Comprehensive Lake Study
of
Clear Lake

in

Waseca, Minnesota

BMI Project No. M13.33471

November 2003

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of
Clear Lake
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I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

By: _____

William R. Douglass, P.E.

License No. 18240

Date: November 21, 2003

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I. INTRODUCTION

BOLTON & MENK, INC.
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November 21, 2003

Waseca Lakes Association
Waseca, MN 56093

RE: Clear Lake Study
Waseca, Minnesota
BMI Project No. M13.33471

Dear Waseca Lakes Association Members:

We are pleased to submit this Comprehensive Lake Study Report. This report has been prepared at the request of the Waseca Lakes Association to analyze the hydrological cycle relative to nutrient loading into Clear Lake and to formulate possible solutions aimed at reducing the inflow of various targeted pollutants. This study and report has been made possible through a grant from the Blandin Community Investment Partnership.

Since Clear Lake has a long history of study and experimental management practices, a primary goal of this report is also to accumulate the multiple studies performed over the years and to categorize the benefits of those studies. In addition to the reduction of pollutant loading, it is also a goal of this study to recommend policies that are designed to reduce the potential of storm water pollution associated with current shore land management strategies and the urbanization of the undeveloped lands within the contributing watershed. To meet the secondary goal we have reviewed the various files available from the City of Waseca, the MPCA, the County Auditor's office and the Cannon River Watershed Partnership to develop a chronological listing of events over the last 100 plus years of record.

For the nutrient loading study, we have mapped the various contributing watersheds and placed flow loggers in key inflowing pipes as a method of quantifying total volume of runoff entering the lake. When this information is added to the accurate rainfall data available from the state rain gauge at the former campus site and the continued volunteer phosphorus testing at key inflow points around the lake, we can formulate a comprehensive lake loading study to determine the effects of the various inflows. With this quantitative information, we have been able to formulate a set of potential solutions to limit the phosphorus loading from major contributing points.

This study attempts to consider the best-fit scenario combining proven shore land management techniques with more innovative inflow treatment considerations to significantly reduce the phosphorus inflow. If this can be accomplished, the lake should slowly clean itself of the phosphorus it already has. Otherwise, more conventional treatment techniques (i.e. alum treatment) may be used to speed up the phosphorus removal from the lake itself.

Finally, we welcome your comments relative to this report, as it is intended for your use. Therefore, any input you can give relative to the goals and assumptions contained within this report will help us finalize a report that meets your expectations and vision for Clear Lake.

We wish to thank the Waseca Lakes Association, the MPCA, the DNR, Waseca County and the Waseca City staff for their support in this project. We look forward to meeting with you all and any other interested citizens to answer any questions regarding this study and the recommended improvements. If you have any questions, suggestions or recommended modifications, please do not hesitate to contact me at your convenience.

Respectfully Submitted,

BOLTON & MENK, INC.

William R. Douglass, P.E.
Sr. Water Resources Engineer
WRD/wrd
Attachment

II. HISTORICAL OBSERVATIONS AND PRACTICES

In our research of the existing files, we were able to compile a brief historical synopsis of the significant events that may have had an effect on the current lake conditions. Those events are listed chronologically in the following:

> **NOTE:** Any examination of the records in an attempt to use precise elevations of the lake should be performed with caution. At the time of original construction of the dam in 1937, an assumed datum was used whose numbers appear to read in sea level values. No correlation between this datum and today's standard could be determined.
>
> Also, subsequent surveys documented a sea level datum but later notations indicate that a 1.13 foot equation exists between some of the surveys performed.

A. 1800's

1. The earliest European settlers in the area recognized the rich resources offered by Clear Lake. Bulrushes lined 1/3 of the shore with aquatic weed beds throughout the Lake, which provided spawning areas. Recognition of the resources brought competing demands to utilize, capitalize and protect them.

2. One of the first attempts to utilize the resources came in the 1860s when the lake bottom was mined for sand and gravel building materials. It was recognized that this caused the lake to become cloudy and algae to increase. The City banned the practice, but the mining may have already changed the bottom environment.

3. In 1871 a second feature of the lake became the target of downstream mill operators who began cutting a channel that would drain the lake for mill operation. The Minnesota State Legislature intervened in 1872 to prevent this potential threat to the lake.

4. The 1873 legislation, as passed, did not limit itself to the threat of draining. The actual wording states:

> *SECTION 1.*
>
> *That all persons are hereby prohibited from digging into or in any way distributing the shores of Clear Lake, said lake being situated in the town of Woodville, Waseca County; or from doing any act with intent to drain said lake or make a reservoir thereof, or raise or lower the water of the same, or in any way to change or attempt to change the natural condition of said lake for milling purposes, or any purpose whatever.* [1]

This legislation appears to have put an end to demands for the "active" use of the Clear Lake resource for industrial purposes.

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[1] Special Laws Of Minnesota For 1873, Chapter LXIII, An Act To Prevent The Draining Of Clear Lake, Situated In The Town Of Woodville, In Waseca County, Approved February 17, 1873.

5. The "natural condition" assured under the 1873 legislation seems to have been ignored once the imminent threat of draining was eliminated. In 1885 when the State of Minnesota began stocking carp in many lakes, sportsmen objected.

6. By the late 19th century, Clear Lake was a nationally known vacation area where such notables as Mark Twain and William Jennings Bryan attended annual Chatauqua celebrations. At this time, the lake was described as having crystal clear water.[2]

B. 1900-1930

1. Submerged vegetation continued to grow profusely throughout this period.

2. During the early 1900s, Clear Lake's popularity for swimming and fishing, especially for large-mouth bass, continued to grow. Resorts and boat liveries are located on its banks.

3. Curly leaf pondweed, which is native to Eurasia, Africa, and Australia, was first noted in Minnesota about 1910 (Moyle and Hotchkiss, 1945).

4. The DNR began stocking game fish in Clear Lake in 1926.

C. 1930-1950

1. The recreational demand for the resource brought regular mowing of submerged vegetation to facilitate swimming and boating.

2. The 1930's brought the first documented water quality problems when algae blooms were noticed on hot, calm days.[3]

3. In 1932, the Minnesota DNR Fisheries Supervisor, Thaddeus Surber, reported algae in Clear Lake.

4. In 1933, the State Dept. of Health investigated a fish kill in Clear Lake. The investigation reported various pollution sources including sanitary sewage entering storm sewers and ditch from a dump on the west side of the lake referred to by many as "Andy's Stink."

5. Although urbanized sanitary sewage flow through the wastewater treatment plant was directed away from Clear Lake and to the Le Sueur River, non-urbanized sanitary flow from developing neighborhoods continued to drain toward the Lake.

6. In 1937, the County granted permission to the State to construct and maintain a core-wall structure (dam). Elevations from this time period are assumed and no correlation to actual elevations is possible. Information from the DNR indicates that the lake level was raised 1.4 feet. [4]

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2 Barten, John. Lake and Watershed management in a Small Rural Community, 1985.
3 Minn. Dep. Nat. Resoures., unpubl. Rep.
4 Thompson, Steve, RLS; Jones, Haugh & Smith, Inc. by letter to Perry A Berg; March 11, 2002.

7. The earliest aerial photos (1938) show a large slough between Loon Lake and Clear Lake being filled with trash and other fill. This fill removed a major filtering mechanism for water entering the Lake.
8. DNR memos from 1942 document that the dam included a concrete spillway with two 6 foot box culverts. A fish screen had been installed; apparently by local sportsmen.
9. In 1963, Regional Fisheries biologist James Groebner wrote that Clear Lake had good fishing and abundant vegetation until 1940-1944. This statement tends to place a hard date on the deterioration of water quality.

D. 1950's

1. By the mid 1950's, the concrete spillway had disappeared, leaving the two 6 foot box culverts.
2. A May 21, 1957 DNR report indicates a double 6 foot span with the flow through "loose piled rock". The approximate lake elevation was 1120.6. [5]
3. By the late 1950's, algae blooms were common throughout the summer, macrophyte growth (large weeds) was interfering with swimming and boating, and rough fish populations had become dominant in the lake. Historical records from this period indicate that the lake received raw sewage (up to 750,000 gal/day) from the adjacent city and an open ditch from a landfill.
4. During this period, the DNR and various agencies and groups adopted a more proactive role.
5. Clear Lake showed a marked decline in 1951 when heavy rains raised its level by three feet.[6] Vegetation was submerged; and carp and sheepshead multiplied.
6. In 1951, the DNR conducted a Fish Survey.
7. In 1954, copper sulfate was applied to the lake to kill algae.
8. In 1957, the DNR conducted a second Fish Survey.
9. In 1958, copper sulfate was again applied to the lake to kill algae.

