LAKE CATHERINE / CHANNEL LAKE

LAKE MANAGEMENT PLAN

2017

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Introduction

Lake Catherine and Channel Lake (LC/CL) are centerpieces of the surrounding community. Maintaining and improving the health and function of the lakes enhances the quality of life not only for those using the lakes, but for everyone who is touched by the economic benefits of these resources.

Over the last 20 years there has been a noticeable degradation in the water quality of the lakes defined by nuisance aquatic plant growth, specifically Eurasian Water Milfoil (EWM) (see Appendix 1) with dense coontail stands, increased algae growth (see Appendix 1), and sediment build-up. Lake conditions continue to quantitatively deteriorate as well. (See data from the Lake County Health Department and the IEPA presented in graphs that substantiate this claim in Appendix 2). A variety of concerned citizens have made efforts to improve conditions either individually or as part of their community. Predictably, the well-intended efforts of various groups with different needs or priorities have resulted in a disjointed array of activities that have made only incremental or temporary improvements. These activities have not been coordinated and, at best, do not take advantage of scale, and, at worst, are counterproductive or even damaging to the environment.

While the Fox Waterway Agency (FWA) was created to maintain the Chain of Lakes (Chain), funding has not kept pace with the eutrophication (the accumulation of nutrients and sediment that shifts the plant and animal population to less desirable – and often non-native – species) of the system. Limited resources necessitates that the FWA focus predominantly on maintaining the safety and navigability of the Chain, primarily through dredging; maintenance of navigational aids; debris removal; and related activities. Consequently, the high demand for FWA services leaves Chain communities uncertain about assistance from that agency – particularly with respect to restoring the environmental health of the lakes – all while water quality and aesthetics continue to decline. Although FWA has a history of work on the lake, some resources, and an existing system of generating funding to maintain Chain waters including LC/CL, a better understanding of current and future FWA funding strategies and how projects are prioritized can be important in making localized decisions regarding LC/CL. This plan assumes lake improvement efforts independent of FWA.

Unfortunately, there is often no simple “silver bullet” solution for improving or restoring the water quality in aquatic ecosystems of the size and complexity of LC/CL. **The goal of this plan is to provide a pragmatic road-map leading to improved water quality for Lake Catherine/Channel Lake.**

To accomplish this, it provides stakeholders:

- Context (including historical data)
- Lake management options and recommendations (including cost estimates)
- List of stakeholders
- Regulatory considerations
- Implementation plan
- Monitoring program to measure progress

Like many excellent plans, this one will be worthless unless it is implemented. There is not an unlimited budget, and, as data shows, the likelihood of being able to affect lake inflow water quality from far up the watershed is very small and consequently not a focal point of the plan. Therefore, this plan is deliberately concise as to be user friendly and not overwhelm readers. Also, it is important to remember that it took decades of human influence for the lakes to reach their current state, and <u>positive changes in conditions and water quality will be incremental and will take time</u>.

Lastly, this plan must be a living document. What will be known in 10 years from advances in monitoring and in management/treatment technologies will likely dwarf what is currently known and what is available today. Future challenges, like the introduction of invasive species not currently seen in LC/CL, as well as new solutions, must be considered with adjustments made to the management approach of these valuable natural resources. In this spirit and as part of the creation of this plan, ILM will be assisting your organization with incrementally advancing this initiative over the next 12 months.

A. Relevant Historical Information

LC/CL are at the headwaters of the 'Chain of Lakes' and benefit from the vast wetland to the north that traps sediment and nutrients of incoming water before entering the lake. A 1999 USGS study shows more sediment leaving the lake, flowing south under Rt. 173, than is entering the lake. An evaluation of current watershed land use (see charts in Appendix 3) show little difference since the 1999 report. Additionally, changes to the flood gates in the last 10 years downstream within the Fox River (i.e., at the Stratton Lock and Dam located near McHenry, IL) allows for greater flow which will move more sediment with it. The general conclusion that the net loss of sediment from these lakes is still occurring remains, but there are identifiable areas within the lakes where sediment is accumulating. This means that in-lake efforts to improve conditions have a better chance at succeeding in LC/LC than in other lakes along the chain that are influenced greatly by flow from LC/CL and developed areas.

Phosphorus is a key nutrient in the growth of algae and aquatic weeds and therefore an important water quality indicator. Total phosphorus concentration, as listed by the IEPA, is shown to be a problem in both lakes, particularly in the deeper samples collected near the lake bottom (Appendix 2). Data and modeling based on watershed land use show the annual proportion of phosphorus compounds coming into the lakes from major sources should be relatively constant as follows:

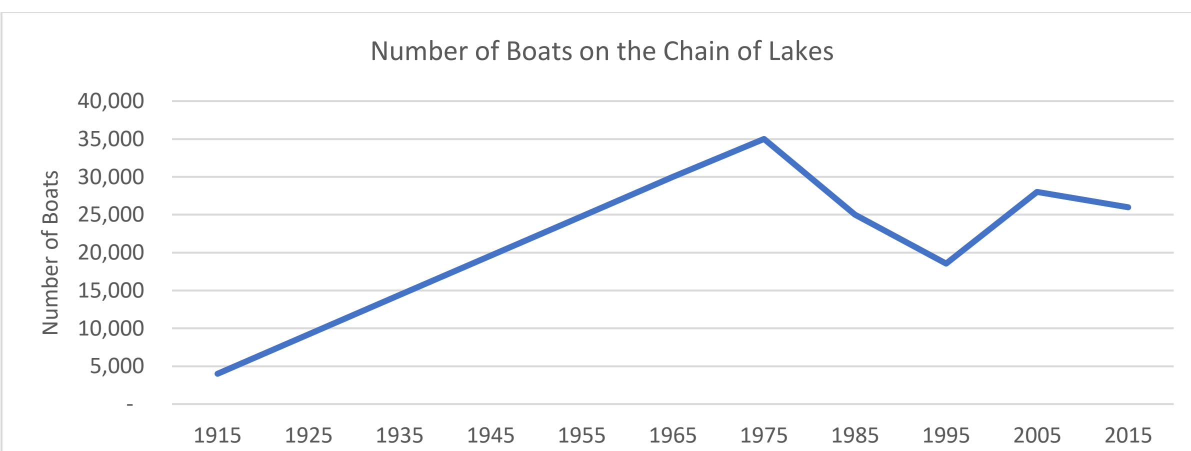
− Precipitation	< 5%
− Decomposing matter (organic debris)	< 5%
− Waterfowl	< 1%

− Internal regeneration (release of phosphorus from anoxic conditions; also known as internal "loading")	40%
− Watershed inflows	30%
− Direct storm drain connections	15%
− Inflow through Rt. 173 bridge	10%

Water quality parameters have been collected on LC/CL for decades (Appendix 2). This data, along with qualitative input from lake users, indicate a degradation of water quality which is inherent in the eutrophication process. This process is accelerated proportional to: land disturbance/development in the watershed (specifically around the lake), the effects of accumulation (available nutrients), newly introduced aquatic species (such as zebra mussels), and lake use.

Lake water quality was of concern in the 1990's which prompted a very significant study and report completed by Cochran and Wilken in 2000. This report took over two years to complete and is very comprehensive (137 pages). It is an excellent source of information regarding all aspects of LC/CL and much of the data presented gave direction for the current data collected resulting in our conclusions and recommendations. (Note: Funding for this report was through the IEPA and Fox Waterway Agency, with assistance from the IDNR, USGS, and USDA. It is important to note that since the time of this report, funding from these agencies to maintain or improve LC/CL have not kept pace with need or have disappeared altogether). While it is reasonable to expect that historical data offers a good baseline for which to compare current data, what we find is that between 1979 and 2014 traditional water quality parameters (clarity, chlorophyll, dissolved oxygen, phosphorus) have either not improved or are trending negatively further evidencing deteriorating conditions of the lakes (Appendix 2).

The loss of water clarity and increased algae growth are mostly a function of re-suspension and reintroduction of solids and nutrients that currently exist in the organic-rich sediments that accumulated on the lake bottom over decades. Motorboat traffic is one of the principle drivers of such solid and nutrient re-suspension. Although the graphic below shows that the density of boats is down from historic highs, boat use frequency and factors like hull design (with the growing popularity of wakeboarding on vessels designed to produce large wakes) and marine engine horsepower are such that turbulence and wave energy in shallower areas and along shorelines is a significant contributing factor in the re-suspension of solids.



*Data based on number of boating permits registered. Data for 1915 and 1977 are estimates from 1977 Fox Chain of Lakes Investigation and Water Quality Management Plan.

Limited sampling and analysis of primary inlet waters in 2017 (Appendix 4) support the claim in the 2000 report that internal nutrient loading (i.e., from existing bottom lake sediments) is the primary cause of water degradation.

It should be noted that all data referred to previously is a result of grab samples collected that are highly susceptible to variability for different, but valid reasons. As such, installation of a continuous water quality monitor(s) to accurately monitor trends in water quality will be amongst our recommendations.

