DRAFT

REPORT SUMMARY

Lake Cornelia and Lake Edina Water Quality Study

Use Attainability Analysis for Lake Cornelia (updated from 2010) and Lake Edina (first version)

Prepared for
Nine Mile Creek Watershed District

May 2019

UNDERSTANDING LAKE CORNELIA AND LAKE EDINA

WORKING TO MEET DISTRICT GOALS

Lake Cornelia and Lake Edina are located in the southeast portion of Edina within the Nine Mile Creek watershed. The shallow, urban lakes suffer from poor water quality. In fact, both lakes are included on the state's impaired waters list for excess nutrients. The NMCWD, a local unit of government that works to solve and prevent water-related problems, conducted a study of Lake Cornelia and Lake Edina in 2018-2019 to help address the poor water quality. Additional information on the current lake conditions, causes of the poor water quality, and recommended management strategies 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. Utilizing monitoring data collected by NMCWD in recent years (2015 – 2017), the objectives of this study were to assess or "diagnose" the lakes' 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 lakes.

LAKE MANAGEMENT GOALS

When assessing the ecological health of a lake, it is important to take a holistic approach, considering the factors including chemical water quality (e.g., phosphorus 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 (e.g., state water quality standards), however, other ecological lake health factors are assessed relative to narrative criteria (e.g., criteria that describe the desired condition) without strict numerical goals. For this study, the primary goals are to achieve the water quality standards for shallow lakes, support more diverse, native macrophyte (aquatic plant) populations, and promote a more healthy, balanced fishery.