E. 1960's

1. During the 1960's, efforts to restore the lake became formalized.
2. In 1960, the DNR conducted a Fish Survey.
3. Efforts to improve the lake began in the 1960s when the City implemented a program to eliminate landfill and sewage discharge into the lake. These efforts, when completed, represented the end of the demand for "passive" industrial uses of the

[5] Yakel, Glen; DNR Waters by phone conversation with Del Jackman, Bolton & Menk, Inc.; November 5, 2003.
[6] Zimmerman, Jim & Madigan, Tim, *The Streets are Wider Now,* 1951.

resource. If the industrial demands for the lake resource could be successfully eliminated, only aesthetic and recreational demands would remain.

4. Apparently, between 1957 and 1962, the dam was replaced. The new structure consisted of two 8 foot wide channels. One was poured concrete and the other was rock and chunks of concrete according to a 1962 survey. Although both were at the same elevation, this may have permitted some fluctuation of water level below the elevation of the fixed concrete weir portion.

5. In 1963, the lake was treated with toxaphene to remove unwanted rough fish populations. This effort had no long-term effect and the public sought additional restorative measures.

6. A 1963 report stated, "*Carp and sheepshead have invaded the lake, most likely by means of Crane Creek. Carp are extremely abundant. Submerged vegetation is very sparse. Only a small area of bulrush is left. Algae is extremely dense. Bluegill and bass fishing are already greatly depreciated and pike and crappie fishing are going downhill.*[7]

7. In 1963, Waseca Sportsmen constructed a rough fish barrier at the outlet of Clear Lake and the DNR initiated a fish reclamation project in the fall of 1963. Toxaphene was applied to the lake to kill all fish prior to restocking with game fish. Overstocking of pan fish resulted in stunted fish.

8. In 1963, the DNR constructed a northern pike spawning area on the east side of the lake after the reclamation.

9. In 1964, special investigation by the DNR determined that aquatic plants responded well and became more abundant after the fish reclamation project.

F. 1970's

1. By 1971, residential development began occurring on the east side of the Lake.

2. In 1974, the City contracted with National Biocentric, Inc. to perform research which concluded that the lake was eutrophic due to the phosphorus loading from the watershed. The specific conclusion was that 70-80% of the hydrologic phosphorus and nitrogen loading came from urban runoff.

3. The City of Waseca received a Clean Waters grant for lake restoration in 1976 from the United States Environmental Protection Agency (EPA) and the Minnesota Pollution Control Agency (MPCA). The purpose was to divert and treat nutrient-rich runoff that was entering Clear Lake.

4. From 1977-1980, sewer sampling and lake water quality monitoring were part of the Clear Lake Restoration Project.

5. In 1978, the DNR removed 30,500 lbs of fish, mostly small crappies, resulting in improved fishing.

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[7] Groebner, James F., DNR Regional Fisheries Biologist, 1963.

6. In 1979, the DNR conducted a Fish Survey.
7. In 1979, two storm sewers are diverted into Gaiter Lake Marsh for phosphorus removal before reaching Clear Lake.

G. 1980's

1. In 1980, a storm water treatment marsh was constructed near the NW corner of Clear Lake.
2. By 1981, storm water from the west side of Clear Lake, and the overflow from Loon Lake, was diverted into the treatment marsh prior to being discharged by pumping station into Clear Lake.
3. Reports in 1982 revealed that the treatment marsh removed 52% of total phosphorus in 1981 and 70% in 1982. Lack of detention time during rainfall is cited as a problem for the marsh. (Water should be held for 5-7 days.)[8]
4. The Clear Lake Restoration Advisory Committee undertook public education programs in 1982 on the proper use of lawn fertilizers, and attempting to reduce the garbage left on the lake during ice fishing.
5. In 1984, the DNR conducted another Fish Survey.
6. A 1984 survey conducted by the DNR shows that one channel through the bridge still had a rock weir.
7. In 1985, Dirk Peterson, Regional Fisheries Supervisor, reported an increase in rough fish population and reduced aquatic vegetation in Clear Lake.
8. In 1986, the southwest shoreline near US 14 was rip-rapped.
9. In 1987, the DNR conducted a second fish reclamation project using rotenone to kill all fish prior to restocking with game fish. Overstocking of pan fish again resulted in stunted fish. A 1992 DNR lake management plan stated, *Aquatic vegetation did increase for a short time after reclamation, but the City of Waseca constantly pumps water into the lake, maintaining artificially high (full) water levels which, in combination with the rip-rapped shorelines, do not allow the establishment of vegetation.*
10. In 1988, the DNR conducted another Fish Survey.
11. In 1988, the southeast shoreline along US 14 and the county road was rip-rapped.
12. From 1980-1990, rural homes without sewer service began surrounding the northern and eastern shores of Clear Lake. Annexation to the City of Waseca was discussed but not accomplished.
13. During the 1980s-1990s, the City of Waseca upgraded sanitary sewers to prevent overflow of raw sewage into the lake and treatment marsh during heavy rains.

[8] Barten, John, City of Waseca limnologist, 1982.

14. In 1988, the lake was treated with alum to immobilize the phosphorus that was entering the water from the lake sediments. The dosage rate used for the alum treatment anticipated a 10-year life.

15. In 1988 curly-leaf pondweed, an invasive European submergent plant, whose life cycle complements the growth of algae during the summer months, is first reported in the lake.

H. 1990's

1. Phosphorus levels were reduced in the two years after the 1988 alum treatment. [9]

2. In 1990, the City of Waseca discontinued employment of a staff limnologist after approximately 10 years. This may have been due to the close of the Clean Waters grant funding.

3. In 1990, the County Water Plan for Waseca County was completed.

4. Aerial photos from 1991 reveal that development had surrounded the Lake, including rural developments to the south that are within the tributary area.

5. In 1992, habitat development and protection were addressed, "*A marsh enhancement project that has potential to improve the quality of water entering Clear lake, as well as increase area available for northern pike spawning, is in the early stages of coordination (with other agencies and the public) and proposal. We should work with the City of Waseca to design a water level regime that is favorable for aquatic vegetation.*"[10]

6. In 1993, the DNR conducted another Fish Survey.

7. In 1995, a Water Management Plan was prepared by the City of Waseca, which included Clear Lake.

8. In 1996, the City of Waseca lake committee no longer exists.

9. In 1996, water quality monitoring of Clear Lake was performed by the MPCA with comparisons to Reeds and St. Olaf Lakes in the area. The results showed that although Clear Lake responded to intensive management in the 1980s, phosphorus levels were very high and water quality was poor compared to the other two lakes.

10. In 1997, the Waseca County Water Plan was updated.

11. In 1997, experimental regulation was implemented for largemouth bass in Clear Lake.

12. In 1999, the City of Waseca cut funds for lifeguards at Clear Lake beaches due to declining use.

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[9] Lee, Jeff , Clear Lake Aluminum Sulfate (Alum [sic]) Treatment, 1993.

[10] Valiant, Hugh, MN DNR Regional Fisheries Supervisor, Waterville, MN, 1992.

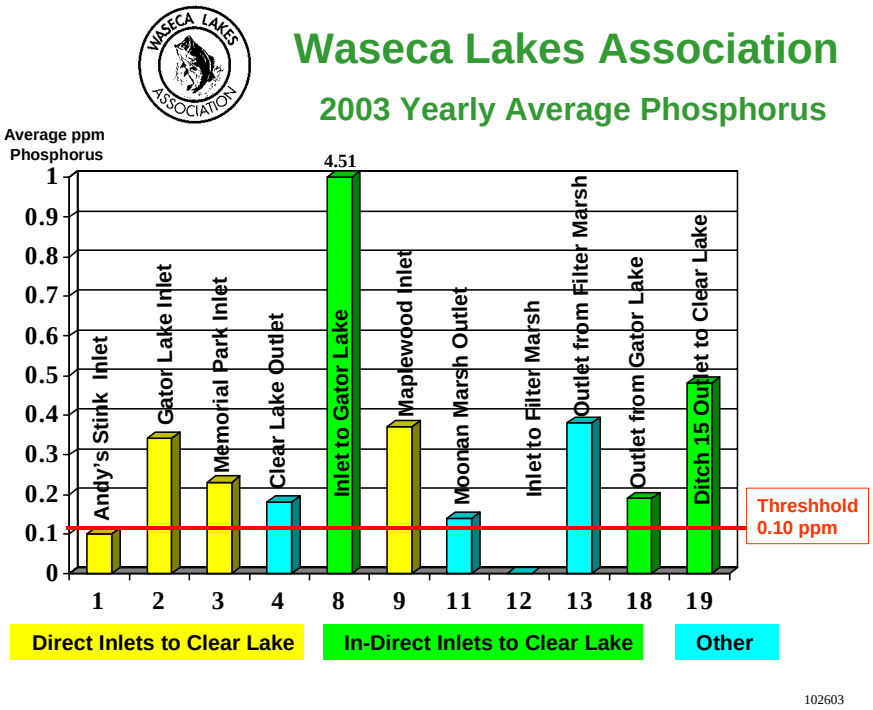
13. In 1999, the overall effectiveness of the treatment marsh at the northwest corner of the Lake was questioned. The tile system had failed and it was difficult to harvest the grasses.