Another indicator of lake health has been the biennial fish surveys conducted by the Illinois Department of Natural Resources (IDNR). These studies use fish population, species, and size primarily for making stocking decisions, but are also an imperfect but useful indicator of lake health. According to IDNR staff, as of 2017 these studies are expected to continue. One of the negative impacts of dense beds of EWM is that it creates more hiding spaces for small fish making them harder for larger fish to catch. The result generally is a population of shrinking fish, and without adequate food sources, these fish typically stay small – a phenomena referred to as stunting.

A source of nutrients into the lake system that does not seem to get much attention are the known antiquated septic connections feeding into the two lakes. The map in Appendix 5 shows these locations. The Lake County Health Department requires new septic systems to meet certain capacity and performance criteria, but once a system is approved and put into service, its function is not checked or validated by any regulatory body or agency. One of the effects of untreated waste into the lakes is the constant addition of nutrients that will support added algae growth and reduce water clarity. These antiquated septic systems will also be addressed within our recommended actions.

B. Recommendations

The components of an effective lake management plan are inter-related, with one challenge being prioritization of implementation. Further, the intensity with which high priority recommendations are pursued can affect the validity of lower priority recommendations. With an unlimited budget and no regulation, much could be done. Neither is the case here, and the focus of this report is on the lakes, and not necessarily the channels which have different influences and behave very differently than the main lakes. The implementation of this report's recommendations need to be part of a process that is fluid relative to stakeholder needs as well as conditions that may be outside of control of the stakeholders. Therefore, these recommendations are listed separately for clarity and it is not intended to imply exclusivity between them.

Tier I Recommendations

(action items that should be initiated immediately)

a. **Reduce the occurrence of and control the growth of EWM:** *This recommendation is supported by Frank Jakubicek (IDNR) and Mike Adam (Lake County Health Department-Lake Management Unit).*

   Healthy water impoundments have 1/4 to 1/3 aquatic vegetative growth on the lake bottom. However, non-native/invasive plants impede healthy lake environments in several ways:

- They outcompete and displace native plants, reducing plant, insect, and fish diversity that are hallmarks of a healthy and sustainable ecosystem. (Since the current practice of consistent limited/targeted chemical management of non-native/invasive plant species has started in some areas within the lakes, IDNR has observed increases in native plant populations.)
- Dense aquatic plant growth hinders mixing and oxygenation of the lake bottom in shallow areas. When the water at the sediment level in a lake becomes stagnant and void of oxygen, the microorganisms in the sediment release phosphorus back into the water column that then fuels algae growth (nutrient regeneration/internal loading accounts for approximately 40% of the nutrient compounds available in the water for algal growth).

Reducing the coverage and density of EWM and replacing this growth with more desirable growth (chara or native plants) is expected to lead to fewer occurrences of blue-green algae by allowing for better oxygenation (in this case through natural diffusion) of the lake bottom that in turn is expected to keep algae-growing nutrients sequestered in the bottom sediment. Care must be taken to discourage establishment of other undesirable species in place of controlled EWM.

Biological control of EWM is not considered since this approach is no longer available commercially. Implementation of a chemical EWM control program and plant harvesting will be described later.

b. **Create a monitoring program that will document improvement to the lakes:** There are several monitoring programs currently practiced. To monitor progress/results of efforts to improve conditions and water quality, a reliable monitoring program must be established and maintained. *(Two different methods are discussed later in this report.)*

c. **Identify and investigate known discharges to the lakes that carry contributing excess nutrients to the lakes:** Internal regeneration of nutrients, failing septic systems, and surface runoff all contribute to phosphorus levels (and therefore algal growth) in the lakes. Further investigation can help determine the relative contributions from each and allow stakeholders to make sound management decisions based on that data. Failing septic systems, nutrient rich sediment in anoxic conditions, and residential practices can all be evaluated and actions implemented to curtail added phosphorus to the lakes.

d. **Implement nutrient deactivation and mixing/oxygenation techniques potentially coupled with the use of approved algaecides <u>if algae growth persists after significant reduction of EWM</u>:** Dissolved nutrient levels in the water may be such that even with improved mixing after the significant reduction of EWM, algae growth continues to be at an unacceptable level. Mixing (oxygenation) can be accomplished via different means with varying costs, zones of influence, and that have different compatibilities with lake use.

Historical Note: An aeration system was installed in the southern end of Lake Catherine in 1978 at a depth of 26 feet. Water quality was monitored that season with the documented conclusion being: 'Aeration had no effect on the concentration of nutrients and other chemical parameters in Lake Catherine.' The following year, the aeration system was operated in conjunction with *copper sulfate applications to address the formation of blue-green algae. While the blue-green algae issue was successfully addressed and water clarity improved, there was no effect on nutrient concentration leading to the conclusion that this management option addressed undesirable symptoms, but did nothing to address the causes of poor water quality. This experience – while dated – suggests that consideration of scaled-up aeration and/or mixing coupled with chemical control may be prudent if after other less intense and less costly methods of management are not effective.*

<u>Tier II Recommendations</u>

(action items that should be planned for)

a. **Sediment probing and sampling in high vegetation production areas:** It may benefit water quality to identify and remove sediment to reduce the nutrient bank in strategic areas of the lakes and to create more depth. This allows for better mixing and cooler water (improved oxygenation), resulting in less algae production and fewer aquatic plants. As a first step, targeted sampling of areas with high vegetation is recommended to assess the potential for excessive nutrient concentrations.

b. **Removal of sediment (if warranted from findings in 'a'):** Removal of sediment from targeted areas where the high nutrient content is fueling algae growth, and/or where added water depth will improve mixing, can reduce rooted aquatic plant growth. Removal of sediment in areas where algae and nuisance aquatic plants appear are prime targets for limited dredging programs that may, in turn, benefit the entire lake. Planning these projects generally takes 9 to 18 months and is historically performed by FWA. Early determination of whether dredging is a good investment allows for planning and permitting that can require long lead times.

c. **Creation, appointment, or hiring of a Lake Manager (volunteer or professional):** Implementation of activities to improve water quality requires coordination of several components (funding, communication, contractor performance, etc.) and should be sustainable past the efforts of the current leadership. This allows time for improvement to occur and to protect the lakes for future generations. A recognized or designated 'manager' to maintain focus and ensure stability through changes in board or committee make-up, and to implement programs, monitor success, and make recommendations for adjustments as needed, is recommended to give water quality improvement initiatives on LC/CL the best chance of success.

<u>Not Recommended</u>

a. **<u>Large Scale</u> Harvesting:** Since the target plant in LC/CL (EWM) spreads fairly easily by fragmentation, <u>large scale</u> harvesting is not recommended. Further, naturally occurring weevils that can help control growth of the plant incrementally, and allow for native plants to fill the void left, inhabit the upper portions of the EWM plant that is cut off during harvesting. Cutting is non-selective and the native/beneficial plants capable of replacing the EWM may also be adversely affected. Lack of rooted plants in the lakes will lead to an alga dominated ecosystem that is highly undesirable. Vacuum methods claiming to be able to economically pull the target plants selectively have been on the market for some time. Our experience is that this approach is very labor intensive and likely not a viable method for vegetated areas the size found in LC/CL. If this technique can be automated to recover the root while minimizing fragmentation, and invasive plants are replaced with native species to avoid re-infestation, it should be considered. *(Note: while large scale or mass harvesting is not recommended, targeted harvesting using certain tactful techniques can be a beneficial strategy and is addressed later in this Plan.)*

b. **Enzymes and Bacteria:** There are many products on the market that claim to reduce sludge or to reduce phosphorus in the water (with the implication being that because of this it will control algae growth). The effect on sludge reduction has been qualified independently and found to be useful for lakes with *a minimal organic layer on the lake bottom*, but for thick accumulations as occurs in key areas of LC/CL, the data suggests that this approach is less cost effective than dredging. Independent research showing that these products inhibit algae growth without proper mixing and aeration cannot be found.

C. Stakeholders

This list is compiled to give Friends of LC/CL a starting point for engaging members and partners. Experience from dozens of lake communities show that the importance of this activity cannot be overstated. Awareness is vital to gaining support for fundraising, supporting the management activities, implementing recommendations, and to help carry the initiative forward. Creation and distribution of a simple guide for lake front property owners on what they can do individually to help control EWM or other invasive species, stabilize shorelines, and manage septic systems is an excellent first step towards achieving the water quality goals of your community.

Organized Homeowner's Associations (HOAs)
See map and table in Appendix 6

Non-HOA Resident Groups
See map and table in Appendix 6 and list of local businesses who may receive benefit from the lake use in Appendix 7.

All Waterfront and Water-view Properties
A graphic of properties surrounding the lakes is in Appendix 8.

Villages
The lakes occur in unincorporated areas near the Villages of Antioch, Fox Lake, Spring Grove, and Richmond. Village of Antioch officials indicated that all land touching the lakes are unincorporated. The unit of local government with boundary jurisdiction containing the lakes is Antioch Township.

Elected Officials
Mayors, Trustees, State office holders, Township officials, County Board Representatives.

D. Regulatory Considerations

Consideration must be given to regulatory constraints and costs when considering lake management activities. This list is provided as comprehensive reference for future use.

