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2004 Little Blake Lake Water Quality Monitoring Technical Report

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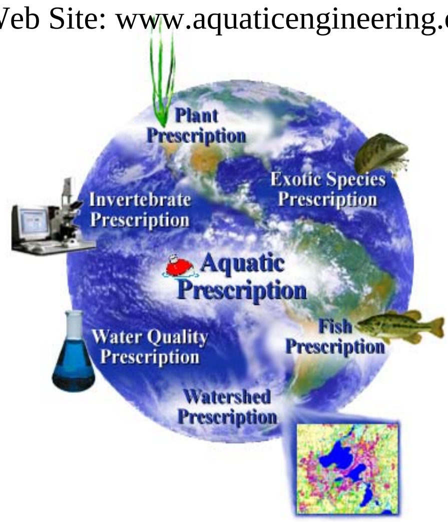

2004 Little Blake Lake Water Quality Monitoring Technical Report

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In cooperation with the Wisconsin Department of Natural Resources and the Polk County Land and Water Resources Department

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Heath Benike	Fish Biologist

Polk County Land and Water Resources

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Executive Summary

Little Blake Lake is an 85-acre drainage lake located in Polk County, Wisconsin. The watershed of Little Blake Lake is predominantly agricultural and is likely the reason the lake experiences advanced eutrophic conditions. Nutrient-high runoff from the watershed is causing elevated phosphorus concentrations that in turn promote extensive macrophyte growth within the lake.

Little Blake Lake suffers from dense macrophyte growth throughout the growing season. Many native species contribute to nuisance conditions in the summer. Besides native species, the invasive plant curly-leaf pondweed (CLP) also causes problems for Little Blake Lake recreationists. Curly-leaf pondweed is a "double threat" because it can create nuisance plant conditions and perhaps contribute to increased algal blooms in the summer. Recent studies have shown that CLP can release large amounts of phosphorus when it decays and can contribute a significant portion of the internal loading of phosphorus to a lake system in the summer.

The main reasons for conducting water quality monitoring in Little Blake Lake were (1) to collect baseline inventory data; (2) because similar sampling was occurring on Big Blake Lake, which is a neighboring connected body of water; and (3) to compare conditions within Little Blake to those in Big Blake Lake to determine if they affect each other.

The water quality of Little Blake Lake was sampled from June to October of 2004, with a single sample station selected at the deepest point of Little Blake Lake. The parameters analyzed were soluble reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, and chlorophyll *a*. These parameters were analyzed by the Water and Environmental Analysis Laboratory *(WEAL)* located in Stevens Point, Wisconsin. Temperature, dissolved oxygen, conductivity, and specific conductance were measured and recorded on site for June through October.

The water quality results and Secchi readings show that Little Blake Lake is a eutrophic lake with a composite[1] TSI value of 57.3. In addition, the condition of the lake water quality is similar to that of other eutrophic drainage lakes. Little Blake Lake did not thermally stratify in the summer of 2004. High concentrations of phosphorus and chlorophyll *a* will produce an algal-dominated system, which will lead to degraded water clarity. This problem will be compounded by the release of phosphorus from decaying CLP in early summer.

[1] A composite TSI value was calculated by averaging the TSI_{TP}, $TSI_{Chl\ a}$ and TSI_{S} values.

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1.0 Introduction

Little Blake Lake is an 85-acre drainage lake with a mean depth of six feet and a maximum depth of ten feet, located in Polk County, Wisconsin (WBIC #2627300, Figure 1). The major inflow is located in the northeast corner of the lake that comes directly from Big Round Lake. The outflow is a continuation of Straight River, which flows into Big Blake Lake. The Little Blake Lake watershed is part of the Upper Apple River watershed in the St. Croix River Basin, which was designated as a priority for non-point source pollution control by the St. Croix Water Quality Management Plan (WDNR 1994) and included in the Polk County Land and Water Resource Plan (Bursik 2001).

In 2003, The Limnological Institute (TLI) wrote a grant for WDNR funding to conduct baseline water quality monitoring in 2004. The monitoring on Little Blake Lake was strongly recommended as part of the monitoring of Big Blake Lake. The grant was approved in 2004 for work to begin that spring. This report covers the water quality parameters sampled on site, water quality analyzed at the Water and Environmental Analysis Laboratory (WEAL) located in UW–Stevens Point, phytoplankton analyzed at the Wisconsin State Laboratory of Hygiene (WSLOH), and zooplankton analyzed at PhycoTech. This technical report will aid in future planning and provide greater understanding of Little Blake Lake and its impact on Big Blake Lake.

Curly-leaf pondweed (CLP) is an exotic aquatic plant that impacts water quality. It was unintentionally introduced to Wisconsin during common carp stocking activities in the 1800s and is present in many Wisconsin lakes. All aquatic plants contribute nutrients to lakes as they decay, but native plants die off in the late summer or early fall, when their nutrients are consumed by bacteria instead of fueling algal growth. However, CLP releases nutrients into the water column in mid-summer and therefore promotes algal blooms (Crowell 2003). As much as 5.5 pounds of phosphorus per acre can be released from monotypic CLP beds (McComas 2000). This release of phosphorus can contribute to over half of the internal load of phosphorus in a lake for the summer.

Conditions within Big Blake Lake are highly influenced by water entering from Little Blake Lake. The 1998 Barr Engineering Big Blake Lake report states that the major source of water for Big Blake Lake is the inflow that originates in Big Round Lake, travels through the Straight River, and enters and exits Little Blake Lake. The 1998 Barr Engineering Big Blake Lake report also cited that CLP is detrimental to lakes because it may cause oxygen depletion and exacerbate internal loading of phosphorus as it decays in the summer. The impacts of water entering Big Blake Lake from Little Blake Lake are not clearly understood.

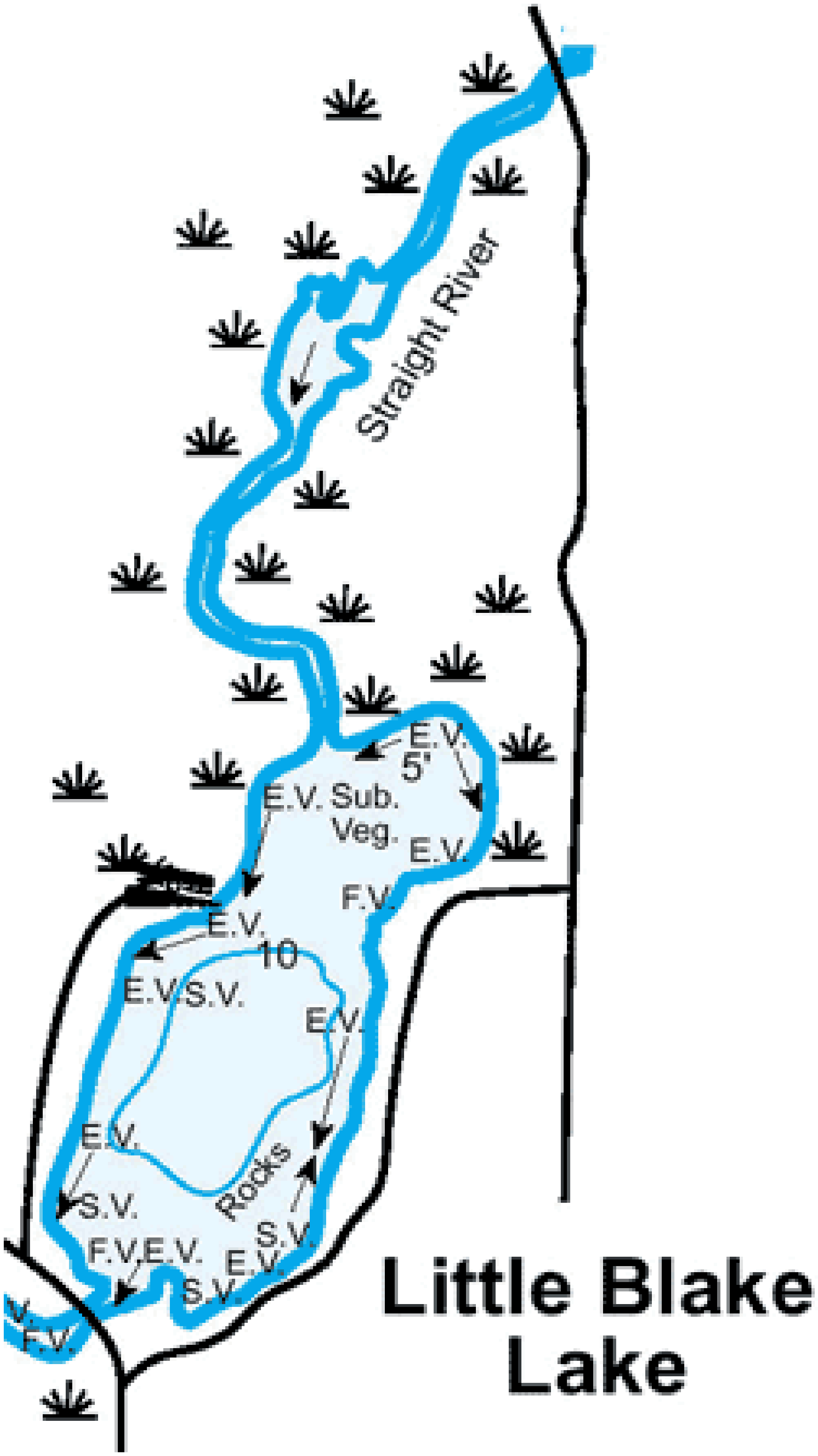

Figure 1. Bathymetric map of Little Blake Lake (Polk County, WI).

2.0 Review of Existing Information

There is relatively little known about the historical water quality of Little Blake Lake. Past management activities have been performed by the WDNR and private property owners. The residents do not currently participate in the "Self-Help Monitoring" program promoted by the WDNR nor do they have a coordinated management effort.

