REPORT SUMMARY

Mirror Lake Water Quality Study

October 2023

Prepared for
Nine Mile Creek
Watershed District

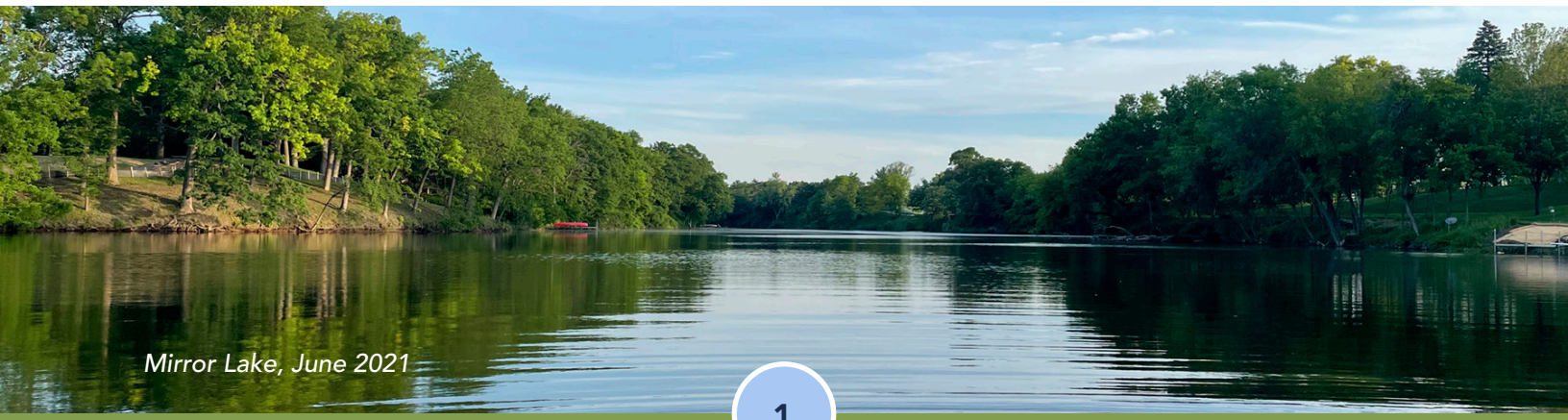
9 MILE CREEK WATERSHED DISTRICT

REPORT SUMMARY CONTENTS

Water Quality Goals to Protect and Enhance Our Lakes

Mirror Lake is a shallow lake located in the northwestern portion of the city of Edina, north of Highway 62, south of Interlachen Boulevard, and east of Highway 169. The shallow, urban lake suffers from moderate to poor water quality. The Nine Mile Creek Watershed District (NMCWD), a local unit of government that works to address water-related problems, conducted a study of Mirror Lake in 2022–2023 to evaluate current water quality and identify protection and improvement strategies. The study incorporated additional data and advanced modeling and analysis methods to confirm the findings of a 2004 NMCWD study. Additional information on the current lake conditions, water quality challenges, and recommended management strategies, including implementation timelines, are summarized in this project overview.

Protecting and enhancing the water quality of the lakes within the Nine Mile Creek watershed is one of the primary goals of the Nine Mile Creek Watershed District. The NMCWD's lake management program includes data collection (monitoring), assessment (e.g., studies), and implementation of projects and programs to protect and improve water quality and aquatic habitat. Using monitoring data collected by NMCWD in recent years (2019 and 2021), the objectives of this study were to assess or "diagnose" the lake's water quality problems, understand the cause or sources of the problems, and recommend management strategies to improve the water quality and overall health of the lake.



Mirror Lake, June 2021

Mirror Lake, June 2021

Lake Management Goals

When assessing the ecological health of a lake, it is important to take a holistic approach, considering factors such as in-lake water quality (e.g., phosphorus and nitrogen concentrations), the health and quality of the aquatic communities, and water quantity (see Figure 1). How recreation and wildlife habitat affect and are affected by overall lake health are also considered. Numerical goals exist for some of these factors, such as state water quality standards. However, other factors are assessed relative to narrative criteria that describe the desired condition and do not have strict numerical goals. For this study, the primary goals are to achieve the water quality standards for shallow lakes; attain a diverse, native macrophyte (aquatic plant) population; and support a healthy, balanced aquatic ecosystem.