Illinois Department of Natural Resources (IDNR)
Concerned with state Threatened and Endangered Species (T&E). Must be consulted and permit obtained for chemical treatments, pier installation, dredging, and shoreline stabilization. Has ability to assess fees. According to Frank Jakubicek of IDNR: *If a person, other than the State, owns property, the property owners may need to give permission to treat over their property even though the State has Jurisdictional Management Authority. Several avenues of State Law may be involved and "someone" may have to decipher the interpretations between Dept. of Agriculture and Jurisdictional Management.*

Illinois Dept. of Public Health (IDPH) (for beaches)
While they have some jurisdiction on the Chain, they defer to Lake County Health Dept. for issues on the Fox Chain.

Fox Waterway Agency (FWA)
Charged with delineating buoy zones, creating safe boating ordinances, and keeping main navigational channels open. Administers user fee program. Requirements to gain approval from FWA for lake management practices such as chemical treatments, aeration, installation of continuous monitors, etc. cannot be found. Sharing this information with FWA is a courtesy and is recommended.

US Army Corp of Engineers (USACOE)
Regulates waterway construction and concerned with wetlands and dredging. USACOE will not issue permits for work until IEPA approval for a project is obtained.

Illinois Environmental Protection Agency (water quality)
Authority over water quality, specifically relating to water treatment having to do with dredging. Has ability to assess fees.

Lake County Health Department
Tasked with monitoring public swimming areas (pools and lakes). This department includes the Lakes Management Unit (LMU).

Lake County Stormwater Management Commission (SMC)
Issues permits for work affecting stormwater management in Lake County. Tasked with policing erosion control as required by Watershed Development Ordinance (WDO) and USACOE. Assesses fees.

Lake County Planning and Development
Responsible for regulating construction (including seawalls) in floodways. Assesses fees.

US Fish and Wildlife Service
For work where there are Federally Threatened or Endangered species (this is the case for LC/CL), this organization must review any plans and may issue permits with limitations to activities.

E. Implementation Plan

Governance

This plan was commissioned by the Friends of Lake Catherine/Channel Lake with the understanding that it has authority to implement the recommendations. As noted previously, FWA is the recognized regulatory authority for the Chain of Lakes, including LC/CL. Communicating any funding or lake management intentions with FWA representatives can help to avoid conflicting or duplicative efforts and may facilitate opportunities for funding and implementation that may not otherwise occur.

An IDNR permit is required for some of the recommendations made below. Either Friends of LC/CL or FWA should consider applying for and owning these permits so that adjustments to the service providers used can be made, if necessary.

Control of EWM

(two recommended control options)

1. **Targeted Chemical control of EWM:** This approach is currently administered on an adhoc, property-by-property basis using a contact herbicide covering approximately 20% of the LC/CL shoreline (mostly on Lake Catherine). By treating only 20% of the shoreline area, it's difficult to maintain the requisite concentration/contact time needed to control growth of the target species given that the herbicide can dissipate amongst surrounding, non-treated waters quite easily. It is important to note that IDNR permitting and the limitations embedded in the permits are out of concern for the effects of product 'drift' that can cause inadvertent damage to sensitive areas. 'Partial' treatments leave a low concentration of the active ingredient in a wider area, thereby making treatment less effective than if permitted treatments of larger areas were performed. Dosing below effective rates potentially encourages the growth of herbicide resistant plant strains and should be administered by licensed and experienced applicators. ILM has been treating EWM along limited shorelines on LC/CL for seven years and IDNR officials have noted incremental improvement (less EWM and establishment of desirable native aquatic plants) over this time. Complete eradication of EWM by any means should not be expected. Of further note, chemical control of EWM is akin to treating the symptoms of an unbalanced lake, but not the underlying root cause of poor water quality (i.e., elevated nutrients and phosphorous). However, a significant reduction in the EWM population can be achieved by scaling this approach up and would require years to realize noticeable benefits to the water quality as a result. While this time frame may not be desirable, one positive is that a slower transition away from EWM gives native plants an opportunity to fill the voids naturally.

   COST: *The current cost of limited EWM control under standard IDNR limitations (which offers some progress towards aquatic plant diversification) is $7,300. The extrapolated cost for this treatment covering the entire LC/CL shoreline (75ft or to the end of a pier, whichever is greater) would be $35,000 annually. Attention should be paid to the application areas, products used, and dosages as to not inadvertently encourage herbicide resistant strains of plants by under-treating. The decision to continue (or expand) the approach to EWM management with individual property owners (or HOA's) engaging qualified services to apply the herbicide should be made by January 2018 so that requisite permits can be issued by spring.*

2. **<u>Targeted</u> Harvesting**: EWM and coontail have similar characteristics and effects on lake use and water quality, and targeted harvesting of these plants can have an immediate impact. While EWM can spread by fragmentation, coontail is not known to. For areas with high boat traffic or in popular swimming areas, harvesting is a viable option. It is important to know that harvesting aquatic plants is like mowing a lawn: the plants grow back. The cost to harvest (machinery, labor, transport of material, disposal) versus the benefits should be considered.

   The *presence* of aquatic plants (native or non-native) stabilize the sediment with roots and sequester nutrients in the plant structure, both leading to the conclusion that algae is less likely to grow. Conversely, the *absence* of aquatic plants allows for greater mixing which would limit the reintroduction of nutrients (specifically phosphorus) back into the water. This also allows for less algal growth. Localized lake conditions (depth, mixing, sediment quality,) play a role in whether a reduction in aquatic plants results in a reduction of the formation and accumulation of blue-green algae. Close observation of treated or harvested areas will help guide future activities.

   Chemical management methods to specifically control blue-green algae should be considered if this type of algae is persistent. It should be noted that early detection and early treatment of blue-green algae are critical.

   COST: *The cost associated with harvesting (including machinery, labor, transport to and disposal of the harvested material in an environmental waste facility) is approximately $1,800/acre. It is highly dependent on the location of the material being harvested and its proximity to the shoreline/temporary disposal site. If chemical management of blue-green algae is needed, the cost to treat is approximately $250/acre. The number of acres and frequency that blooms will occur is unknown.*

<u>Water Quality Monitoring</u>
(several options can be considered as reliable measurements of water quality improvement)

1. **Continuous dissolved oxygen (DO) monitoring**: Dissolved oxygen is an important water quality parameter that is *highly variable* by time of day, temperature, season, location within the lake, weather conditions, algae or aquatic plant growth, and depth. Newer technology allows for the monitoring and recording of DO through the water column at key points <u>continuously</u> and can produce reliable data that can be used to assess lake improvement initiatives and quantify improvement. In-Situ and other manufacturers of monitoring and data logging instrumentation have equipment that can measure dissolved oxygen and log data continuously. There are telemetry options available that allow access to data remotely. This data would be a very reliable indicator of water quality changes over time. After review of bathymetric maps of the lakes, data from various monitoring points, and in consideration of discretion when deploying continuous monitors of any kind, two recommended monitoring sites on LC/CL are highlighted in Appendix 10.

   COST: *The cost to obtain and set-up/install eight units (four in each of two locations) that measure DO at 1ft, 6ft, 11ft, and 16ft water depths would not exceed $30,000. Once installed,* *the only cost would be the annual cellular connection (less than $500/year) and batteries for the units (less than $100/year). Some amount of labor to install in the spring and remove before the formation of ice can be accomplished with volunteers. Specifications for the instrumentation described above is in Appendix 10. Vandalism to the buoys or monitors should be considered before making this investment.*

2. **Lake vegetation mapping**: This can be employed to measure and chart the occurrence of EWM as well as desirable aquatic plants in the lakes so that shifts in these populations can be monitored. Since the current concern is EWM and potentially coontail, mapping <u>total vegetative cover</u> does not differentiate between plant species (recall that it is desirable to have EWM replaced by lower growing native plants) and is useless for your purpose. To avoid creating an alga dominated lake, 25-33% of the lake bottom should support vegetative growth. Gathering data that can be used as a reliable indicator for progress in the reduction of EWM requires trained personnel to gather aquatic plant samples on a grid, identify the percentage of the target plant, and record the results. A program takes this data and maps the plant location and density in the lake. Consistency in how the data is collected is important since the samples represent larger areas and any inaccuracies can have magnified effects.

   COST: *A certain amount of plant identification expertise is required to execute this task and, to gain accurate information, two studies per season should be done so that plants appearing at different times during the growing season can be included. If contracted professionally, the cost to sample, identify and catalog plant species, and map the vegetation of each lake (up to approximately 10ft in depth) will cost an estimated $5,000-$7,000/season depending on the density of the sampling points. A modified program that looks only at EWM may be completed within a budget of $4,000, and a condensed version that looks at representative areas of the lakes as opposed to the whole lake can have lower costs proportionally.*

3. **Chemical and biological indicators (secchi readings, phosphorus, chlorophyll, dissolved oxygen):** These are traditional methods to determine lake health for short-term monitoring by the IDNR and separately by the Lake County Health Department's Lake Management Unit on a five-year cycle. There is value in comparing historical data to current data. However, these indicators are highly susceptible to variation due to influences that are outside the control of the community (weather, upstream watershed, time of day, seasonal variability) and small degrees of improvement can easily be overshadowed by the lack of consistency in these data summaries. Further, the cost for consistent and reliable labor to collect samples and monitor and lab fees can be quite high and worse, may not represent the condition of the lake as a whole.