The findings of the 1998 Macrophyte Survey and Management Plan were that Big Blake Lake is and has been a eutrophic system beginning as early as 1978. A phosphorus budget performed by Barr Engineering in 1998 used data collected by the WDNR in 1978-79 and found that 90 percent of the phosphorus load to Big Blake Lake came from the Straight River, and ultimately the majority came from Big Round Lake. In addition, Big Round Lake is eutrophic, like Little Blake Lake, and has high levels of internal phosphorus loading in the summer (Barr 1998). Data collected in 1983 and 1993 by Saint Thomas University also showed that Big Blake Lake was eutrophic.

Without having past monitoring data for Little Blake Lake, it is impossible to say for certain if conditions within Little Blake Lake are similar to those of Big Blake Lake. Since the two bodies of water share similar physical characteristics, it is likely that water conditions of Little Blake Lake are similar to Big Blake Lake’s.

3.0 Methods

3.1 Sample Collection

A sample site was established at "mid-lake" (Figure 2); the sample site was at the deepest location in the lake (approximately 10 feet deep). Water samples were collected by representatives of Polk County Land and Water Resource Department (LWRD) and were sent to WEAL at UW–Stevens Point for analysis. The samples were analyzed for reactive phosphorus, total phosphorus, total Kjeldahl nitrogen, and chlorophyll *a*. These samples were collected monthly from June to October with a composite surface sampling device designed to sample a column of water from zero to six feet deep. The samples were kept on ice until they arrived at the laboratory in Stevens Point.

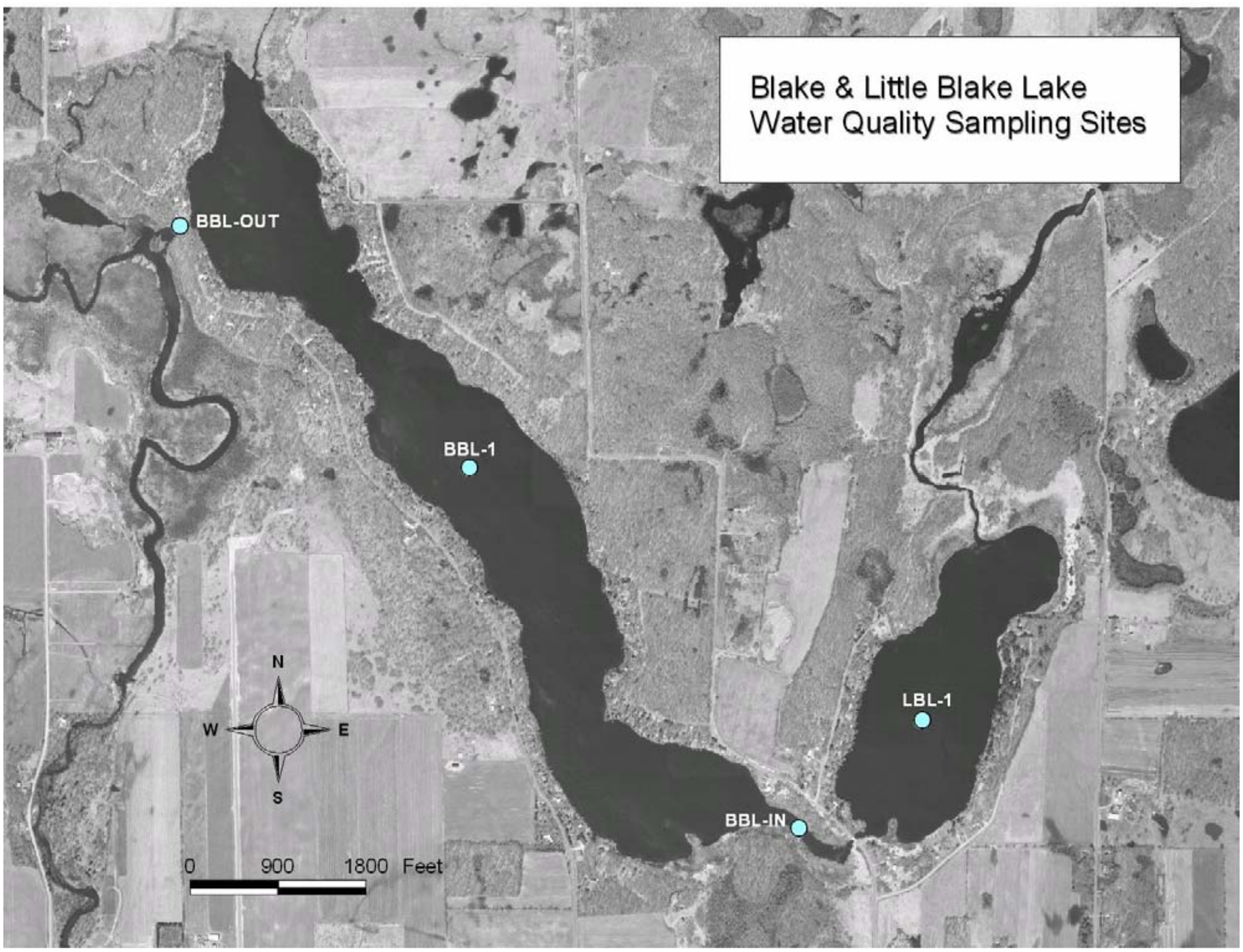

Figure 2. Little Blake Lake water quality sampling stations (Polk County, WI) 2004.

3.2 On-Site Measurements

Depth profiles were collected at the mid-lake water quality monitoring site during the summer sampling periods (June through October). Samples were collected weekly in June and July and monthly from August to October. Data points were collected at one-meter intervals throughout the water column for dissolved oxygen, conductivity, and temperature with a YSI SONDE probe. The probes were calibrated according to the following schedule:

Dissolved Oxygen Probe

The dissolved oxygen probe was calibrated using water-saturated air prior to each day it was used, and the membrane was changed as needed.

Conductivity Probe

The conductivity calibration was performed with a 1000 µS/cm standard once at the beginning of summer. The probe was inserted into a clean glass containing approximately three inches of conductivity standard solution. The temperature was allowed to stabilize and any air bubbles were dislodged by moving the probe vigorously from side to side. Then the user pressed and released the UP ARROW and DOWN ARROW buttons simultaneously, adjusted the reading on the display so it matched the value of the calibration solution, and pressed enter to save the value. The YSI Model 85 is designed to retain its last conductivity calibration permanently. Therefore, there is no need to calibrate the instrument after powering down.

Temperature Probe

The temperature probe did not require calibration.

3.3 Phytoplankton and Zooplankton Samples

Phytoplankton and zooplankton samples were collected in August and September at the mid-lake water quality monitoring site. A 66-micron zooplankton tow net was used to collect zooplankton samples. The net was lowered to one meter above the sediment and slowly pulled to the lake surface. Samples were put on ice and mailed overnight to

PhycoTech for identification. All taxa were identified to the lowest practical taxonomic level.

Phytoplankton samples were collected monthly from July to September in 2004. The samples were collected with a six-foot integrated surface sampling device, put on ice, and mailed overnight to the WSLOH in Madison, WI. All taxa were identified to the lowest practical taxonomic level.

3.4 Trophic Status Calculations

Trophic status was calculated for Little Blake Lake water samples using the following equations (the units of measurement required for each parameter are included as a subscript in the equation):

$TSI_{SD} = 60 – 14.41* \ln (SD_m)$

$TSI_{chl} = 9.81* \ln (chl_{\mu g}) + 30.6$

$TSI_{TP} = 14.42 * \ln (TP_{\mu g}) + 4.15$

The following scale is used to evaluate trophic status (Lillie and Mason 1983):

TSI < 30	oligotrophic
30 < TSI < 50	mesotrophic
TSI > 50	eutrophic

3.5 Watershed Analysis and WiLMS Modeling

The watershed delineation was provided by Polk County Land and Water Resource Department (LWRD) in GIS shape file format. The shape file was added to land use data collected from the online WDNR Web View service and the land use layer (WISCLAND) was clipped to the watershed boundary. The land use types were selected by attributes using the categories listed in the WiLMS software and exported as individual shape files. The area of each land use category was calculated, summed and entered into the WiLMS program.

Default data for Polk County was used whenever possible (*e.g.* soil coefficients, evaporation, etc.). The lake volume was estimated so that the software reported an average depth of 6 feet. The June total phosphorus (TP) results were used as the spring overturn TP concentration and all 2004 TP readings were averaged to get the mean growing season TP.

Septic system information was not available so the following assumptions were made to estimate the non-point source septic contributions:

- 20 homes on the lake
- 50% seasonal and 50% year-round residences
- Year round residences were occupied 12 months per year
- Seasonal residences were occupied 2 months per year
- Average residence housed 2.7 people when in use

The number of "capita years" was calculated using the above assumptions as follows:

Year-round residences

10 homes X (12 occupancy months/12 months per year) X 2.7 people = **27**

Seasonal residences

10 homes X (2 occupancy months/12 months per year) X 2.7 people = **4.5**

Total Capita Years = 31.5

4.1 Water Quality

Little Blake Lake is a eutrophic system that did not thermally stratify in the summer of 2004, and has pH, conductivity, and dissolved oxygen profiles typical of drainage lakes of northern Wisconsin. The total phosphorus, chlorophyll *a*, and Secchi disk readings all support the eutrophic status.

4.2 Phosphorous

Total phosphorus was reported for each sampling event (Figure 3). The average TP for the mid-lake site of Little Blake Lake in 2004 was 47.2 µg/L, and ranged from 17 µg/L to 100 µg/L. The TSI_{TP} value for Little Blake Lake in 2004 was 59.7.

