

2004 LAKE ORONO MANAGEMENT PLAN EXECUTIVE SUMMARY

Lake Orono is a dammed-up portion of the Elk River in Sherburne County. The 300-acre lake is situated entirely inside the city limits of the City of Elk River, and beyond the dam the Elk feeds into the Mississippi River. It is unique in that it is a manmade lake at the tail end of a river, and its watershed is an astounding 391,269 acres, which encompasses 70% of Sherburne County and 68% of Benton County, and the water turnover rate is only 3-4 days. This means that the lake itself reflects not only what happens in and around its immediate shores, but also conditions upstream relatively quickly.

With the input from concerned citizens and government agencies, this Plan was compiled to help manage what we can to keep this resource and as healthy as possible for its dependent wildlife and for the enjoyment of future generations.

The four main issues that were decided to focus on are: water quality, land use and zoning, fish management, and aquatic vegetation.

The following are prioritized objectives extracted from the Plan for each major issue that affects the lake, along with their respective totals in-kind and cash costs where known.

Issue 1: Water Quality

There is a lot of historical data available on the lake as referenced throughout the text and in the appendix. Of particular note is the fact that as part of a river, the lake was noticeably filling in at its mouth, and was dredged of sediment in selected areas in 1998. There also is a tremendous focus on water quality, as this affects almost every aspect of the lake, from recreation to sustaining fish populations.

One primary indicator of water quality is the presence of phosphorus, as this nutrient encourages the growth of algae and in turn this depletes oxygen levels and transparency of the lake for sustainability of favorable vegetation and therefore fish populations and pleasurable recreation. For a lake in its particular ecoregion, Orono has a high level of concentration of phosphorus, but as a river it relatively normal.

The causes of this concentration are considered from nonpoint sources, or rather not easily identifiable points where they come from. They may range from goose droppings to excessive dead *Curly Leaf Pondweed* to runoff of fertilizers and lawn waste, either local and/or an accumulation from upstream.

Another major recent concern is the effects of feedlots upstream. The City of Elk River does a good job of monitoring Orono Beach for fecal coliform, and the past couple of summers has closed the beach because of high concentrations considered unsafe for swimming. Sampling and direct observation suggest that a major source(s) of this may be cattle with access to the river and their subsequent fecal droppings on shore or in the river.

Objective: Reduce the sources of phosphorus and other contaminants entering the lake.

Action Items:

Conduct lake and surface water monitoring, educate the public about ordinances and other regulations that affect lake quality, and educate and encourage use of BMPs and other lake-friendly practices.

**Cash investment by other entities subtotal (City of Elk River,
SWCD, Sherburne County, MPCA): \$27,950**
LOIA budget subtotal (includes monies from Education section): 2,070
LOIA in-kind subtotal: 4,165

Issue 2: Land Use and Zoning

As we have noted previously, Lake Orono has an extremely large watershed, and uses of the land not only surrounding the lake but in the County affect its water quality and amount of sedimentation. In fact, Sherburne County is one of the fastest growing counties in the upper Midwest states, which puts extreme stress on the lake. Although both the City and County have ordinances, it is tough to keep on top of things and balance human needs and wants with natural resources.

Objective: Work with with other lake associations and Elk River watershed communities regarding land use issues.

Action Items:

Host an initial get-acquainted meeting for other lake associations and entities in the Elk River watershed; encourage the use of land trusts and/or conservation easements.

Cash investment by other entities subtotal: \$ 0
LOIA budget cash subtotal: 1,200
LOIA in-kind subtotal: 100

Issue 3: Fish Management

Objective: Provide fisheries and population numbers such that all typical species for the lake class are represented.

Action Items:

Request fish inventories, stock game fish, study commercial removal of rough fish, and communicate fish management activities.

Cash investment by other entities subtotal (City): \$1,000
LOIA cash budget subtotal: 1,250
LOIA in-kind subtotal: 100

Issue 4: Aquatic Vegetation

Objective: Keep the lake free from unwanted vegetation that chokes out desirable habitat and inhibits recreational use.

Action Items:

Inventory vegetation in lake, educate the public about exotic species, remove invasive species.

Cash investment by other entities subtotal: \$ 0
LOIA cash budget subtotal: 500
LOIA in-kind subtotal: 1000

Cash investment by other entities total: \$28,950
LOIA cash total: 5,020
LOIA in-kind total: 5,365

GRAND TOTAL: \$39,335

LAKE MANAGEMENT PLAN

for

Lake Orono

Sherburne County, Minnesota

Revised April 2004



Lake Orono Improvement Association
INC.

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i. ACKNOWLEDGEMENTS

This document was prepared by the Lake Orono Water Quality Task Force; which consists of staff from the City of Elk River, the Sherburne County Soil and Water Conservation District; and members of the Lake Orono Improvement Association (LOIA) with input from participants in Operation Lake Orono, an event sponsored by LOIA through the Central Minnesota Initiative Foundation's Healthy Lakes program in an effort to obtain public opinion.

Special consideration goes to Paul Dietrich, Area Fisheries Supervisor, Minnesota Department of Natural Resources, whose writings contribute considerably to this document.

ii. INTRODUCTION

This Lake Management Plan is intended to serve as a guide to the protect, preserve and improve the land, water and biological resources of Lake Orono. Implementation of this Plan should ensure the use and enjoyment of these resources for future generations.

One purpose of this Plan is to pull together all the various reports and information into a single report for planning purposes. For additional information the reader is referred to the references and cited sources of information.

The Plan identifies priority management strategies that are of both short- and long-term in nature. The Lake Orono Improvement Association (LOIA) recognizes that the implementation of this Plan is a long-term effort and will not be effectively achieved unless all the identified stakeholders play active roles in this process.

A great deal of biological, chemical and physical information is available for Lake Orono. Much effort has been made to collect good scientific information about the lake and watershed processes. For instance, the watershed has been delineated and land use identified (*see Appendices, Figure 4 and Table 1*). Several years of water quality data exist including estimates of phosphorus loading. With such information available it seems likely that LOIA can move ahead to begin programs to improve water quality. The Lake Management Plan also identifies a strategy for ongoing monitoring of the lake.

The Plan consists of four broad issues including background information, goals, objectives and action items which have been developed for the lake. A list of the detailed reports available follows, and the appendix contains the currently available biological information.

Background

Lake Orono is a 300 acre lake located in southeastern Sherburne County. It was created when the Elk River Dam was constructed in 1915. The Elk River Dam is located approximately 1.1 miles above the confluence of the Elk River with the Mississippi River, in the City of Elk River.

Drainage from the 391,269-acre watershed (70% of Sherburne County and 68% of Benton County) flows through Lake Orono. It is important to note that the rate of exchange of water is only 3-4 days. This means that whatever happens upstream will quickly affect the lake, whether good or bad.

Soils and Topography of the Lake Orono Watershed

The surficial geology of the watershed can be divided into three general areas. Glacial tills associated with moraines and drumlin fields are located in the upper one third of the watershed. Soils are predominantly loamy in this area. On this landscape, soil infiltration rates are low and runoff tends to rapidly concentrate in low areas where intermittent streams carry runoff to main channels. These soils are susceptible to water erosion. Most of the lower part of the watershed consists of sand plains and sandy outwash with predominantly coarse textured soils. Because of the gently sloping topography and well-drained sandy soils, this part of the watershed is not as susceptible to erosion from water. Wind erosion, however, is a common problem and can result in deposition of windblown soil particles to surface water. In the southeast part of the watershed, the area located to the north of Lake Orono, is characterized by soils formed on moraines. This area comprises about 3 to 4% of the total watershed area. The topography is rolling to steep with soil textures ranging from coarse textured to loam. Because of the steeper slopes, more stormwater runoff is expected in this part of the watershed as compared to the sand plain and outwash areas. Bank erosion on the Elk River is most commonly seen from the eastern half of Big Lake Township to Lake Orono. High bluffs and steep banks are common in this reach. Further upstream, stream banks tend to be lower and wooded flood plains predominate. Wetlands and lakes occupy low areas throughout the watershed. Approximately 22% of the total land area of the watershed consists of wetlands and lakes.

Water Quality

Lake Orono is located in the North Central Hardwoods Forest Ecoregion. Ecoregions are areas of the state with similar geology, soils, vegetated cover and land use. The MPCA has developed a water quality database for reference lakes within Minnesota's ecoregions. The reference lakes selected are regarded as representative and minimally impacted by surrounding land use and can be used as a baseline for comparison. Lake Orono water quality can be compared to typical ranges for ecoregion reference lakes. Further analysis of water quality data can be made using computer models. MINLEAP (Minnesota Lake Eutrophication Analysis Procedures) is a model developed based on analysis of the data from the ecoregion reference lakes. It can be used to compare measured in-lake water quality with predicted water quality. In predicting water quality, MINLEAP takes into account watershed size and lake characteristics such as average depth.

The water quality information for this plan comes from several sources. The sources include: the Minnesota Pollution Control Agencies website; Lake Assessment Notes 1997, Lake Orono by Steven Heiskary of the MPCA; monitoring done by the Lake Orono Improvement Association and also a report prepared for the City of Elk River by Wenck Associates titled, Lake Orono

Sedimentation and Water Quality Study, 1997. Water quality data are summarized in Tables 2, 2a and Figures 1 through 3 of the Appendix.

Using the above data sources the average in-lake water quality can be determined. The average Secchi disk reading is 2.2 feet. The average total phosphorus is 139 micrograms per liter, and the average chlorophyll-a is 52 micrograms per liter. The trophic status indexes for the three measurements are 66, 75 and 69. All indicate a hypereutrophic status for Lake Orono.

The actual measured Secchi disk and total phosphorus averages are similar to those predicted by the MINLEAP model but the predicted value for chlorophyll-a is somewhat higher. The MINLEAP model predicts the following in-lake averages for water quality: 2.0 feet Secchi disk, 132 micrograms per liter total phosphorus and 82 micrograms per liter chlorophyll-a.