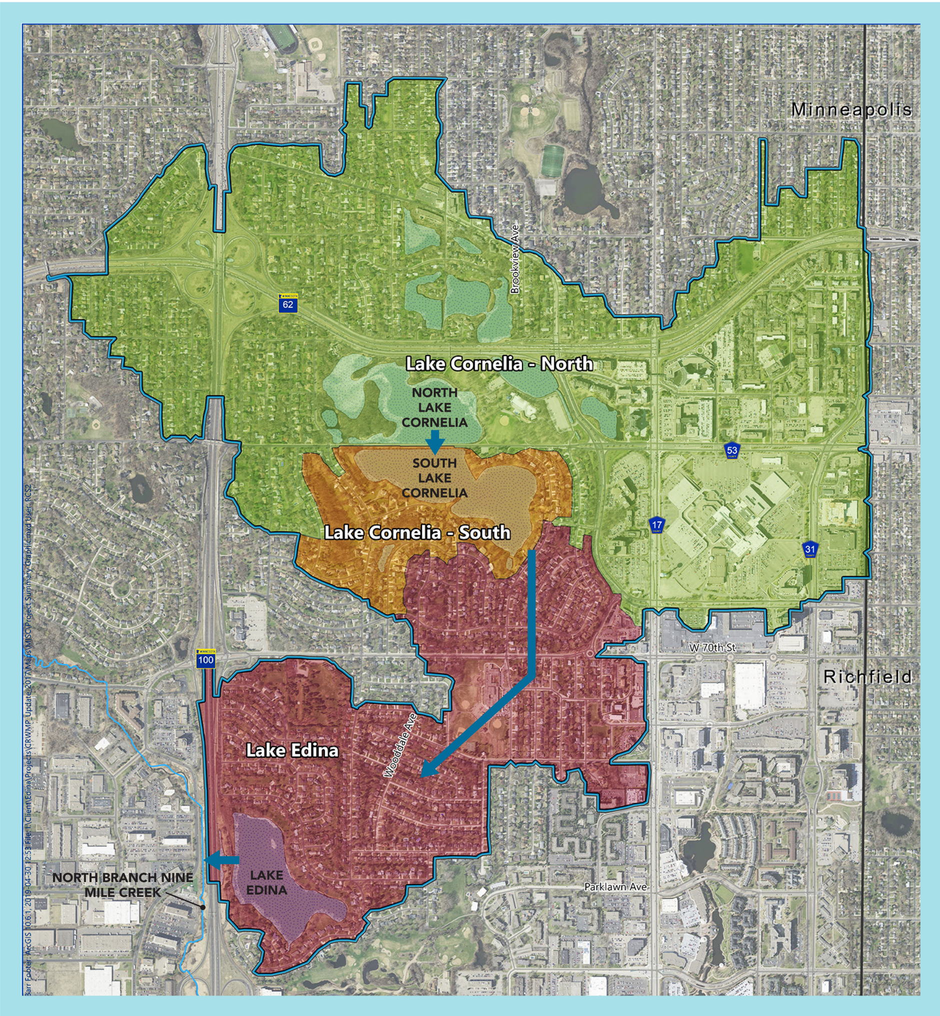
Figure 1

AN IN-DEPTH LOOK

THE LAKES AND HOW THEY ARE CONNECTED

Lake Cornelia is a shallow lake with a northern and southern basin, which are connected by a storm drain. North Cornelia, spanning 19 acres, has a maximum depth of 7 feet, and a mean depth of approximately 3 feet. South Cornelia, with a water surface area of 33 acres, has a maximum depth of 8 feet, and a mean depth of approximately 4 feet.

North Cornelia receives stormwater runoff from a relatively large watershed (863 acres), shown in green in the map below. Land use within the highly developed watershed includes a large commercial area (including the Southdale Shopping Center), portions of Highway 62 and Highway 100, residential areas (high and low density), and Rosland Park. Most of the runoff from the highly impervious commercial area drains through a series of waterbodies (i.e., Point of France Pond and Swimming Pool Pond) prior to reaching North Cornelia. In addition to flows from North Cornelia, South Cornelia receives runoff from a relatively small, residential watershed (112 acres), shown in orange in the map below.

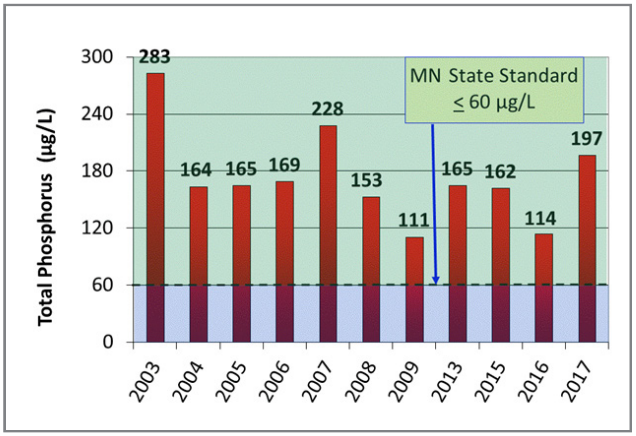


= FLOW DIRECTION

Runoff that flows through Lake Cornelia drains to Lake Edina, which ultimately discharges into the North Fork of Nine Mile Creek. Lake Edina is a shallow, 25-acre lake, with a maximum depth of 5 feet and a mean depth of approximately 3 feet. The Lake Edina watershed, shown in red in the map to the left, encompasses approximately 400 acres. Land use within the watershed is mainly low-density residential, with smaller portions of high density residential, commercial, institutional (Cornelia Elementary School), and park.

LAKE CORNELIA WATER QUALITY CHALLENGES

Water quality in Lake Cornelia is poor, with summer-average total phosphorus and chlorophyll *a* concentrations well above the state standard for shallow lakes. The poor water quality is primarily due to excess phosphorus in the lake, which fuels algal growth and decreases water clarity. The phosphorus in Lake Cornelia comes from several sources, including stormwater runoff from the watershed (external source) and internal sources such as nutrient-rich sediments and decomposition of curly-leaf pondweed. Fish activity, specifically the disruption caused by bottom-feeding species such as bullhead and goldfish, may also be decreasing water clarity. The primary sources of phosphorus to Lake Cornelia are described further below.



Summer average phosphorus concentrations in Lake Cornelia (North Basin) have historically been well above the state standard for shallow lakes.

SOURCES OF PHOSPHORUS TO LAKE CORNELIA

Phosphorus in stormwater runoff — Stormwater runoff conveys phosphorus from streets, lawns, and parking lots to Lake Cornelia via a series of storm drain pipes. Computer models indicate that stormwater runoff is the major contributor of phosphorus to Lake Cornelia, ranging from 48% - 76% of the contribution to North Cornelia in evaluated years (2015, 2016, 2017).

Nutrient-rich sediments — Phosphorus builds up over time in lake bottom sediments as a result of sedimentation and die-off of vegetation and algae. When oxygen levels are low at the lake bottom (typically periodically throughout the summer), some of the phosphorus is released from the sediment into the water column, contributing to poor water quality conditions. Sediment cores collected from Lake Cornelia confirmed the potential for internal phosphorus loading. Analysis of the sediment indicates the amount of phosphorus in the sediment is similar to other metro lakes that have poor water quality.

