Technical Status Memorandum
For
Lakes Limerick and Leprechaun 2012
Aquatic Plant Management

December 2012

Prepared for
Lake Committee
Lake Limerick Country Club

Prepared by
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Introduction

Consistent with previous years, the long-term management of the aquatic plants (primary production of both aquatic plants and phytoplankton including Cyanobacteria, formerly called blue-green algae) in both Lakes Limerick and Leprechaun will always require annual management in order to maintain the lakes beneficial uses. Nutrient availability within the lakes is from their sediments, surface inflow and from shallow groundwater. One of the goals is to promote a balanced ecosystem that minimized the cost of controlling the undesirable excesses of over production (too many plants and algal blooms).

Although the two lakes are morphologically different and their biological communities reflect these differences there still remains a common management theme. Successful implementation of a management theme is dependent upon recognizing two keys aspects of management for these lakes. One key is the control of the rooted aquatic plants in order to allow boat passage, water contact, and aesthetic appeal. The second key to successful management is to maintain enough aquatic plants in the lakes to service as structure for fisheries habitat and to provide direct and indirect competition for algae (phytoplankton free floating photosynthetic organisms). This competition is for the soluble macronutrients (phosphorus and nitrogen) by the microbial community that grows on the plants versus the phytoplankton. Some of surfaces of all aquatic plants provide areas for microbes to adhere forming a community of periphyton (attached algae), bacteria and fungus that in turn absorb nutrients from the water column. It is this removal of nutrients that is direct competition to phytoplankton. The nutrient levels in both lakes (as indicated by the production of aquatic plants in both lakes and the observed phytoplankton both filamentous and free floating) render the complete removal of aquatic plants undesirable. If all aquatic plants were removed from the lakes there is a high probability that significant cyanobacteria blooms would occur. These potential blooms could in themselves be dense enough to prohibit fishing and water contract recreation. In addition, certain types of cyanobacteria have the ability to produce toxins further impairing the beneficial use of the lakes.

Simply put, the aquatic plant management program must balance the promotion of direct lake activities while still providing for a set of biological controls to overproduction. This is exactly what has been put into motion in Lake Limerick and Lake Leprechaun. Lakes Limerick and Leprechaun are in fact moving toward this equilibrium state. The program carried out for 2011 and in 2012 reflects this basic status and the need for balanced approach. Given that there has been significant progress made toward control of aquatic macrophytes through the 2010 season, 2011 and 2012 program was less aggressive in Lake Limerick and no action was taken in Lake Leprechaun in 2011 but was again in 2012.

The following briefly presents the aquatic plant status for both lakes and year 2011 and 2012 management program.

Lake Limerick

The aquatic plant control program for Lake Limerick in 2012 continued to build upon the efforts started in 2005 with the intensive herbicide treatment followed by the high-beneficial use annual treatments in 2006 through 2011. In 2012 the objective of management actions were designed to continue to control non-natives, but also to reduce the adverse impact of native plants due to their density and coverage of the lake bottom. At the same time the plant community was encouraged to develop in a sustained manner to promote habitat structure and direct competition to phytoplankton for nutrient uptake.

Figure 1 illustrates the locations and type of plant communities within Lake Limerick as of the June 2012 survey. Figure 1 also shows the red hatched areas where treatment took place in 2012. The 2012 treatment continued to inhibit the re-expansion of the non-native Brazilian elodea.

A total of 8.3 acres were treated in 2012. First treatment was with the contact herbicide Diquat conducted in August. The follow-up treatment was in September and at that time the systemic herbicide Sonar PR was used. The purpose of the contact herbicide is to weaken the dominate plants within the target area but then allow these same plants to start to regrow (10 to 14 days after the contact herbicide treatment) so that the systemic herbicide will kill non-native plants in the area and limit the regrowth and over production of the pond weeds (native plants) in the follow summer. This is the same objective as the 2011 treatment efforts.