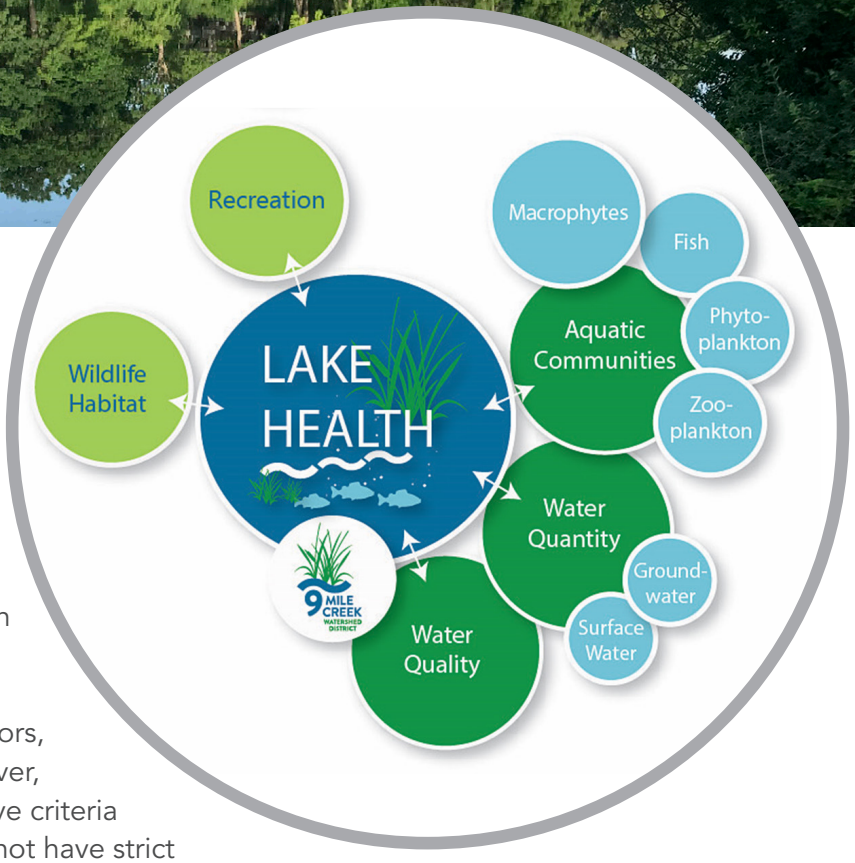


Figure 1
NMCWD Holistic Lake Health Assessment Factors

For this study, the primary goals are to achieve the water quality standards for shallow lakes; attain a diverse, native aquatic plant population; and support a healthy, balanced aquatic ecosystem.

Low clarity and higher algal abundance have historically been a concern in Mirror Lake (Aerial view October 2014)

Current Lake Conditions

Currently, the state of Minnesota uses three parameters to indicate lake health and help track and quantify water quality changes. These three parameters include:

1) Total Phosphorus, which is a nutrient that can fuel algae and plant growth (Figure 2)

2) Chlorophyll-*a*, which is a measurement of algae growth (Figure 3)

3) Secchi disk transparency depth, which is a measurement of lake clarity. (Figure 4)

Monitoring data indicates that Mirror Lake is not meeting Minnesota's water quality standards for shallow lakes in the Twin Cities. The observed summer average (June 1–Sept 30) total phosphorus and chlorophyll-*a* concentrations have exceeded Minnesota's shallow lake water quality standards (60 ug/L total phosphorus and 20 ug/L chlorophyll-*a*) for all monitored years since 1990. The clarity of Mirror Lake has also failed to meet the shallow lake water quality standard of greater than one meter for all monitored years since 1990. The poorer water quality is primarily due to excess nutrients, which fuels algal growth and decreases clarity.