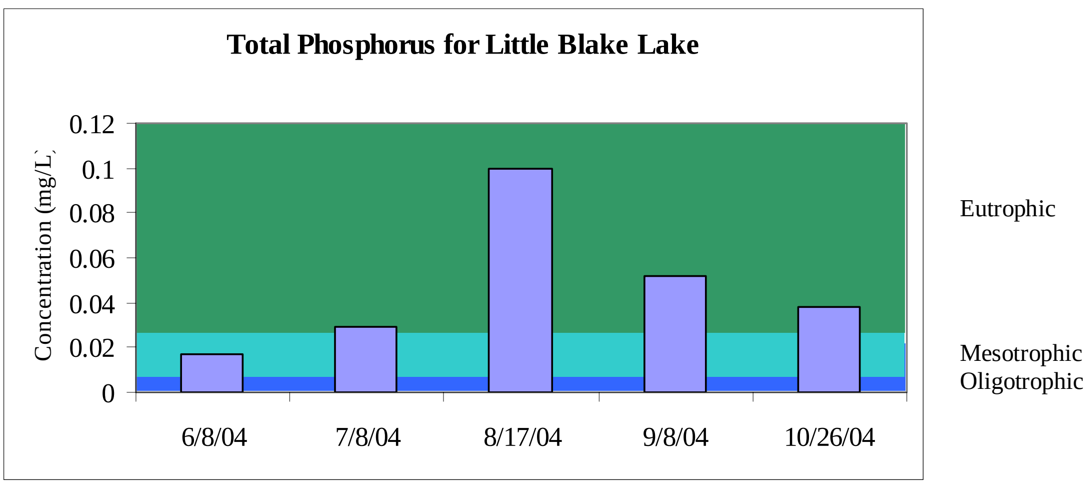

Figure 3. Total phosphorus measurements for the Little Blake Lake (Polk County, WI) 2004.

4.3 Chlorophyll *a*

Chlorophyll *a* was also reported for each sampling event (Figure 4). The average chlorophyll *a* for the mid-lake site of Little Blake Lake in 2004 was 11.94 µg/L, and ranged from 1.0 µg/L to 20.3 µg/L. The TSI_{chl} value for Little Blake Lake in 2004 was 54.5.

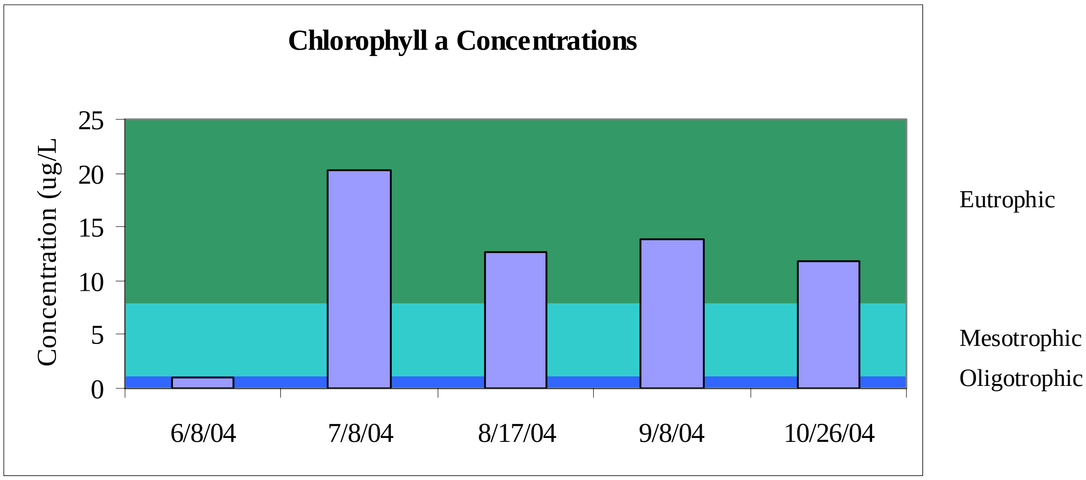

Figure 4. Chlorophyll *a* measurements for Little Blake Lake (Polk County, WI) 2004. June analysis reported a concentration <1.0 µg/L. The lowest detectable level for the method used; therefore the actual concentration is not known.

4.4 Secchi Transparency

Secchi disk readings were collected ten times in 2004. The average Secchi reading in 2004 was 6.0 feet and ranging from 3.0 to 8.0 feet (Figure 5). The TSI_{SD} for Little Blake Lake in 2004 was 51.3.

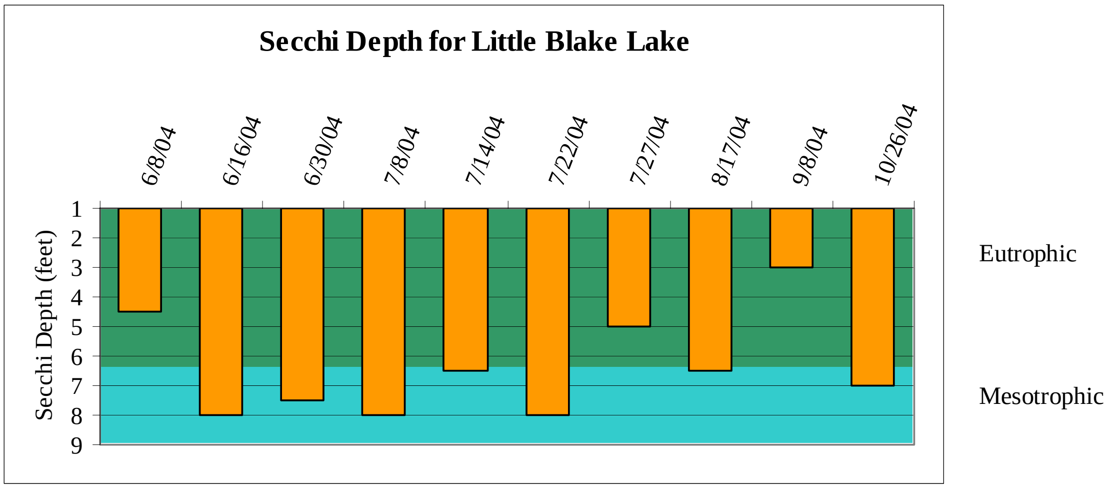

Figure 5. Monthly average Secchi depths from the mid-lake sample location of Little Blake Lake (Polk County, WI) 2004.

4.5 Other Parameters

Other parameters measured were total Kjeldahl nitrogen, soluble reactive phosphorus, temperature, conductivity, specific conductance, and salinity. The aforementioned chemical and physical parameters affect water quality in many different ways and are discussed separately in the following subsections.

Total Kjeldahl Nitrogen (TKN)

The Kjeldahl technique is a laboratory test for measuring the amount of organic nitrogen contained in water. The organic nitrogen concentration is actually the TKN concentration minus the ammonia concentration. Organic nitrogen may be either dissolved or suspended particulate matter in water, and high levels of organic nitrogen in water may indicate excessive production of organic pollution from the watershed. Animal and human waste, decaying organic matter, and live organic material like tiny algae cells can cause organic nitrogen enrichment of lake water (Tippecanoe Environmental Lake and Watershed Foundation 2005). Nitrogen, like phosphorus, is an essential macronutrient needed for algal production. Most lakes, however, are phosphorus-driven, and attempts to reduce lake nitrogen levels may have little effect on algal biomass (Holdren et al. 2001). The average TKN for the mid-lake site of Little Blake Lake in 2004 was 1,194 µg/L. The N:P (TKN:TP) ratio was approximately 25 to 1 (by mass) and supports the fact that Little Blake Lake is phosphorus-driven (generally any ratio over 7:1 N:P by weight is phosphorus limited).

Soluble Reactive Phosphorus (SRP)

Soluble reactive phosphorus (SRP) is a dissolved form of phosphorus. Dissolved phosphorus is the form of phosphorus that plants and algae use to create biomass. Since plant and algae growth is typically limited by phosphorus, added phosphorus, especially in the dissolved bio-available form, can fuel plant growth and cause algae blooms. Sources of SRP can include failing septic systems, animal waste, fertilizers, decaying plants and animals, and resuspension from the lake bottom. Because phosphorus is cycled so rapidly through biota, SRP concentrations as low as 5 µg/L are enough to maintain eutrophic or highly productive conditions in lake systems (Tippecanoe Environmental Lake and Watershed Foundation 2005). The average SRP for the mid-lake site of Little Blake Lake in 2004 was 12.0 µg/L.

Temperature

Temperature plays a major role in water quality, especially in lakes that become thermally stratified. Thermal stratification occurs when water in the top layer of a lake becomes heated by the sun and insufficient mixing action allows the warm water layer at the surface (epilimnion) to "float" on top of a cooler, more dense layer of water near the bottom (hypolimnion). As the summer progresses, the difference in density between the two layers increases and, when the difference becomes too great for wind energy to mix, the lake becomes stratified (Holdren et al. 2001). The region between the epilimnion and hypolimnion is called the metalimnion. The particular depth within the metalimnion where the rate of change in temperature is greatest is called the thermocline (Holdren et al. 2001). In 2004, Little Blake Lake did not thermally stratify; many drainage lakes do not thermally stratify because the constant drainage prevents a thermocline from forming. The difference between the surface temperature and bottom temperature on July 22nd was less than one degree Celsius. This is the time of year one would expect the strongest thermocline to form. However, the greatest temperature difference from top to bottom occurred in early June. None of the readings show a true thermocline (Figure 6).