Water quality parameters are influenced by: land uses as they contribute nutrients to the lake, shallowness as phosphorus is continually available from sediment for algae growth, and the Elk River, which is a fertile warm water river that flows through the lake.

I. ISSUES, BACKGROUND INFORMATION, GOALS, OBJECTIVES AND ACTION ITEMS

Issue 1: Water Quality

Background

Water quality parameters indicate that the lake is hypereutrophic and has phosphorus values that are well above the 75 percentile for lakes in this ecoregion. However, the phosphorus levels are in the mid range for streams in this ecoregion, which is expected in that Lake Orono is a "wide section" of the Elk River. Non-point sources of nutrients from private property, such as fertilizers and leaves, are often difficult to correct outside of the city limits of Elk River. The City of Elk River has adopted a ban on phosphorus containing fertilizer and is being encouraged to sweep streets more often. The City is also working to become compliant with the Environmental Protection Agency's Phase II National Pollutant Discharge Elimination System (NPDES) Program. This is not the situation in the rest of the watershed.

The Lake Orono Improvement Association has participated in a Minnesota Pollution Control Agency (MPCA) program called Citizen Lake Monitoring. The program volunteer measures the water clarity with a Secchi disk. The Secchi disk is lowered into the water until it is no longer visible to the observer. By taking weekly readings throughout the open water season an average value for the Secchi disk can be calculated. By taking readings over a period of 10 years or more trend analysis can be done. That is, statistical methods can be applied to the data that show whether water transparency is increasing, decreasing or stable. This is the easiest, best and least expensive way to monitor water quality.

Phosphorus is the major cause of algal blooms in lakes. When algal blooms occur the water becomes green and sunlight cannot penetrate, thus submerged aquatic vegetation cannot grow. When algae dies often a scum and odors are formed as decomposition occurs. Lakes with extreme algal blooms are less pleasing aesthetically and less suited for water sports and recreation. Septic systems can contribute significant amount of phosphorus to lake when they do not function properly. Stormwater runoff can also cause significant phosphorus loading to surface waters if not treated. Other sources of phosphorus include yard waste and fertilizer residues which can enter the lake with direct runoff, through stormwater systems and from being directly deposited in the lake. Because of the shallowness of Orono Lake it can be expected to show the symptoms of continuous phosphorus loading.

In cooperation with the Sherburne County Soil and Water Conservation District (SWCD) and the City of Elk River, the Lake Orono Improvement Association conducted water sampling in 2002 and 2003, then continue to do so every 5 years. The parameters have included total phosphorus, total suspended solids, volatile suspended solids and chlorophyll-A with samples collected on a monthly basis, May through September. [The Lake Orono Sedimentation and Water Quality Study](#)

prepared for the City of Elk River by Wenck Associates (October 1997) is an invaluable source of information for preparing this Plan.

For Lake Orono tributaries during 1997 average total phosphorus values were approximately 0.12 mg/l. In-lake values were 0.171 mg/l. Total phosphorus removal efficiencies within Lake Orono were calculated to be less than 10 percent. With its water turnover rate of only 3-4 days, this is much lower than lakes with longer residence times where removal efficiencies can be on the order of 90 percent. This refers to the observation that for lakes with longer residence times, phosphorus concentrations tend to be reduced in the out-flowing waters as compared to the inflowing waters. As a wide section of the Elk River, Lake Orono functions differently from lakes that have smaller inflows and outflows.

In their report, Wenck Associates determined that the Elk River dominates Lake Orono's water quality (October 1997). Internal loading is most likely not a significant source of phosphorus for Lake Orono. Internal loading occurs when phosphorus is released from the lake bottom sediments due to oxygen depletion in the bottom strata of water. This often occurs in deeper lakes during periods of thermal stratification when the bottom and upper strata do not mix. With an average depth of 5 feet and maximum depths of approximately 16 feet, thermal stratification is probably very limited in Lake Orono if it occurs at all. Temperature and dissolved oxygen profiles done in 2002 and 2003 showed that dissolved oxygen levels were adequate near the bottom.

Water Research Management Inc. concluded that the re-suspension of bottom sediments by carp, wind and power boats contributed to the phosphorus load for Big Elk Lake (1992 Water Quality Monitoring Report, Briggs Chain of Lakes, Sherburne County, MN). This may also apply to Lake Orono because, like Big Elk Lake, it is shallow and has a significant carp population.

Lake Orono has an ongoing problem with Canadian geese. An annual goose control program was implemented in 2000 and was funded by the City of Elk River. In 2003, that program was put on hold due to City budget restraints. The problem continues to persist, therefore a new source of funding should be pursued at least until the City can once again fund this important pollution control measure.

Livestock have been identified as a source of nutrients and chemical oxygen demand in agricultural areas. The Lake Orono Improvement Association should request that the SWCDs of Benton and Sherburne Counties conduct an inventory and assessment of feedlot impacts for Lake Orono and that they work with feedlot owners to mitigate problems identified.

Since Lake Orono was dredged in 1998, the City has been monitoring fecal coliform bacteria levels at the public beach to assure safe swimming conditions. During the past three summers, the levels have risen above the threshold considered safe for swimming and the beach has been temporarily closed. In 2002, the beach remained closed for 5 weeks because of high bacteria levels. This prompted the Lake Orono Improvement Association and SWCD personnel to investigate whether there were point sources around the lake itself or if they were coming down

river. Sampling was done numerous times at various locations within the lake, along the Elk River, and each major tributary to the Elk. The samples were tested at the Elk River Wastewater Treatment Plant and Traut Wells labs. From these test results, a large part of the problem appeared to be coming from up river. In fact, extremely high concentrations were found immediately down river from a large cattle pasture. This information was forwarded to the Minnesota Pollution Control Agency (MPCA) for resolution. The state has laws governing larger feedlots and would require buffers along streams or lakes where needed to prevent pollution. Sherburne County has a manure ordinance which regulates animal manure for feedlots not covered by state permitting requirements. However, there are no laws or ordinances which require buffers along streams or lakes in pastures or which would restrict livestock access to streams or lakes from pastures. Minnesota Chapter 7020 which regulates feedlots distinguishes between feedlots and pastures. A feedlot is a confinement of animals such that vegetation cannot establish (the ground is bare) and manure can accumulate. Areas where livestock graze and vegetation is growing within the area are considered pastures. There may be areas of bare ground within a pasture but if the animals are not confined to that area and can move to areas where there is forage it is still a pasture. Therefore, Sherburne County needs to be convinced that an ordinance governing pastures and smaller feedlots needs to be passed to ensure public safety. Until this matter is resolved, continued vigilance and fecal coliform testing of the Elk will be necessary.

No point discharges from industries within the Elk River watershed have been identified. There is only one wastewater treatment plant discharging directly to the Elk River which is in Becker. The wastewater treatment plants of Zimmerman and Foley discharge to tributaries of the Elk River.

Another concern is promoting the proper disposal of hazardous waste. Sherburne County does an extensive citizen education program on this issue and has a day each fall when wastes can be turned in for disposal. Tri-County Household Hazardous Waste Facility in St. Cloud also accepts these materials year round. Sherburne County is looking into another such permanent facility in Elk River. These items are not permitted in regular garbage disposal but must be handled separately.

NOTES ON ACTION ITEMS:

In-kind is based on \$10/hour. Costs may include materials, supplies, and/or equipment.

City means City of Elk River

LOIA means the Lake Orono Improvement Association

SWCD means the Sherburne County Soil and Water Conservation District

The **Water Quality Task Force** consists of staff from the City of Elk River, the SWCD, and members of LOIA

Operation Lake Orono refers to groups formed at an event sponsored by LOIA through the Central Minnesota Initiative Foundation's Healthy Lakes program in an effort to obtain public opinion.

Goal 1: Improve lake surface water quality

Objective: Reduce the sources of phosphorus and other contaminants entering the lake.

Action Items:

- 1.1. Participate in the MPCA Citizens Lake Monitoring Program (Secchi disk).
Timeline: Weekly May – Sept. 2004, ongoing **Budget:** \$400 in-kind
Responsibility: Water Quality Task Force

- 1.2. Conduct lake and surface water monitoring, report water quality results to SWCD, LOIA membership and post on LOIA’s website.
Timeline: Monthly May – Sept. 2008 **Budget:** \$775 in-kind,
repeat every 5 years \$500 City,
Responsibility: Water Quality Task Force, City \$500 LOIA

- 1.3. Continue to work with the City of Elk River to ensure compliance of individuals and commercial entities in accordance with the Lawn Fertilizer Application Control Ordinance.
Timeline: Ongoing **Budget:** \$150 in-kind
Responsibility: Water Quality Task Force, City enforcement of licenses

- 1.4. Encourage citizens to adopt Shoreline Best Management Practices (BMPs) to control point and non-point sources of pollution and implement these through membership and community education.
 - Copy and mail existing fertilizer brochure to shoreland homeowners.
 - Educate local retail businesses regarding the city’s ban on applying fertilizer containing phosphorus to lawns and deliver signage for them to post.
 - Emphasize individual responsibility through educational efforts for the proper disposal of all household waste, animal waste and lawn maintenance issues (use of fertilizers, disposal of leaves and lawn clippings, etc.). (See Education)
 - Encourage the use of buffer strips adjacent to the lake and along ditches and put up signage to identify areas that have been restored.
 - Partner with the Elk River Watershed Association and the City of Elk River to establish sites which demonstrate the use of innovative storm water management practices which reduce and filter runoff such as rain gardens, vegetated swales and infiltration systems.**Timeline:** Ongoing **Budget:**-\$150 in-kind,
\$100 cash
Responsibility: Water Quality Task Force, LOIA Communications Committee, City