   COST: *These services come at <u>no cost</u> to the community and have a place regarding long-term trends in the condition of the lakes, and should continue with new data evaluated for meaning as part of a more comprehensive monitoring program.*

Improved water quality can be expected as a result of a combination of several factors and actions:

- Continuation of negative sediment load coming into the lake
- Tracking and mitigating known sources of nutrients into the lake

- Shifting the aquatic plant population from EWM to native plants like eel grass and chara (a bottom anchored form of algae)
- Identification and addressing of ‘hot spots’ where sediment is nutrient rich and likely a source of nutrient regeneration into the water column will all contribute to improved water quality

Nutrient Deactivation / Aeration

In LC/CL, nuisance algae growth is fueled by ortho phosphorus in the water. Compounds such as bulk aluminum sulfate, or trade products with a functionally similar molecular structure, can be applied to the water to combine with the phosphorus in the water and sink to the lake bottom making that nutrient unavailable for algae growth. This has been effective in many lakes, but would likely not be a realistic approach as a whole-lake treatment. It can be considered in areas where nutrients are cycling back into the water and dredging is not a viable option. If the lake bottom is allowed to become void of oxygen (anoxic), the bacteria that flourish in that environment release the phosphorus back into the water as part of the decomposition process. To minimize this effect, aeration of the treated areas of the lake is required.

Oxygenation of lakes is accomplished naturally with waterfalls/streams (turbulence), at the air-to-water interface, and through the respiration of oxygen from subsurface plants. In many instances, and especially in lakes with a significant nutrient bank, the oxygen content of the water can be increased using equipment in several ways depending on water depth, cost of and availability of electrical power sources, desired areas of influence, and lake uses. Since this plan prioritizes actions that encourages natural oxygenation first, it cannot be known before control of EWM occurs:

- If mechanical aeration will be beneficial (or cost effective)
- The location(s) where the air introduction or mixing will occur
- How much aeration may be required
- The best/most cost effecting methods to accomplish the introduction of added oxygen into the water

The broad categories of lake aeration methods are fountains, mixers and air diffusion. Because of the size and the potential for interference with lake use, fountains and mixers are not appropriate options for LC/CL. Air diffusion could be a viable option.

Air diffusion systems are the most unobtrusive aerators and are most effective in deeper lakes. Air diffusion is commonly accomplished through land based air pumps pushing air through weighted lines to diffusers beneath the water surface. The more horsepower of the motor, and the deeper the diffuser, the greater the zone of influence. The diffuser emits the air in the form of bubbles that capture and entrain the bottom water and lift it to the surface. The rise of air bubbles pulls the cool bottom water to the surface where the atmospheric oxygen exchange occurs. In the presence of a now oxygen-rich environment, nutrients (i.e. phosphorus) stay locked in the sediment at the bottom of the lake – unavailable to weeds and algae. This reduction of nutrient cycling will slowly break up the stagnant zones, raise the DO, decompose the organic materials and improve water quality overall. There are several approaches to air diffusion, and understanding where in the lake to best position the diffusers helps to ensure proper system sizing.

COST: *The purchase cost for these systems are as follows:*

- *Lake Catherine: Equipment $80,000 plus building cost ($15,000) and electrical cost per month*
- *Channel: Equipment $148,000 plus building cost ($15,000) and electrical costs*

Increase the percentage of native plants

Increasing the native plant population is best achieved by decreasing the populations of non-native/invasive plants to reduce competition and encourage the native growth. Consistent, targeted chemical management has accomplished this in areas of the lakes where this approach has been utilized.

COST: *Treatment costs for the primary target, EWM, are outlined in the 'Control of EWM' section above. The extrapolated cost covering the entire LC/CL shoreline (75ft or to the end of a pier, whichever is greater) would be $35,000 annually. Please see additional notes under 'Control of EWM'.*

Dredging / Sediment Removal

Dredging (sediment removal) could be considered for targeted locations within the lake area (i.e., Trevor Creek and/or the southwest side of Channel Lake). Any recommendations to dredge must be based on an evaluation of which combination of sediment richness (i.e. phosphorus concentration) and anoxic conditions make any area the highest priority. A sediment investigation study would help to identify areas that could most benefit from dredging and provide the greatest impact to the lakes overall. A sediment study would provide critical information such as sediment volumes, locations, DO in each area, and nutrient level of the sediment.

COST: *To execute a sediment investigation study (a necessary step prior to dredging) the cost is $12,000. Average costs for sediment removal are $35-$65/yard, depending on location, material, and disposal options. It is likely that even a 'small' job will include 1,000 yards for removal, meaning the cost for just that much is $35,000 to $65,000.*

Awareness Program

Creating awareness among community members and visitors is a key step to achieving incremental improvements to the lakes. A common theme among many of the recommendations contained in this plan is the need for excellent communication to lake stakeholders so that engagement and support and maintained. Lake community members, municipal leaders, local businesses, neighboring communities, county officials, state level officials, regulators, and others within the Fox River watershed should be considered partners so that educational resources can be shared where applicable.

COST: *This could be a low cost or free option, depending on the types of communication that are deemed to be most appropriate. Utilizing existing communication channels, and partnering with the FWA and other established stakeholders will help to reach a large percentage of the target audience.*

Summary (Steps stated generally to improve water quality in LC/CL);

1. Identify and engage immediate participants. *Reversing eutrophication will take time and maintaining a lake has no end. Ensuring longevity of the initiative requires broad participation.*

Formation of the 'Friends of Lake Catherine/Channel Lake' is complete. Creating a plan to expose, educate, and engage stakeholders should be an ongoing task.

2. Determine short and mid-term direction (what action items will be implemented, budget). *Many management strategies have long lead times, and positive changes to the lakes can occur by implementing recommendations while other activities are being planned. -Investigation into potentially leaking septic systems has been started. -There are ongoing treatments of EWM by various lake front associations. -A method to measure improvement should begin. Purchase and installation of continuous DO monitors/data loggers is recommended as this is immediate and sustainable at a relatively low cost. Based on DO readings, aeration system types and their locations can be investigated, with an implementation plan ready if needed.*
3. Identify targets (partners, funders, agencies, other stakeholders). *In the same spirit, as #1 above, useful partnerships will be identified through this process and should be cultivated.*
4. Implement action items as time and funding allows.
5. Establish measures for success and milestones for evaluation and management plan adjustment.

As discussed, the reversal natural lake eutrophication is a process that takes an ongoing commitment of time, planning, organizing, educating and resources. ILM stands ready to help the 'Friends of Lake Catherine/Channel Lake' as a professional and technical resource through July 2018 as part of this plan.

Appendices

Appendix 1

Invasive/Non-native Aquatic Plants Eurasian water milfoil (EWM) is a highly aggressive/non-native aquatic plant that disrupts lake use because of its growth near and at the surface. It also displaces beneficial/native aquatic plants. The population of EWM has stabilized in LC/CL at an 80% occurrence rate and is by far the dominant plant species in the lake and because of its density inhibits mixing (oxygenation) of the deep water, leaving less habitat to support a healthy fishery.

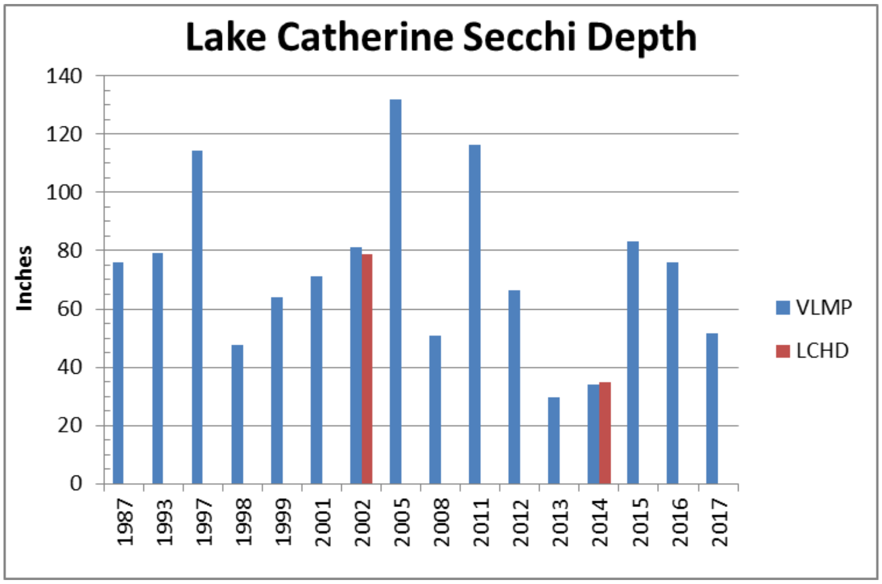
Algae Phosphorus in the water column is the primary driver of algae growth. There are reports of nuisance blue-green algae blooms as early as 1979. Algae can develop in isolated areas (bays, shallows, channels) and often grows near the surface throughout the lake and can accumulate in more stagnated areas. While filamentous (floating/horse hair algae) is a nuisance, blue-green algae can emit microsysten that can be toxic to wildlife, pets, and humans.