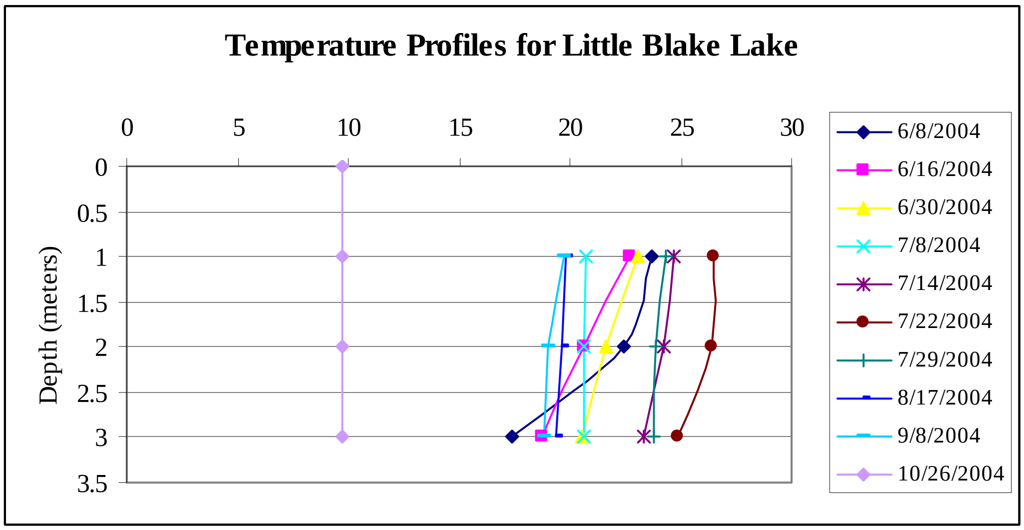

Figure 6. Temperature profiles for Little Blake Lake (Polk Country, WI) 2004.

Conductivity and Specific Conductance

Conductivity in lake water comes from a variety of sources like agricultural and industrial runoff that contributes large amounts of dissolved salts, which raises conductivity. In addition, sewage from septic tanks and treatment facilities also add to the conductive properties in water. Another source of conductive properties comes from decomposing organic matter near the sediment. As planktonic algae die throughout the summer, a "rain" of dead algal cells is constantly falling on the sediments of the lake. The dead algal cells are decomposed by bacteria in and near the sediment by breaking high energy bonds stored in the algal cell wall. When this occurs, CO_2 is released into the water where it rapidly dissolves into carbonic acid, bicarbonate, and carbonate ions that contribute to the conductive properties of the lake water. On average, conductivity of Little Blake Lake at two meters deep in 2004 was approximately 183 µS/cm and is a typical value of freshwater lakes.

Dissolved Oxygen

Dissolved oxygen plays an important role in both the biology and chemical properties of the lake. Anoxic conditions make certain compounds more soluble in water. Chemical and biological properties are most affected during summer stratification when the hypolimnion does not mix with the oxygen-rich epilimnion. As reported earlier, Little Blake Lake did not thermally stratify in 2004. The water column was fairly well mixed throughout the season, which is typical of drainage lakes. The percent saturation of oxygen typically decreased as the probe neared the sediment (Figure 7). This oxygen depletion is likely due to a high biological oxygen demand caused by algae, plankton, and bacteria and is common for all types of lakes. Decomposition of organic waste near the sediment consumes oxygen faster than it can be replaced through photosynthesis and natural mixing of the water in the lake.

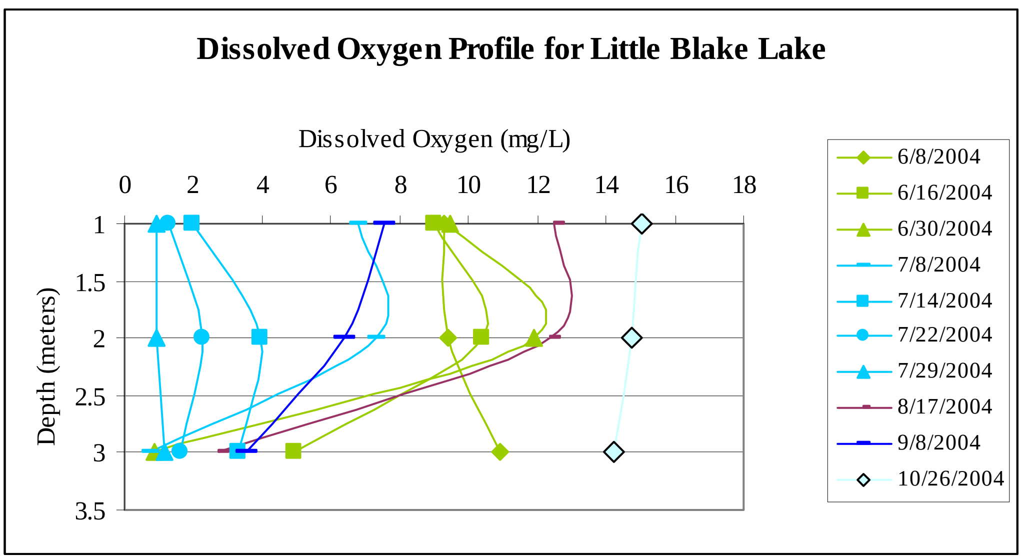

Figure 7. Mid-lake dissolved oxygen profiles for Little Blake Lake (Polk County, WI) 2004.

The low dissolved oxygen readings recorded in all three of the July sampling dates are likely due to equipment or operational malfunction. The levels of oxygen represented above would negatively affect fish and insects within the lake and should have been noticeable. Since no biological damage was reported, it is assumed the readings are not accurate.

4.6 Phytoplankton and Zooplankton

Phytoplankton

Composite surface samples were collected for phytoplankton analysis from the water quality site three times in 2004. The results show that Cryptophyta (cryptomonads) dominated the community in early summer (Figure 8) while Chrysophyta (golden-brown algae) and Cyanophyta (blue-green algae) were the most common species present in August and September (Figure 9, Figure 10) (Appendix B).

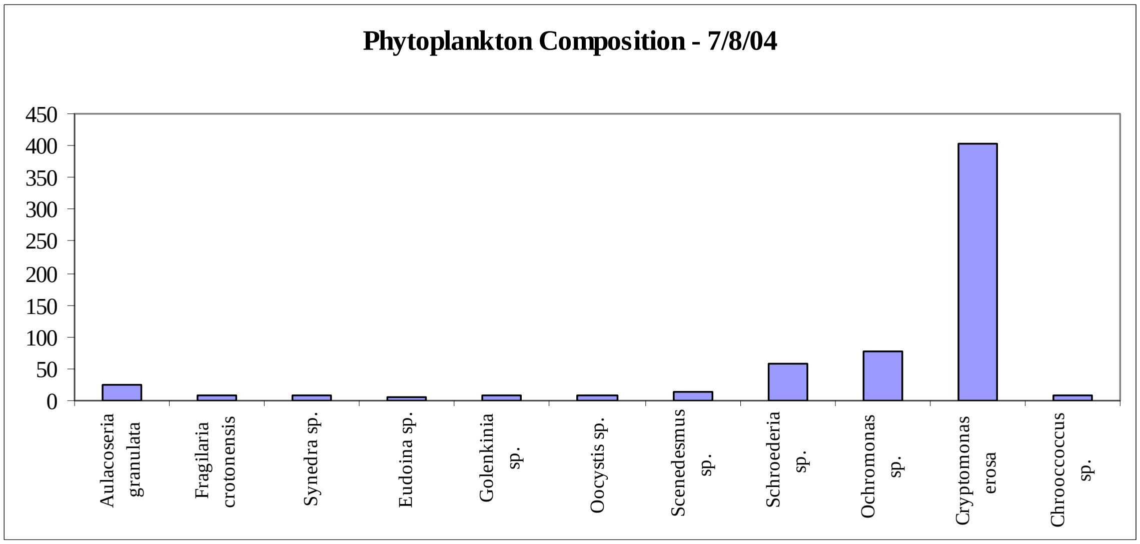

Figure 8. August phytoplankton community composition of Little Blake Lake (Polk County, WI) 2004.

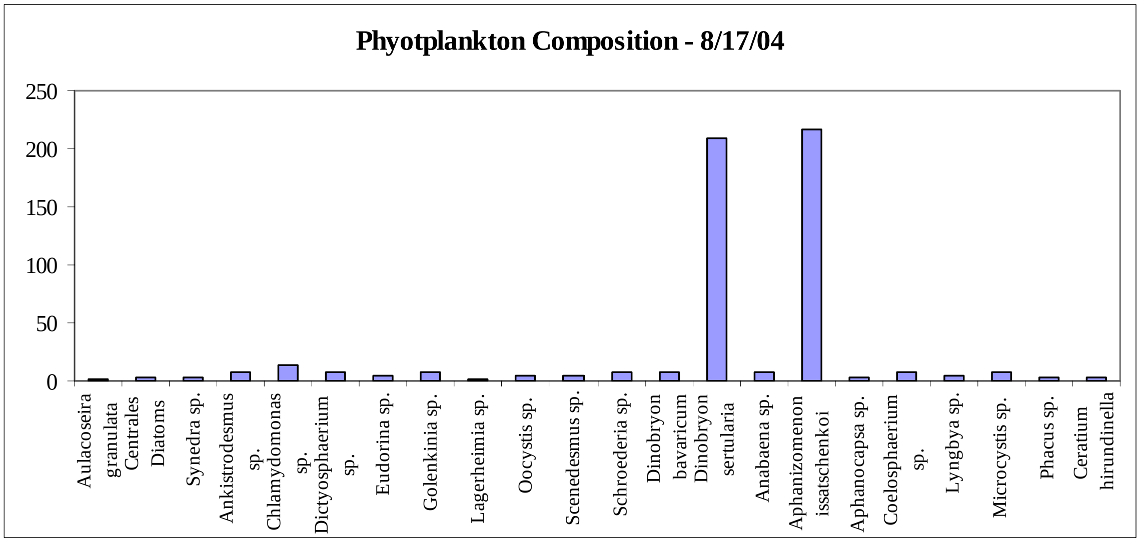

Figure 9. August phytoplankton community composition of Little Blake Lake (Polk County, WI) 2004.