- 1.5. Conduct surveys to profile shoreline owners' understanding of and need for shoreline best management and safety practices in order to improve communications.
Timeline: May 2004 **Budget:** \$200 in-kind
Responsibility: Water Quality Task Force
- 1.6. Review the city's National Pollutant Discharge Elimination System (NPDES) permit plan.
Timeline: October 2004 **Budget:** \$800 in-kind, \$15,000-20,000 City (plan development)
Responsibility: Water Quality Task Force, City
- 1.7. Implement strategies to reduce the amount of leaves and other lawn waste that enters the lake through storm sewers and runoff:
 - When lake is lowered, encourage the city to continue its practice of dredging out organic material that has accumulated in front of drainage areas.
 - Request that the city sweep streets near the lake on a regular schedule and prior to storm events.
 - Educate citizens in keeping waste out of the streets, ditches, and areas of high runoff. (See Education)**Timeline:** Ongoing **Budget:** \$200 in-kind
Responsibility: Water Quality Task Force, City (street sweeping)
- 1.8. Legally control the number of geese so that they do not impact water quality.
Timeline: Yearly as needed **Budget:** \$2600/year, including up to \$750 from LOIA if City budget does not permit
Responsibility: City
- 1.9. Encourage the City of Elk River to continue to aggressively enforce the MPCA's rules on Individual Sewage Treatment Systems (ISTS) for septic system compliance within the Shoreland district and educate homeowners regarding laws and maintenance. Obtain data from the city regarding ages of septic systems to help determine the feasibility of extending city sewer.
Timeline: Ongoing **Budget:** See Education
Responsibility: Water Quality Task Force, LOIA Communications Committee
- 1.10. Develop septic education through the Elk River Building and Zoning Department.
Timeline: Ongoing **Budget:** \$1000
Responsibility: City

- 1.11. Monitor fecal coliform bacteria levels at Orono Beach during the swimming season.
Timeline: Twice weekly, June – Sept. **Budget:** \$3200
Responsibility: City
- 1.12. Request that the Sherburne and Benton SWCDs and MPCA work with feedlot owners within the watershed to encourage implementation of practices to reduce feedlot runoff to surface water.
Timeline: Ongoing **Budget:** \$300 in-kind
Responsibility: Water Quality Task Force, SWCD
- 1.13. a. Help identify pollution sources affecting the Elk River or Lake Orono directly or through tributaries by direct observation.
Timeline: Ongoing **Budget:** \$300 in-kind
Responsibilities: 1) Lake Orono and the Elk River/tributaries within the City limits: Water Quality Task Force
2) Outside of City Limits: Sherburne County, Sherburne SWCD, Water Quality Task Force
- b. Collect samples and have bacterial counts done by state-certified labs.
Timeline: Ongoing **Budget:** 1) See item 1.11.
2) \$5650, pursuing funding
Responsibilities: 1) Lake Orono: City of Elk River
2) Elk River and Tributaries outside of the City limits: MPCA. Request that Sherburne County sample if MPCA will not.
- 1.14. Educate the public regarding issues that affect water quality, including efforts such as articles about use of fertilizers, disposal of leaves and lawn clippings, animal wastes, hazardous waste recycling, etc., in the city and LOIA’s newsletters and on LOIA website.
Timeline: Ongoing **Budget:** See Education
Responsibility: All Operation Lake Orono groups, LOIA Communications Committee, City
- 1.15. Develop financial plan and resources for continued support and improvement of the Lake Orono ecosystem.
Timeline: Annually in July **Budget:** \$140 in-kind
Responsibility: LOIA, City
- 1.16. Continue to mail copies of the Shoreland regulations to new property owners.
Timeline: Ongoing **Budget:** N/A
Responsibility: City

Issue 2: Land Use and Zoning

Background

Land uses along the immediate shoreline and within the watershed affect the lake water and all of the organisms and wildlife that use this resource. Previously land uses have not been planned nor have plans been developed with ecological considerations.

Sherburne County is one of the fastest growing counties in the upper Midwest states and Elk River is the fastest growing city in Sherburne County. The corridor between the Twin Cities and St. Cloud is being rapidly developed and sold to community dwellers and commuters.

Lakes are scarce in Sherburne County and many have had their entire shorelines developed for years. Lake Orono, with over 100 homes, has a highly developed lakeshore.

Since only 2.8% of the total Elk River watershed is located within City limits, land use and zoning upriver become an important issue when considering the health of Lake Orono. The City of Elk River and Sherburne County are responsible for land use that may impact the lake and they coordinate with other appropriate government agencies.

Sherburne County, Benton County, and the City of Elk River have adopted shoreland management ordinances that appear to be sufficient to protect the environment of Lake Orono. Lake Orono is classified as general development lake. The shoreland district extends for 1,000 feet around Lake Orono and other lakes in the watershed, and 300 feet on either side of the Elk River (*see Appendix, Figure 7*). On new development, the vegetation is protected such that only the understory may be removed in order to have a view of the lake. Setbacks for new development on general development lakes are 75 feet for lots served by onsite septic systems and 50 feet for lots served by city sewer.

Surface water use and zoning authority lies with the City of Elk River; enforcement is provided by the Sherburne County Water Patrol. While there have been no extreme conflicts, increased undisciplined use of personal watercraft may conflict with property owners' values. It appears that some sort of surface water zoning will be in the future of Minnesota's water use.

The role of the Soil and Water Conservation District and the Elk River Watershed Association is to promote conservation and water quality protection by assisting landowners in implementing Best Management Practices on a voluntary basis, which included providing cost share for practice implementation.

Realizing that watershed boundaries overlap political boundaries, the Joint Powers Agreement between Sherburne and Benton Counties was entered into and the Elk River Watershed Board was formed. The Board, with cooperation from landowners, can accomplish tasks which benefit lakes and rivers in both counties. It has limited funds to assist with projects such as fencing animals out

of the waterways, planting to control erosion, and manure management. The Board consists of one County Commissioner each from Sherburne and Benton Counties, a SWCD Supervisor and two at-large representatives from each of the two counties.

Goal 1: Work with all entities to preserve water depth

Objective: Keep all four lobes of the lake open for recreation.

Action Items:

- 2.1. Monitor sedimentation in the lake every other year.
Timeline: 2005, every other year **Budget:** \$2000 cash
Responsibility: City
- 2.2. Identify and eliminate sources of erosion within the City of Elk River. Also work with the Sherburne County Water Plan Committee and Elk River Watershed Board to identify and eliminate sources of erosion upstream.
Timeline: Ongoing **Budget:** \$15,000 cash
Responsibility: SWCD and private landowners
- 2.3. See that the DNR updates their depth map (*see Appendix, Figure 4*).
Timeline: 2004 **Budget:** \$30 in-kind
Responsibility: LOIA
- 2.4. Encourage the city to use BMPs in the use of silt fencing and sedimentation ponds (NURP standards).
Timeline: Ongoing **Budget:** N/A
Responsibility: Water Quality Task Force

Objective: Monitor development and encourage enforcement of shoreland ordinances.

Action Items:

- 2.10. Establish a contact and a liaison at pertinent agencies (DNR Fisheries, Enforcement, Plant Management, Sherburne County Planning and Zoning, Soil and Water Conservation District, Pollution Control Agency, Joint Powers Board, City of Elk River). Maintain communication and attend meetings when relevant issues are discussed.
Timeline: Ongoing **Budget:** N/A
Responsibility: Water Quality Task Force, Operation Lake Orono committees

- 2.11. Retain seats on and actively participate in the Sherburne County Water Plan Committee and Elk River Watershed Board.
Timeline: Ongoing **Budget:** N/A (per diem & mileage provided)
Responsibility: Water Quality Task Force
- 2.12. Review pertinent ordinances, track sales and land development/redevelopment that affects the river/lake, attend county and city meetings when a variance is requested within areas governed by shoreland ordinances and lobby for enforcement of those ordinances.
Timeline: Ongoing **Budget:** \$120 in-kind
Responsibility: Operation Lake Orono Land Use group
- 2.13. Participate in the U of M Extension Service Shoreland Volunteer Program.
Timeline: 2004, ongoing **Budget:** \$600 in-kind/year
Responsibility: Water Quality Task Force
- 2.14. Help the city enforce its shoreland ordinances.
Timeline: Ongoing **Budget:** N/A
Responsibility: Homeowners
- 2.15. Encourage the updating of a DNR biological survey and map of Sherburne County's rare species and unique habitats.
Timeline: Sept. 2004 **Budget:** \$100 in-kind
Responsibility: LOIA, SWCD

Objective: Educate the public about shoreland ordinances and guidelines.

Action Items:

- 2.16. Publish pertinent ordinances and guidelines on the City of Elk River's website and establish a link from LOIA's site.
Timeline: 2004 **Budget:** N/A
Responsibility: City
- 2.17. Submit outlines for articles to editors of Sherburne County *Environmental Educator* newsletter.
Timeline: Ongoing (in fall the best) **Budget:** \$150 in-kind
Responsibility: LOIA

- 2.18. Set up a booth and pontoon rides at the county fair for the purpose of educating the public about lake history and environmental issues.
Timeline: July 2004 **Budget:** \$1000 in-kind
Responsibility: LOIA
- 2.19. Conduct a shoreline control/Best Management Practices workshop for contractors/developers/excavators and homeowners.
Timeline: 2004 **Budget:** \$645
Responsibility: City
- 2.20. Ensure that a watershed exhibit is available for use in schools and in educating the public.
Timeline: Oct. 2004 **Budget:** N/A
Responsibility: Water Quality Task Force in cooperation with MN Extension

Objective: Work with with other lake associations and Elk River watershed communities regarding land use issues.

Action Items:

- 2.21. Host an initial get-acquainted meeting for other lake associations and entities in the Elk River watershed.
Timeline: Oct. 2004 **Budget:** \$1200
Responsibility: LOIA, SWCD
- 2.22. Encourage the use of land trusts and/or conservation easements.
Timeline: Ongoing **Budget:** \$100 in-kind
Responsibility: Operation Lake Orono Land Use group

Issue 3: Fish Management

Background

Fish populations are dynamic and can be the first indicators in changes in water quality. There is a need to continually update fisheries information, and stocking is necessary since some species do not reproduce naturally in Lake Orono.