I. 2000+

1. Heavy rains in 2000 again resulted in raw sewage entering the lake.
2. In early 2001 the WASECA LAKES ASSOCIATION (WLA) was formed to "*promote and maintain the environmental, economic, and recreational protection of Clear Lake and other Waseca County lakes in the Crane Creek Watershed*."[11]
3. The WLA began a monthly monitoring program in 2001 to determine water quality at eight locations on three of the area lakes (Gaiter, Clear and Loon).
4. The City of Waseca elected to by-pass Clear Lake with the discharge from the treatment marsh by pumping it directly to County Ditch 54 that flows into Rice Lake.
5. In 2002, the WLA retained Bolton & Menk, Inc. (BMI), consulting engineers, to study Clear Lake and prepare this report. BMI began monitoring the flow volumes from the Memorial Park Marsh and County Ditch 15-1 (Gaiter Lake).
6. An early task of the BMI study was to develop a comprehensive history of the lake that included constructing a single spreadsheet with all historic water quality information available. Sources for the information included the EPA Storet Database and manual records from the City of Waseca, the DNR, the PCA and the WLA. This information goes back to 1960 when the phosphorous level in the Lake was measured to be 225 ppb and includes:
    a. Sampling results from several inlet sources.
    b. Sampling results from surface locations throughout the lake.
    c. Dissolved oxygen (DO) and phosphorous depth profiles at various locations.

    NOTE: The way of expressing the concentration of phosphorous and other items changed over the years from parts per million (ppm), also known as milligrams per liter (mg/L), to parts per billion (ppb). Caution should be exercised when using this data.
7. During the assembly and examination of the documents, it was discovered that a majority of the flow from County Ditch 15-1 that enters the Lake actually bypasses Gaiter Lake and therefore, receives no treatment. The 2003 sampling program conducted by the WLA was modified to measure the phosphorous concentration entering Gaiter Lake, exiting Gaiter Lake and the combined flow that enters clear lake through County Ditch 15-1, separately. The effectiveness of the Gaiter Lake Marsh in removing phosphorous is exhibited in the following graph.

[11] Waseca Lakes Association, By-Laws, Article II, Section 1, February 26, 2001.



As can be seen in the graph, the inlet of 4.51 ppm was treated to a level of less than 0.2 ppm by Gaiter. Once that outfall joined the untreated County Ditch 15-1 water, the concentration that reached Clear Lake was approximately 0.48 ppm.

8. During the investigations by BMI in 2003, it was observed that the loose rock channel under the bridge had been replaced with concrete, which established a fixed elevation. The result would be that fluctuations below this elevation could only occur in very dry periods.

9. During the summer of 2003, an extremely dry period occurred and the lake elevation was significantly lower.

10. The DNR reported that fishing during the fall of 2003 was excellent with a large population of pan fish. The condition of the lake was cited as, "close to pre-City of Waseca conditions". [12]

III. PUBLIC OPINIONS

A. Background

Throughout the recorded history of Clear Lake, the public's desires have driven actions. Each action led to outcomes; some were predicted, and others were not. Some were desirable in the short term for a particular special interest group, but ignored the potential disruption to other interested groups who may have been satisfied with the status quo. Of course, the knowledge

[12] Valiant, Hugh, DNR Fisheries by phone conversation with Del Jackman, Bolton & Menk, November 5, 2003.

available in the early years did not recognize long term effects of certain practices, policies, or the interaction of the biology of the lake. This shows that a key aspect of public opinion is education.

B. Curly Leaf Pondweed

Today the principal invasive species that continues to affect the health of Clear Lake is the curly leaf pondweed. This weed was introduced to Minnesota around 1910, when it was used as an aquarium plant. Its life cycle is unusual compared the native species of this area, as shown below.

Life Cycle Comparison												
Dec	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	
X	**X**	**X**	**X**									**Ice Condition**
Phosphorous is permitted to settle to the bottom in the more quiescent winter months where it becomes part of the bottom sediment.				Begins growing but can be thwarted by lack of sunlight due to pondweed..		Active growing cycle that takes up phosphorous..				Tends to die and release phosphorous.		**Native Species**
Turions (hardened stem tips) can begin growing, even under thick ice and snow.			Active growing cycle that takes up phosphorous. During this time it can shade out native sprouts from sunlight and thereby stop their growth.				Tends to die and release phosphorous.		Turions (hardened stem tips) are distributed in the sediment.			**Curly pondweed**
With little to no sunlight, algae is not very active even if phosphorous is available. Phosphorous is permitted to settle out.							In response to sunlight and any excess phosphorous, algae has opportunity to bloom.			Tends to die and release phosphorous.		**Algae**

This life cycle gives the pondweed a competitive advantage by denying sunlight to the more native species during their sprouting cycle. Then, the pondweed's death and release of phosphorous coincides with the maximum sunlight for the algae to flourish.

C. Questionnaire

The Waseca Lakes Association (WLA) prepared a questionnaire that was inserted into the City of Waseca water bills in May of 2003. In an effort to broaden the responses, questionnaires were made available to other areas in the adjacent township and Waseca County.

The results from this study were analyzed and can be used to guide the WLA in both achieving the goals and educating / motivating the public. All the results should be considered in light of the potential respondents to a survey on lake condition, etc. Theoretically there are individuals in the general public:

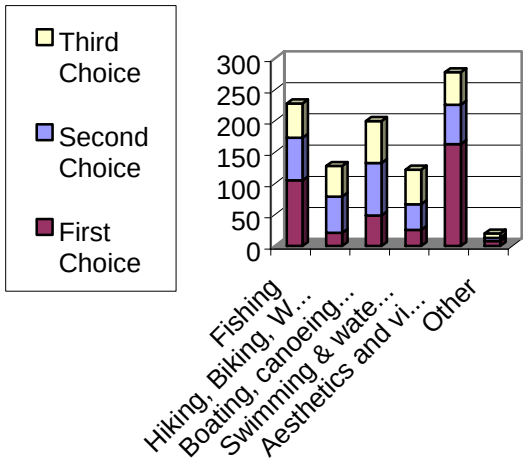
- With intense interest and utilize the lake a lot.
- With an interest but do not actively use the lake.
- Who not use the lake but have few opinions.
- Who do not care one way or another.

Given these patterns, it may be reasonable to assume that the respondents include a higher percentage of those who are interested or use the Lake than is present in the general public.

Several of the questions ask the respondent to rank their opinions on a particular issue. The responses to enjoyment are illustrated to the left.

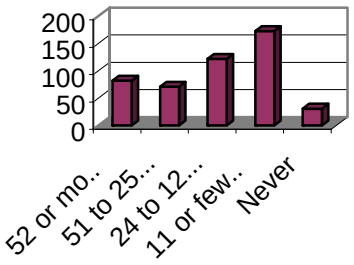
This may be more of a comment on our society that the more athletic activities rank lower than the more passive ones.

1. Which activities you enjoy most about Clear Lake?



Question 3 describes the frequency of uses described in question 1. A correlation between the times per year and the 'enjoyment' question could be performed to place a weighting on the enjoyment statistic.

