN. Phone: 219-489-8511. hlandrest@aol.com.