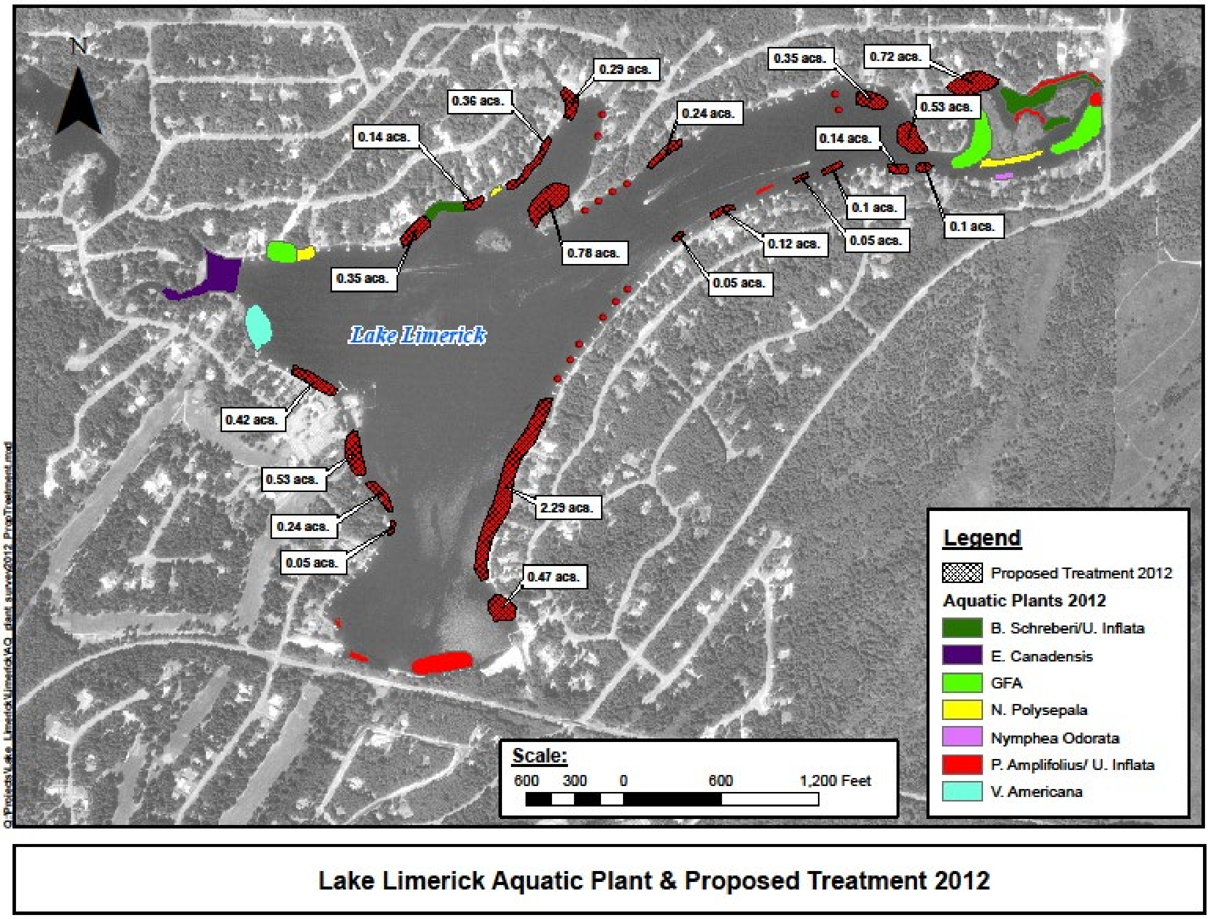


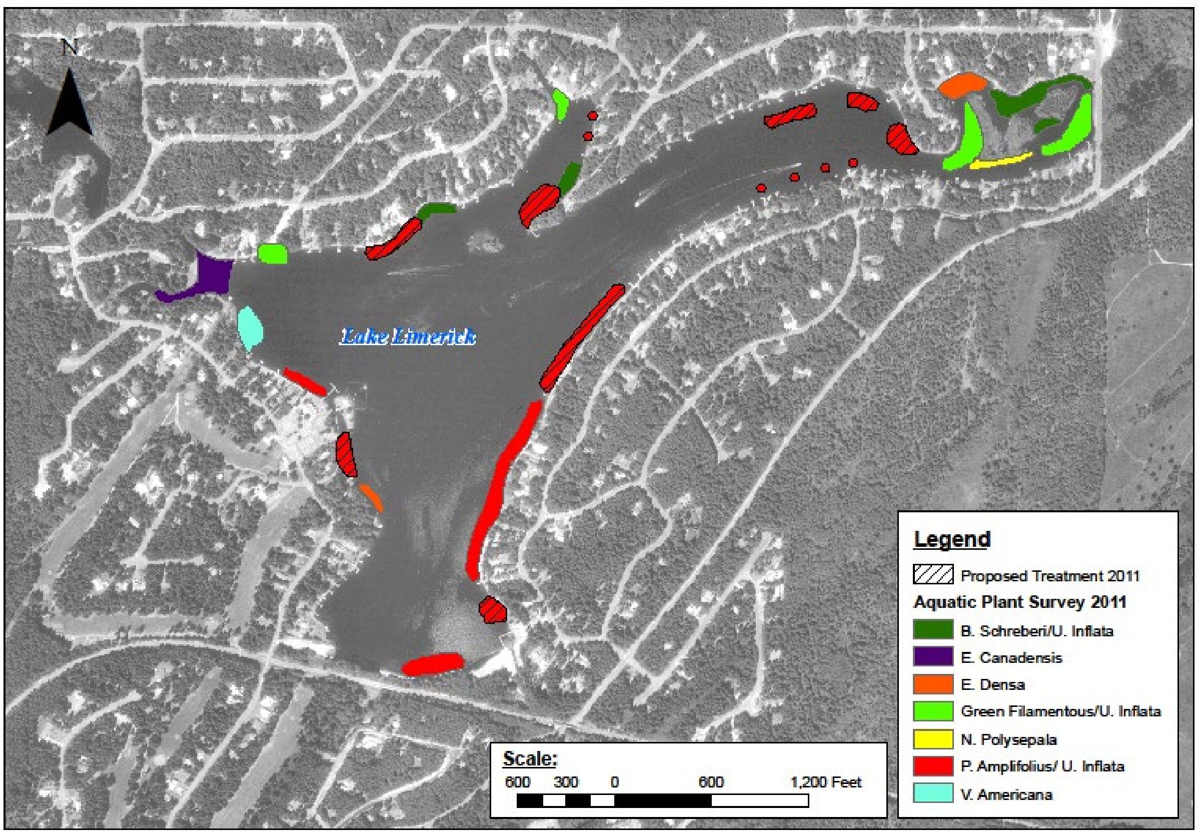
Figure 1. Lake Limerick plant map and treatment areas for 2012 as proposed and treatment applied.

The area treated in 2011 was the smallest acreage treated since 2005. Less than 5 acres were treated and all to limit the ever increasing growth of the native plant call pond weed (*Potamogeton amplifolius*). The original intent of the aquatic plant management program was to control the non-native Brazilian elodea (*Egeria densa*). This plant dominance of the aquatic plant community has been reduced to a small fraction of the area and density that it covered in the 1990's and early 2000's. The objective of the 2011 and future management actions are to continue to control non-natives but also to reduce the adverse impact of native plants due to their density and coverage of the lake bottom, while still allowing for sustained existence to promote habitat structure and direct competition to phytoplankton for nutrient uptake.

Figure 2 illustrates the locations and type of plant communities within Lake Limerick as of the June 2011 survey including dense growths of the filamentous green algae that are over produce biomass in the east end of the lake reflecting excess nutrient availability and the decrease in rooted pants due to previous years aquatic plant management treatments, particularly targeting

Brazilian elodea. Figure 2 also shows the red hatched areas where treatment took place in 2011. The treatment this year will hopefully yield results in limiting plant growth in the summer of 2012 in those treated area. In addition the 2011 treatment will continue to inhibit the re-expansion of the non-native Brazilian elodea.

A total of 4.4 acres were treated in 2011year. First treatment was with the contact herbicide Diquat conducted on 25 August. The follow-up treatment was on 19 September and at that time the systemic herbicide Sonar PR was used. The purpose of the contact herbicide is to weaken the dominate plants within the target area but then allow these same plants to start to regrow (10 to 14 days after the contact herbicide treatment) so that the systemic herbicide will kill non-native plants in the area and limit the regrowth and over production of the pond weeds (native plants) in the follow summer.



Lake Limerick Aquatic Plant June 2011 Proposed Treatment 2011

Figure 2. Lake Limerick plant map and treatment areas for 2011 as proposed and treatment applied.

Figures 3 presents the Lake Limerick aquatic plant maps for 2009 and the treatment zones for 2010. Based on the large reduction of aquatic plant coverage and density observed when comparing the coverage in 2008 (Figure 4) with the observed coverage and density in September 2009, the 2010 and the 2011 aquatic plant treatment program was reduced from a total of 32 acres to not more than 12 acres in 2010 and less than 5 in 2011.

In the previous years (2007-2010) the treatment procedure follow the same protocol:

1) Mid June apply Sonar Q (Quick Release) in pellet form to the treatment area. Apply Sonar Q at concentration of 12 parts per billion every two weeks for a total of 3 treatments (mid-June, end of June and mid-July).

2) After 15 July Diquat (Reward) was added to the treatment areas; Diquat cannot be applied at a sooner date due to fishery restriction of Coho in the system.

3) 10-20 days after the Diquat application Sonar PR (Precision Release) in pellet form was applied to the treatment areas. Apply Sonar PR at a concentration of 8 parts per billion. This is a slow release pesticide and use of Sonar PR will help to control next year's growth. This was a one time application.

In 2011 the protocol was reduced to just the Diquat and Sonar PR application to save money and to prevent over control of the aquatic plants that would lead to an increase probability of cyanobacteria blooms.

Over the last six years the density of Brazilian elodea has been controlled to a manageable level and now the density of native species where they interfere with beneficial uses have been targeted by the management efforts as well as to keep the non-native Brazilian elodea from re-establishing as sole plant dominant.