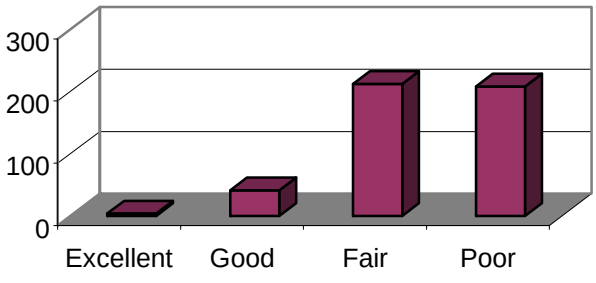
3.. What is the frequency of your activities described in # 1:



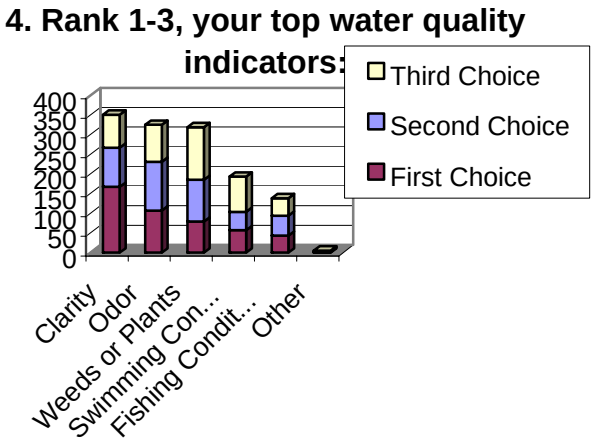
The next scope addressed by the survey dealt with overall perception of water quality.

2. Rate Last Season's Water Quality.

Clearly, the perception of the respondents is less than

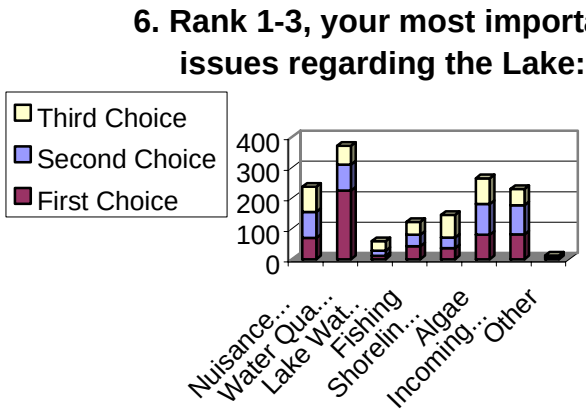


favorable, as indicated by the responses shown in question 4, below.

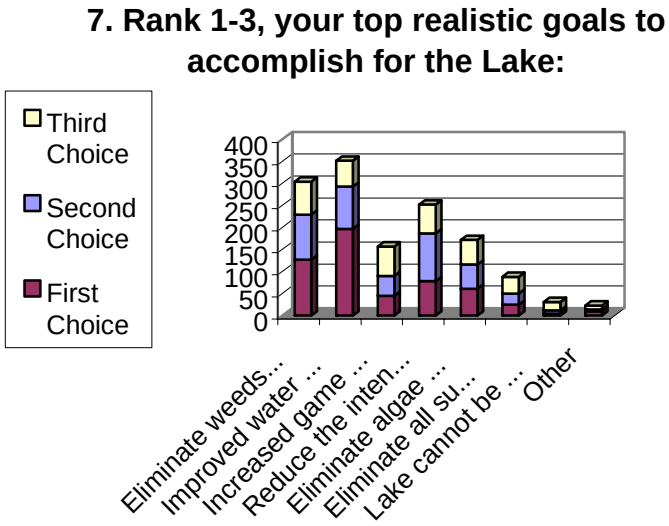


Question number 6 begins to address areas that the WLA should consider in setting its educational goals by asking the respondent to rank the issues.

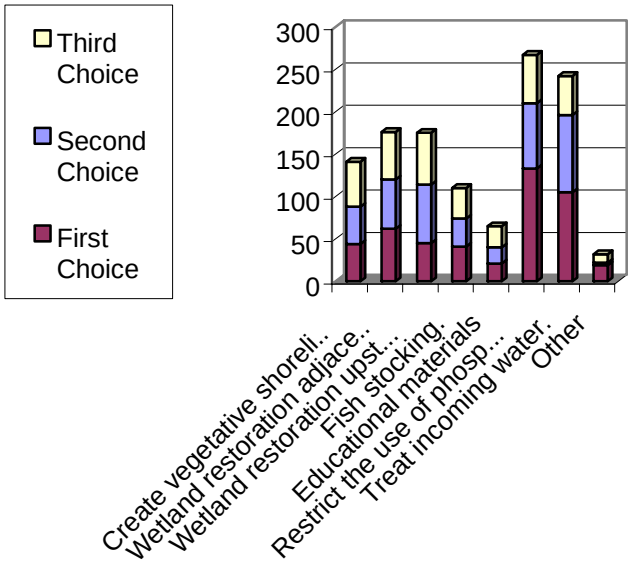
The public may not realize the fact that shoreline management and algae control has significant impacts on water quality.



Question 7 helps target specific goals for the WLA to tackle and also demonstrates the extent of the knowledge that interested individuals have.



8. Rank 1-3, the top methods to improve the quality of the Lake.



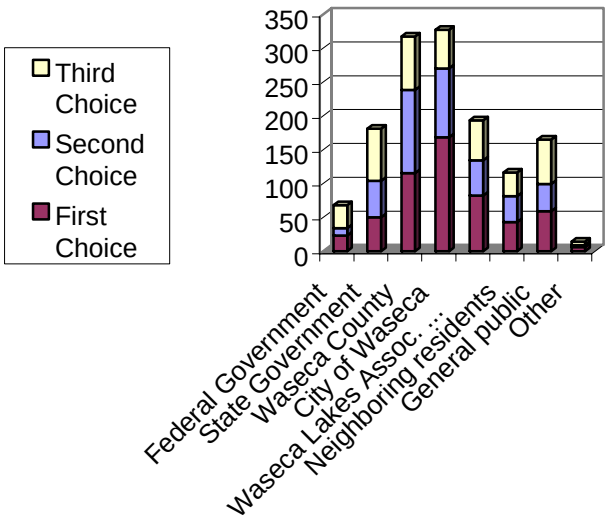
The public's perception of actions taken is imperative in securing their involvement and support. Question 8 illustrates these perceptions.

Some education may be necessary to show that wetland restoration is a key element to the treatment of incoming water; otherwise, the support may not be forthcoming. i.e., "You're not doing the right thing."

The last question in the survey shows that, in general, the public sees restoration of the Lake as a local one directed to the City of Waseca or the County.

Although this bodes well for promoting restoration efforts among the respondents who use the Lake and are knowledgeable, explaining it to less interested parties could be difficult.

9. Rank 1-3, people or agencies that you believe are responsible for improving the Lake:



IV. CURRENT LAKE CONDITIONS

Clear Lake currently has the following general characteristics:

1. Approximate Lake Area ..... 636 Acres
2. Current Watershed..... 2,092 Acres
3. Estimated Lake Volume ..... 6,712 Acre Feet
4. Estimated Annual Phosphorus Loading ..... 507.4 lbs
5. Estimated Average Phosphorus Inflow Concentration..... 0.35 mg/l
6. Best Secchi Disk Transparencies since 1951:
   - August, 1997..... 5.25 feet
   - August, 1990..... 4.92 feet
7. Worst Secchi Disk Transparencies since 1951:
   - August, 1996..... .0.67 feet
   - August, 1985..... 0.75 feet
8. Since 1951, the phosphorus levels in the lake ranged from 0.02 mg/l in November of 1989 to nearly 1 mg/l on several occasions.
9. The average phosphorus in the lake over this period is 0.15 mg/l.
10. The threshold for total phosphorus inflow is typically 0.1 mg/l.
11. Average monthly evaporation for the period of May 2003 to September 2003 is 6.62 inches, and the total evaporation for this period is 33.09 inches.
12. A significant biomass of curly leaf pondweed. This plant "*has a unique life cycle which gives it competitive advantages over many native aquatic plants. Unlike most native plants, curly leaf pondweed may be in a photosynthetically active state even under thick ice and snow cover (Wehrmeister and Stuckey, 1978). Therefore, it is often the first plant to appear after ice out. By late spring it can form dense mats which may interfere with recreation and limit the growth of native aquatic plants (Catling and Dobson, 1985). Curly leaf plants usually die back in early summer in response to increasing water temperatures, but they first form vegetative propagules called turions (hardened stem tips). New plants sprout from turions in the fall (Catling and Dobson, 1985).*" [13]

Both nitrogen and phosphorus are the primary nutrients causing algae blooms. Both of these nutrients are very difficult to control. However, phosphorus is vital in photosynthesis and is

[13] Wendy Crowell, Minnesota Department of Natural Resources, *Research in Minnesota on Control of Curly Leaf Pondweed* , as published on November 11, 2003 on web site: http://www.mcjweb.com/weaverlake/research_in_minnesota_on_control%20of%20curlyleaf.html

therefore the one nutrient, which if limited, immediately reduces algae blooms and improves water clarity. Hence, there is a need to develop a phosphorus budget. The following is a brief description of the monitoring data we have been collecting over the last two summers.