Blue-green algae, or cyanobacteria, have historically been found in Mirror Lake since monitoring began, with a notable increase in abundance in 2021. Blue-green algae are associated with water quality problems and can be a source of health concerns not only for humans who use the lake, but for wildlife.

Example blue-green algae bloom

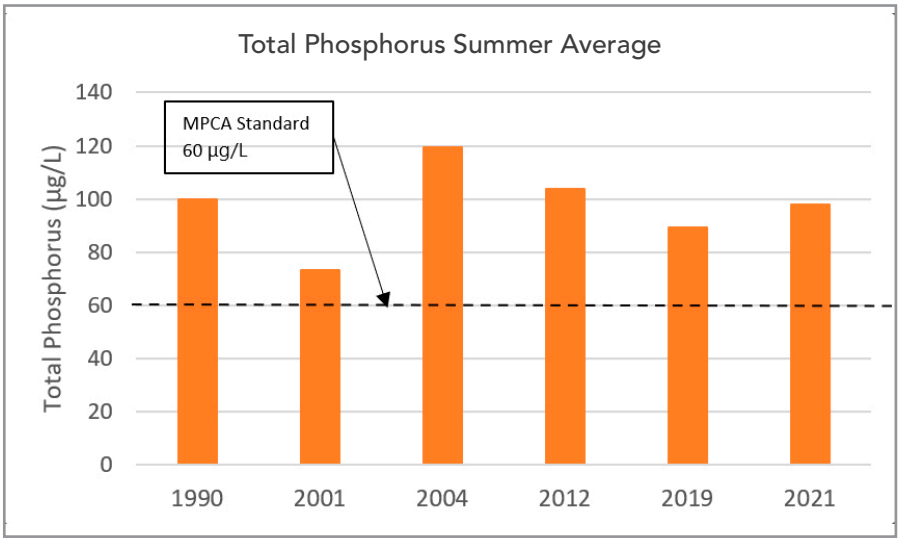


Figure 2
Summer average total phosphorus concentrations measured in Mirror Lake between 1990 and 2021

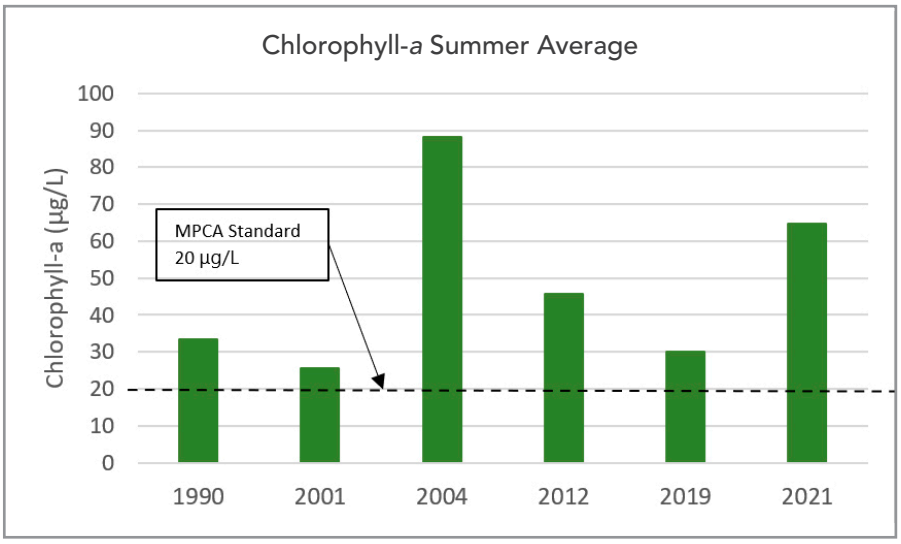


Figure 3
Summer average Chlorophyll-a concentrations measured in Mirror Lake between 1990 and 2021