The earliest fisheries investigations for Lake Orono go back to only 1984. While it appears that little has changed in the past 20 years, it would have been nice to know what the lake was like before pre-intensive agriculture years. It's widely thought that Minnesota's central lakes were degraded after World War II when intensive agriculture combined with unbridled lakeshore development occurred. A good pre-history would allow better goal setting for fisheries. For instance, some lake basins are naturally fertile and efforts to change that fact might not be prudent.

Past efforts at fisheries management have included carp seining and stocking of gamefish. An initial fisheries survey was conducted in 1984 and a population assessment in 1989. Fisheries surveys of the Elk River took place in 1987 and 1999. In the last 20 years walleye fry were stocked 1985, 1987 and 1989-92, 1995 and 1999. Bluegills and black crappies were stocked by the DNR in 1987, 1999, 2001 and 2002. A local bait dealer stocked Lake Orono with crappies periodically during the 1980s. A fishing pier was installed at the city park in 1986.

It is not necessarily troublesome that walleye do not spawn in Lake Orono. Throughout most of southern Minnesota walleye do not successfully spawn due to lack of habitat or predation by other species. The walleye fry stocking seems to have the most potential for providing quality fisheries because large numbers are available at a small cost. The lack of northern pike is more indicative of the water quality conditions. In general, lakes with clear water tend to favor largemouth bass, northern pike and sunfish production. Lake Orono with its more turbid water favors crappies and walleye.

The downside of the Elk River connection is that the Elk River could be seen as a repository for nearly an infinite number of carp. Carp are generally considered a nuisance wherever they are found because of their habit of uprooting aquatic vegetation and stirring lake sediments. Those actions cause lakes to become less clear, and can even release phosphorus into the water column which causes algal blooms. At Big Elk Lake in 1992 a water quality monitoring report suggested that there might be as much as 2,000 pounds per year of internal phosphorus loading due to carp activity. While this is significant it is not easily ameliorated. Carp activity can be expected to occur as long as the eutrophic status of the lakes does not change. Carp populations cannot be cost-effectively controlled by removal, only by improving water quality.

Goal 1: Provide quality, sustainable fish populations in Lake Orono

Objective: Provide fisheries and population numbers such that all typical species for the lake class are represented.

Action Items:

- 3.1. Request that the DNR conduct fisheries surveys at least every six years.
Timeline: Done in 2002, request in 2006 **Budget:** \$100 in-kind
Responsibility: Operation Lake Orono Fisheries group

- 3.2. Stock Lake Orono with game fish until such time as those populations reproduce.
Timeline: Ongoing **Budget:** \$1000 LOIA
Responsibility: Operation Lake Orono Fisheries group \$1000 City as allowed

- 3.3. Study commercial removal of rough fish.
Timeline: Ongoing **Budget:** N/A
Responsibility: Operation Lake Orono Fisheries group
- 3.4. Encourage voluntary catch and release for a period of time during and after stocking.
Timeline: Ongoing **Budget:** \$50
Responsibility: Operation Lake Orono Fisheries group
- 3.5. Communicate the ongoing fish management activities to the Lake Association and the community through various mediums including the Lake Association newsletter, local newspapers and at the bulletin board at the public landing and fishing pier.
Timeline: 2004, ongoing **Budget:** \$200
Responsibility: Operation Lake Orono Fisheries group

Issue 4: Aquatic Vegetation

Background

Very little submerged vegetation grows in Orono Lake. This lack of habitat may be limiting the fisheries. Submerged aquatic vegetation is limited by poor water quality and transparency. If sunlight cannot penetrate the water, plants cannot use it for photosynthesis and growth. The ecology of the lake has also been disrupted at least twice in recent years by draw-downs, once by vandals and also in 1998 when sediment was removed from various parts of Orono Lake.

In the spring of 2003, it was observed that an exotic species called *Curly Leaf Pondweed* had made an unwanted inroad into the lake, particularly in shallow bays. Like *Eurasian Water Milfoil* (*EWM*), this plant can be extremely invasive. By the time its proliferation was noticed, it was too late to manage it in any organized way. This weed has an unusual life cycle in that it prefers cooler weather, and it was hypothesized that in the previous winter it grew uninhibited beneath the ice as there was not much snowfall to block sunlight. It dies off in late summer and if dead plants are not removed can contribute to exacerbated algae blooms. In the fall, the Water Quality Task Force met with the DNR, and a plan was drawn up to lower the lake for a period of time in late fall/early winter in an attempt to kill off as much of the weed as possible by drying and freezing roots. LOIA should be as proactive as possible in eradicating any *Curly Leaf* still evident in the spring of 2004.

Purple Loosestrife has also been observed in Lake Orono, and the Association should also consider an eradication effort for this while it is in the early stage of invasion. A watchful eye should be also be kept to look out for any evidence of *Eurasian Water Milfoil*, which has not yet been introduced into the lake.

The benefits of bulrush have been recognized but the habitat requirements are not completely understood. Attempts should be made to prosper floating leaf and emergent vegetation. Because bulrush and cattails absorb phosphorus, provide fish spawning habitat and improve aesthetics, the plants are considered desirable and it is unlawful to remove them without a permit from the DNR. Waterlilies are also favorable and grow in areas where organic material has accumulated. They are prevalent particularly in the northern lobe of Lake Orono.

Goal 1: Improve Lake Orono habitat by increasing the extent and diversity of favorable native aquatic and shoreline vegetation

Objective: Manage the vegetation in such a way as to remove nutrients, encourage habitat and provide for recreational use.

Action Items:

- 4.1 Inventory vegetation presently growing in Lake Orono.
Timeline: Annually in June **Budget:** \$100 in-kind
Responsibility: DNR

- 4.2 Map sites for planting aquatic and/or shoreline vegetation.
Timeline: 2005 **Budget:** \$200
Responsibility: Operation Lake Orono Aquatic Vegetation group, DNR

- 4.3 Create bulrush stands or plant other aquatics on an experimental basis to promote fish habitat and water quality benefits. Restore a portion of shoreline each year as a way to demonstrate the benefits of natural shorelines.
Timeline: 2005 **Budget:** \$480 in-kind plus
\$2250 cash for 3 sites
Responsibility: Operation Lake Orono Aquatic Vegetation group, DNR

Goal 2: Control existing and prevent the introduction of additional exotic species

Objective: Keep the lake free from unwanted vegetation that chokes out desirable habitat and inhibits recreational use.

Action Items:

- 4.4. Educate watershed residents regarding preventing the introduction of Eurasian Milfoil and other exotics; conduct a milfoil inspection of the lake twice a year.
Timeline: Ongoing **Budget:** \$50
Responsibility: Operation Lake Orono Aquatic Vegetation group

- 4.5. Control and eliminate *Curly Leaf Pondweed* and other harmful exotic aquatic vegetation and organisms.
Timeline: Yearly in May **Budget:** \$1000 in-kind,
Responsibility: Operation Lake Orono Aquatic \$400 cash
Vegetation group
- 4.6. Conduct annual exotic species inventories in Lake Orono.
Timeline: Yearly in June **Budget:** \$100 in-kind
Responsibility: Operation Lake Orono Aquatic Vegetation group
- 4.7. Use GPS and lake mapping technology to prepare maps that show the extent of unwanted vegetation.
Timeline: Every 3 years **Budget:** N/A
Responsibility: DNR

II. EDUCATION AND COMMUNICATION

Most property owners are just beginning to understand all the environmental concerns that are involved with lakeshore ownership. In addition, properties change hands frequently so there is always a need to provide information.

A great deal of information is available to property owners regarding lake management. Indeed, the central push of all the agencies has been watershed management and providing information to interested citizens. The City of Elk River should be encouraged to continue its practice of identifying new landowners in the shoreland areas and providing them detailed information on shoreland regulations. Statewide organizations such as the Minnesota Lakes Association (MLA) are in the process of obtaining grants to help lake associations write management plans. The DNR has recently hired a comprehensive lake management specialist recognizing that the fisheries lake management plans cover only one aspect of the planning process.

That said, most property owners have not been schooled in ecology and environmental issues so therefore there is a great need to provide education and information to lakeshore residents. Newsletters help to spread the word about environmental concerns. A newsletter can be a common bond for the Lake Orono Improvement Association. The City of Elk River and Lake Orono Improvement Association newsletters should include articles about watershed management in each issue. This is because it is so important that everyone realizes what happens on the land influences the water quality.

LOIA also produces a directory that includes information about LOIA, pertinent agency contacts, ordinances (including lawn fertilizer, watercraft and shoreland), and permitting.

Another way to communicate is through the internet. LOIA maintains an internet website with information about water quality, BMPs, contact information and links to agencies' websites, and information about LOIA including by-laws, contacts, events, etc.

Emergencies that affect the lake must also be communicated to homeowners, as a posting at the beach is not always helpful to those who live on the lake. LOIA and the city have set up an emergency calling tree for items that need immediate attention. The internet may also be used via email to communicate messages of an urgent nature. LOIA and the city should pursue creating an email alert system.

In 2002 LOIA created a one-sheet fact page about the lake, which includes fishing information, a map of the public access/park, a short article about a pertinent issue that affects the lake, and lists contacts for the Lake Association and city. This is distributed through the Elk River Chamber of Commerce to new residents and is also posted for downloading on the website.

It has been observed that lakeshore residents often have yards and lawns typical of the city dweller. The natural vegetation which once was so attractive in the first place has been replaced with vegetation that needs constant and expensive care. Recently, publications such as *Landscaping for Wildlife* and *Lakescaping for Wildlife* have appeared which provide excellent information and helpful tips on making lake lots attractive to wildlife and to the human beholder. Lots landscaped in this way stimulate an attitude of lake stewardship and release others from keeping up with the neighbors which, in its negative sense, means that unhealthy practices continue.