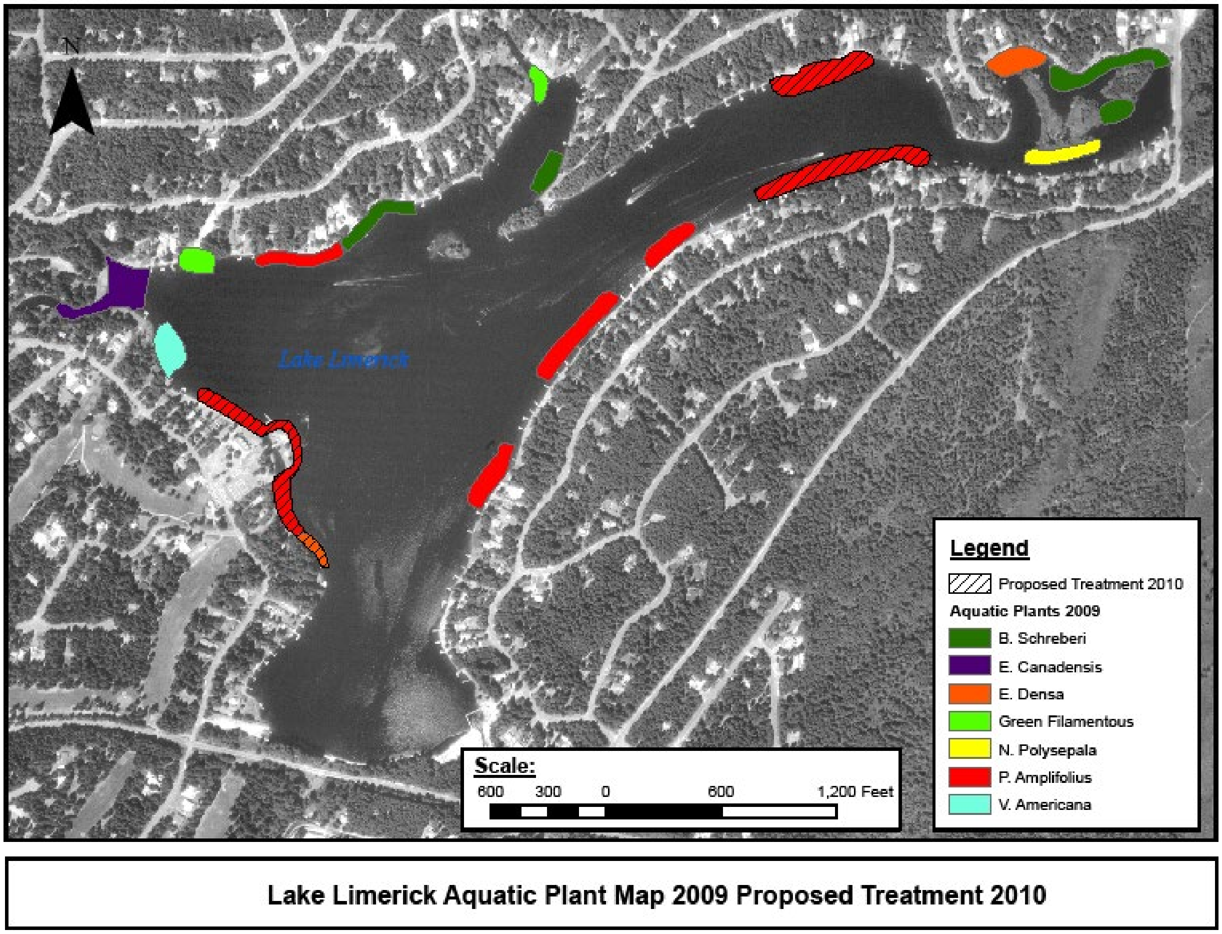


Figure 3. Lake Limerick aquatic treatment map for 2010

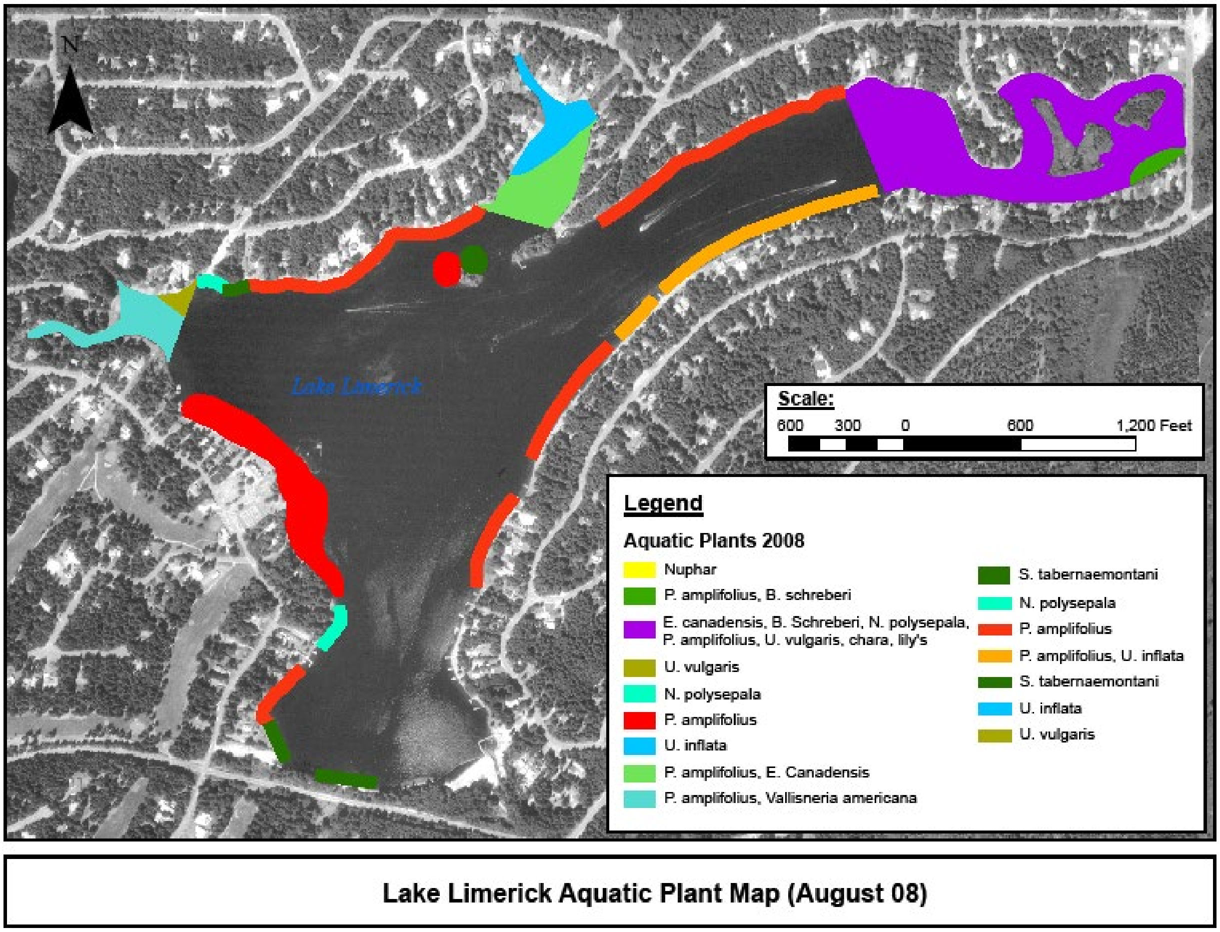
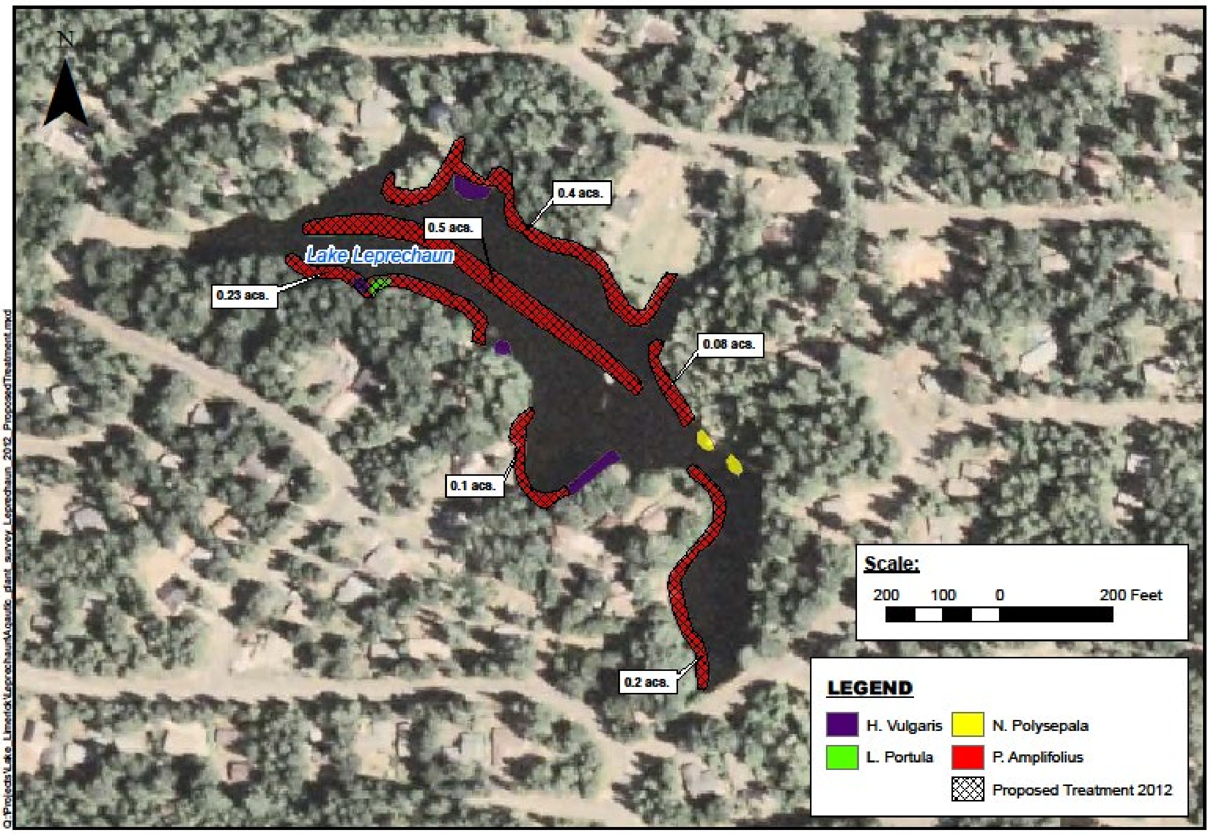