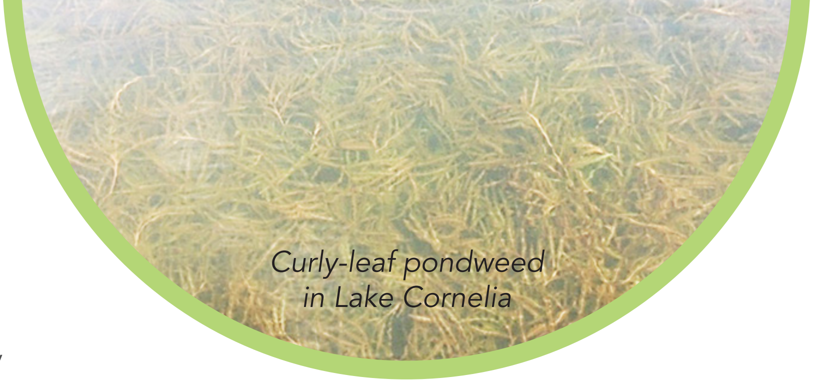
Curly-leaf pondweed — The invasive (i.e., non-native) aquatic plant grows under the ice during the winter and gets an early start in the spring, often crowding out native species. It dies back in late-June and early-July, much earlier than native species. As the plants decay, phosphorus is released into the water column, fueling algal production and causing oxygen depletion.

Bottom-feeding fish — Fish activity, specifically the disruption caused by bottom-feeding species such as the bullhead and goldfish found in Lake Cornelia, can influence phosphorus concentrations in a lake. These fish feed on decaying plant and animal matter found at the sediment surface and transform sediment phosphorus into phosphorus available for uptake by algae through digestion and excretion. Bottom-feeding fish can also cause resuspension of sediments, causing reduced water clarity and poor aquatic plant growth.

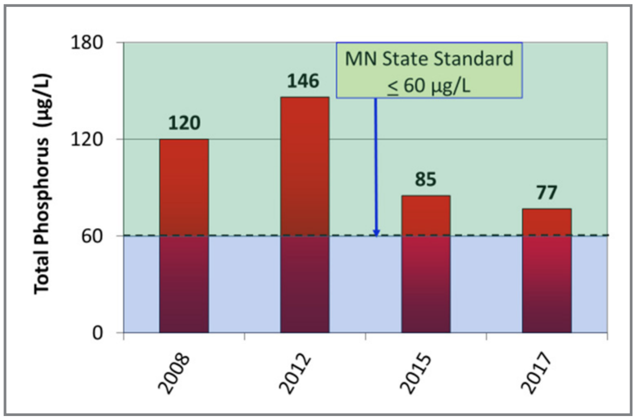
LAKE EDINA WATER QUALITY CHALLENGES

Water quality in Lake Edina is poor, with summer-average total phosphorus and chlorophyll *a* concentrations generally not meeting the state standard for shallow lakes. The poor water quality is primarily due to excess phosphorus in the lake, which fuels algal production and decreases water clarity. Phosphorus in Lake Edina comes from several primary sources, including stormwater runoff from the watershed (external sources) and flows from upstream Lake Cornelia (see pie charts below).

The invasive aquatic plants curly-leaf pondweed and Eurasian watermilfoil are both present within the lake. In recent years, curly-leaf pondweed was observed at low levels in two areas on the west side of the lake. Eurasian watermilfoil is widespread throughout the shallow lake. The invasive plants can outcompete native species, overtaking habitat and lowering native plant diversity.