Finally, it is important to record all the progress that has been made with the lake. This provides encouragement and optimism. People want to own property that has stable or increasing values. A summary list of accomplishments could be provided to new owners to educate them, draw them into the membership of the organization and promote a sense of pride in their lake.

Provide targeted and meaningful educational programs for lakeshore residents

Objective: To inform property owners of all aspects of the lake management planning efforts.

Action Items:

- II.1. Publish a newsletter for LOIA membership, agency and other lake association contacts; include timely articles on lake and watershed issues.

Timeline: 2-3 times/year, ongoing

Budget: \$360 in-kind,
\$200 cash

Responsibility: LOIA Communications Committee, articles submitted from all Operation Lake Orono groups

- II.2. Submit timely articles on lake and watershed issues to be published in the city's newsletters.
Timeline: Quarterly, ongoing **Budget:** \$360 in-kind
Responsibility: LOIA Communications Committee, Water Quality Task Force
- II.3. Publish the LOIA Directory and distribute to all lake homeowners.
Timeline: May 2004, ongoing **Budget:** \$120 in-kind,
\$100 cash
Responsibility: LOIA Communications Committee
- II.4. Produce a fact sheet for new Elk River residents.
Timeline: May 2004, ongoing **Budget:** \$150 in-kind
Responsibility: LOIA Communications Committee, LOIA president
- II.5. Promote and maintain LOIA website.
Timeline: Bimonthly and as needed, ongoing **Budget:** \$120 in-kind,
\$70 cash
Responsibility: LOIA Communications Committee
- II.6. Stimulate an attitude of lake stewardship among lakeshore and watershed residents through LOIA stewardship activities, demonstrations and educational programs.
Timeline: Ongoing **Budget:** \$500 in-kind,
Responsibility: LOIA \$50 cash
- II.7. Support local school programs environmental study.
Timeline: Ongoing **Budget:** \$200 in-kind,
Responsibility: LOIA \$50 cash
- II.8. Provide a summary of existing work and data to LOIA leadership so that as often as leadership changes progress can still continue.
Timeline: Ongoing **Budget:** N/A
Responsibility: Operation Lake Orono group leaders, Water Quality Task Force
- II.9. Develop a historical record of significant events and dates so that it may be included within this Plan and also posted on the website.
Timeline: January 2005 **Budget:** \$200 in-kind
Responsibility: LOIA and local historians
- II.10. Continue LOIA membership in the Minnesota Lakes Association (MLA).
Timeline: Dec. 2004 **Budget:** \$100 cash
Responsibility: LOIA treasurer

- II.11. Fund representatives to attend MLA conferences.
Timeline: 2004, ongoing **Budget:** \$200 cash
Responsibility: LOIA

- II.12. Continue use of lake homeowners emergency calling tree.
Timeline: Ongoing **Budget:** N/A
Responsibility: City staff, LOIA officers and reps

- II.13. Create email alert system for lake homeowners.
Timeline: Ongoing **Budget:** N/A
Responsibility: City staff, LOIA Communications, LOIA reps

III. EVALUATION

Management plans can quickly become outdated as information is collected and circumstances change. It will be necessary to review the plan on an annual basis in an active management program.

As new information becomes available it is necessary to modify plans and develop new strategies. By reviewing the plan on an annual basis it ensures that the goals and objectives are current, and it also provides a framework for measuring progress. An active program will mean that new goals are developed annually as previous work is accomplished. Also, Plan participants can gain a sense of accomplishment when viewing progress.

Evaluate and modify Lake Management Plan as needed

Objective: Maintain a proper and current focus on goals, objectives and tasks.

Action Items:

- III.1. Amend this plan on an annual basis with the continued re-evaluation of goals and tasks.

IV. REFERENCES

2002 and 2003 Lake Orono Improvement Association Volunteer Monitoring

Secchi disc, total phosphorus, chlorophyll-a, total suspended solids and volatile suspended solids were sampled monthly at two locations from May through September.

1997 Lake Orono Sedimentation and Water Quality Study. October 1997. Wenck Associates for the City of Elk River.

The purpose of the report was to collect data concerning a project which would remove sediment primarily from the north basin of Orono Lake. Data includes information on water quality, sedimentation rates and sediment loading from the Elk River.

Lake Assessment Notes, 1997, Lake Orono (ID#71-0013), Sherburne County. Steven Heiskary, Minnesota Pollution Control Agency.

A summary of water quality monitoring done by the MPCA in 1994.

Water quality information from the Minnesota Pollution Control Agency's website: pca.state.mn.us.

A compilation of water quality information, corresponding trophic status index and lake rankings.

Elk River Watershed stream water quality data, 1996 to 2002. Available from Sherburne SWCD.

Streams monitored include the Elk River, St. Francis River, Tibbits Brook, the Snake River and Rice Creek. Parameters measured include, total phosphorus, total suspended solids, volatile suspended solids, dissolved oxygen and temperature. Data collected by Sherburne SWCD.

Fisheries Information from the Minnesota Department of Natural Resources. Located at 7372 State Highway 25 SW, Montrose, MN 55363. 612/675-3301.

Fisheries lake surveys, population assessments and management plans, dissolved oxygen testing, fish stocking records, lake maps, some water quality and aquatic plant information.

Results: Water quality favors crappie and walleye. Other species present are northern pike, smallmouth and largemouth bass, bluegill, bullhead, redhorse, suckers and carp.

V. APPENDIX

Table 1. Orono Lake: Morphometric and Watershed Characteristics

	Area (a)	Maximum depth (ft)	Volume	Schupp Lake Class
Orono	300	15	1,249 ac-ft	42
Watershed Area	391,269			
Lake surface ratio	1,304:1			
Water residence time:	3 days			

Land Use (%)	Forest	Water & Marsh	Pasture & Open	Cultivated	Urban
North Central					
Hardwood Forests	6-25%	14-30%	11-25%	22-50%	2-9%
	Forest	Water & Wetlands	Agricultural	Urban & Residential	Low Density Residential
Lake Orono Watershed*	16%	22%	48%	4%	10%

* Sources: Agricultural based on 2001 Minnesota Agricultural Statistics data; water and wetlands based on the National Wetlands Inventory; estimates for forest, urban/residential and low density residential based on data from Minnesota Planning which was adjusted using population growth data and recent land use mapping for minor watersheds within the Elk River Watershed area

Shoreland Zoning: Orono - General Development

Table 2. Average summer water quality and trophic status indicators.

Parameter	Orono Lake*	Typical Range for NCHF Ecoregion
Total phosphorus (mg/l)	0.139	0.06-0.15 (streams)
Chlorophyll a (ug/L)	52	5-22
Secchi disk (ft)	2.2	4.9-10.5
Alkalinity (mg/l)	155	75-150
pH	8.99	8.6-8.8
Conductivity	302	300-400

* Sources: All values averaged from MPCA, Wenck and LOIA volunteer monitoring except for pH and conductivity from DNR files

Trophic Status Indicators

Carlson Trophic State Index Values

	Percentile	
	Orono Lake	NCHF Ecoregion
TP	75	19
Chl a	69	12
Secchi	66	13
Mean (all)	70	

Table 2a. Summary of annual water quality data

Secchi Disc Averages for June through Sept.					
		SD	SD	TSIS	
Year	n	feet	meters		
94	16	1.8	0.5	69	site 202
95	14	2.3	0.7	65	site 202
96	8	1.8	0.5	69	site 202
99	18	2.1	0.6	66	site 203
2000	6	2.1	0.6	66	site 203
2002	10	3.3	1.0	60	sites 202/203
2003	8	2.2	0.7	66	sites 202/203
Average		2.2	0.7	66	
Total Phosphorous averages:					
		TP	TSIP		
Year	n	ug/L (P)			
81	1	130	74		
94	4	136	75		
97	5	171	78		
2002	11	127	74		
2003	8	132	75		
Average		139	75		
Chlorophyll-a averages:					
		Chl-a	TSIC		
Year	n	ug/L			
94	4	72	73		
2002	11	38	66		
2003	8	49	69		
Average		52	69		
Average TSI (SD, TP, Chla)			70		

Sources: MPCA, Wenck Associates, LOIA volunteer monitoring

SD=Secchi Disk Transparency

TP=Total Phosphorus

Chl-a=Chlorophyll-a

n=number of measurements

ug/L=micrograms per liter (same as parts per billion)