Figure 4. Lake Limerick aquatic plant coverage in August 2008

Lake Leprechaun

Similar to 2010 the density and coverage of aquatic plants in Lake Leprechaun in 2011 did not warrant treatment. However, this did not hold for 2012 so a more intense aquatic plant mapping was performed in June 2012 of the plant community in Lake Leprechaun to determine if plant density control is needed. The aquatic plant density and coverage within Lake Leprechaun had increased particularly with the expansion of common big leaf pond weed (*Potamogeton amplifolius*). Figure 5 shows the 2012 plant communities and areas treated with the same protocol used in Lake Limerick on the same dates. A total of 1.51 acres was treated to control the expanding growth of big leaf pond weed.



Lake Leprechaun Aquatic Plant Zones & Proposed Treatment 2012

Figure 5. The 2012 Aquatic plant map of Lake Leprechaun showing treatment areas.

The dominate plants observed in the Fall of 2007 are listed in Table 1 and shown in Figure 6, which, is a map of the relative coverage or those dominate plants within the lake. It is evident from the results of the herbicide treatments of 2008 and 2009 that the aquatic plants coverage in the lake has been greatly reduced. This can be seen by comparing the plant coverage shown in Figure 6 for 2007 with the pretreatment coverage shown in Figure 7 for 2009. Note that in September 2009 aquatic plants were rarely observed. Hence, no treatment is recommended for Lake Leprechaun in 2010 and 2011.

Table 1. List of dominant aquatic plants observed in Lake Leprechaun in 2007.

Species Name	Common Name
Hippuris vulgaris	Common mares tail
Myriophyllum sibericum	Northern milfoil
Potamogeton amplifolius	Big leaf pond weed

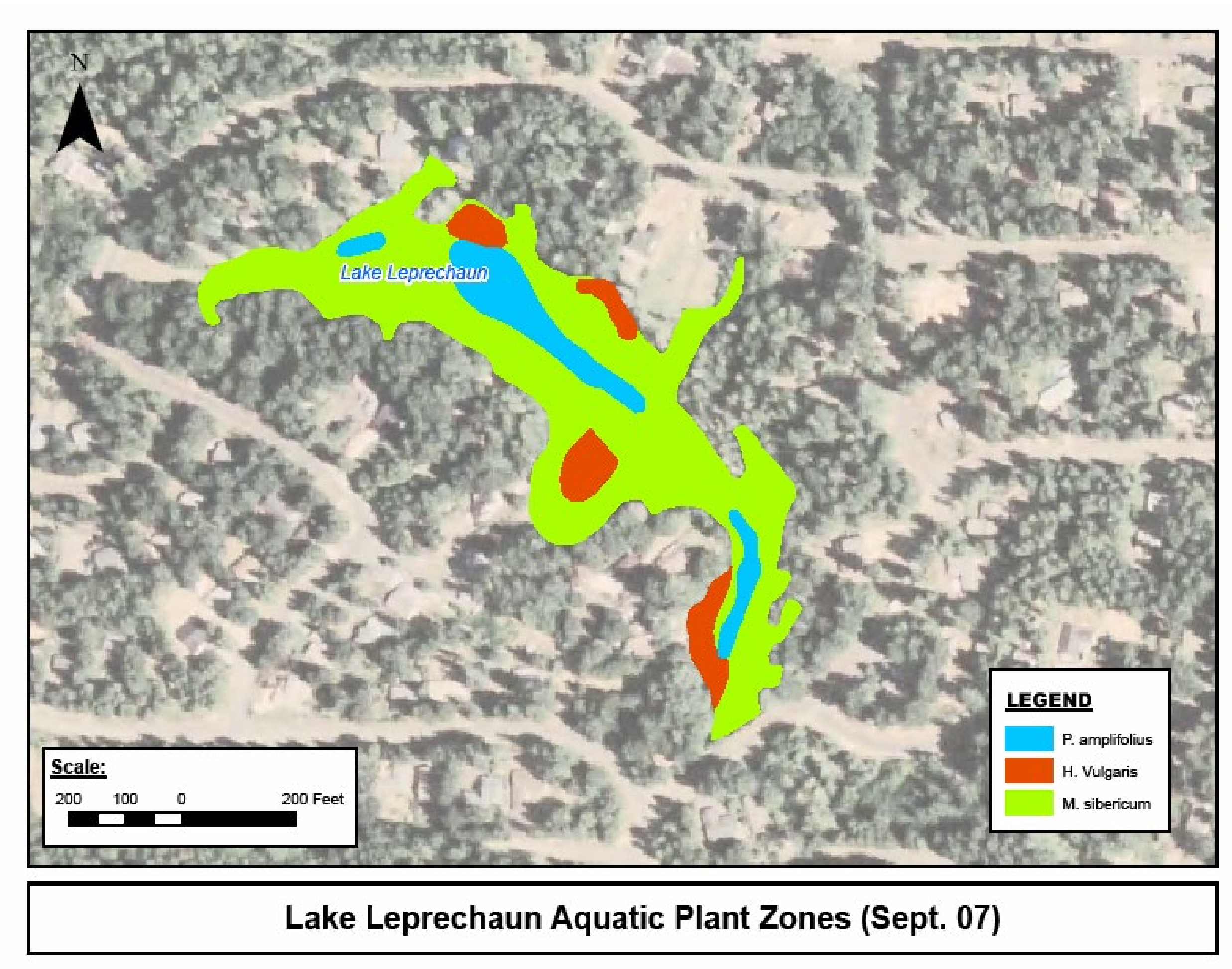


Figure 6. Aquatic Plant Map of dominant plants in Lake Leprechaun, 2007.