A. Figure No. 1 is an aerial photo of Clear Lake with the known, point source inlet locations indicated. During the summer of 2002, Bolton & Menk, Inc. installed flow loggers in the two most prominent inlets on the south side of Clear Lake – the inlet from Gaiter Lake and the inlet from the Memorial Park. Although this information helped to quantify the volumes of flow coming from these inlets, the monitoring period was too short for the purposes of this report. The data collected verified the assumption that the Gaiter Lake inlet is the largest contributing point source of inflow.

B. During the continued research over the winter of 2002-2003, the exact configuration of the Gaiter Lake outlet was determined. Figure No. 2 shows the current pipe configuration associated with the outlet from Gaiter Lake. As shown in this figure, a key finding is that the original County Ditch 15-1 tile completely bypasses Gaiter Lake.

C. Over the summer of 2003, both available flow monitors were placed in the junction manhole downstream from the lake outlet in an effort to determine how much flow is bypassing Gaiter Lake through the original County Ditch 15-1 tile.

D. Given the actual monitored flow data from Gaiter Lake, and the 2001 data from the Memorial Park inlet, SCS storm water modeling techniques were used to generate a storm water model for all inlets to the lake. The model was calibrated to match the actual flow data and the local rain gauge information.

E. We have used this information to perform a water balance for the lake. The following percentages have been estimated from the calculated and monitored information from the May through September of 2003:

Inflow Components

Direct Precipitation	18%
Watershed Runoff	4%
Estimated Groundwater Inflow	78%
Total	100%

Outflow Components

Evaporation	45%
Direct Outflow	55%
Total	100%

This water balance works for only the summer of 2003. The most questionable flow parameter is the lake outflow. An attempt to monitor the outflows over the last summer was by the Cannon River Watershed Partnership, but the results were not available, as they were

deemed inaccurate due to the failure to calibrate the outflow stream data. To perform the water balance, the outflow volume was calculated using the original weir elevation plans and a general broad crested weir equation. **We believe that actual lake outlet flows are actually significantly less. Because of this, the estimated ground water component may be significantly higher than the actual groundwater contribution**. Obtaining actual outlet flow data is critical in estimating these components. A current survey of the outlet structure is recommended to ensure that the overflow elevations are still the same as shown on the original plans. It is very possible that the actual overflow may have changed when the fish barrier was installed

F. WLA volunteers have been faithfully taking samples at the various lake inlet locations shown in Figure No. 1 as well as the random mid-lake samples. When the average monthly measured phosphorus concentrations from 2001 and 2002 are multiplied by respective inlet volumes estimated from the calibrated hydrologic model using 2003 rainfall data, an estimate of the total seasonal phosphorus entering the lake can be made.

G. Although there is some missing data, the relative phosphorus concentrations can be used to extrapolate the missing data and allow a reasonable estimate of the total lake loading. The following table shows the results of the analysis over the summer of 2003:

Monitored Inlet Phosphorus Loading

	March lb P	April Lb P	May lb P	June lb P	July lb P	August Lb P	Sept. lb P	Total Summer
Andy's Stink	0.9	0.7	16.4	2.9	2.2	0.5	3.6 A	27.2
Gaiter Lake	3.9	6.9	74.3	55.0	61.3	6.2	9.8	217.6
Memorial Park	1.2	0.4	14.5	34.5	21.8	0.7	2.7 A	75.8
Maplewood	12.1 A	14.1 A	51.5	36.9 A	46.0 A	10.6 A	13.4 A	184.6
Diechen Tile	0.1 A	0.1 A	0.7	0.5 A	0.6 A	0.1 A	0.1 A	2.2
Totals	**18.2**	**22.2**	**157.6**	**129.8**	**131.8**	**18.1**	**29.7**	**507.4**

Table Note:

A = Some locations do not have data for all months. An estimated amount was calculated using the ratios of the May amounts when all areas were sampled.

If this total loading is extrapolated to account for the total annual precipitation over the entire watershed and then evenly distributed over the entire lake volume, the total added phosphorus concentration per year would be 0.037 mg/l. Given that most lakes tend to hold their phosphorus for long periods of time, if the lake was initially phosphorus free (understandably impossible), it

would take approximately 2.7 years to reach a 0.1 mg/l concentration. As stated earlier, the threshold for *inflow* is 0.1 mg/l. The lake concentration should be significantly lower. Estimated average phosphorus inflow concentration is 0.35 mg/l. In addition, evaporation during the period of May 2003 to September 2003 alone accounted for approximately 1,850 acre-feet of water leaving the lake, in effect causing higher concentrations of phosphorus in the lake because evaporation slows down the rate of flushing of phosphorus from the lake.

The following is a description of the methodology used in calculating the phosphorus loading into the lake:

Since the sample locations we have data for cover 98.5% of the watershed area (Clear Lake is not included in total), multiply total summer pounds P by 100%/98.5% to estimate a total for the summer for the entire watershed:	515.2 lb P total for the summer (March through September) for the entire watershed
Then estimate a total for the year by multiplying the total pounds P for the summer by 100%/76.1% to get a total pounds P for the entire year for the entire Clear Lake watershed:	677.1 lb P total for the year for the entire watershed
In order to calculate the concentration in Clear Lake due to these flows, divide the total pounds P for entire year for entire watershed by the volume of Clear Lake in L (8.28E+09 L) then convert lbs to mg by multiplying by 453,592 mg/lb:	0.037 mg/L P in Clear Lake due to the flow coming in (This assumes the P concentration in the lake is 0 mg/L before flows enter it, which is likely not true)
To calculate the concentration in the flows going into Clear Lake, first estimate the total flows for March through September, and then estimate the flows for the entire year using 76.1%:	668,847,857 L Total flow into Clear Lake for March through September
	878,906,513 L Estimated total yearly flow based on March through September percentage (76.1%)
To calculate the concentration in the flows going into Clear Lake, divide the total pounds P for entire year for entire watershed by the volume of flows for the entire year then convert lbs to mg by multiplying by 453,592 mg/lb:	0.35 mg/L P flowing into Clear Lake

This minor calculation shows that the WLA is justified in its belief that employing direct lake alum treatments would merely treat the symptom and not the problem. Although alum treatment may be the final step in the water quality improvements needed, without limiting the phosphorus loading, the effects of alum treatment alone will only be short-lived.

V. WATERSHED ANALYSIS

A. Gaiter Lake Watershed

The general watershed characteristics serving Clear Lake must be analyzed to enable a full understanding of the factors contributing to the current conditions. To that end we have assembled several watershed maps to show how the watershed has changed over the years. Gaiter Lake is a significant contributor to Clear Lake because it accounts for approximately 36 percent of the Clear Lake watershed. This is significant when considering that Clear Lake itself accounts for approximately 24 percent.

Before the expansion of the Waseca Industrial Park in the 1980s, the Gaiter Lake watershed was approximately 660 acres in size. The area was served by County Ditch 15-1 (CD 15-1) which flowed through the Gaiter Lake area, crossed the Railroad and outletted into Clear Lake. Figure 3 shows the watershed map with the most significant CD 15-1 tile branch highlighted in red. Note that the current Industrial Park is outside the watershed limits.

The area to the south and west of the original CD 15-1 watershed was part of County Ditch 15-2 (CD 15-2) that drains to the south and into the Le Sueur River. When the Industrial Park was expanded, the City of Waseca petitioned the Waseca County Board for the abandonment of the upper reaches of CD 15-2. The area of the successfully petitioned watershed abandonment is shown in green in Figure 4. This area was diverted into Gaiter Lake. Although the officially abandoned watershed is 315 acres in size, actual contributing area may include some additional area in the northwest quarter of Section 20. Because of this expansion, the Gaiter Lake watershed grew to 975 acres as shown in Figure 5. This is an increase of nearly 50 percent over the original watershed.

In 1970, a new municipal storm sewer was constructed to serve the residential area north of 11th Avenue. In 1983, a new municipal storm sewer was constructed to the Industrial Park. The storm sewer network associated with these two new inlets to Gaiter Lake is shown in black in Figure 6. With the exception of the tile crossing nearest to Gaiter Lake, all crossings of the original CD 15-1 tile were connected into the new storm sewer. As can be seen in Figure 6, only a small length of CD 15-1 remains active.

This section of CD 15-1 and its watershed have never been abandoned. The County Auditors office has carried forward a single repair bill from the 1970s, an amount less than $300, which has never been assessed to the benefiting properties.