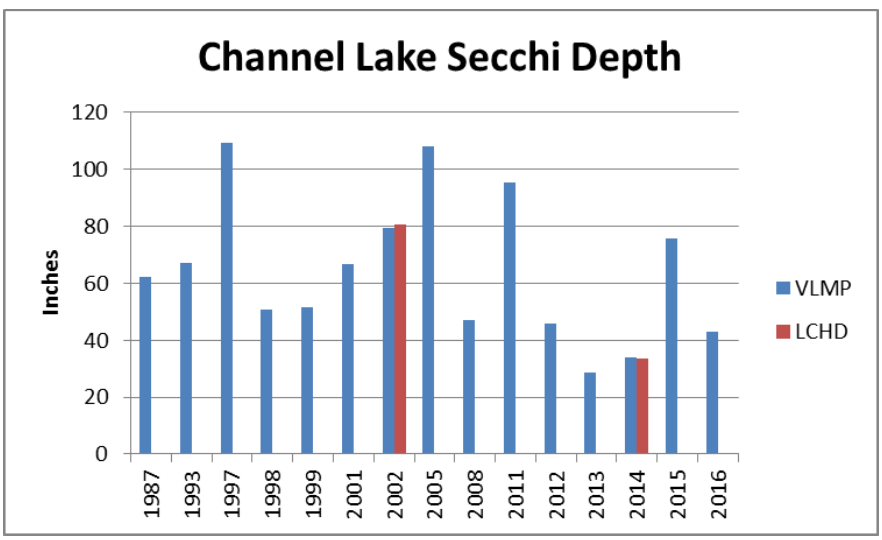
Appendix 2

Degraded Water Quality
(Data from Lake County Health Department, IEPA and Volunteer Lake Monitoring Program).

Figure 1: Average annual secchi depth measured by the Volunteer Lake Monitoring Program. Multiple sites are used within the lake and multiple dates.

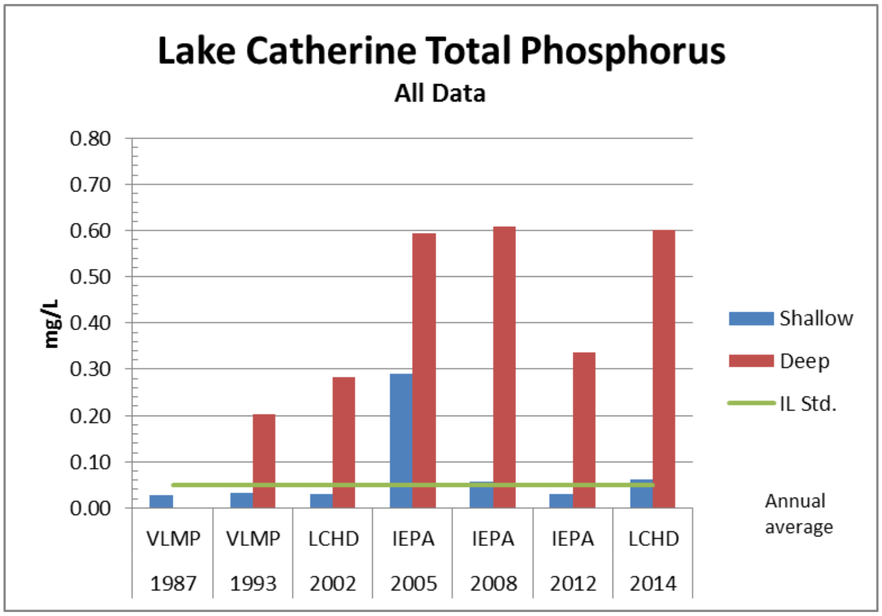
The average secchi reading has decreased, indicating that water quality is degrading.





info@ilmenvironments.com | ilmenvironments.com
ILM North: 110 Le Baron Street, Waukegan, IL 60085 (847) 244-6662

Figure 2: Total phosphorus measured by IEPA and the Volunteer Lake Monitoring Program.



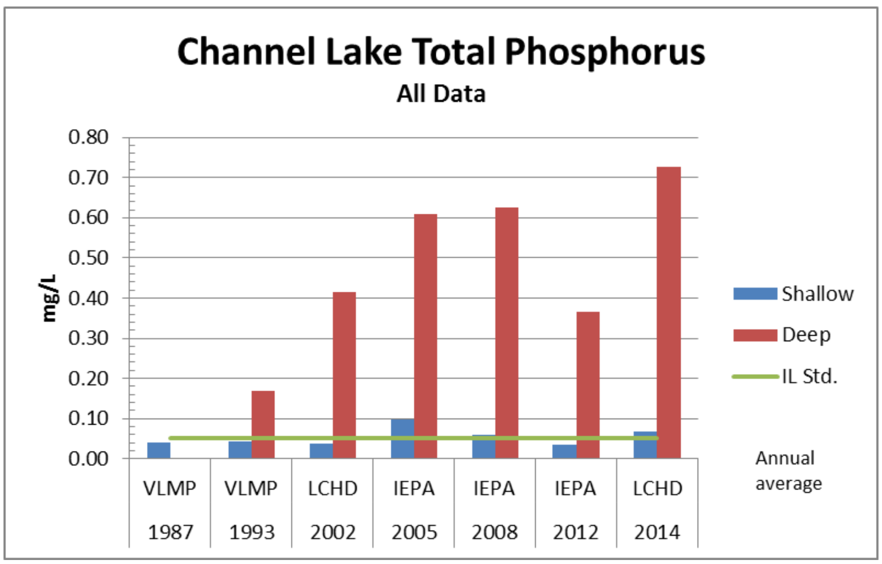


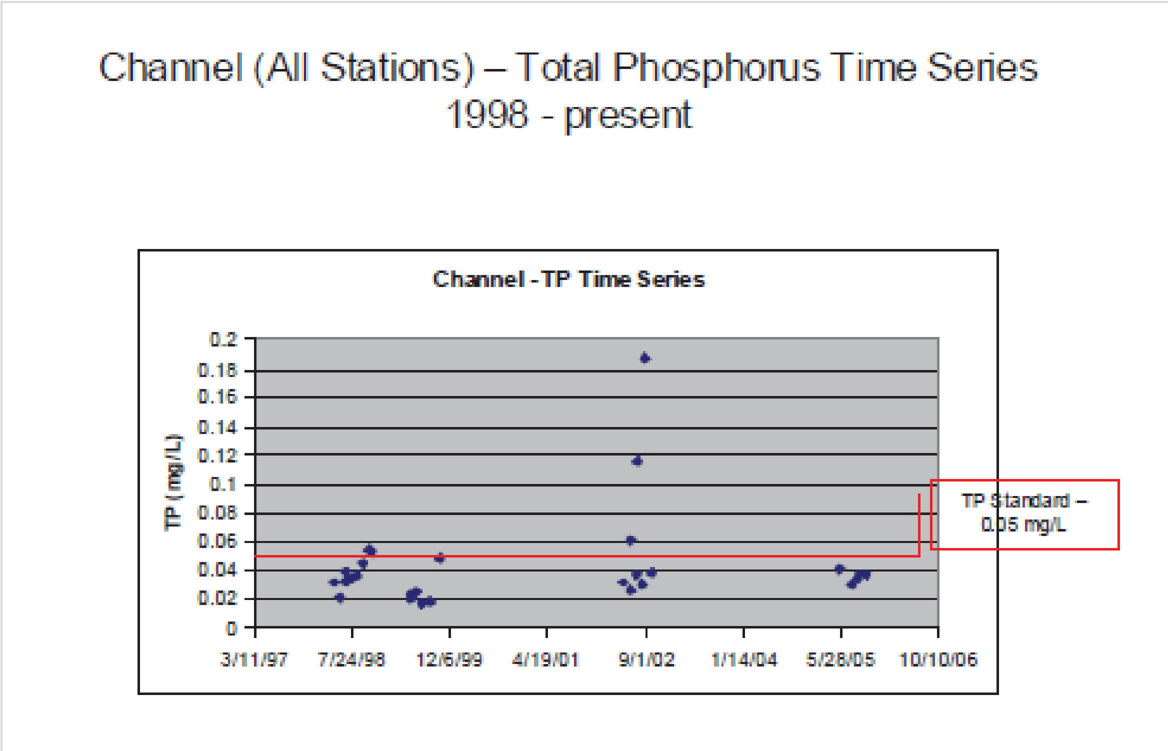
Figure 3: Total phosphorus data measured by Lake County Health Department. Data outliers are noted.