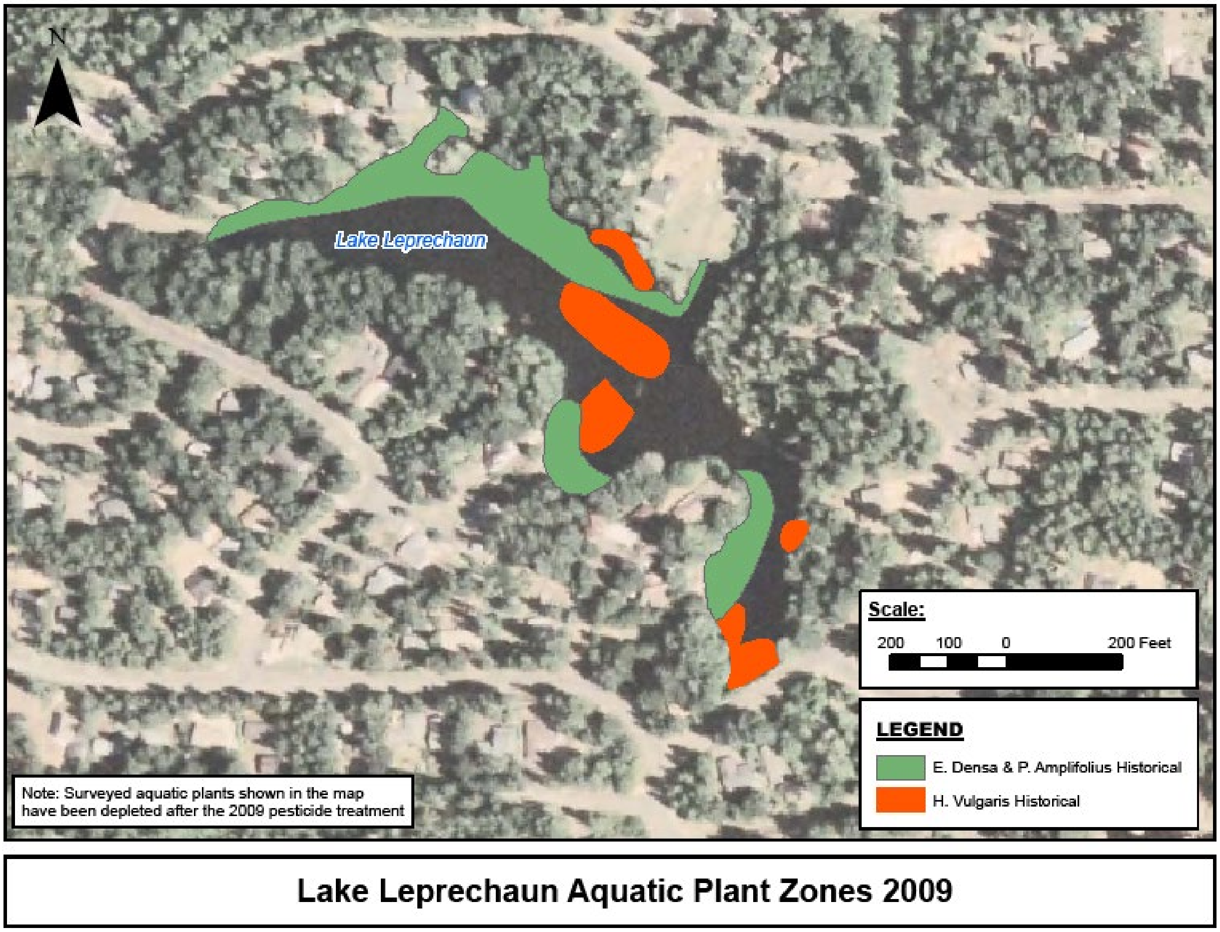


Figure 7. 2009 Aquatic plant map of plants showing to summer 2009 treatment areas.

Permit Status

The herbicide permit through the Ecology was transferred to AquaTechnex (herbicide applicator) in 2011 and will continue to be administered by them in the future.

2013 Recommendations

It is advised the an aquatic plant mapping be conducted at both Lakes Limerick and Leprechaun in June 2013 to establish treatment zones and strategy for both lakes. An additional plant mapping should be conducted in September 2012 to assess the treatment effectiveness of the summer control activities to plan for the efforts that will be needed in 2013.

It is proposed that Tetra Tech continue to map the plants and formulate the management activities and that AquaTechnex provide permit and treatment support as directed and under Tetra Tech contract. It is also recommended that LLCC initiate a water quality monitoring program to build a database for future lake management decisions. This monitoring program is outlined in Appendix A.

Appendix A

Monitoring Plan

LAKES LIMERICK AND LEPRECHAUN WATER QUALITY MONITORING PROGRAM SAMPLING & ANALYSIS PLAN

December, 2012

Prepared For
Lake Limerick Country Club

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FIGURES

1.0 INTRODUCTION AND BACKGROUND

Thank you for participating in the Lake Limerick and Lake Leprechaun Citizen Monitoring Project. Regular monitoring provides the valuable information needed to identify environmental stressors and understand how they are impacting the lakes in order to make informed management solutions.

The goal of this lake water quality monitoring program is to better understand the lake dynamics and potential for excess algal production that would decrease beneficial uses of the lake, and to help identify potential sources causing excess phosphorus loading contributing to water quality degradation. The water quality monitoring program is in addition to the aquatic plant monitoring that occurs annually as part of the integrated aquatic plant management plan. Specific goals of the water quality monitoring program are:

- To define and track the water quality of the lakes,
- To identify any water quality issues at each lake and determine actions needed to solve the problems,
- To use these data to inform the Board of LLCC in order to allow for management decision the will ensure the lakes' beneficial uses, specifically, aesthetic, water contact, and fishing purposes,
- To help citizens become informed stewards of their lake.

2.0 GENERAL INFORMATION ABOUT THE LAKES

Lake Leprechaun is a shallow lake formed by a flooding a flood plain wetland and stream corridor. The lake is used for aesthetic appeal, non-motorized boating, and fishing. Lake Limerick is much deeper and was formed by a damming a stream and flooding the associated riparian and stream corridor. There is a fish ladder that allows salmon to migrate and spawn in the upstream waterways. The lake is used for aesthetics, boating, water contact recreation, and fishing. A golf course and residential community surround the lakes.