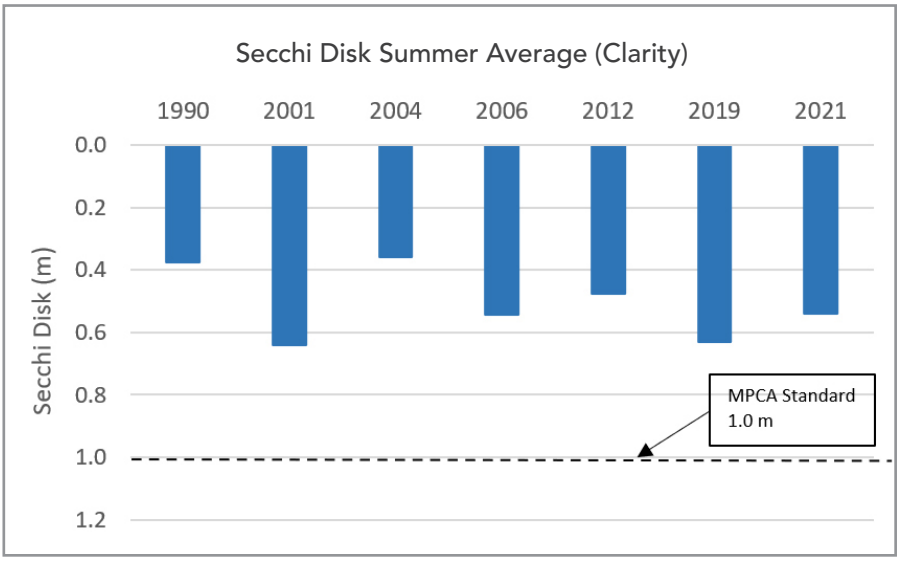


Figure 4
Summer average Secchi Disk transparency depths (clarity) measured in MIrror Lake between 1990 and 2021

Healthy Shallow Lakes Have...Plants!

Shallow lakes are unique ecosystems that differ from deeper lakes. They have depths that allow for light to reach the lake bottom throughout most or all of the lake (often less than 10 feet deep). Shallow lakes also tend to be more nutrient-rich than deeper lakes, especially in an urban setting where they receive nutrients (e.g., phosphorus and nitrogen) from stormwater. A healthy, shallow, urban lake will have an abundance of aquatic plants growing throughout the entire lake due to the shallowness and higher amounts of nutrients. Aquatic plants, such as coontail, native pondweed, and water lily, can provide excellent habitat for insects, zooplankton, fish, waterfowl, and other wildlife. The plants can also help to take phosphorus and nitrogen from the lake water, reducing the amount of nutrients available for algae growth. However, if nutrients are high enough, excess nutrients can lead to an overabundance of algal growth that creates turbid (murky-looking, low clarity) water. Lake water with low clarity can limit or prevent aquatic plant growth, which can lead to an unhealthy plant community.

To help define the health of a lake's plant community, the Minnesota Department of Natural Resources (MNDNR) has developed an index of biological integrity (IBI), which is a score that compares the types and numbers of plants observed in a lake to what is expected for a healthy lake. Observing 11 or more species in a shallow lake is an indication of a healthier plant community. As shown in Figure 5, only one to four plant species were found in Mirror Lake since 2001.

In 2021, only two to three plant species were found in Mirror Lake, indicating a degraded plant community.