It should be noted that this active tile effectively bypasses the Gaiter Lake Marsh and flows untreated into Clear Lake as shown in the sketch of Figure 2. Flow monitoring of the CD 15-1 tile and the discharge tile from Gaiter Lake Marsh revealed that during 2003, an average of 60% of the flow bypassed the marsh and discharged directly to Clear Lake with no treatment. This is runoff from the agricultural areas in the watershed. Figure 7 shows the component flows from the Gaiter Lake Marsh and from CD 15-1, which bypasses the marsh.

One key recommendation of this study is that the WLA should work with the City to petition the abandonment of the CD 15-1 tile. Then, if none of the other recommended improvements is completed, the CD 15-1 tile can be rerouted to outlet into the southern end of Gaiter Lake and the bypassing pipe can be removed and/or plugged. Although the abandoned pipe could be plugged without rerouting, this is not recommended, because of the outside chance that

some private footing tile is connected into this line. Since CD 15-1 is below Gaiter Lake, the abandoned part is proposed to continue to function as a siphon.

B. Clear Lake Watershed

After the diversion of the Loon Lake outlet to the north treatment marsh, the majority of the municipal runoff was diverted from Clear Lake. Although this has effectively removed a significant pollution source, it also removed a significant water source. The reduced watershed means a reduced flushing rate for Clear Lake. The remaining watershed is largely comprised of an area within a few hundred feet of the shore and the wetland complex to the south and east of the lake. The best management practices suggested by the NPDES Phase II storm water laws as recommended in the Recommended Lake Management Practices Section of this report are considered the best recommendation for controlling nutrient loading from this watershed.

C. General Hydrological Analysis

As mentioned earlier, the entire watershed has been modeled using SCS TR-20 and TR-55 methods. The general procedure used in the runoff modeling aspects of this analysis has been performed using the HydroCAD Modeling Software as developed by Applied Microsystems, Inc. The typical analysis is based on Soil Conservation Service, Technical Release No. 20 (SCS TR-20). The SCS TR-20 methodology is widely accepted among drainage engineers across the United States. However, the SCS procedure is based on a standard rainfall hydrograph, which is modified by local parameters (i.e., rainfall, soil type, time to peak flow, etc.).

The monitored flows coupled with the local rain gauge data is considered to be the best representation of the flow generation characteristics entering Clear Lake because is reflects actual rainfall events and actual flow data for the monitored outflow. However, the flow monitors were only used on the Gaiter Lake and Memorial Park inlet sites. Hence, a tailoring of the generally accepted SCS modeling and the monitored flows has been used to make the SCS model report similar results to the monitored flows from Gaiter Lake and Memorial Park. By extrapolation, the model can then be used to estimate the flows from the other inlets around the lake.

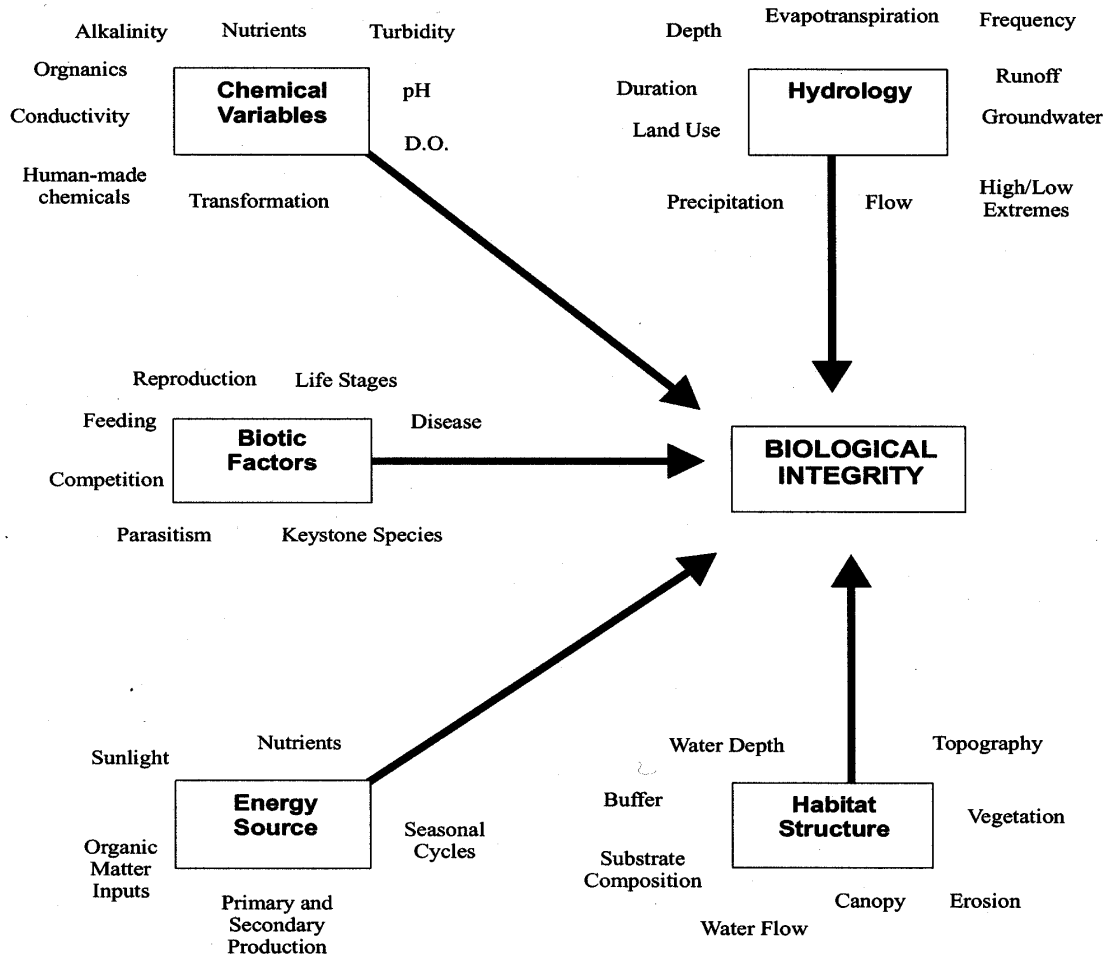
The general methodology used to model the existing flows from the Gaiter Lake and Memorial Park watersheds was to calibrate the SCS hydrograph volumes (as generated by

the HydroCAD program) to match the volumes measured by the flow monitors for the same area and rainfall events.

Once the model system was calibrated, volume ratios for the various watershed sources and/or inlets were used to estimate the total annual volume of inflow from each inlet. This, coupled with the measured phosphorus concentrations at the various inlets, was used to estimate the total annual phosphorus loading into the lake.

VI. RECOMMENEDATIONS, ALTERNATIVE SOLUTIONS & COSTS

The level of information available on the current condition of the Lake limits the ability to make detailed recommendations. Consideration of any action should include the development of an understanding of the interplay of the various factors that influence the health of the lake ecosystem. As shown below, nutrient loading is but an individual element in a complex matrix.



Ecosystem Influences on Biological Integrity (Adapted from Karr, et. al. 1986, Yoder 1995 [14]

[14] Danielson, Thomas J., Maine Department of Environmental Protection, *#1 Introduction to Wetland Biological Assessment,* EPA 822-R-02-014, Manrch 2002, page 7.

The biomass in Clear Lake depends on phosphorous as the primary nutrient. This conclusion is made by this and previous studies. Since the current biological condition is less than desirable, reducing phosphorous levels should alter the condition. However, to accomplish this, all sources of phosphorous that are available to the vegetation must be considered:

- That which continues to flow into the Lake, as discussed above.
- That which is already in solution in the volume of water in the lake.
- That which is in plant material that may die and decompose.
- That which is in the bottom sediment and can be utilized by plant life.

Although efforts have been made in recent years to document the phosphorous entering the Lake, there is insufficient information on the volume of phosphorous which is recycling within the Lake in sediment, plant material and solution. The determination of a true phosphorous budget requires this information.

Although surface sampling is relatively convenient and informational, it does not provide the necessary detail required to determine the volume of phosphorous the lake is holding. For example, during previous studies phosphorus depth profiles were regularly determined, as shown in the table below.

Phosphorous Concentration Depth Profile
Clear Lake, Waseca County

Depth	July 5, 1989	July 15, 1989	July 31, 1989	June 25, 1990	July 9, 1990
Feet	Ppm	ppm	ppm	ppm	Ppm
0	<0.010	0.015	0.021	0.054	0.121
6 ½	<0.010	0.017	0.043	0.096	0.074
13	0.013	0.012	0.030	0.047	0.049
19 ¾	0.010	0.071	0.046	0.032	0.071
26 ¼	0.013	0.026	0.049	0.037	0.049
29 ½				0.088	74

The variability of the phosphorous concentrations vary tremendously with the life cycle of the vegetation, the life cycle of the algae and the depth. Although some historic data is available, the last sampling of this type was performed in November 7, 1990. Current information is necessary.