Both Lakes Limerick and Leprechaun should be monitored for algal blooms and excess nutrients, specifically phosphorus. The past and continued loading of phosphorus to the lakes is promoting excessive algal production. Excessive production of algae greatly reduces the lakes' uses and makes them unpleasant for any recreational activity. In addition, excess nutrient loading contribute to the excess production of aquatic plants in the lakes further reducing their beneficial uses.

Lake Eutrophication

Eutrophication is the process where water bodies receive excess nutrients that stimulate excessive plant growth. If a lake receives enough nutrients, plants will continue growth and take over the lake. Lakes Limerick and Leprechaun experience nutrient inputs, especial of concern is phosphorus, from both internal (within the lake) and external (watershed including groundwater inputs) loading. With the addition of more nutrients and plants, the lakes will decline in water quality, be cloudy and turbid, and have unpleasant surface scums (and potentially produce cyanobacteria that can in turn generate algal toxins).

Eutrophic lakes experience low levels of oxygen due to large amounts of organic and plant material build up in the lake that as it degrades consumes oxygen. Low levels of oxygen adverse effect fish and other aquatic organisms valuable to lake health in addition to creating chemical conditions that increase internal recycling of nutrients (higher degree of nutrient loading or availability.

2.0 WHAT WILL OUR MONITORING DATA DESCRIBE?

Water Level

Water levels at both lakes and the Lake Limerick outflow dam will be measured with either level loggers that record water level readings every 15 minutes, or staff gauges read daily by volunteers. These measurements will determine the water level in each lake and through an understanding of lake storage. From that information the inflows due to direct precipitation and surface and groundwater inflows can be understood. Combined with the outflow data lake level measurements will help to create a water budget for each lake and help describe inflow dynamics of each lake.

Precipitation

A rain gauge will be used to measure precipitation daily. Gauge levels will help determine what impacts rain has on lake level fluctuations. Precipitation data will also be used in conjunction with rain phosphorus data to determine potential nutrient loading from atmospheric deposition.

Total and Soluble Phosphorus

Phosphorus is a necessary element for the growth of all plants and animals. Lakes can receive phosphorus through runoff from the lake's watershed. Human impacts such as detergents, pet wastes, fertilizers, waste disposal and car emissions contribute to increased phosphorus levels in runoff to lakes. In Lakes Limerick and Leprechaun, phosphorus levels are caused by internal cycling of phosphorus from the lake sediments and aquatic plants. External phosphorus loading enters the lake through stormwater runoff, stream inflow, groundwater inflow. Excess levels of phosphorus lead to increased plant and algae growth and decreased water quality and dissolved oxygen. Monitoring phosphorus will help in determining the potential for eutrophication and what if any future management activity is needed to ensure the maintenance of lake beneficial uses.

Phytoplankton

Phytoplankton (algae) are microscopic plants that float in the water column and are the base of the food chain because they generate organic carbon through photosynthesis. They require sunlight and nutrients such as phosphorus for growth. Sampling of phytoplankton is also used as an indicator of eutrophication and lake health through the identification of type (species). This sample will be taken at the Lake Limerick deep station at the water surface only.

Chlorophyll –*a*

Chlorophyll *a* is a pigment in all plants and algae that uses light to create energy. We can use chlorophyll *a* samples as a tool in analyzing algal biomass in lakes. Chlorophyll is usually high with increased nutrients and sunlight. High chlorophyll *a* concentrations indicate a eutrophic lake. Chlorophyll samples will be taken at all surface water stations.

Water Clarity

A secchi disk is used to determine water clarity by measuring the amount of light that penetrates the water at certain depths. A secchi disk is a circle shaped device marked with black and white markings. The disk is attached to a nylon cord which can be lowered into the water. The greater the amounts of algae and plant growth in the water, the more shallow the depth of light that will penetrate water. The secchi disk is a good indicator of surface scums, water column algae, and other runoff materials that could be clouding lake water. Lakes with low Secchi disk depths have poor water quality and are considered eutrophic.

Weather Conditions

Current weather conditions should be recorded by lake monitors. Weather conditions affect the lake level, Secchi disk depth, and other water quality parameters. The time of day, cloud cover, and precipitation should be documented.

Observations

Water quality volunteers are urged to document any additional observations they notice while sampling. Comments about odor, lake color, dead fish and surface films can help in determining lake problems and finding solutions.

3.0 SAFETY PROCEDURES

Safety should be the number one priority of volunteer lake monitors. If they do not feel comfortable sampling due to weather, or other health and safety issues, monitoring should be rescheduled. Samples should not be collected during a storm. Instructions should be read for all equipment before use. These should not be used by children. In the event of an accident please call 9-1-1 for immediate assistance, and let your lake management supervisor know. Life jackets should be worn at all times if on a boat. Do not use your boat if there are cracks or malfunctions. Please adhere to all safety rules and regulations.

4.0 PROJECT/ TASK DESCRIPTION

The first step in the process of analyzing potential causes for algal growth and determining mitigation strategies is to implement a water quality monitoring program. This program will require the installation of two data loggers or staff gauges that will read lake water elevation (one at each lake), and a rain gauge. An additional water level data logger will be placed in the outflow structure to record outflows. Manual water samples will be taken and sent to a lab to be analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP), phytoplankton, and chlorophyll *a*. A Secchi disk reading will also be taken at each site. The following describes the equipment needed for sampling, and was found online through the Forestry Suppliers Website at https://www.forestry-suppliers.com/. Instructions on how to perform sampling operations are also included.

As a volunteer lake monitor all instructions should be read and understood prior to sampling.

5.0 SAMPLING PROCEDURES

Prior to Sampling

Task 1: Lake Limerick Country Club (LLCC) to Purchase Equipment

Sampling equipment will need to be purchased prior to a sampling event. All equipment listed below can be found on the Forestry Suppliers Inc. website.

- Three level loggers at the cost of $1400 each will need to be purchase and installed. Or to save cost three staff gauges (around $65-$85) can be installed at the CC dock for Limerick and at the outlet structure for Leprechaun and within the outlet channel below the dam at Lake Limerick as an alternative to the level loggers. If level loggers are installed, either Tetra Tech can personally install these level loggers, or can instruct local staff on how they are to be installed.

- A rain gauge will need to be purchased (< $40), and installed on a dock.
- A van dorn water bottle kit (Forestry Suppliers Inc. Student Water Bottle Kit $229) can be used for obtaining water samples at various depths.

Figure 5.1. Example of a Van Dorn water sampling device

- A Secchi disk will be needed to measure water clarity. This can be found on Amazon.com for $29.00 by Science First.