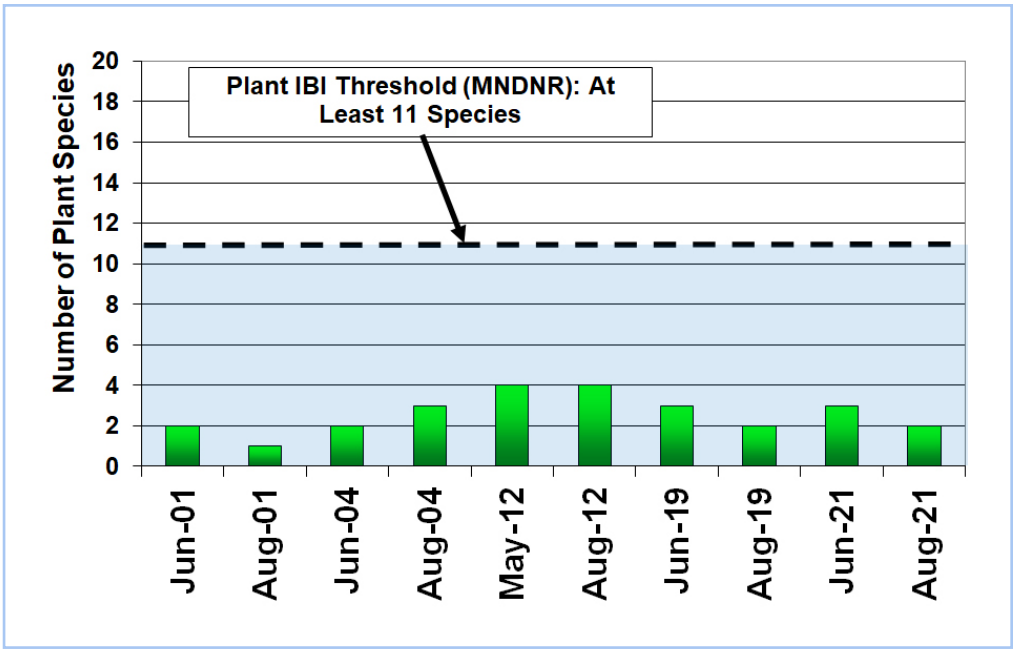


Figure 5 *Mirror Lake Plant Species Richness compared with MNDNR Plant IBI score, which is an indication of plant health*

Urban Watersheds Transfer Pollutants to Lakes

A lake watershed is all the land area that drains to the lake through overland flow, channels, and storm pipes. Land use practices within a lake's watershed impact the lake and its water quality by altering the amount of stormwater runoff, sediment, and nutrients that reaches the lake. Each type of land use contributes a different amount of runoff and pollutants to the lake, thereby impacting the lake's water quality differently. Land use within the highly developed Mirror Lake watershed is primarily single family residential. The watershed also includes open water and golf course, and to a lesser extent undeveloped/open space, parks and recreational, and institutional (church, cemetery) land uses. Mirror Lake generally has two tributary watershed types where runoff is either (1) tributary via treatment from upstream management practices, such as stormwater ponds, wetlands, or underground filtration practices (pink watersheds shown on Figure 6) or (2) directly tributary through surface drainage or storm sewer networks with no prior treatment (green watershed shown on Figure 6). Surface drainage includes runoff that drains to Mirror Lake along the shoreline. Unstable or eroding shorelines can increase the amount of sediment and nutrients entering the lake.

Mirror Lake has no gravity surface outlets. The water level of Mirror Lake has historically been controlled by a pump located in the southwestern portion of the lake near Fox Meadow Park.