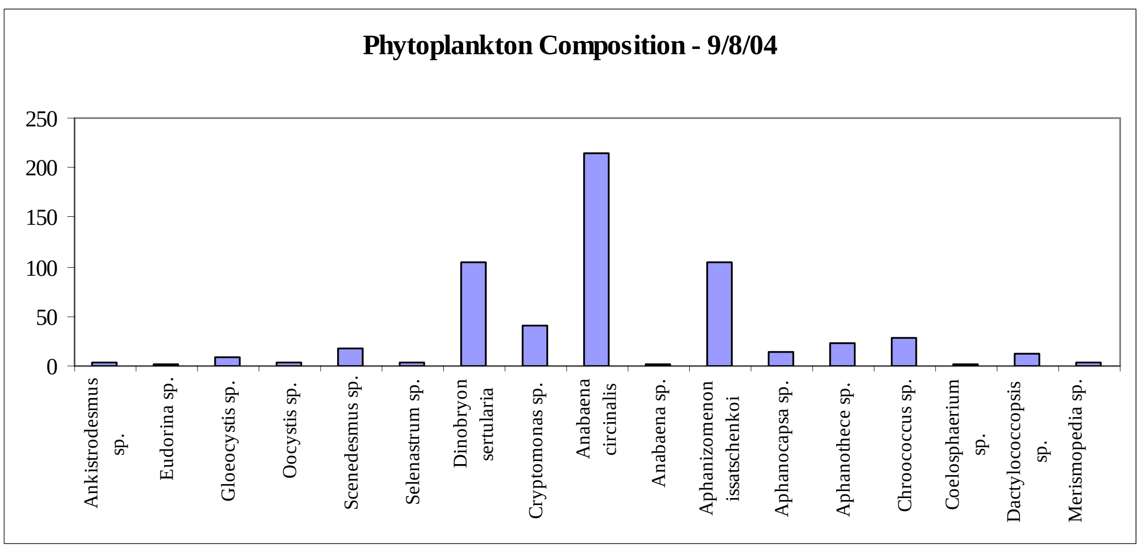

Figure 10. September phytoplankton community composition of Little Blake Lake (Polk County, WI) 2004.

Zooplankton

The most common organisms during the August 17th survey in 2004 were the Copepoda and non-Daphiniidae Diplostraca (Figure 11). The most common individual species in the order Diplostraca was *Diaphanosoma leuchtenbergi* (37.5 percent relative concentration). The order Copepoda comprised 37.5 percent of the relative concentration but individual species were not identifiable.

By early September the Rotifera were the most common organisms (Figure 12) and the most dominant species was *Keratella cochlearis* (52 percent relative concentration).

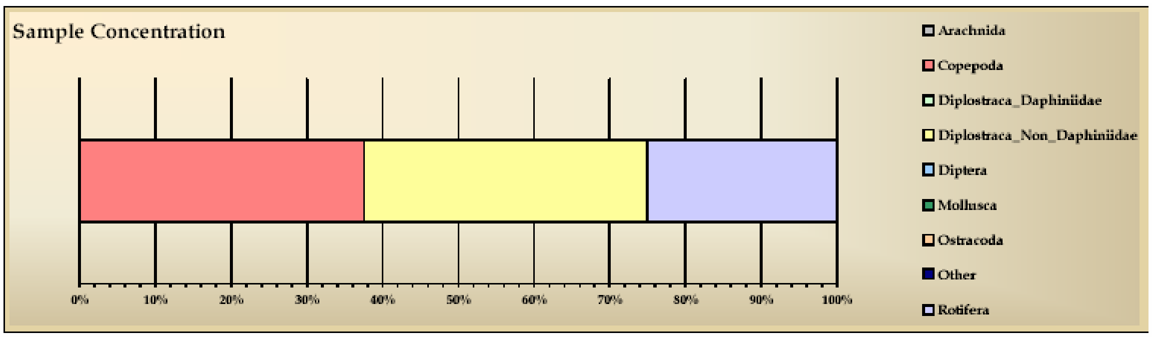

Figure 11. Zooplankton community structure of Little Blake Lake (Polk County, WI) August 17, 2004.

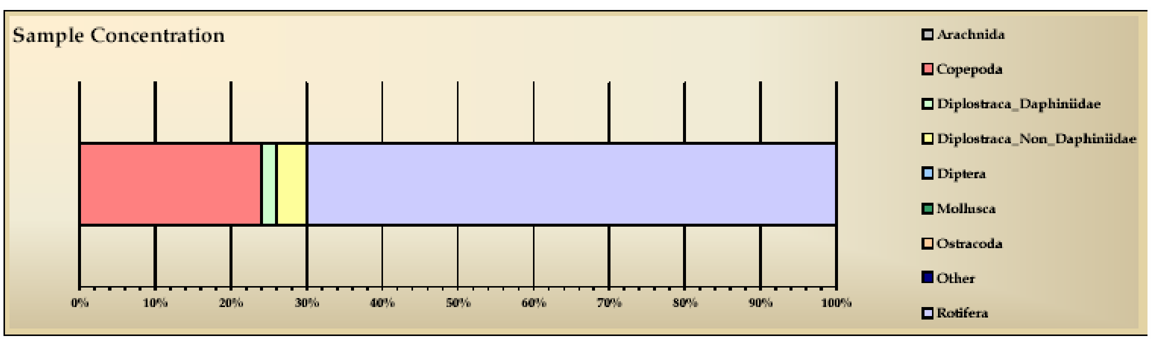

Figure 12. Zooplankton community structure of Little Blake Lake (Polk County, WI) September 8, 2004.

4.7 Watershed Analysis and WiLMS Modeling

The watershed analysis revealed that there is little agricultural influence in the immediate catchment for Little Blake Lake. The total area of the immediate Little Blake Lake watershed is approximately 200 acres (Figure 13). The majority of land use coverage was forest (Figure 14 and Table 1).

Table 1. Land use within the immediate Little Blake Lake watershed (Polk County, WI).

Land Use Category	Total Area (acres)	Percentage of Watershed
Forest	131.8	33%
Pasture and Grasslands	87.2	22%
Open Water	81.3	20%
Wetlands	68.6	17%
Row Crops	18.6	5%
Mixed Agriculture	12.6	3%
Total	**400.1**	**100%**

The WiLMS software computed phosphorus contributions by land use types within the immediate watershed. It also estimates the phosphorus load by septic systems and includes that estimate as part of the non-point source pollution. There was no point source data entered for the modeling.

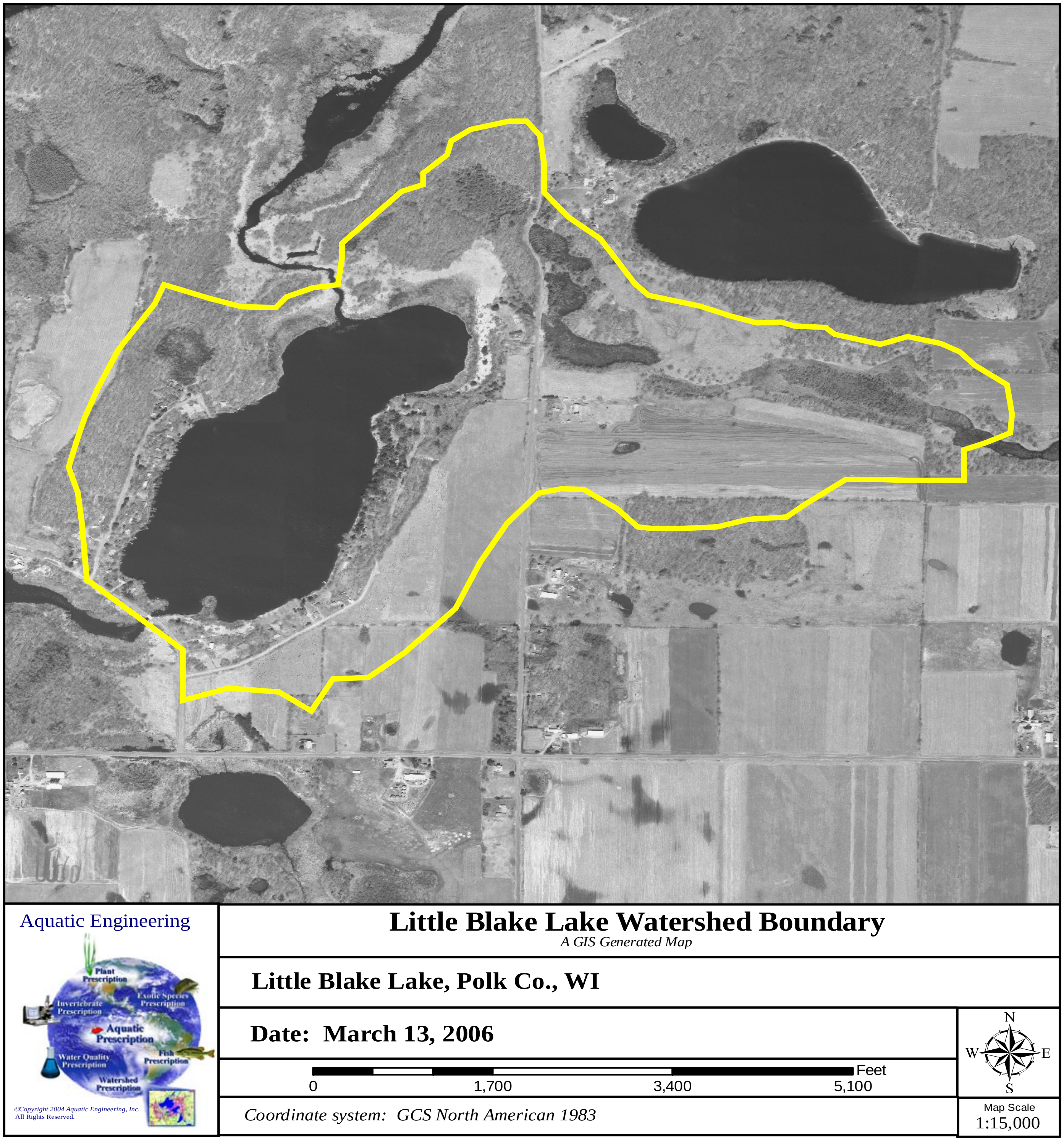

Figure 13. Immediate watershed of Little Blake Lake (Polk County, WI).