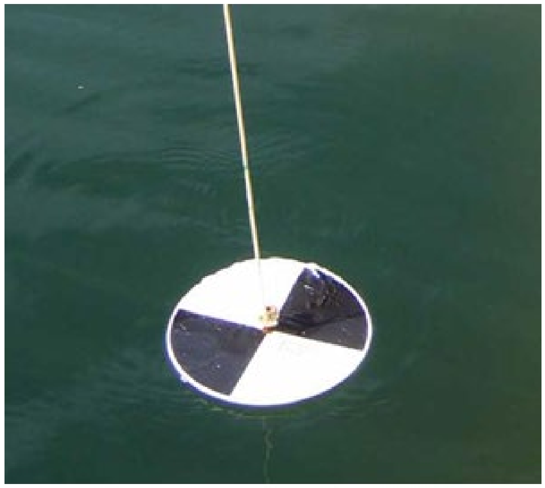

Figure 5.2. Secchi disk

- Water quality measurements should be recorded in a field notebook (can purchase waterproof Rite in the Rain Notebook from Forestry Suppliers for $7.70)

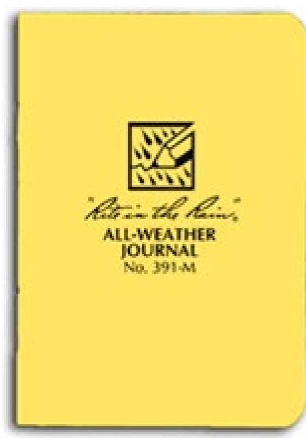

Figure 5.3. Rite in the Rain waterproof field notebook

Task 2: Create a Sampling Schedule
A sampling schedule should be created and made available to all lake monitoring volunteers. Monitoring should occur once every month, or preferably twice a month if possible. Total costs can be reduced by not sampling in November, January, and February.

Task 3: Check Weather Forecast
Before sampling, monitors should check the weather forecast and make sure they feel comfortable with the proposed weather conditions during the sampling time. Do not sample during a storm. Water quality information taken is influenced by choppy water and stormy weather.

Task 4: Collect and Organize Your Equipment
You will need:

- Field notebook
- Pencil
- Secchi Disk
- Sample bottles with labels filled out for date, time, and sample depth, and sample ID (TP, SRP, chlorophyll *a*, phytoplankton). These bottles can be obtained through Aquatic Research Laboratory via Tetra Tech prior to a sampling event.
- Van dorn Sampler
- Boat anchor
- Life Jackets
- Cooler for sample bottles with ice

Sample bottle labels should be filled out before sampling and should contain information about what parameter is being sampled, and at what depth (ex. TP .5 meters). Sample bottles will be in different sizes and some (chlorophyll *a*) will include preservative. Bottles should be labeled according to each specific sample. All cords for equipment such as the van dorn bottle and Secchi disk, should be marked with either permanent marker or duct tape at each .5 meter increment, or 0.1 meter increment for the Secchi disk depth cord.

In Lake Sampling

Task 5: Locating Your Monitoring Site

A map should be provided to you by LLCC that shows the location of each sampling site. A GPS device can be used to ensure you are collecting samples at the right location. LLCC will provide you with GPS coordinates of each monitoring location. Take the boat to this site and drop your anchor.

Task 6: Field Observations

Record observations such as lake name, weather conditions, odors, lake color, date and time, and water depth in your field notebook or on your field data form.

Task 7: Sample Collection

In Lake Limerick water samples should be taken at the two inlet streams to the lake, and the three lake stations shown in the map below (Figure 5.4.). Phytoplankton samples will only be taken if Secchi disk transparency measurements are less than 1 meter. All samples should be taken from the lake surface, except for the deep lake station in front of the dam. At this site a grab sample should be taken using the Van Dorn 1 meter above the lake bottom. For surface water samples, the individual should reach down to slightly below the surface, and open the lab sample bottle under the water, obtain the sample, and close the bottle under water before bringing it back up. To use the van dorn water sampling device, one end will be kept open by moving the messenger up the top wire; then lower the sampler to the desired depth as indicated by the depth markings on the rope. Once the desired depth is reached, the messenger is then dropped down the wire that triggers the closing of the bottle. The bottle can then be retrieved and the water sample can be poured into each specific sample bottle. Once the sample bottles are full, place them in a cooler with ice and deliver them to the lab as soon as sampling is complete. It is especially important to keep chlorophyll *a* samples cool and dark.