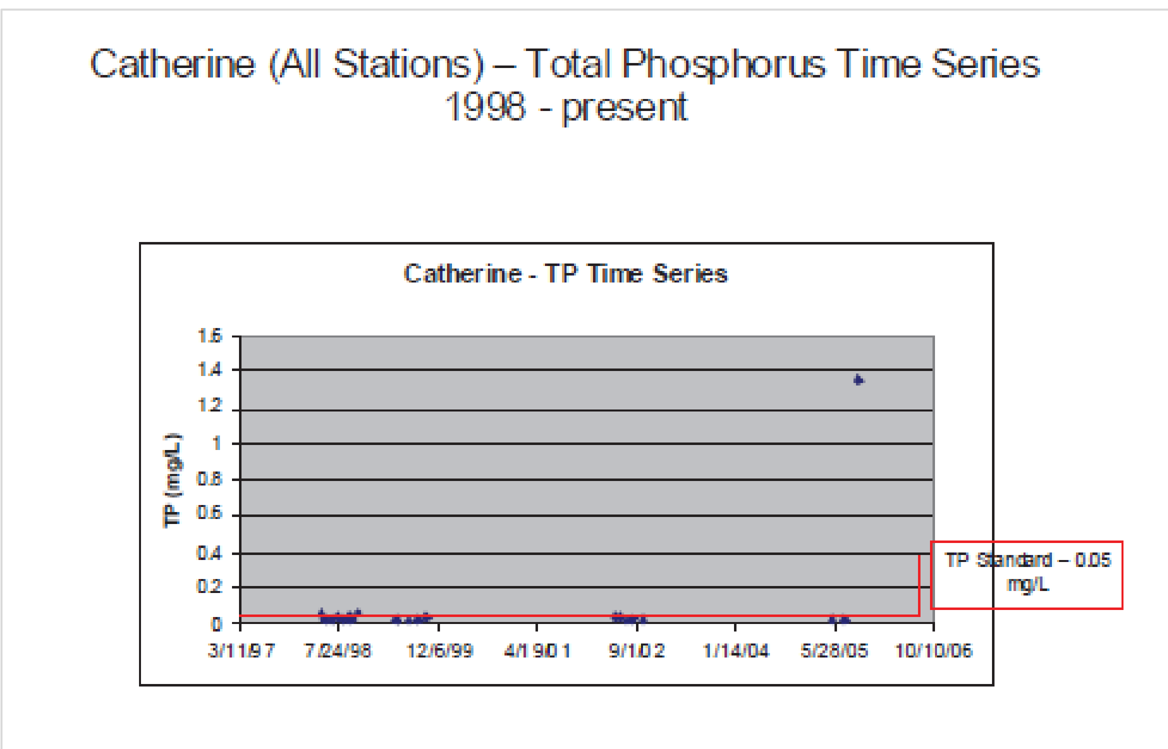
Deep samples for phosphorus are increasing (while surface samples are improving). The deeper samples are part of the anoxic layer, and where nutrients are recycled from. Phosphors leaving the sediment and going into the water supports algae growth. Mixing and aeration could help mitigate this effect.

Historical WQ data - Catherine.pdf

Historical WQ data - Channel Lake.pdf

Figure 4: Historical total phosphorus from the 2009 Upper Fox River/Chain O' Lakes Watershed TMDL Stage 1 Report.

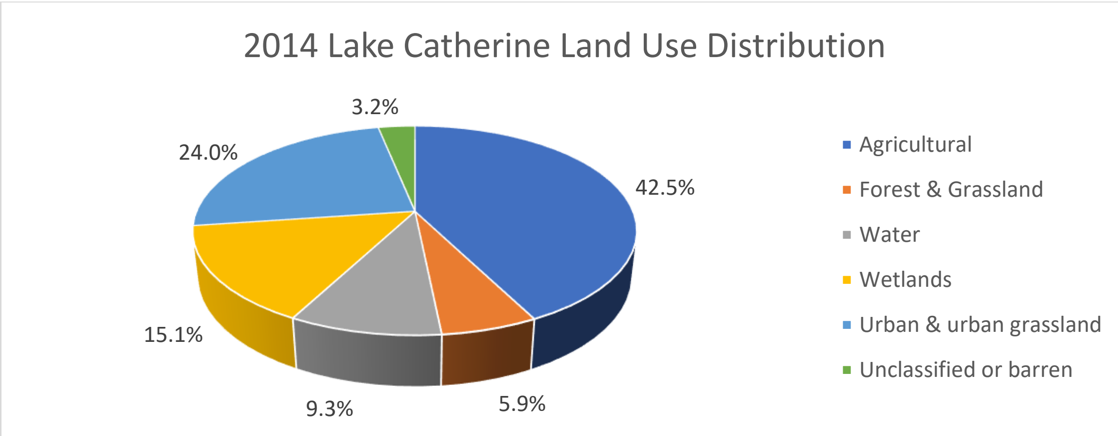


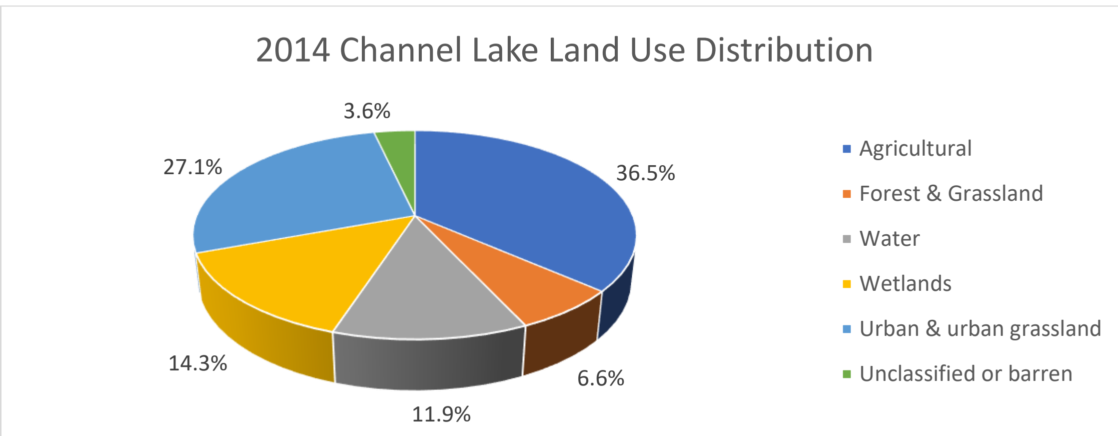


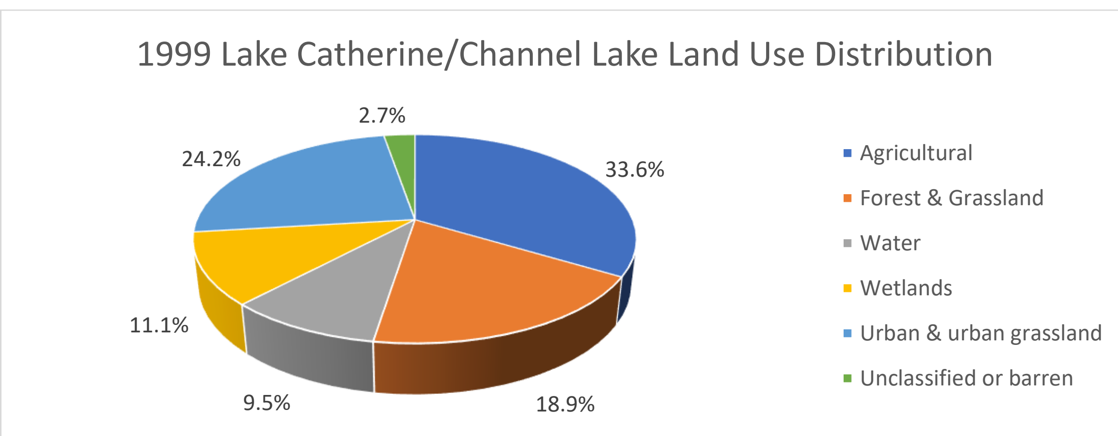
Appendix 3

Watershed Land Use Distribution
(Data from 2014 Summary Report Channel Lake/Lake Catherine and 1999 USGS Study).

Although there are differences in how land use is categorized, the uses and relative percentages are fairly constant. Since regulations and enforcement of erosion control measures have been strengthened since 1999, it is logical that external influences on the lakes are steady and more likely improving.