(Above and left) Mirror Lake shoreline erosion examples, April 2023

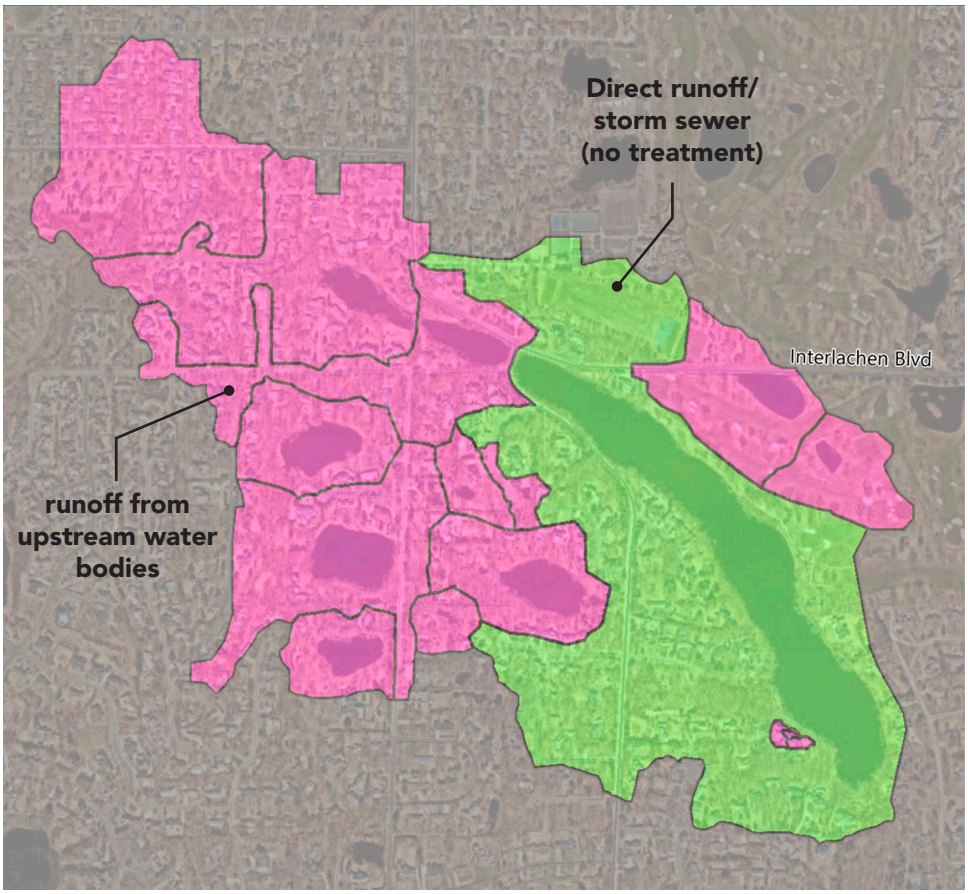
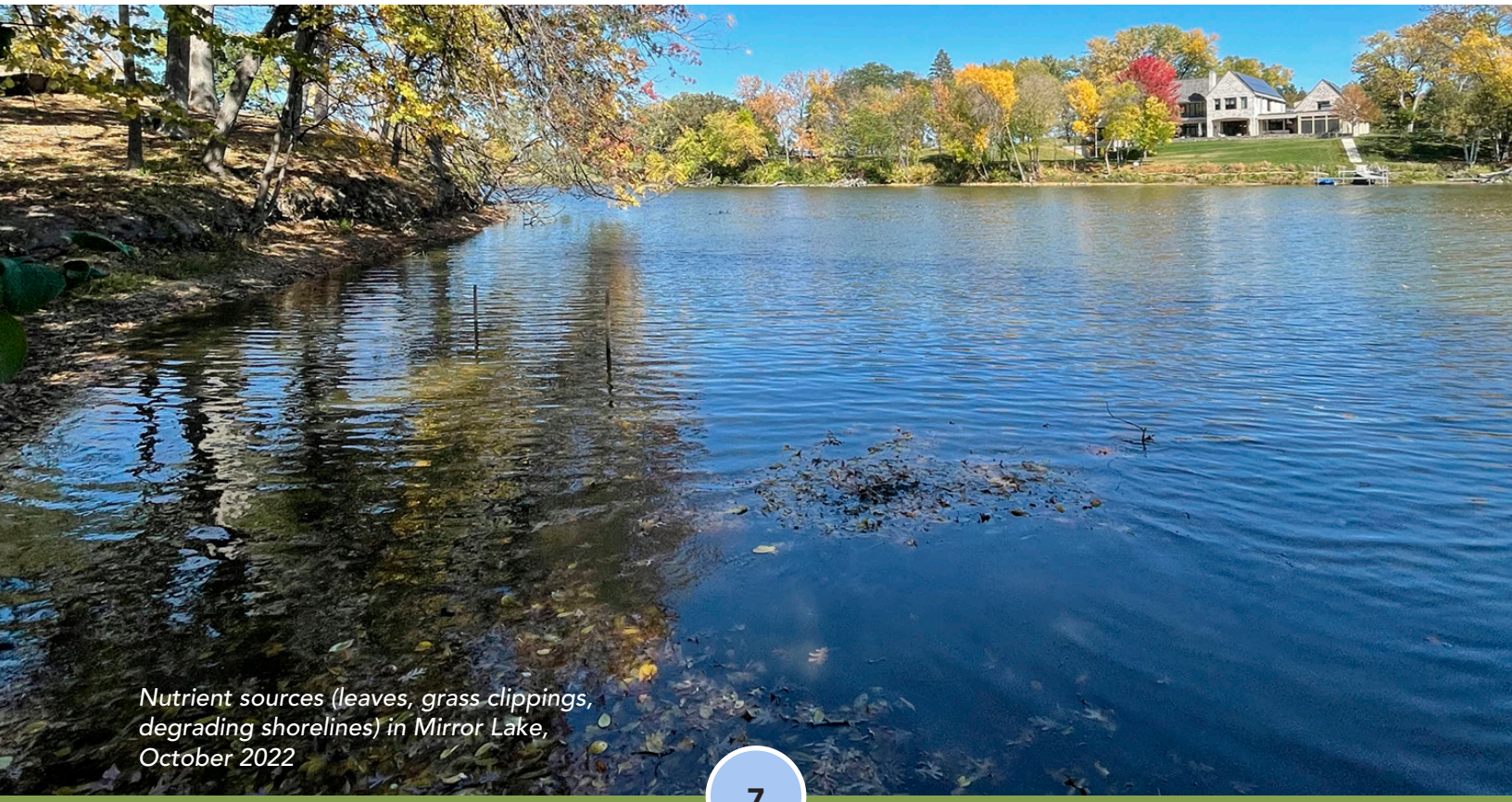