TSIS=Trophic state index computed from secchi disk measurements

TSIP=Trophic state index computed from Total Phosphorus concentration

TSIC=Trophic state index computed from Chlorophyll-a concentration

TSI=Trophic State Index - average of TSIS, TSIP and TSIC

Figure 1. Lake Orono Average Annual Secchi Disc

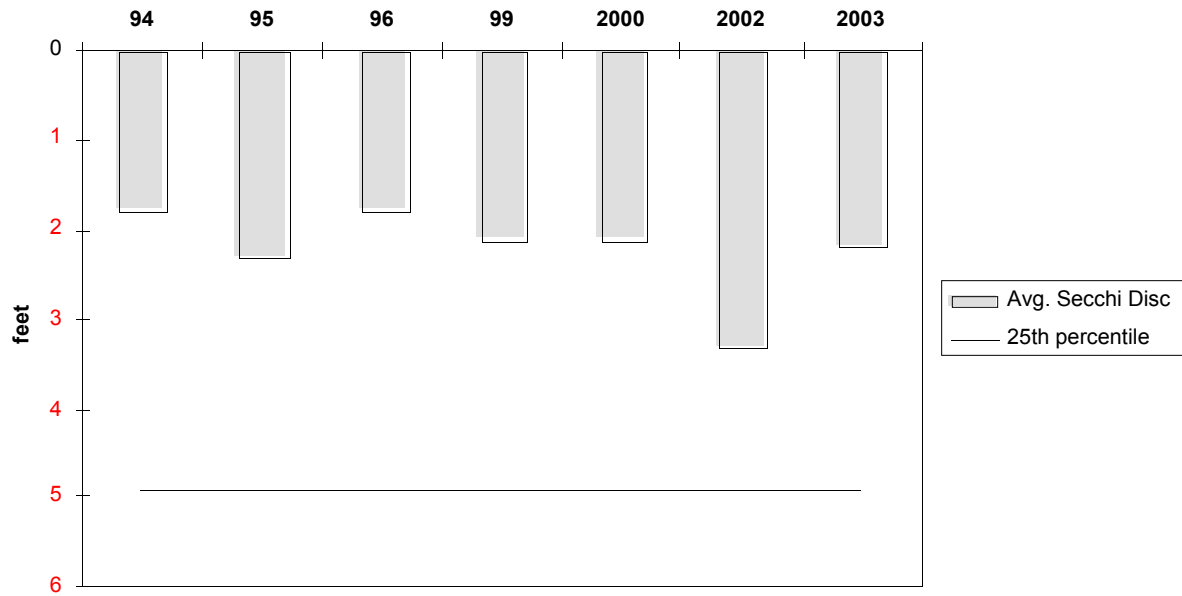


Figure 2. Lake Orono Average Annual Total Phosphorus and Chlorophyll-A

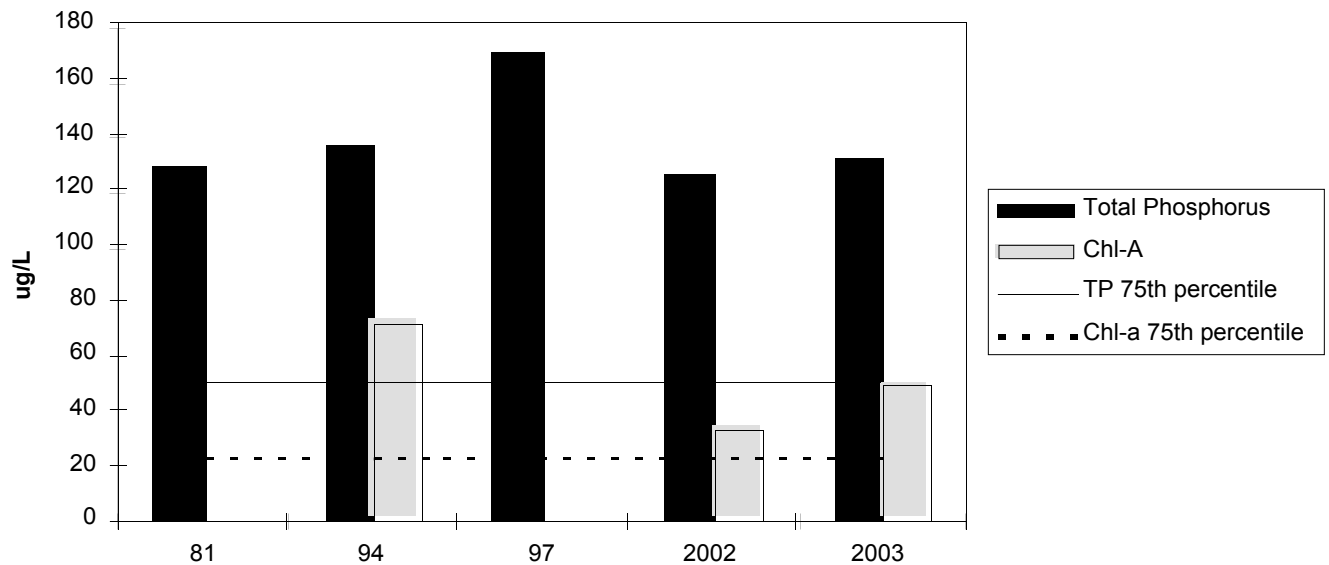


Figure 3. Lake Orono Average Annual Total Suspended Solids

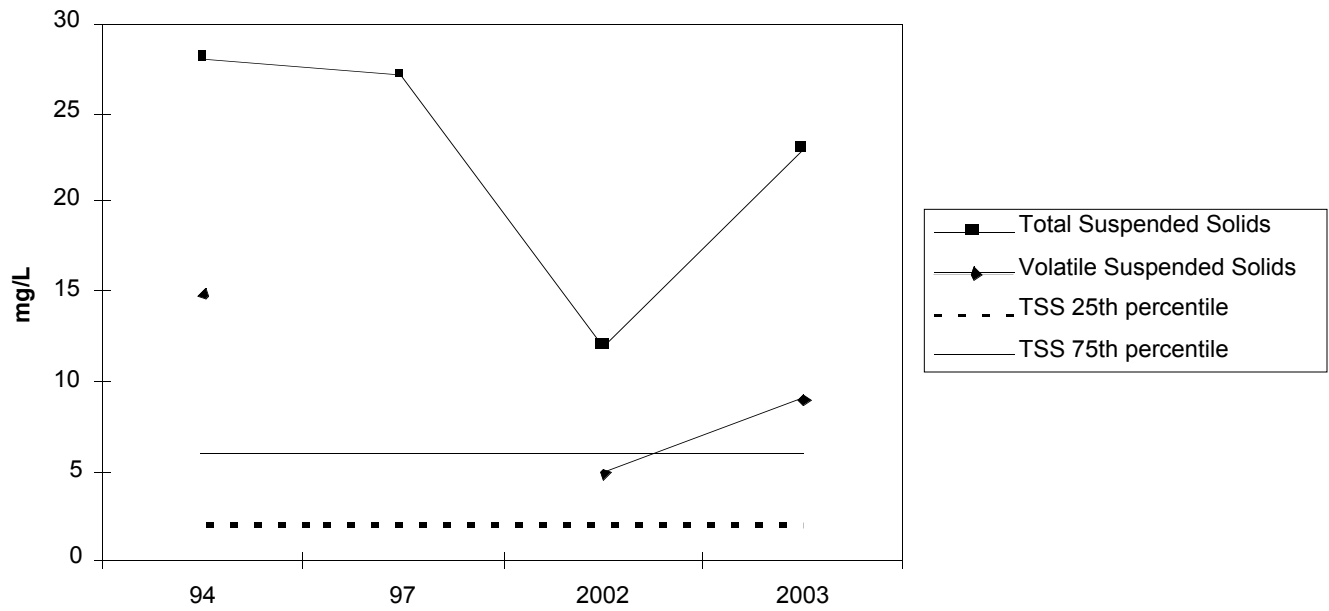
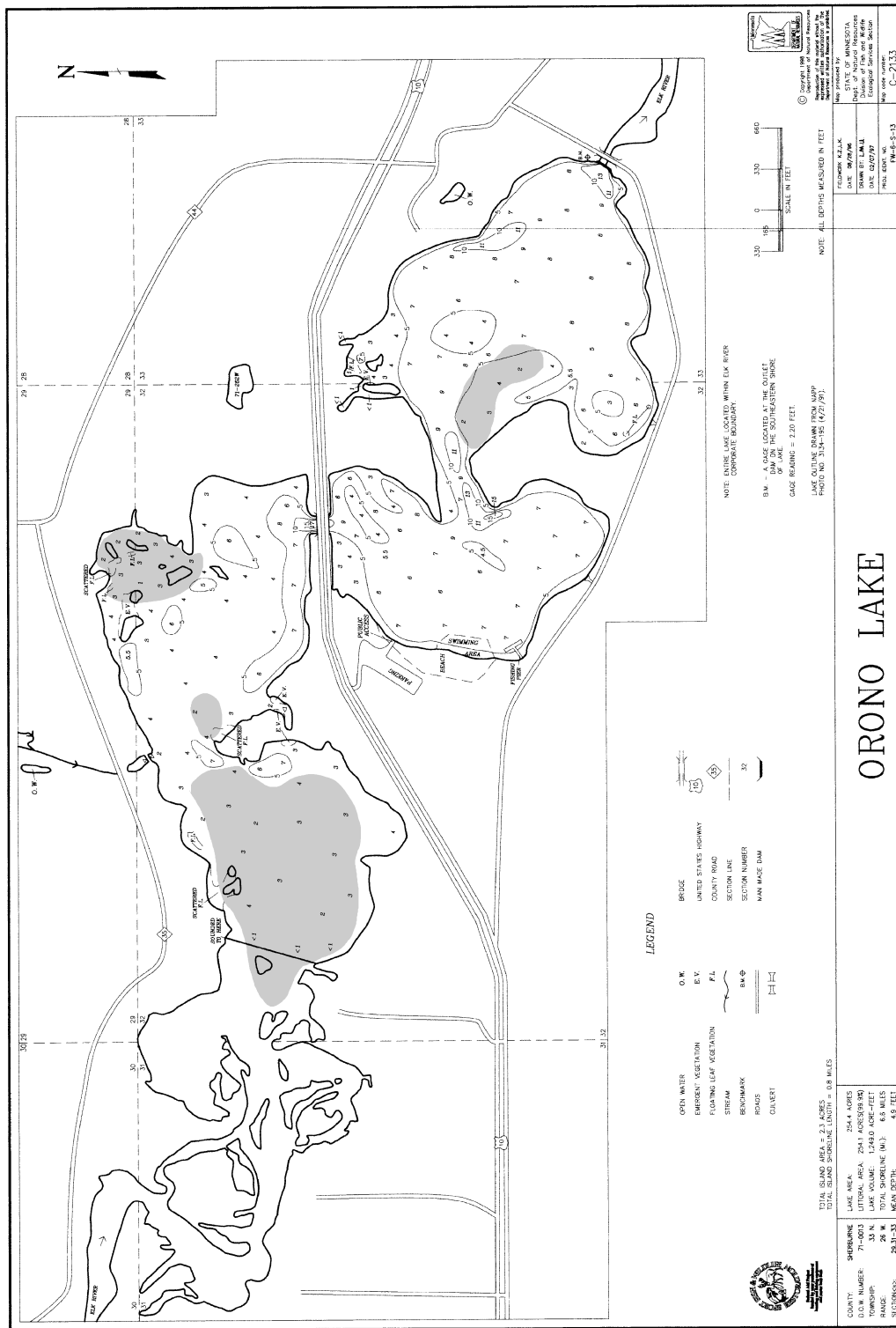


Figure 4. Lake Depth Map

Dredged



Sources: MN DNR Lake Map 1997, City of Elk River dredging info 1998

Table 3. Recent net catches of fish species from Lake Orono. Includes possible goals for each species.