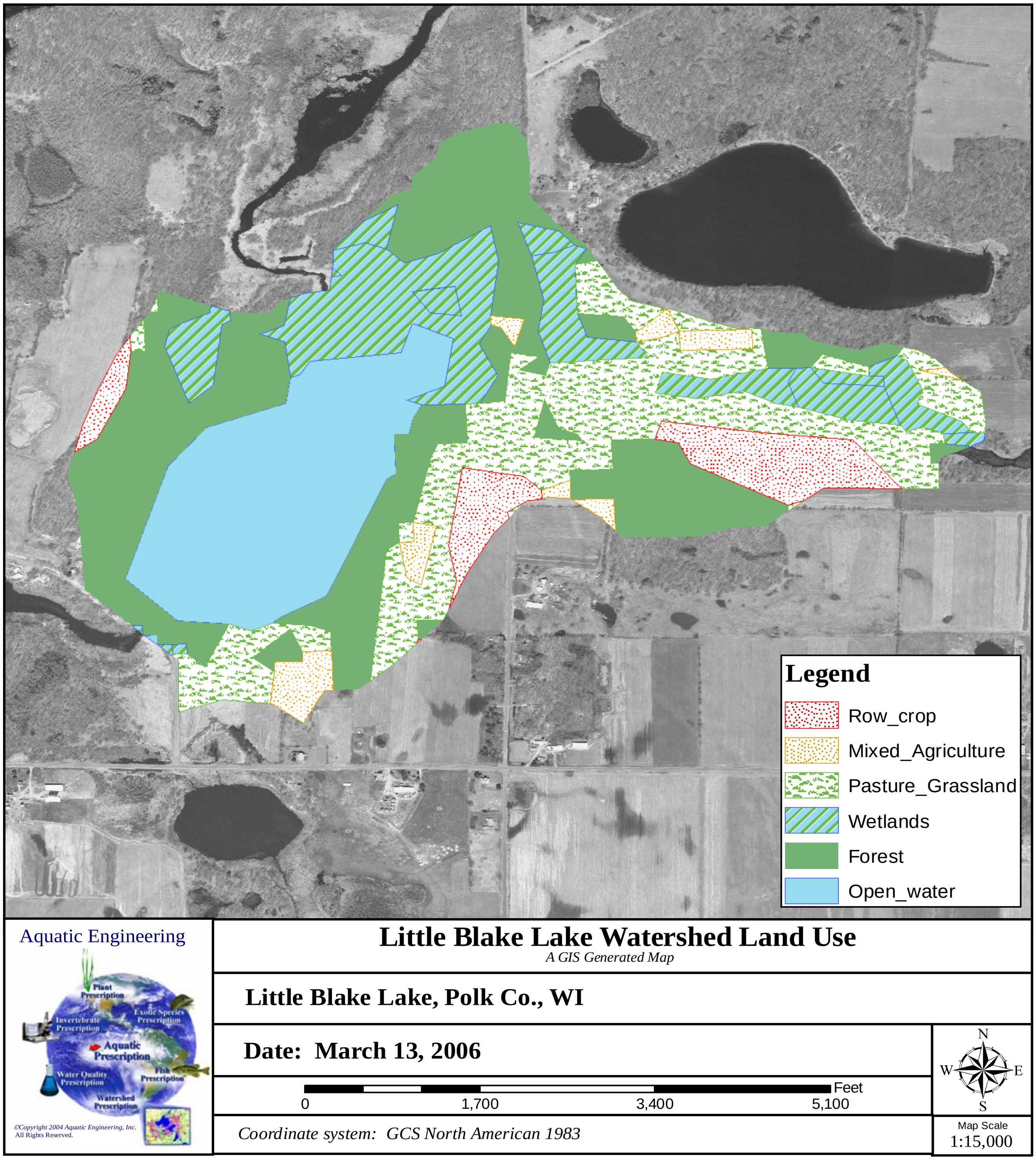

Figure 14. Land use within the immediate watershed of Little Blake Lake (Polk County, WI).

5.0 Discussion

5.1 Trophic Status Index

The TSI values for 2004 show that Little Blake Lake is a eutrophic lake. Water clarity data shows that the average Secchi depth suggests a moderate eutrophic status, while chlorophyll *a* and total phosphorus support a higher eutrophic status. Little Blake Lake has qualities expected of its eutrophic status that occur seasonally. Phosphorus and chlorophyll *a* levels peak each summer and decline in the fall. This cycle is caused by environmental conditions that favor algae growth in the heat of the summer when sunlight is high and rain washes nutrients into the lake. An additional source of phosphorus comes from decaying CLP in early summer. Scientific studies have shown that one acre of monotypic CLP is capable of releasing 5.5 pounds of phosphorus when it decomposes (McComas, 2000). Some nutrient budgets consider the amount of CLP within a lake as a source of phosphorus in the summer. It may be possible to control algal growth in the summer by limiting CLP biomass accumulation in the spring.

The TSI values represent what is expected to be found in any given body of water based on nutrient levels and water clarity. It is possible that nutrient rich lakes maintain relatively clear water and vice versa. However, in more instances than not water clarity and nutrient levels are inversely proportionate. The true measure of trophic status is to consider all three values (based on TP, Chl *a*, and Secchi depth). Considering all three values will help identify discrepancies in the observed conditions versus predicted conditions. The discrepancies could have implications on the “big picture” of the Little Blake Lake water quality and ecology.

5.2 Water Quality

Little Blake Lake is a phosphorus-driven lake that remains well mixed throughout the year with water quality similar to other lakes in its region. In addition, parameters measured for conductivity, temperature, pH, SRP, dissolved oxygen, TNK, and TP fell within normal ranges for Wisconsin lakes.

Internal loading of nutrients from lake sediments is accelerated when sediments become anoxic. Depletion of dissolved oxygen near the sediment of Little Blake Lake is likely due to biological oxygen demand caused by microbes during decomposition of organic matter. However, the water column is well mixed and internal loading is not thought to be a major source of nutrients. Therefore, the majority of nutrients entering Little Blake Lake come from the watershed and runoff.

The inflow from Big Round Lake is adding to the nutrient problem in Little Blake Lake; water entering Little Blake from Big Round is high enough in phosphorus to cause the eutrophic effects within Little Blake Lake. Self-Help data reported by the WDNR show that the TSI value calculated for Big Round Lake in 2004 was 49 and shows the lake is mesotrophic. However, this value is based on Secchi depth alone. In 2003, TP and chlorophyll *a* were also reported. The 2003 TSI values for all three parameters show that the lake is mesotrophic in the spring and highly eutrophic in the summer. The worst water clarity and highest nutrient levels in Big Round Lake occur in August and September. Regardless of the seasonal variation, it is clear that water leaving Big Round Lake is high in nutrients and is likely contributing to the decreased water quality in Little Blake Lake.

5.3 Phytoplankton and Zooplankton

These organisms are the largest contributors to the bottom level of the food chain in aquatic systems. Macroinvertebrates, fish, and some waterfowl feed on these organisms. Some zooplankton are also very efficient consumers of phytoplankton. Most of the energy transfers within an aquatic system food chain start with phytoplankton and zooplankton. The changes in abundance of these organisms throughout the year trigger growth cycles and feeding activities of many low and mid-level predators (*e.g.* aquatic insect larvae, bait fish, and panfish). In turn, changes in the predator populations can trigger changes in plankton assemblages.

Their relationships with their environment and responses to conditions, including predation, have been widely studied. However, the assemblages of plankton in our freshwater inland lakes have not been widely documented. Most of the research available for this region was performed on the Great Lakes. Currently, criteria are being established that may allow ecologists to make predictions of water quality based on the assemblages of plankton in the water.

Phytoplankton

Division Cryptophyta: Cryptomonads are single-cellular diflagellates (having two flagellae) that contain green photosynthetic pigments. Cryptomonads are found in a wide variety of moist and aquatic environments. *Cryptomonas erosa* was the most common species present during the July sampling event with 64 percent of the relative concentration. This species is a common species in the Great Lakes in the spring.

Division Chrysophyta: *Dinobryon sertularia* was the second most common species found during the August survey (39 percent relative concentration). *Dinobryon sertularia* is a golden-brown algae that reproduces by cell division. Unlike most cell divisions, the daughter cells of *Dinobryon sertularia* remain attached to the parent cell. By repeating this process several times, this species forms colonies of cells. This species is also one of the dominant species found in the Great Lakes.

Division Cyanophyta: These are the blue-green algae and are common in freshwater ecosystems. The organisms are thought to be over 2.5 billion years old and the reason that atmosphere around the earth exists. Two species within this division were dominant in 2004. In August *Aphanizomenon issatschenkoi* was the most common species (40 percent relative concentration). In September *Anabaena circinalis* was the most common species (36 percent relative concentration).

Specific phytoplankton thrive under certain environmental conditions. Nutrient availability, water temperature and light penetration play a significant role in shaping the phytoplankton community. Because of this, there is a typical seasonal succession in phytoplankton assemblages. The succession plays an important role in energy transfers within the aquatic food web. Phytoplankton feed zooplankton and insects which, in turn feed bait fish and panfish, which in turn feed picivorous fish and other wildlife.

There is not enough background information regarding phytoplankton populations in Wisconsin lakes to make a judgment on water quality based on the 2004 data. Continued sampling and analysis of these organisms will provide background information for the lake and may be used in the future to construct assessment criteria for water quality biomonitoring. It is important to continue monitoring the phytoplankton community if future biocriteria will be used for gauging water quality changes.