Appendix 4

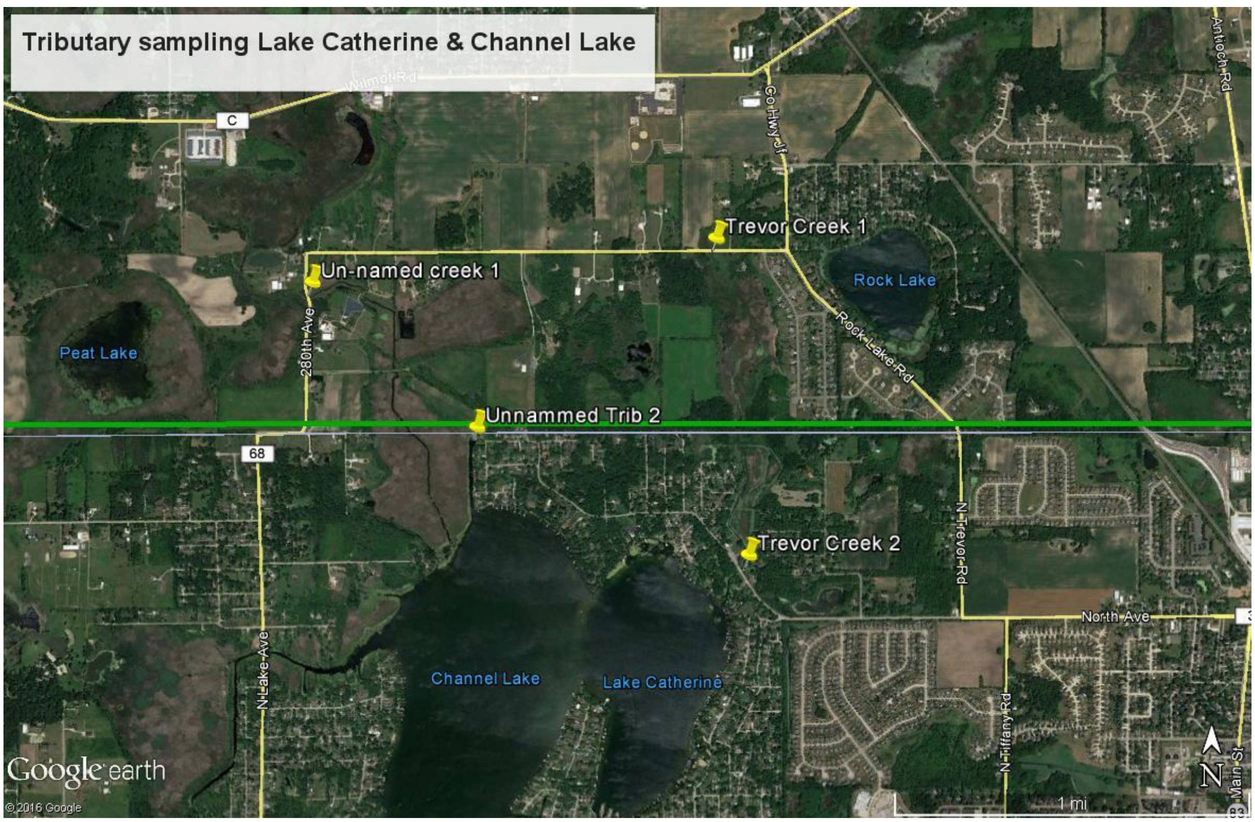
Sampling and analysis of primary inlet waters

	DRY WEATHER SAMPLE (7/7/17)		WET WEATHER SAMPLE (6/16/17)	
Site	T-Phos. (mg/l)	o-Phos (mg/l)	T-Phos. (mg/l)	o-Phos. (mg/l)
Trevor Creek #1	0.15	0.21*	0.13	0.08
Trevor Creek #2	0.08	0.08	0.18	0.16
Tributary #1	0.06	0.06	0.15	0.17
Tributary #2	0.03	0.04	0.18	0.11

**this data point is an outlier.*

The largest identifiable inlet to LC/CL is Trevor Creek. This limited grab sample data can only be confidently when compared internally. This indicates o-Phos. contribution between TC-1 and TC-2.

Comparison to historical external data does not indicate significant increases in phosphorus load from upstream sources.



Appendix 5

Septic Connections feeding into Lake Catherine/Channel Lake
(Map supplied by Lake County Health Department)

Contact Tom Copenhaver at Lake County Health Department for more information.

- *Phone: 847-377-8000*
- *Email: TCopenhaver@lakecountyil.gov*

Fecal coliform data from the 2000 report provided extensive review of 1998 and 1999 Lake County Health Department monitoring (page 85) that showed no exceedances of the state standard for primary contact (500 cfu's for swimming). There are sites where concentrations are elevated (up to 220 cfu's) but still considered safe.

As with other data, snap shots in time of water quality, especially a biological parameter like fecal coliform, can be unreliable or misleading.

Appendix 6

Known HOA and Resident Groups on Lake Catherine/Channel Lake and Water Treatment Areas
(Map and table supplied by ILM, based on client data)

Association/Group	Address	Treatment Type	Spend	Contact info
Channel Lake Residents	43220 Andyville Ln. Antioch, IL 60002	Herbicide and algaecide	$800 (since 2017)	Erika Frable 847-656-6395 efrable@yahoo.com
Club Zobak*	25135 W. North Ave Antioch, IL 60002	Herbicide	$2,700 (since 2012)	Paul Hruby 847-395-7569 opiks@msn.com
Crandall Subdivision*	42355 N Park Ln W Antioch, IL 60002	Herbicide and algaecide	$1,540 (since 2016)	Gregg Zink 847-343-3472 gzink@ilmenvironments.com
Lake Catherine Felters*	42500 N. Addison Ln. Antioch, IL 60002	Herbicide	$8,500 (since 2012)	Richard (Tommy) Doty 847-309-9663 wake2wood@ameritech.net
Linden Lane	42515 N. Linden Ln. Antioch, IL 60002	Herbicide	$2,300 (since 2017)	Barb Mazzeffi 815-923-0309 barb.maz@att.net
Oak Lane	42449 Oak Lane Antioch, IL 60002	Herbicide and algaecide	$2,700 (since 2015)	Mike Turner 847-239-4969 mrmike7351@gmail.com
Warriner's Shores*	42948 Janette Antioch, IL 60002	Herbicide	$15,400 (since 2012)	Gordon Nelson 847-603-1613

**Denotes associations. Other listings are groups of individual homeowners.*

Appendix 7

Local Businesses Benefiting from Lake Use

Marinas/Boating Services:

- Bob's Marina
- Webb's Boat Services & Marina
- Turtle Beach Marina
- Diebold Marina

Lodging:

- Norshore II
- Lake Marie Lodge

Restaurants/Bars:

- Steve's Sports Bar
- Thirsty Turtle Brew and View Pub
- Toppers
- Choppers Bar and Grill

Other Services:

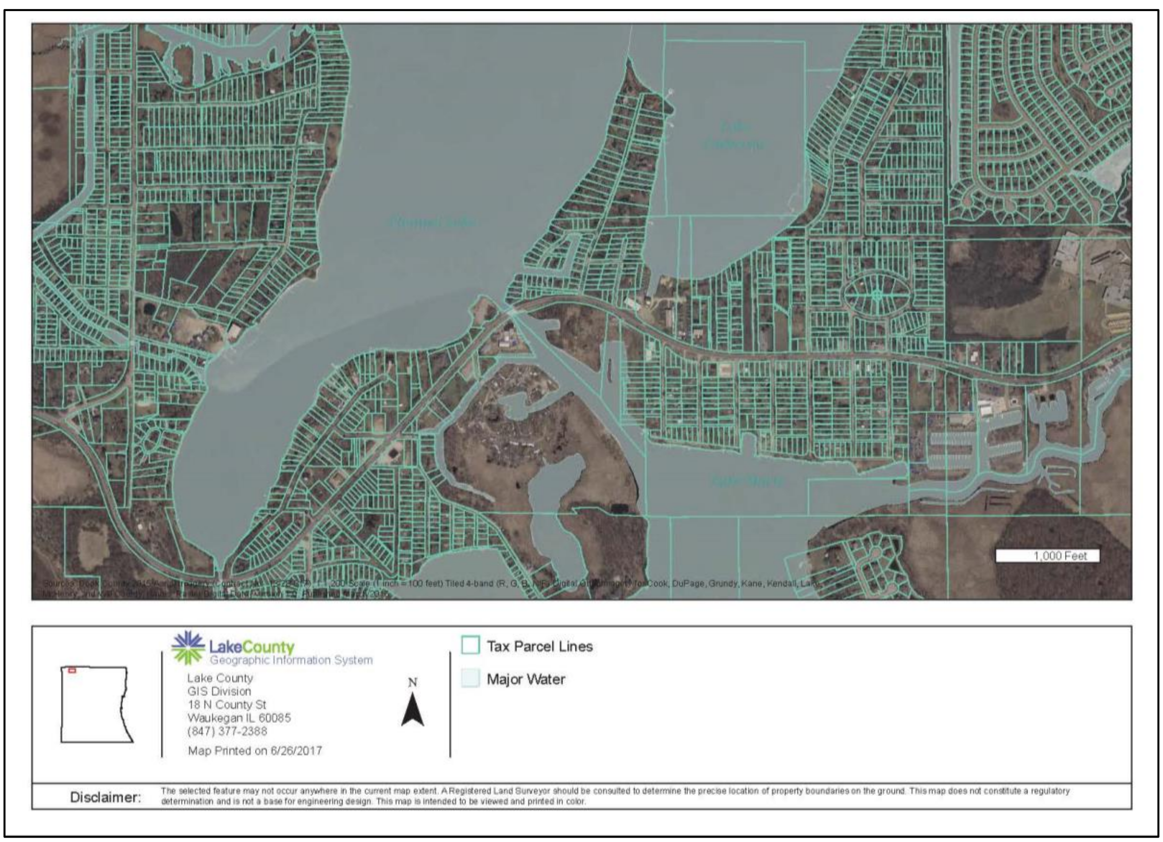
- Lakeshore Builders
- Wake to Wood, Inc.
- VA Loans Midwest
- Roy's Auto Services
- Evante Purification Solutions