Next Lake Inventory (Survey): 2004

Lake class 42

Other lake class 42 in the area include: Great Northern, Becker, Black Oak, Maria (all in Stearns County)

Species	1984	1989	Expected catch	Goal
Bluegill	7.7*	1.8	1.29 - 27.0	10-15
Black crappie	11.4	6.0	2.5 - 19.8	8-12
Northern pike	2.0	2.0	1.0 - 6.5	3-5
Walleye	0	0.5	1.0 - 15.7	2-4
Smallmouth bass		23	30 - 50 per hour	30-40
Black bullhead	11.8	5.6	3.2 - 80.4	5-10
Carp	2.0	4.75	1.5 - 3.85	2-4
Redhorse	1.0	4.0	0.63 - 1.8	2-4

* Numbers mean the number of fish per 24-hour gill or trap net set.

In order to meet the goals:

Bluegill	Stock 1,200 adults for 3 years
Black crappie	Stock 800 adults for 3 years
Northern pike	Stock 300 adults every other year
Walleye	Stock 150,000 fry every other year
Smallmouth	No stocking needed

Rationale: A goal near the 3rd quartile value seems achievable for game fish. Stocking these species over several years might get us there. Following that natural reproduction might suffice except for walleye and northern pike. For bullhead, carp and redhorse we would like to set our goals toward the 1st quartile. However, we have no tools to help us get there except indirectly when water quality is improved.

Table 4. A list of aquatic plant species found growing at Lake Orono. 1984 and 2002.

Species	1984	2002
<i>Floating leaf</i>		
Lesser duckweed	P	P
Greater duckweed		R
Star duckweed	P	
White waterlily	R	C
<i>Submerged plants</i>		
Coontail		R
Narrowleaf pondweed		R
Curled pondweed	P	P
<i>Emergent plants</i>		
Arrowhead		R
Giant burreed		R
Common cattail	P	
Water smartweed	P	
Jewelreed		P
Horsetail		R
Marsh bellflower		P
Common skullcap		P
Marsh milkweed		P
Bugleweed		P
Purple loosestrife	P	P

P = present

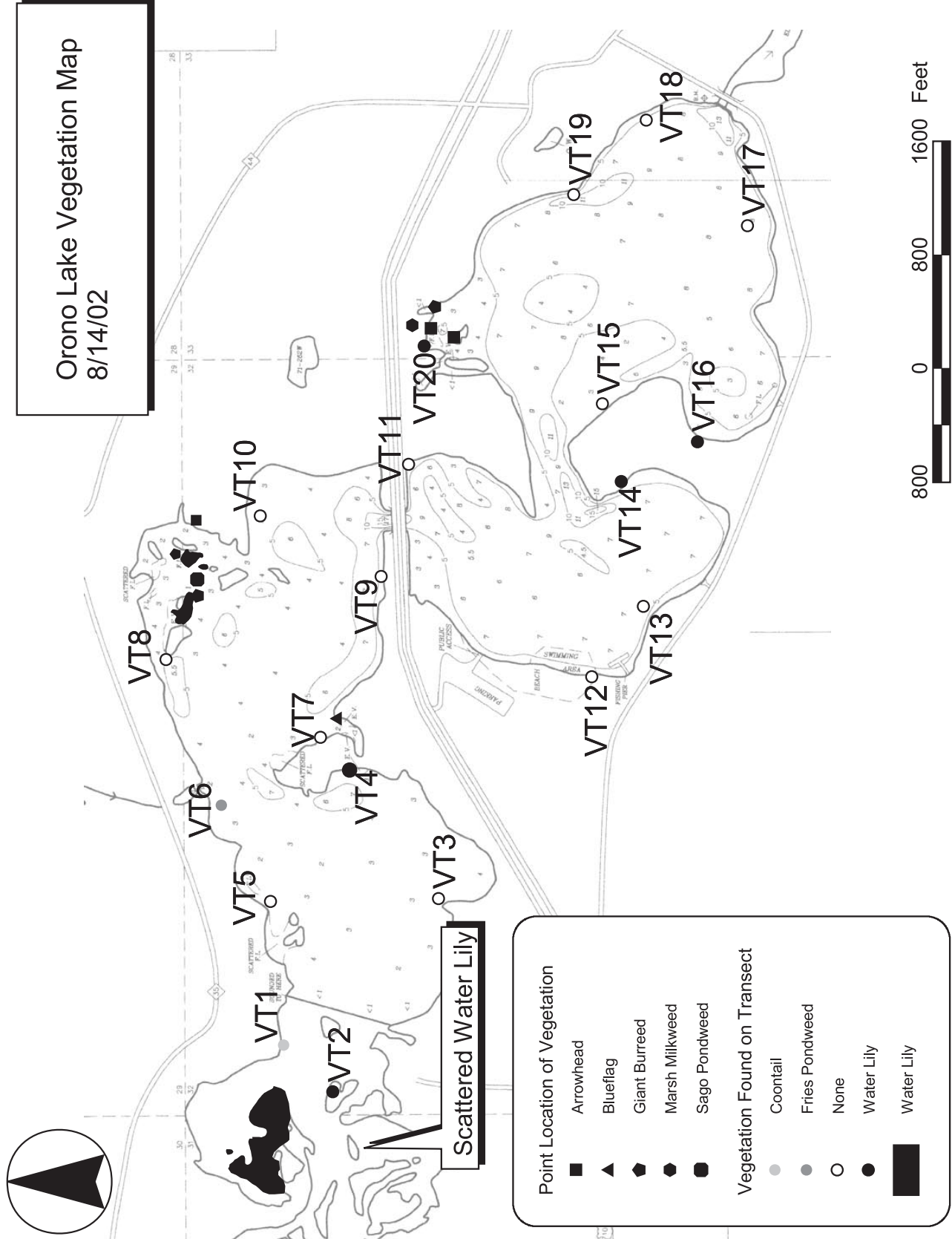
R = rare

C = common

A couple of sprigs of wild celery were found floating at the water's surface on 8/14/02. Shoreline areas on the basin north of Hwy 10 were wooded and naturalized. Since white water lilies and giant burreed were two species which seem to be doing well, any restoration efforts should consider expansion of these. Secchi disk clarity was 4.5' and the water was brownish in color.

Source: 2002 Minnesota Department of Resources sampling (8/14/02)

Figure 5. Emergent and Floating Vegetation Map



Source: Minnesota Department of Resources

Figure 6. Map of the Watershed of Lake Orono

Lake Orono Watershed

Watershed Area: 391,269 acres (611 square miles)