Zooplankton

Zooplankton are the base of the animal food web in that small fish graze on zooplankton, which is often their primary food source. In addition, zooplankton respond to many environmental and community changes throughout the year and may be good indicators of environmental stress. Zooplankton consume phytoplankton and are therefore dependent on the phytoplankton community. The number and type of zooplankton is highly dependent on the number and type of phytoplankton present along with environmental conditions.

There is not enough data available regarding zooplankton in Wisconsin lakes to make any judgments on water quality based on the assemblage present in Little Blake Lake in 2004. Some bio-assessment criteria are available through the USEPA. These criteria require that the members of the population be broken down into their respective functional groups for analysis of the whole community. As with phytoplankton sampling, continuing this effort is important to establishing criteria for biomonitoring.

5.4 Watershed Analysis and WiLMS Modeling

The WiLMS software estimated that non-point source pollution from pasture/grasslands and the lake surface itself contributed the greatest phosphorus load to the lake (Figure 15). However, the phosphorus load entering from the Straight River is likely the single largest load for Little Blake Lake, but no water chemistry analysis was performed on the incoming water. In order to know the exact contribution from the Straight River, a separate collection of water samples taken just upstream from the river/lake confluence would need to occur. Given the past data collected for Big Round Lake and Big Blake Lake, this type of analysis is not necessary to say with a degree of certainty that the water entering Little Blake Lake contains high levels of phosphorus.

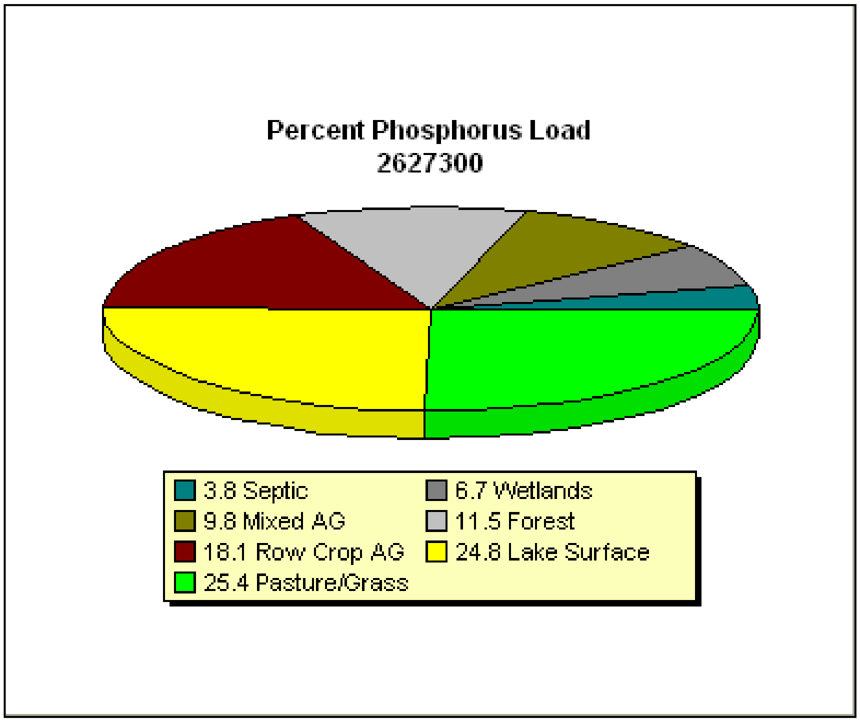

Figure 15. Non-point source of phosphorus load by land use type for Little Blake Lake (Polk County, WI).

6.0 Recommendations

The water quality of Little Blake Lake is impacted by one major component - the Straight River Inflow. The Straight River connects Big Round Lake to Little Blake Lake and is a likely cause of excess phosphorus to Little Blake Lake. Since Big Round Lake is high in phosphorus, it is likely that the Straight River transports its high nutrient water to Little Blake Lake with adverse effects. Although no specific study has been performed on Little Blake Lake, the lake does have a range of CLP density ranging from zero to roughly eighty percent, which may be the cause of the internal loading. Previous scientific research has proven decaying CLP contributes to nutrient loading in the summer, and it is fair to assume that decaying CLP will react similarly from lake to lake. Therefore, the CLP in Little Blake Lake and/or the inflow from the Straight River could be a cause of the nutrient loading.

As part of a future monitoring strategy, the TSI values should be calculated and compared from year to year to indicate whether the eutrophication process is increasing, decreasing, or remaining constant. Sudden changes could be due to environmental changes or major changes in the watershed. If TSI values steadily increase over several years, the water quality of the lake will continue to decrease. Watershed best management practices will be needed to halt or reverse the eutrophication process.

We are recommending the following practices for improving the water quality of Little Blake Lake:

- Organize the lake residents and preferably utilize the current Lake District
- Public education and implementation of buffer strips and shoreline restoration
- Help found a committee including members from Big Blake Lake, Big Round Lake and any organizations or special interest groups interested in improving the Straight River watershed whose goal is to reduce nutrient loading throughout the Straight River watershed
- Work with the county and local townships as they create their land use and zoning regulations to help minimize effects of current and future development

- Conduct a monthly two-meter surface integrated laboratory analysis for TP, Chl *a*, TKN and SRP one year out of every three from May to October during that year. Annually participate in WDNR's Self-Help monitoring program
- Complete and adopt an Aquatic Plant Management Plan with a focus on reducing internal loading in the summer by minimizing CLP biomass throughout the spring

7.0 References

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Holdren, C., W. Jones, and J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Mange. Soc. And Terrene Inst. In coop. with Off. Water Assess. Watershed Prot. Div. U.S. Environ. Prot. Agency, Madison, WI.

Lillie, R. A. and J. W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. Wisconsin Department of Natural Resources Technical Bulletin 138, Madison, WI.

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Appendix A: ***WEAL Water Quality Lab Reports***

Date	Depth (m)	Secchi (ft)	Temperature (C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/L)	Conductivity (ms)	Specific Conductance (ms at 25 C)	Salinity (ppt)	Reactive Phosphorus (mg/L)	Total Phosphorus (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Chlorophyll-a (ug/L)
6/8/2004	1	4.5	23.7	112.3	9.31	198.6	203.3	0.1	0.01	0.017	0.611	1
	2		22.4	113.1	9.38	191.9	202.1	0.1				
	3		17.4	110.5	10.94	176.3	206.8	0.1				
6/16/2004	1	8	22.7	115.1	9.01	179.6	187.5	0.1				
	2		20.6	118.8	10.37	182.1	198.1	0.1				
	3		18.7	61.7	4.95	181.2	206.2	0.1				
6/30/2004	1	7.5	23.1	108.3	9.47	188.3	195.5	0.1				
	2		21.6	131.5	11.88	184.7	198	0.1				
	3		20.5	1.5	0.86	182.6	197.2	0.1				
7/8/2004	1	8	20.7	76.1	6.8	183.8	200.3	0.1	0.009	0.029	0.379	20.3
	2		20.6	80.6	7.29	183.4	200.2	0.1				
	3		20.6	48.6	0.76	184.9	201.7	0.1				
7/14/2004	1	6.5	24.7	23.9	1.99	197	198.4	0.1				
	2		24.2	45.7	3.92	195.3	198.2	0.1				
	3		23.3	29.7	3.29	203.1	209.8	0.1				
7/22/2004	1	8	26.5	15.4	1.26	203.9	198.5	0.1				
	2		26.4	27.5	2.25	202.7	197.6	0.1				
	3		24.9	19.8	1.63	230.3	230.8	0.1				
7/29/2004	1	5	24.3	11.1	0.92	193.5	196.4	0.1				
	2		23.9	11.2	0.95	192.2	196.5	0.1				
	3		23.8	13.9	1.19	192.2	196.6	0.1				
8/17/2004	1	6.5	19.8	131.7	12.46	175.2	194.8	0.1	0.02	0.1	1.38	12.7
	2		19.6	118.7	12.34	174.2	194.3	0.1				
	3		19.4	36	2.7	182.8	205	0.1				
9/8/2004	1	3	19.7	86	7.54	177.3	197	0.1	0.012	0.052	0.69	13.9
	2		19	72.5	6.4	175	197.4	0.1				
	3		18.8	43.8	3.52	175.4	199.1	0.1				
10/26/2004	surface	7	9.7	154.1	16.34	147.2	208.1	0.1	0.009	0.038	0.64	11.8
	1		9.7	132.9	15.02	148.1	209.3	0.1				
	2		9.7	131	14.76	148.1	209.4	0.1				
	3		9.7	130.4	14.23	148.1	209.5	0.1				

Appendix B: *Phytoplankton Raw Data*

WISCONSIN STATE LABORATORY OF HYGIENE

Environmental Health Division
2601 Agriculture Dr.
P.O. Box 7996
Madison, WI 53707-7996
Phone: (608) 224-6202 • (800) 442-4618
FAX: (608) 224-6213

University of Wisconsin

Algae Identification Report

Site: Little Blake Lake
Station/Location: Midlake
Depth: 6 feet composite
Laboratory Number: 2004-366

Collection Date: September 8, 2004
Identification Date: September 17, 2004
Identified By: Dawn Karner

Taxa	Division	# Counted	Concentration (Units/mL)[a,b]	Relative % Concentration
Ankistrodesmus sp.	Chlorophyta	2	4	0.6%
Eudorina sp.	Chlorophyta	1	2	0.3%
Gloeocystis sp.	Chlorophyta	4	8	1.3%
Oocystis sp.	Chlorophyta	2	4	0.6%
Scenedesmus sp.	Chlorophyta	9	17	2.9%
Selenastrum sp.	Chlorophyta	2	4	0.6%
Dinobryon sertularia	Chrysophyta	55	105	17.8%
Cryptomonas sp.	Cryptophyta	21	40	6.8%
Anabaena circinalis	Cyanophyta	112	214	36.2%
Anabaena sp.	Cyanophyta	1	2	0.3%
Aphanizomenon issatschenkoi	Cyanophyta	55	105	17.8%
Aphanocapsa sp.	Cyanophyta	8	15	2.6%
Aphanothece sp.	Cyanophyta	12	23	3.9%
Chroococcus sp.	Cyanophyta	15	29	4.9%
Coelosphaerium sp.	Cyanophyta	1	2	0.3%
Dactylococcopsis sp.	Cyanophyta	7	13	2.3%
Merismopedia sp.	Cyanophyta	2	4	0.6%
	TOTAL		591	100%

Notes/Comments: Sample was preserved with Lugol's in the field. Analyzed via the Utermohl settling chamber method.