These concentrations could be multiplied by the volume of water at that depth to estimate the total pounds of phosphorous present at each level. The ideal time to conduct such sampling would be when as little phosphorous as possible is captured by plant life, algae or bottom sediment. This would be after the curly pondweed has died and released its phosphorous and before the algae has had time to take it up.

It is recommended that weekly profile sampling be conducted for a minimum of four weeks as the pondweed dies at three locations in the lake. Given this information and the continued monitoring of inflow and outflow concentrations, an appropriate phosphorous budget can be determined.

Although a phosphorous budget cannot be determined with reliable accuracy at this time, the following recommendations and potential alternative solutions are designed to reduce the annual phosphorus loading into the lake. Where applicable, an estimate of the initial construction cost has been made and reported. Please be aware that any opinion of probable cost has been made using 2003 dollars, care should taken to account for construction inflation associated with material cost changes, fuel costs, labor, bonding, and legal costs, etc. if any of these recommendations are planned at some time in the future.

This short list of suggestions is not assumed to be comprehensive. Anyone reading this report is encouraged to offer additional solutions. This report is intended for use by the WLA as a lake management tool. As was made obvious by the questionnaire, the different groups have varying degrees of intent and use for the lake. What is termed undesirable by one group may be an ideal condition for another. Hence, outside suggestions are welcome.

A. Abandon County Ditch 15-1

As mentioned earlier, County Ditch 15-1 (CD 15-1) is still legally intact. As such, the WLA and/or the City of Waseca have no right to interrupt its flow. As shown in Figure No. 2, CD 15-1 completely bypasses Gaiter Lake. The natural sediment settling and phosphorus filtering capabilities afforded by Gaiter Lake are limited to less than 50 percent of the total flow from the watershed. During drier summers, like the latter part of 2003, the CD 15-1 flow accounts for up to 70 percent of the flow from the Gaiter Lake watershed.

The recommended procedure is for the WLA, through the City of Waseca, to petition the County for the abandonment of this tile. It is hoped that none of the remaining properties within the watershed will object, as it is being developed faster than other areas around Waseca.

If the abandonment can be accomplished, that portion of the pipe that bypasses Gaiter Lake can be removed and plugged. This will force all of the runoff through the area to flow through the Gaiter Lake treatment marsh. This will undoubtedly be a marked improvement. It should restrict the amount of turbid (dirty) water that is often seen as a plume entering Clear Lake. Since the removal of nutrient-laden sediment can reduce the phosphorus concentration by up to 90 percent, this single revision could have a marked impact on the total phosphorus entering the lake.

B. Bypass Pumping

The example of the previous diversion of the majority of the City storm sewer to the treatment marsh and consequently away from Clear Lake shows how diversion of a major pollution source can improve the Lake's water quality. A similar diversion could be pursued relative to the Gaiter Lake and Memorial Park inlets. However, careful consideration of the water sources and the lake flushing rates must be reviewed first. Again the statistics associated with Clear Lake should be reiterated.

1. Approximate Lake Area ..... 636 Acres
2. Current Watershed ..... 2,728 Acres
3. Estimated Lake Volume ..... 6,712 Acre Feet

4. Estimated Total Annual Inflow .....256 Acre Feet
5. Estimated Flushing Rate[15] .....26 years
6. Current Gaiter Lake Watershed.....975 Acres

If the outflows from Gaiter Lake are pumped to bypass Clear Lake, the watershed contributing to Clear Lake would be reduced by 36 percent and the flushing rate would be increased by at least this amount. In dry years, the lake may never outlet and essentially become a dead-end lake.

Because of the potential of hydraulically starving the lake, this alternative is not recommended.

C. Point Source Treatment

There are a multitude of point source treatment devices that could be constructed at the various inlets. The following is a short list of the various products available:

1. Storm Water Management, Inc.

   This is a simple grit chamber with a patented filter system. The filter media used targets the type of treatment desired.

   For the Gaiter Lake outlet, the size of the chamber and the number of filters required becomes extremely cost prohibitive. Also, the filters need to be changed routinely creating a significant annual cost.

   Although this system is not practical for the Gaiter Lake outlet, it may be worth consideration for the smaller inflow areas around the lake. It is a very successful treatment alternative for drainage areas smaller than 5 acres in size.

2. Bay Saver, Stormceptor, and Vortechnics.

   These are prefabricated grit chambers designed to remove large sediment. These devices do no other treatment. They are generally designed for use when available area restrictions do not allow accepted water quality pond designs.

3. Wet Retention Basins

   The MPCA now requires these water quality basins for all new developments creating more than one acre of new impervious surface. The design calls for 1800 cubic feet of dead storage per acre of drainage area. When properly designed, these basins can remove up to 95 percent of the phosphorus by settling out even very fine particles.

   Again, land restrictions do not allow room for this type of treatment for the Gaiter Lake inflow. However, new developments within the watershed will need to allow space for these ponds to comply with federal and state law.

[15] The flushing rate, as calculated, does not account for annual evaporation. As such the actual flushing rate is undoubtedly longer.

4. Alum Treatment Basins

   This treatment system is currently being used as a treatment method in Loon Lake on the west side of Waseca. Although this system is viable, the annual operational cost for the alum treatment may be prohibitive. It is presumed that the WLA is more intimately familiar with the cost of this type of system and no opinion of probable cost is given here.

This listing is not considered comprehensive. Other options may be available. New treatment mechanisms are patented every year. If one of these options is considered, it is strongly suggested that proven research by independent testing laboratories and/or references from the successful installation elsewhere be reviewed prior to any installation.

D. Rerouting Through the Existing Wetland System

This alternative has the most merit in that the initial cost is not exorbitant and the annual costs are limited. If CD 15-1 is abandoned, the outlet from Gaiter Lake can be rerouted without legal consternation. Figure 8 is an aerial photograph that may be of some help in following the description of this alternative. The proposed improvements are best listed as follows:

1. Reroute the Gaiter Lake inlet to flow into the ditch leading around the Memorial Park softball fields to the wetland to the east.
2. Plug the Gaiter Lake inlet to Clear Lake.
3. Plug the Memorial Park outlet to the Clear Lake.
4. Excavate an open ditch around the south side of Kiesler's Campground to connect the Memorial Park wetland to the wetland on the east side of Kiesler's Campground. This may also be done with a culvert if the various property owners do not accept the open ditch alternative.
5. Work with the DNR to utilize the Rearing Pond area as a finishing pond prior to outletting into Clear Lake through the existing Maplewood Inlet.

This rerouting has the benefit of forcing the flow through a long wetland expanse prior to entering the lake. If flooding easements can be obtained from the property owners abutting the affected wetlands, the normal water elevations can be increased to store, detain and possibly infiltrate some of the runoff.

The fishermen often report that there is a natural spring in the southeast part of Clear Lake. Apparently this is always the last part of the lake to freeze over in the winter. It is possible that existing water in these perched wetlands are filtering through to feed the lake by groundwater. If so, the proposed rerouting and possible increase in wetland ponding level would promote more infiltration. Combined with the potential natural treatment by the wetlands, ground water infiltration feeding the lake would be the best possible treatment.

In our preliminary discussions with the area DNR officials, they were excited about the possibility. They are welcoming the opportunity to provide a more consistent inflow source for their rearing pond.

A final consideration relative to this recommendation is that it successfully combines the three greatest sources of phosphorus inflow into Clear Lake. As such, if additional treatment is desired in the future, a single inflow treatment station could be constructed to threat the inflow. If a future alum treatment system is considered, the rearing pond would be an ideal settling pond.

Our opinion of probable cost associated with this option is $80,000. This figure includes a 10 percent contingency factor and an 18 percent Engineering, Administration and Construction Control factor.

When originally presented at a WLA meeting, there was some discussion that the outlet from the Maplewood lake inlet could be diverted to the north to bypass the lake. If the elevations remain consistent, it is even possible that this diversion could be done with a gravity piped outfall.

Although it is possible, the same concern relative to hydraulically starving the lake and significantly increasing its flushing rate is even more prevalent than before. This is because the diversion would serve an even larger part of the current Clear Lake watershed. For example, the entire wetland complex to the along the southeast side of Clear Lake would also be diverted. If diverted, there will be only 945 acres of watershed remaining including the lake. This leaves a watershed/lake ratio of 1.5/1. This could decrease the average lake levels significantly.