Lake Area: 300 acres

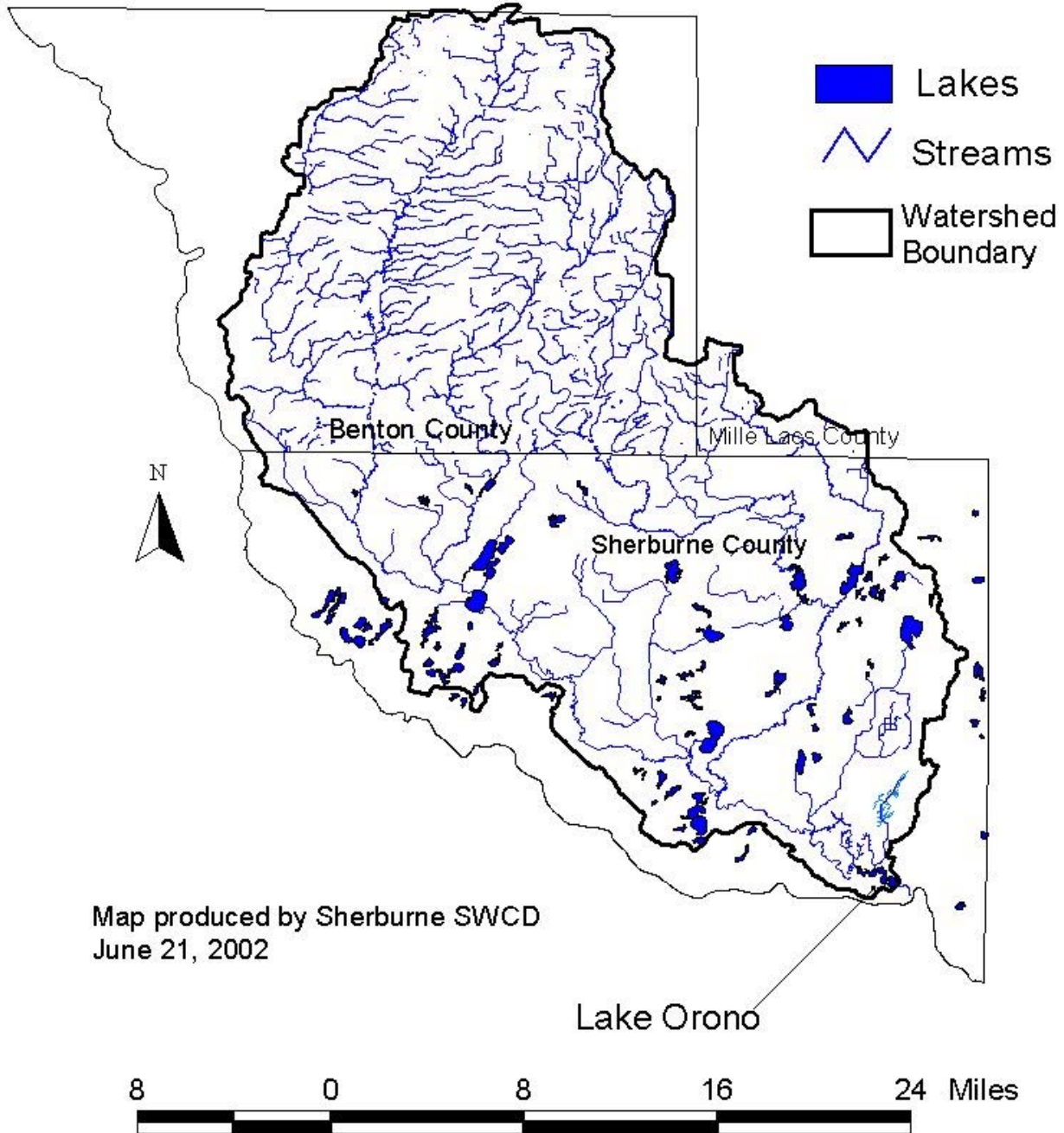
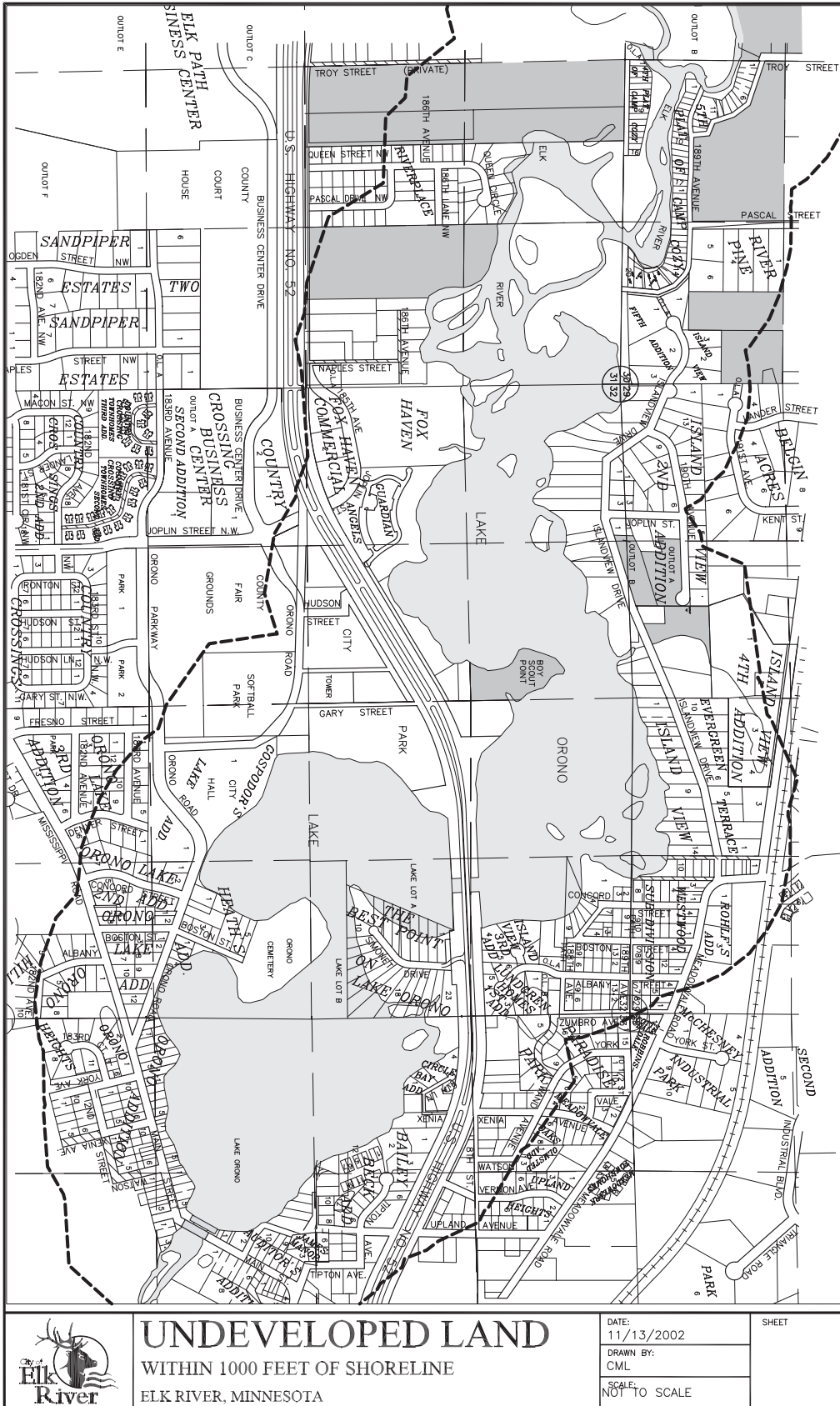


Figure 7. Undeveloped Land within 1000 Feet of Shore



UNDEVELOPED LAND
 WITHIN 1000 FEET OF SHORELINE
 ELK RIVER, MINNESOTA

DATE:
 11/13/2002
 DRAWN BY:
 CML
 SCALE:
 NOT TO SCALE

SHEET

Source: City of Elk River

VI. GLOSSARY AND ABBREVIATIONS

Aerobic: Aquatic life or chemical processes that require the presence of oxygen.

Algal bloom: An unusual or excessive abundance of algae.

Alkalinity: Capacity of a lake to neutralize acid.

Anoxic: The absence of oxygen in a water column or lake; can occur near the bottom of eutrophic lakes in the summer or under the ice in the winter.

Best Management Practices (BMPs): A practice determined by a state agency or other authority as the most effective, practicable means of preventing or reducing pollution.

Buffer Zone: Undisturbed vegetation that can serve as to slow down and/or retain surface water runoff, and assimilate nutrients.

Chlorophyll a: The green pigment in plants that is essential to photosynthesis.

Conservation Easement: A perpetual conservation easement is a legally binding condition placed on a deed to restrict the types of development that can occur on the subject property.

Eutrophication: The aging process by which lakes are fertilized with nutrients.

Eutrophic Lake: A nutrient-rich lake – usually shallow, “green” and with limited oxygen in the bottom layer of water.

Exotic Species: Any non-native species that can cause displacement of or otherwise threaten native communities .

Fall Turnover: In the autumn as surface water loses temperature they are “turned under” (sink to lower depths) by winds and changes in water density until the lake has a relatively uniform distribution of temperature.

Feedlot: A lot or building or a group of lots or buildings used for the confined feeding, breeding or holding of animals. This definition includes areas specifically designed for confinement in which manure may accumulate or any area where the concentration of animals is such that a vegetative cover cannot be maintained. Lots used to feed and raise poultry are considered to be feedlots. Pastures are not animal feedlots.

Groundwater: water found beneath the soil surface (literally between the soil particles); groundwater is often a primary source of recharge to lakes.

Internal Loading: Nutrients or pollutants entering a body of water from its sediments.

Lake Management: The process of study, assessment of problems, and decisions affecting the maintenance of lakes as thriving ecosystems.

Littoral zone: The shallow areas (less than 15 feet in depth) around a lake's shoreline, usually dominated by aquatic plants. These plants produce oxygen and provide food, shelter and reproduction areas for fish & animal life.

Native Species: An animal or plant species that is naturally present and reproducing.

Nonpoint source: Polluted runoff – nutrients or pollution sources not discharged from a single point. Common examples include runoff from feedlots, fertilized lawns, and agricultural fields.

Nutrient: A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake eutrophication and nonpoint source pollution.

pH: The scale by which the relative acidity or basic nature of waters are assessed,

Photosynthesis: The process by which green plants produce oxygen from sunlight, water and carbon dioxide.

Point Sources: Specific sources of nutrient or pollution discharge to a water body, i.e., a stormwater discharge pipe.

Riparian: The natural ecosystem or community associated with river or lake shoreline.

Secchi Disk: A device measuring the depth of light penetration in water.

Sedimentation: The addition of soils to lakes, which can accelerate the “aging” process by destroying fisheries habitat, introducing soil-bound nutrients, and filling in the lake.

Trophic Status: The level of growth or productivity of a lake as measured by phosphorus, content, algae abundance, and depth of light penetration.

Watershed: The surrounding land area that drains into a lake, river, or river system.

COMMON BIOLOGICAL OR CHEMICAL ABBREVIATIONS

BOD	Biological Oxygen Demand
°C	degree(s) Celsius
cfs	cubic feet per second (a common measure of rate of flow)
cfu	colony forming units (a common measure of bacterial concentrations)
chl <i>a</i>	Chlorophyll <i>a</i>
cm	centimeter
COD	Chemical Oxygen Demand
Cond	conductivity
DO	dissolved oxygen
FC	fecal coliform (bacteria)
ft	feet
IR	infrared
l	liter
m	meter
mg	milligram
ml	milliliter
NH ₃ -N	nitrogen as ammonia
NO ₂ -NO ₃	nitrate-nitrogen
NTU	Nephelometric Turbidity Units, standard measure of turbidity
OP	Ortho-phosphorus
ppb	parts per billion
ppm	parts per million
SD	Standard Deviation (statistical variance)
TDS	total dissolved solids
TN	total nitrogen
TP	total phosphorus
TSI	trophic status index
TSI (C)	trophic status index (based on chlorophyll <i>a</i>)
TSI (P)	trophic status index (based on total phosphorus)
TSI (S)	trophic status index (based on Secchi disc transparency)
TSS	total suspended solids
µg/l	micrograms per liter
µmhos/cm	micromhos per centimeter, the standard measure of conductivity
UV	Ultraviolet