Appendix 8

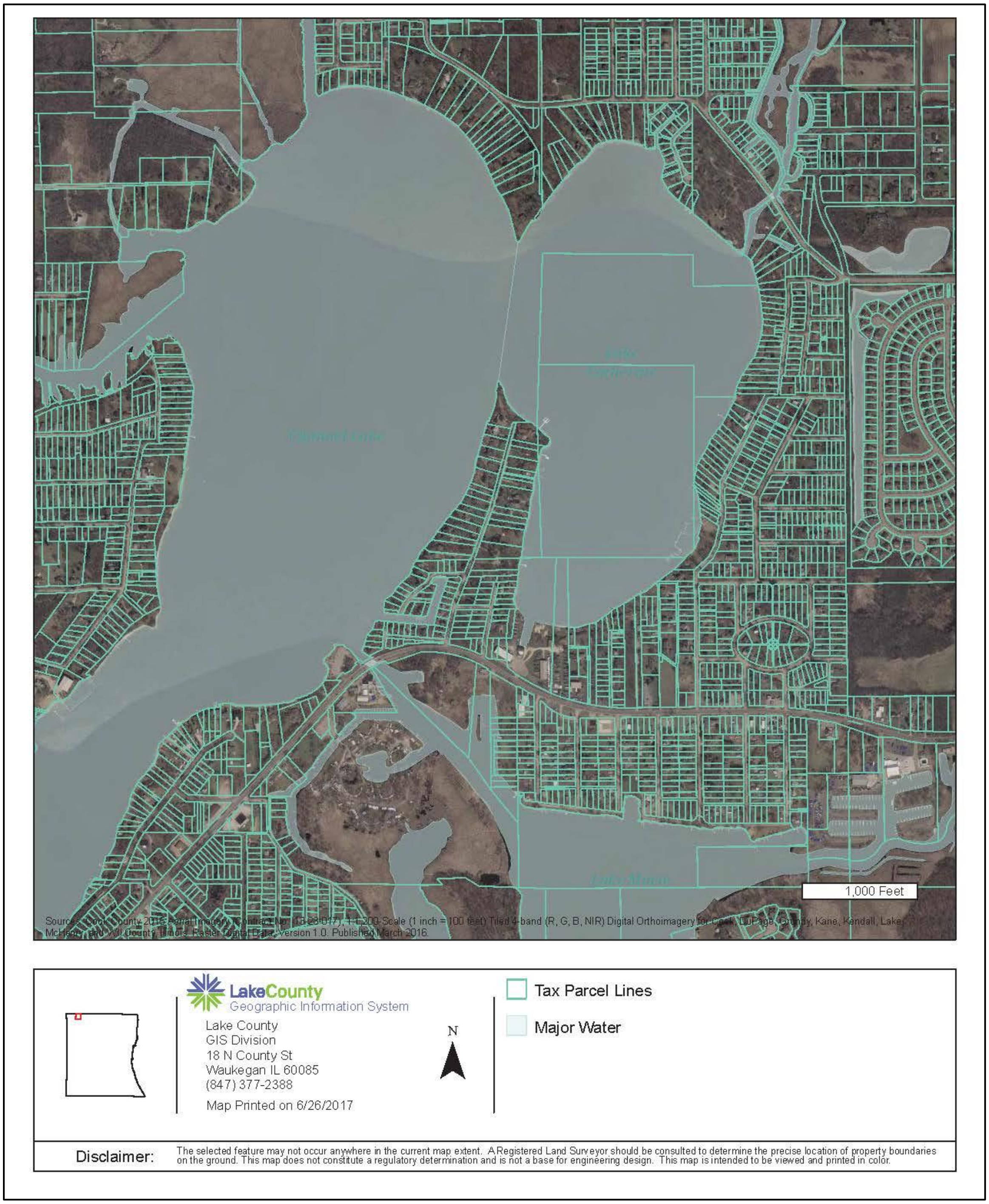
Waterfront and Water-view Properties
(Maps from Lake County Maps Online)

View 1:

View 2:



View 3:


1,000 Feet
Sources: Cook County 2015 Aerial Imagery (Contract No. 13-28-017), 1:1,200-Scale (1 inch = 100 feet) Tiled 4-band (R, G, B, NIR) Digital Orthoimagery for Cook, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will County, Illinois. Raster Digital Data, Version 1.0. Published March 2016.
LakeCounty
Geographic Information System
Lake County
GIS Division
18 N County St
Waukegan IL 60085
(847) 377-2388
Map Printed on 6/26/2017
N
Tax Parcel Lines
Major Water
Disclaimer:
The selected feature may not occur anywhere in the current map extent. A Registered Land Surveyor should be consulted to determine the precise location of property boundaries on the ground. This map does not constitute a regulatory determination and is not a base for engineering design. This map is intended to be viewed and printed in color.

Appendix 9

2009 IEPA Phytoplankton Report for Lake Catherine

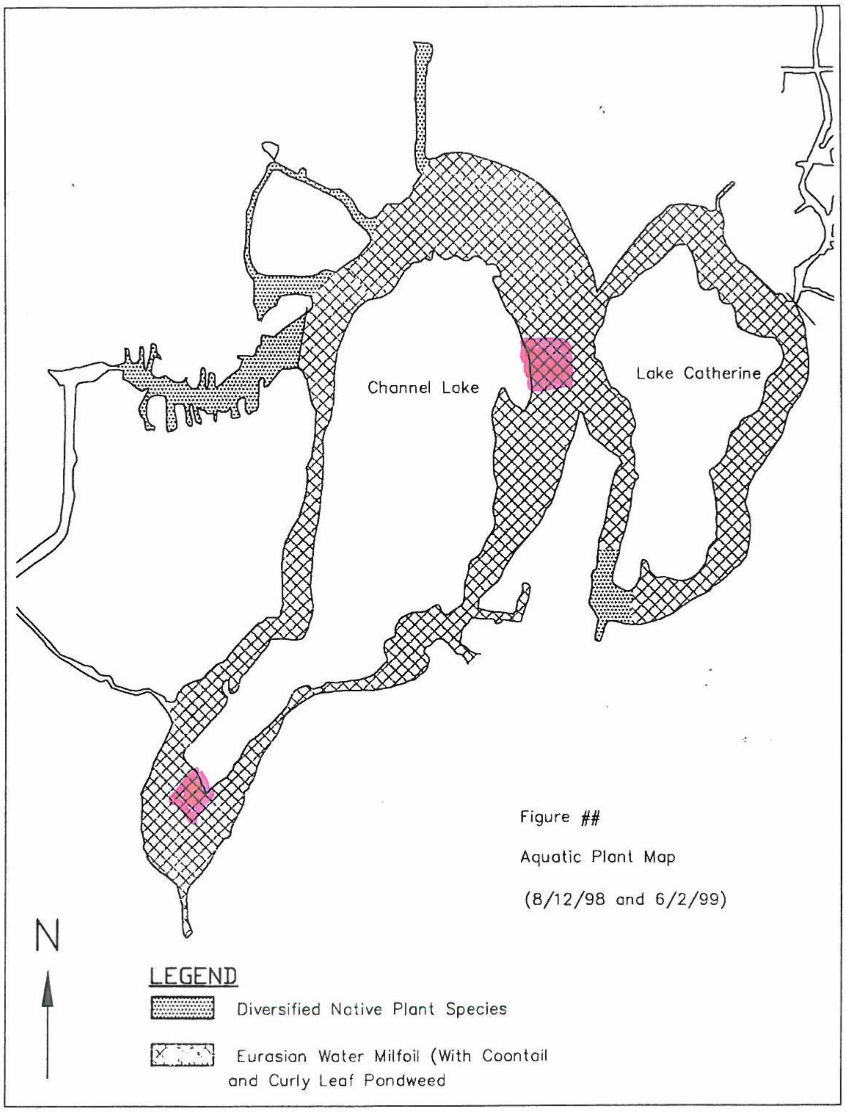
Catherine Report
(2009).pdf

Appendix 10

Dissolved Oxygen (DO) Monitoring

Figure 1: Dissolved Oxygen (DO) Recommended Monitoring Sites

Figure 51. Aquatic Plant Map for Channel Lake and Lake Catherine



Source: Lake County Health Department

Figure 2: Specifications for DO Monitoring Units

In-Situ DO
Monitoring Specs_Inte

Appendix 11

2014 Summary Report Channel Lake/Lake Catherine
http://www.lakecountyil.gov/DocumentCenter/Home/View/14187
http://www.lakecountyil.gov/DocumentCenter/Home/View/14191

Online IL Volunteer Lake Monitoring Program Database (provides historical data)
http://dataservices.epa.illinois.gov/waBowSurfaceWater/Default.aspx