VII. RECOMMENDED LAKE MANAGEMENT PRACTICES

The ultimate health of the lake depends on effective management of several factors including:

- Reaching a consensus among the various agencies, community groups and the public on the ultimate goals for lake use.
- Identifying activities in the lake that can contribute (positively or negatively) to the water quality.
- Monitor the quality and volume of the water coming to the lake.
- Recommend and monitor activities at the shoreline.

GOAL 1: Re-establish a buffering shoreline.

Strategy 1: Reduce or eliminate direct access to the lake from yard runoff, including grass clippings etc.

Action: Establish a ten foot vegetative buffer around the perimeter of the lake that is not mowed.

Action: The City of Waseca adopt restrictions to mowing within ten foot of the high water line.

Action: The Township adopt restrictions that match the City's.

Strategy 2: WLA encourage property owners who abut the lake to use no-phosphorous fertilizers.

GOAL 2: Reduce storm water pollution entering the lake from the entire watershed.

Strategy 1: Volunteer to comply with the Best Management Practices (BMP's) associated with the NPDES Phase II standards.

Action: City of Waseca enact legislation requiring compliance.

Action: The Township or the County enact a resolution requiring compliance within the watershed.

Strategy 2: Mitigate inflow that by-passes the established BMP's.

Action: Identify storm sewer discharge points and install BMP's, if possible.

Action: Determine the storm event that triggers the bypassing to the lake instead of the treatment marsh. (Flow from the area west of the lake.)

Action: Increase the capacity of any bottlenecks going toward the Treatment Marsh or install appropriate BMP's on the bypass channels.

GOAL 3: Reduce the phosphorous recycling in the lake.

Strategy 1: Contact other lake associations in this climatological area who are successfully removing curly pondweed to learn from their experiences.

- Weaver Lake Conservation Association, PO Box 1529 Maple Grove, MN 55311, Deryk Marcaccini (763-416-6783) or Ray Johnson (763-420-3907) [16]
- Bald Eagle Area Association, White Bear Township, Ramsey County, Dave Sorenson, president. [17]
- Cedar Lake Association, Rice County Minnesota.

Strategy 2: Chemically control the curly leaf pondweed.

Action: Aquathol K (a formulation of endothall) in 60 F water has been shown to control the growth of the pondweed by prevent turion (seed) formation (Netherland et. al, 2000) if it applied early in its life cycle. The University of Minnesota Development Center, DNR, COE and the City of Eagan have conduced field studies on three lakes starting in the spring of 2000 and continuing through 2002. [18]

Action: Contact Wendy Crowell at the MN DNR at 651-282-2508 for an update on the study status and the possibly of extending the research to Clear Lake.

Action: Other chemicals can be used as well. ***Sonar*** *or* ***Avast!*** *can be applied at very low doses (as low as 8 parts per billion!) that will kill the Curly-leaf Pondweed, but will not harm most native plants.* [19]

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16 http://www.mcjweb.com/weaverlake/curly_leaf_cutting.html

17 http://www.mcjweb.com/weaverlake/pioneerpress.html

18 Wendy Crowell, Minnesota Department of Natural Resources, *Research in Minnesota on Control of Curly Leaf Pondweed* , as published on November 11, 2003 on web site: http://www.mcjweb.com/weaverlake/research_in_minnesota_on_control%20of%20curlyleaf.html

Strategy 3: Harvest the existing vegetation and dispose of it.

Action: The use of grass carp to eat the vegetation is not permitted in the State of Minnesota, even if genetically altered to not reproduce.

Action: Manually or mechanically harvest the vegetation. "*Curly-leaf pondweed can be removed by raking it from the pond, but it will reestablish from any remaining roots.*

Active ingredients that have been successful in treating curly-leaf pondweed include diquat (G), copper with diquat (G), endothall (E), and fluridone (E). E = excellent, G = good

Make a note that any chemical control method provides the chance for oxygen depletion. This may occur because of the decomposition of the dead plant material. Oxygen depletions can kill fish in the pond. If the pond is heavily infested with weeds it may be possible (depending on the herbicide chosen) to treat the pond in sections and let each section decompose for about two weeks before treating another section. Aeration, particularly at night, for several days after treatment may help control the oxygen depletion also.[20]

Strategy 4: Use flow augmentation from ground water to dilute the point sources of phosphorous and more effectively "flushing" the lake. Although DNR Waters has no prohibition on this practice, [21] DNR Fisheries indicated some potential objection. [22]

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[19] Keystone Hatcheries, Richmond, IL as published on Nov. 11, 2003 on http://www.keystonehatcheries.com/?id=144

[20] **Polk County, WI Land & Water Resources Department, *Exotic Species*, as published Nov. 11, 2003 on http://www.co.polk.wi.us/landwater/exotic_species.htm**

[21] Getsfried, Leo, Mankato office of DNR Waters by phone conversation with Del Jackman, Bolton & Menk, November 5, 2003.

[22] Valiant, Hugh, Waterville office DNR Fisheries by phone conversation with Del Jackman, Bolton & Menk, November 5, 2003.

GOAL 4: Establish a coordinated effort to manage lake quality and enforce standards.

Strategy 1: Create a Clear Lake Watershed Management District.

Action: Enact appropriate legislation by the City, Township and County.

Action: Develop some funding mechanism to assure monitoring of water quality and the implementation of the lake management Plan. This could be a minor assessment on properties within the District.

Strategy 2: Design and implement a water level regime that is favorable for aquatic vegetation as recommended in 1992 by the DNR.

Strategy 3: Adopt wetland preservation practices to be enforced throughout the watershed.

Strategy 4: Continue the cooperative effort with the Cannon River Watershed Partnership (CRWP).

Action: In 2003, the CRWP attempted to determine the discharge flow rates from the lake. The data has not been analyzed but the CWRP is willing to re-install the logger again in 2004. [23]

Strategy 5: Continue to utilize the data from the University of Minnesota Southern Experiment Station to monitor the water budget, as prepared.

GOAL 5: Engage the general public in all phases of lake management.

Strategy 1: Continue the public education programs advanced by the WLA.

Action: Request speaking opportunities to audiences that are not directly involved with the lake (i.e., schools, community groups, local radio interviews, etc.)

Strategy 2: Create opportunities for volunteer participation.

Action: Continue to coordinate neighborhood shoreline clean-up programs where the concept of a healthy shoreline is implemented.

VIII. CONCLUDING DISCUSSION

It has been 13 years since the City of Waseca discontinued employment of a staff limnologist and this study represents the first comprehensive examination of the Lake's management and condition since that time. The lack of current information concerning the phosphorous profile prevents the determination of an appropriate phosphorous budget. Therefore, it is recommended that weekly profile sampling be conducted for a minimum of four weeks as the pondweed dies at three locations in the lake.

Although a complete phosphorous budget is not attainable at this time, specific actions can be taken to lessen the new phosphorous entering the system. In concept, these include:

[23] Justin Watkins at Cannon River Watershed Partnership (CRWP) by phone conversation with Del Jackman, Bolton & Menk, Novemver 11, 2003.

A. Restricting through voluntary compliance or ordinance, as necessary, the use and availability of phosphorous in the contributing watershed.

B. Rerouting all runoff from south of Hwy 14 to the Maplewood Inlet near the south east corner of the lake. This will require:

   1. Abandoning County Ditch 15-1.
   2. Connecting the upper reach of the existing tile to the Gaiter Lake Marsh.
   3. Connecting the existing County Ditch 15-1 tile to the City of Waseca storm sewer where the siphon crosses it (north of the Railroad).
   4. Plugging the County Ditch 15-1 tile at its discharge to Clear Lake. This will force any water between the siphon and the outlet to backflow toward the siphon location.
   5. Excavating a channel around the south side of Kiesler's Campground to form a new discharge for the flow from the athletic field marsh.
   6. Plugging the culvert under Hwy 14 near the athletic field (Memorial Park inlet).
   7. Working with neighboring property owners to secure necessary easements
   8. Working with the DNR to assure coordinated operation of their rearing pond.

In addition, other actions included in the NPDES Phase II program should be employed; including development of a shoreline buffer, improving street sweeping programs, encouraging farmers to use residue cover to limit erosion entering field tile systems, etc.

Although voluntary compliance may be forthcoming from many citizens and companies, encouraging public officials to enact appropriate legislation to require compliance is necessary. Otherwise, voluntary compliance may wane in the presence of persistent violators. Visitors will then be required to comply also.

Figures 1 through 8

HydroCAD Runs Using 100-yr, 24 hour Storm (6.1 inches rainfall) for Existing Conditions and Proposed "Rerouting Through the Existing Wetland System" Conditions (25 pages)

Additional Information