Figure 6 *Map showing the Mirror Lake watershed*



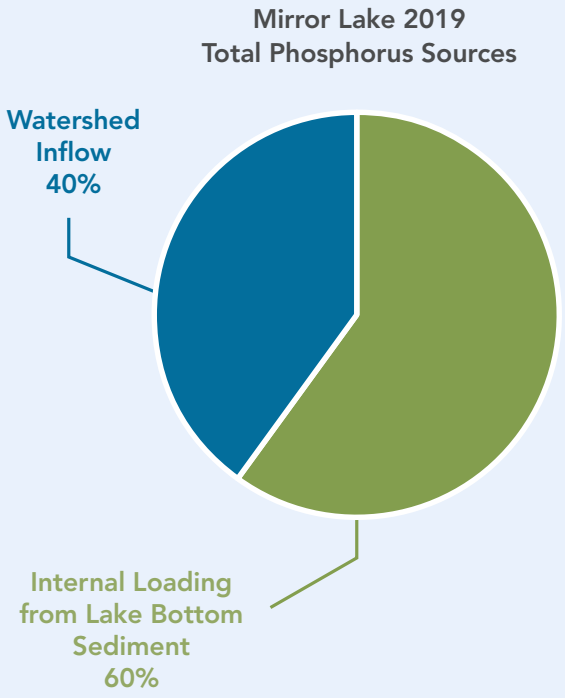
Nutrient sources (leaves, grass clippings, degrading shorelines) in Mirror Lake, October 2022