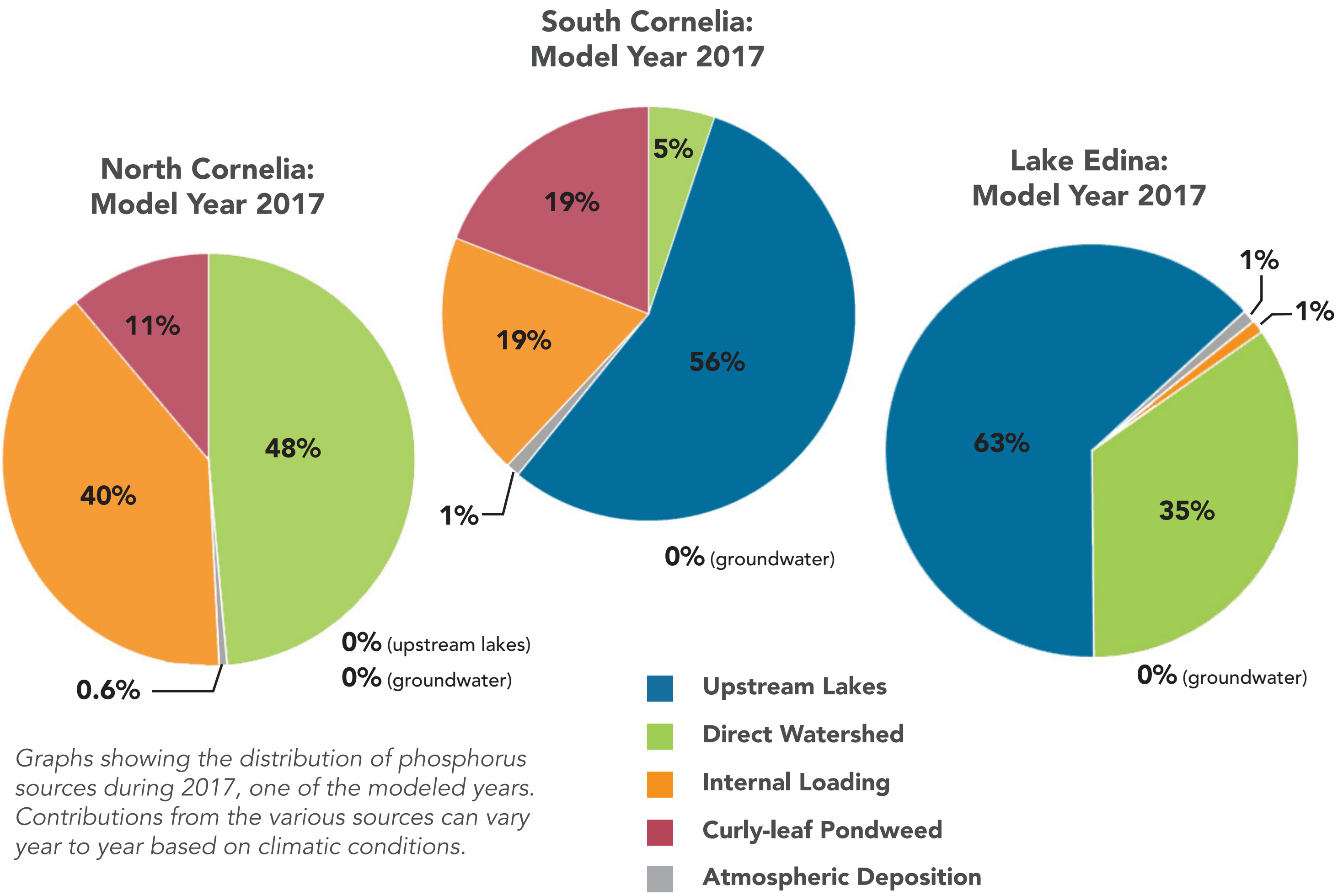


Curly-leaf pondweed in Lake Cornelia



Summer average phosphorus concentrations in Lake Edina have historically been above the state standard for shallow lakes.

PHOSPHORUS SOURCES



Graphs showing the distribution of phosphorus sources during 2017, one of the modeled years. Contributions from the various sources can vary year to year based on climatic conditions.

MANAGEMENT STRATEGIES TO IMPROVE LAKE CORNELIA & LAKE EDINA

Water quality in Lake Cornelia is impacted by both external sources (stormwater runoff from the watershed) and internal sources of phosphorus (i.e., release from lake bottom sediments and die-off/decay of curly-leaf pondweed). Because of this, the recommended management strategy is to implement a combination of in-lake and watershed management practices.

Water quality in Lake Edina is highly influenced by the water quality of Lake Cornelia. Accordingly, the primary recommended management strategy is to implement the recommendations for upstream Lake Cornelia. Opportunities to reduce phosphorus from the direct watershed to Lake Edina should also be considered.

The following section highlights the recommended management practices.