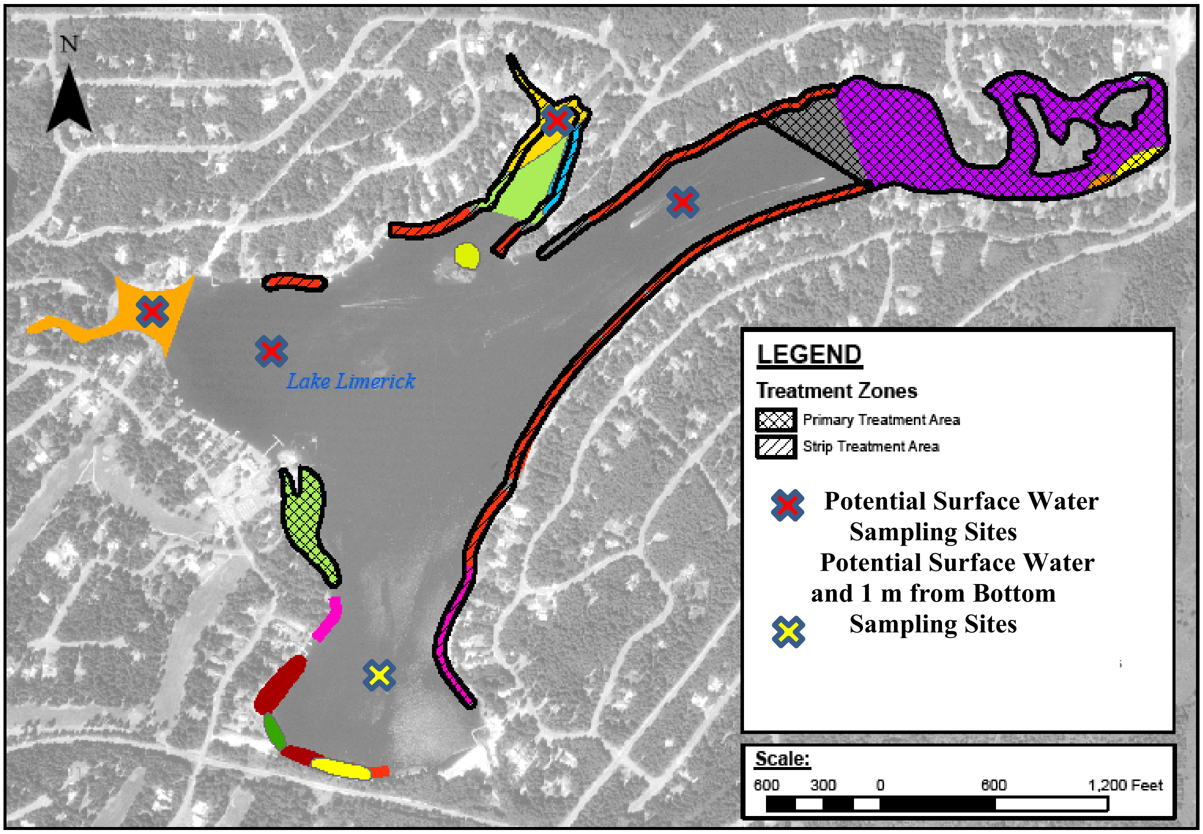

Figure 5.4. Potential Lake Limerick water quality monitoring sites

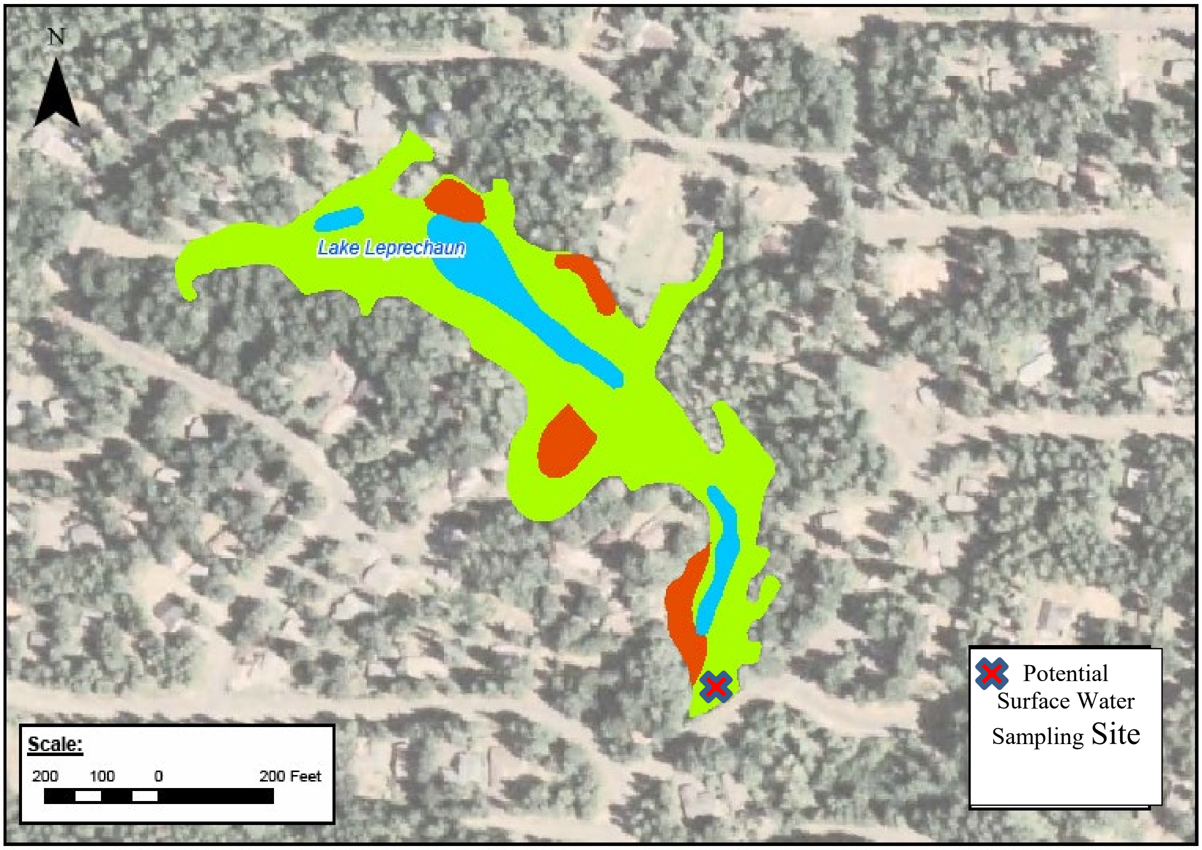

Figure 5.5 Potential water quality monitoring sites for Lake Leprechaun

Filling out a Chain of Custody Form

Once samples are collected, a chain of custody form obtained from Aquatic Research Inc. should be completed for phosphorus and chlorophyll *a* samples. For phytoplankton samples a chain of custody form obtained from WATER Environmental Services should be completed. The forms will required the date of sampling and your name. As well as the lake name and depth of each sample. There are spaces at the bottom of the sheet to print and sign your name at the time of lab delivery. Note if delivered to lab by UPS and FedEx no bottom signature is required.

Task 8: In Lake Water Quality Measurements

Secchi disk measurements should be taken at each site where samples are collected. The Secchi disk should be lowered down into the water until you can barely see the markings on the disk (1 on Figure 5.6.). Record meter depth at this point. Then lower the disk down a bit more. Slowly pull the disk up until you can barely see the markings on the disk (2 on Figure 5.6.). Record the depth at this point (it should be similar to the first depth reading) and take an average of these two measures (3 on Figure 5.6.). That is your Secchi disk depth measurement at a site.

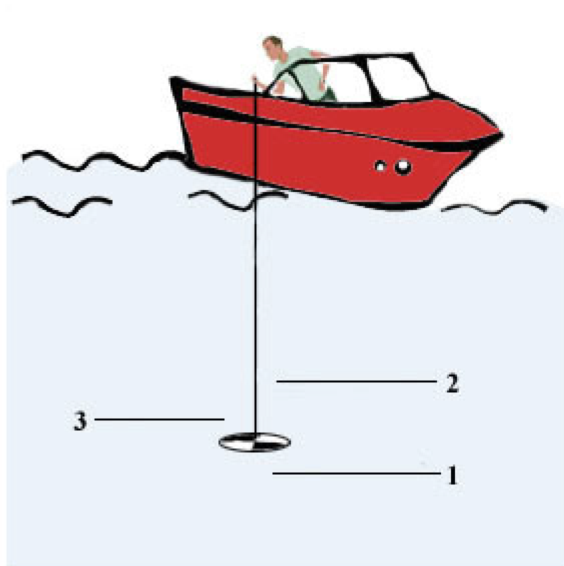

Figure 5.6. How to measure Secchi disk depth

Task 9: Preparing Samples for Delivery to Aquatic Research
Once sampling is complete, samples will need to be prepared for lab shipment quickly. Samples will need to be shipped overnight after sample collection due to 24 hour time sensitive samples. Samples should be packaged with ice in coolers. A chain of custody form should be included. This form will serve as a record of drop off times for lab samples, and will keep data organized. On average the lab costs should be around $245 a month (including phytoplankton). Phytoplankton analysis is $100 per sample.

Task 10: Safely Store Monitoring Equipment
Once sampling is complete, equipment will need to be dried and stored in a safe place. Make sure that fragile equipment is stored carefully. Turn in all field notes and data.
Thank you for your monitoring efforts. Your time will help us in implementing a lake management program that will benefit our community.

Task 11: Thermistor/ Staff Gauge and Rain Gauge Installations and Measurements
Two level logger thermistors or staff gauges will be installed, one at the country club dock for Lake Limerick, and the other at the outlet structure for Lake Leprechaun. The devices can either be installed by Tetra Tech, or Tetra Tech can train local individuals to install these. If installed, the thermistors will take lake level measurements at 15 minute intervals. This data can be downloaded at any time.
A rain gauge should be installed, and the gauge level will need to be documented daily in a notebook. Five to ten samples of rain water will be collected (in small sample bottles) throughout the year and delivered to a lab for phosphorus analysis (TP).

8.0 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Periodic regular inspection of equipment is needed to ensure the satisfactory performance of the systems. Before any piece of sampling or measurement equipment is taken into the field, it should be inspected to ensure that the equipment is appropriate for the task to be performed, all necessary parts of the equipment are intact, and the equipment is in working order. In addition, the equipment will be visually inspected before its use. Broken equipment will be labeled “DO NOT USE” and returned to the point of origin to receive necessary repairs, or it will be disposed of. The objective of preventive maintenance is to ensure the availability and satisfactory performance of the measurement systems. All field measurement instruments should receive preventive maintenance in accordance with the manufacturer’s specifications.

9.0 ADDITIONAL IN LAKE SAMPLING MEASURES

Additional water quality parameters could be measured to provide a database of information that could be used to create a more detailed view of lake dynamics. While collecting samples, in lake temperature, dissolved oxygen (DO), and pH could be measured. Fluctuations in these measurements could be valuable indicators of changes in lake health. A DO and pH meter that both include temperature can be purchased from Hach or Forestry Suppliers for around $1200.