Signature and Date: Dawn Karner 9/17/04

a Natural Unit Count = unicell, colony or filament equals 1 Unit
b Method Reference = American Public Health Association et al. 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed. Method 10200 F2c1

http://www.slh.wisc.edu

WISCONSIN STATE LABORATORY OF HYGIENE

Environmental Health Division
Biomonitoring Unit – Dawn Karner
2601 Agriculture Drive
Madison, WI 53718
Phone: (608) 224-6230 • (800) 442-461
Fax: (608) 224-6267

ALGAE IDENTIFICATION TEST REQUEST

Sample Location – Waterbody Name: Little Blake Lake	Sample Location – City, State: Balsam Lake, WI
Sample Point Description: Mid Lake	
Identification Requested: ☒ Algae ID ☒ Cyanobacteria ID	Additional Test Instructions: most common to species, rest to genus

Sample Information:

Sample Type: [illegible]	Sample Reason: lake monitoring
Depth of Sample: 6ft integrated	Comments:
Collected By: JW, ALD	Collector Telephone Number: 715, 485-6639
Sample Date: 9 / 8 / 04	Sample Time: 11 : 00 (hh:mm) ☒ a.m. ☐ p.m.

For Lab Use Only:

Date Received at Lab: 9 / 10 / 04
Laboratory Number: 2004-3666
Sample Preserved: ☒ In Field ☐ At Lab
Preservative: Lugols
Date Analyzed: 9 / 17 / 04
Analyst: [illegible]

Field Conditions:

Lake Surface Temperature – (°C): 21	Wind Direction:
Ambient Air Temperature - (°C): 70°F	Approximate Wind Velocity (MPH):

Cloud Cover (Check Most Appropriate):

☐ Clear Skies
☐ Partly Cloudy (Mostly Sun)
☐ Overcast
☒ Partly Sunny (Mostly Clouds)
☐ Raining

Comments:

Send Report & Bill To:

Name (First, Last): Josh Britton, TLI
Address: P.O. Box 304
City: LaCrosse State: WI Zip: 54602

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WSLH WISCONSIN STATE LABORATORY OF HYGIENE

Environmental Health Division
2601 Agriculture Dr.
P.O. Box 7996
Madison, WI 53707-7996
Phone: (608) 224-6202 • (800) 442-4618
FAX: (608) 224-6213

University of Wisconsin

Algae Identification Report

Site: Little Blake Lake
Station/Location: Midlake
Depth: 3 feet integrated
Laboratory Number: 2004-183

Collection Date: July 8, 2004
Identification Date: July 29, 2004
Identified By: Dawn Karner

Taxa	Division	# Counted	Concentration (Units/mL)[a,b]	Relative % Concentration
Aulacoseira granulata	Bacillariophyta	11	26	4.1%
Fragilaria crotonensis	Bacillariophyta	4	9	1.5%
Synedra sp.	Bacillariophyta	4	9	1.5%
Eudorina sp.	Chlorophyta	2	5	0.8%
Golenkinia sp.	Chlorophyta	4	9	1.5%
Oocystis sp.	Chlorophyta	4	9	1.5%
Scenedesmus sp.	Chlorophyta	6	14	2.3%
Schroederia sp.	Chlorophyta	25	59	9.4%
Ochromonas sp.	Chrysophyta	33	78	12.4%
Cryptomonas erosa	Cryptophyta	170	402	63.9%
Chroococcus sp.	Cyanophyta	3	7	1.1%
	TOTAL		630	100%

Notes/Comments: **Analyzed via the Utermohl settling chamber method.**

Signature and Date: Dawn Karner 8/10/2004

a Natural Unit Count = unicell, colony or filament equals 1 Unit
b Method Reference = American Public Health Association et al. 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed. Method 10200 F2c1

http://www.slh.wisc.edu

Environmental Health Division
Biomonitoring Unit – Dawn Karner
2601 Agriculture Drive
Madison, WI 53718
Phone: (608) 224-6230 • (800) 442-4618
Fax: (608) 224-6267

WISCONSIN STATE LABORATORY OF HYGIENE

ALGAE IDENTIFICATION TEST REQUEST

Sample Location – Waterbody Name	Sample Location – City, State
Little Black Lake	Georgetown, WI

Sample Point Description: Midlake

Identification Requested: ☒ Algae ID ☒ Cyanobacteria ID

Additional Test Instructions: most common to species, rest to genus

Sample Information:

Sample Type: Surface H2O	Sample Reason: lake monitoring
Depth of Sample: 3' integrated	Comments:
Collected By: J. Williamson	Collector Telephone Number: (715) -
Sample Date: 7 / 8 / 04	Sample Time: 1 0 : 0 2 (hh:mm) ☒ a.m. ☐ p.m.

For Lab Use Only:

Date Received at Lab: 7 / 9 / 04

Laboratory Number: 2004 - 183

Sample Preserved: ☐ In Field ☒ At Lab

Preservative: Glut

Date Analyzed: 8/7 / 29 / 04

Analyst: DK

Field Conditions:

Lake Surface Temperature – (°C): 20.7	Wind Direction: S
Ambient Air Temperature - (°C): 23.8	Approximate Wind Velocity (MPH): 3 mpH

Cloud Cover (Check Most Appropriate):

☒ Clear Skies
☐ Partly Cloudy (Mostly Sun)
☐ Overcast
☐ Partly Sunny (Mostly Clouds)
☐ Raining

Comments: Sample LBL-1

Send Report & Bill To:

Name (First, Last): Josh Britton

Address: PO Box 309 3634

City	State	Zip
La Crosse	WI	54602-0309 -3634

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Appendix C: ***Zooplankton Raw Data***

PhycoTech, Inc.
620 Broad Street - Suite 100 - St. Joseph - MI 49085 - Phone: 269-983-3654 - Fax: 269-983-3653
info@phycotech.com - www.phycotech.com

Zooplankton Analysis
Report and Data Set

Customer ID : 184
Calc Type : Zooplankton - Tow Volume Calculated (Field Method)

Tracking Code: 040014-184
Customer ID: 184
Job Number: 2
System Name: Little Blake Lake

Sample ID LBL
Sample Date: 8/17/2004
Station: .
Site: Mid-Lake

Replicate # 1
Level .
Depth 8
Preservative Ethanol

Report Notes .

Taxa ID	*Genus*	*Species*	*Subspecies*	*Variety*	*Morph*	*Structure*	*Concentration* Animal/L	*Relative Concentration*
Phylum: Arthropoda								
Order:	**Calanoida**							
131852	*.	spp	.	.	.	nauplius	0.44	37.50
						TOTAL Calanoida	0.44	37.50
Phylum: Arthropoda								
Order:	**Diplostraca**							
104403	Diaphanosoma	leuchtenbergi	.	.	Female	Whole Animal	0.44	37.50
						TOTAL Diplostraca	0.44	37.50
Phylum: Rotifera								
Order:	**Ploima**							
125281	Keratella	cochlearis	.	.	.	Whole Animal	0.15	12.50
126153	Polyarthra	vulgaris	.	.	.	Whole Animal	0.15	12.50
						TOTAL Ploima	0.29	25.00

☒ = Identification is uncertain
= = Subclass level identification
* = Family level identification

Tracking Code: 040024-184
Customer ID: 184
Job Number: 2
System Name: Little Blake Lake

Sample ID .
Sample Date: 9/8/2004
Station: .
Site: Mid-Lake

Replicate # 1
Level .
Depth 8
Preservative Ethanol

Report Notes .

Taxa ID	*Genus*	*Species*	*Subspecies*	*Variety*	*Morph*	*Structure*	*Concentration* Animal/L	*Relative Concentration*
Phylum: Arthropoda								
Order: Calanoida								
131852	*.	spp	.	.	.	nauplius	0.24	8.00
1000344	*.	spp	.	.	CI-CIV	Whole Animal	0.36	12.00
128120	Diaptomus	spp	.	.	.	Whole Animal	0.03	1.00
						TOTAL Calanoida	0.63	21.00
Order: Cyclopoida								
1000248	*.	spp	.	.	CI-CV	Whole Animal	0.09	3.00
						TOTAL Cyclopoida	0.09	3.00
Phylum: Arthropoda								
Order: Diplostraca								
1000146	Daphnia	galeata	mendotae	.	Female	Whole Animal	0.06	2.00
						TOTAL Diplostraca	0.06	2.00

☒ = Identification is uncertain
= = Subclass level identification
* = Family level identification

Phylum: Arthropoda

Order: Diplostraca

104403	Diaphanosoma	leuchtenbergi	.	.	Female	Whole Animal	0.12	4.00
						TOTAL Diplostraca	0.12	4.00

Phylum: Rotifera

Order: Flosculariaceae

125572	Conochilus	unicornis	.	.	.	Whole Animal	0.36	12.00
						TOTAL Flosculariaceae	0.36	12.00

Order: Ploima

131840	Ascomorpha	spp	.	.	.	Whole Animal	0.06	2.00
131841	Asplanchna	spp	.	.	.	Whole Animal	0.06	2.00
125281	Keratella	cochlearis	.	.	.	Whole Animal	1.55	52.00
126153	Polyarthra	vulgaris	.	.	.	Whole Animal	0.06	2.00
						TOTAL Ploima	1.73	58.00