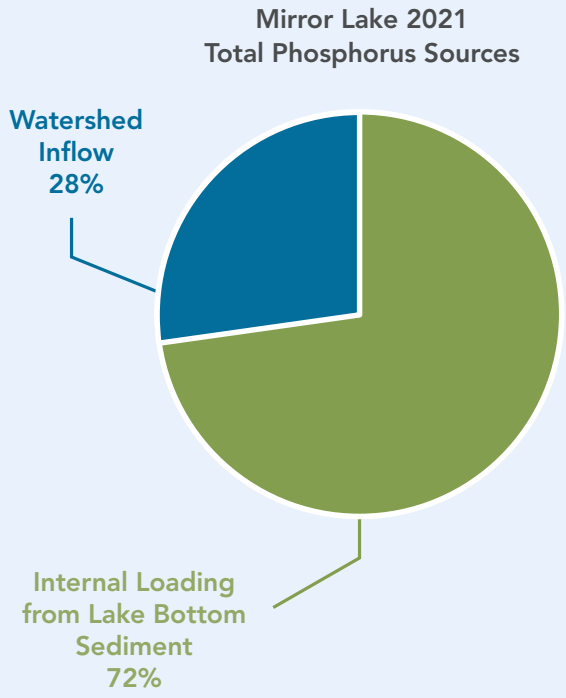
Sources of Nutrients

Nutrients (phosphorus and nitrogen) are a food source for algae. An overabundance of these nutrients in a lake can result in nuisance algal blooms and threaten the health of the aquatic plant community. In Minnesota, phosphorus is most commonly the "limiting nutrient," although nitrogen can also be limiting for portions of the growing season. Whether phosphorus or nitrogen is the "limiting nutrient" this means the available quantity of this nutrient tends to control the amount of algae and aquatic plants produced. The two primary sources are summarized below. The amount of nutrients coming into the lake from each source can vary from year to year.

- **Phosphorus and nitrogen in stormwater runoff from the direct watershed—**Stormwater runoff conveys phosphorus and nitrogen from streets, driveways, lawns, and golf courses within the direct watersheds to Mirror Lake via a series of drainage channels and storm pipes. This study confirmed that stormwater runoff is a major contributor of phosphorus and nitrogen to Mirror Lake.

- **Nutrient-rich sediment—**Phosphorus builds up over time in lake bottom sediments as a result of sedimentation and die-off of vegetation and algae. When certain environmental conditions are met, such as low oxygen and/or higher temperatures, phosphorus can release back into the water column from the sediment. This study confirmed that phosphorus release from lake bottom sediments, typically termed "internal loading," is a major contributor of phosphorus to Mirror Lake.





Mirror Lake, June 2021

Lake Management Alternatives

Water quality in Mirror Lake has been moderate to poor in the past 30 years and the lake currently does not meet water quality and ecological health goals. Given this, future management efforts should focus on improving lake water quality and ecosystem health, monitoring for changes, and continuing water quality and ecosystem health protection measures as improvements are obtained. The recommended management and protection strategies for Mirror Lake are summarized on the next page.

Planning-level opinions of probable cost were developed for several new management alternatives evaluated as part of this study. These opinions of cost are intended to provide assistance in evaluating and comparing alternatives and should not be considered as absolute values. All estimated costs are presented in 2023 dollars and include costs for engineering and project administration.

- Bottom Sediment Treatment: $273,000
- Shoreline Restoration: $484,000
- Mirror Lake Watershed Street Sweeping Program: $11,000
- Mirror Lake Fertilization Optimization Program: $27,000
- Fox Meadow Park Filtration Basin: $545,000

Management/Protection Action		Basis	Estimated Timeline
Address Internal Bottom Sediment Phosphorus Loading	Alum Treatment #1	Reduce sediment phosphorus load	2025
	Sediment Release & Water Quality Monitoring	Assess management effectiveness	2026–2030+
	Explore plant re-establishment options	Re-establish native plant community to support longevity of sediment treatment benefits	2028+
	Follow-up Sediment Treatment(s)	Reduce sediment phosphorus load	2028+
Address External Watershed Loading	Address Shoreline Erosion	Reduced sediment loading from shoreline erosion and protect upland habitats	2023/2024 (Feasibility) 2024/2025 (Design) 2025 (Construction)
	Enhanced Street Sweeping Program	Reduce pollutant loading from stormwater	2023–2024 (Planning begins)
	Fertilizer Management Program	Reduce nitrogen sources from excess fertilizer use	2023–2024 (Planning begins)
	Chloride Monitoring	Continue to identify/track chloride levels from winter salt use	As part of continued lake monitoring program
	Promote NMCWD Cost-Share Grants to watershed residents	In a fully developed watershed, opportunities for largescale BMPs are limited	2023+
	Fox Meadow Park Filtration Basin	Reduce pollutant loading from stormwater	Reconsider in the future
Manage Aquatic Plants (Macrophytes)	Curly-leaf Pondweed Management	Continue to monitor invasive species growth and managed as needed	2023+
	Promote Native Aquatic Plant Growth	Encourage native plants to promote clear water conditions and competition with algae	2023+
Assess Fisheries	Electrofishing Assessment	Consider performing additional fisheries assessments to determine if carp are degrading water quality (e.g., low clarity)	2023–2024 (Planning begins)

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