Alum treatment barge

Recommended In-lake Management Practices

Study results indicate the internal management practices described below will result in the greatest predicted improvements in water quality throughout the three lakes, as compared to other evaluated management activities. The predicted improvements in summer-average phosphorus concentrations in all three lakes as a result of these internal management practices are shown in Figure 2 on the next page.

Alum treatment in Lake Cornelia — A whole-lake alum treatment in North and South Lake Cornelia is recommended to bind (or immobilize) the phosphorus in lake bottom sediments and prevent release into the water column.

Curly-leaf pondweed treatments in Lake Cornelia — Continued city-led spring herbicide treatments in Lake Cornelia are recommended to reduce the presence of curly-leaf pondweed and promote a healthy native aquatic plant population.

Although not directly evaluated in the modeling analysis, these other in-lake management activities should be further considered to promote the health of the lake ecosystems:

Management of bottom-feeding fish in Lake Cornelia — Installation of a winter oxygen injection system in North and South Lake Cornelia is recommended for further consideration to prevent winterkill of beneficial predator fish species and promote a healthy, more balanced fishery. Other management activities to reduce the bottom-feeding fish population should also be considered after collection of additional information on the migration and movement of these species.

Invasive plant management in Lake Edina — Treatment of invasive curly-leaf pondweed in Lake Edina is recommended to prevent it from further threatening the lake's aquatic plant community and to minimize the plant fragments conveyed to Nine Mile Creek and downstream Normandale Lake.

Recommended Watershed Management Practices

Study results indicate that the greatest source of phosphorus to Lake Cornelia and Lake Edina is stormwater runoff. Because the watersheds are fully-developed, significantly reducing the phosphorus inputs from watershed runoff is logistically challenging and expensive. One BMP that is recommended is installation of a **spent lime/CC17 treatment chamber** under the parking lot in Rosland Park (see image at right). The innovative spent lime/CC17 treatment chamber would serve as a "polishing" step, diverting a portion of the discharge from Swimming Pool Pond through the

WHAT IS SPENT LIME TREATMENT?

Using spent lime, or other calcium carbonate-based media like crushed limestone (CC17), to remove phosphorus from stormwater is a relatively new and innovative approach that several local watershed management organizations have been experimenting with in recent years. While still experimental, benefits of using spent lime to treat stormwater include:

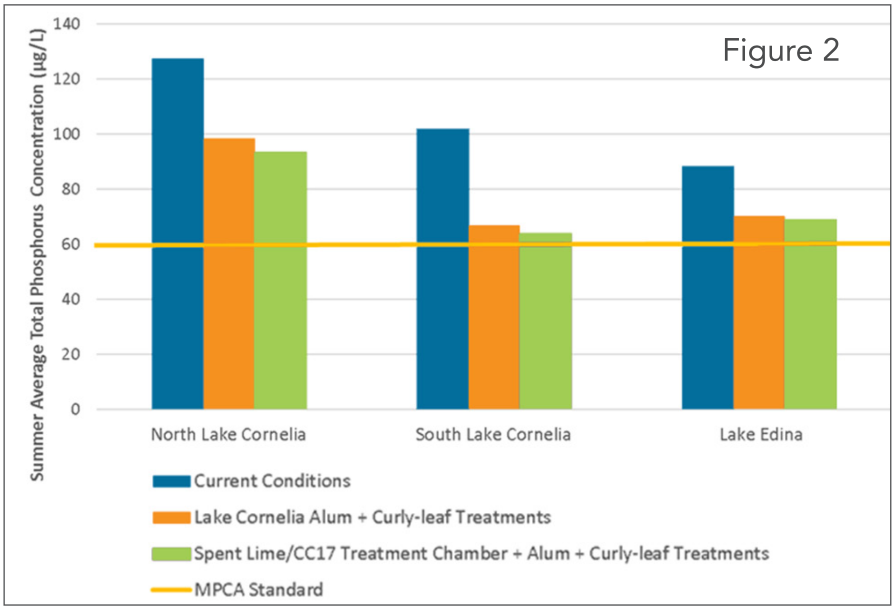
- Spent lime is considered a "waste material" from water treatment plants and thus, a green material with low material costs.
- Rapid chemical substitution reactions between phosphate and carbonate lead to a high treatment capacity.
- Unlike iron-sand filters, spent lime performance is not affected by low oxygen conditions.
- Spent lime material has high hydraulic conductivity, so it can treat a large amount of water in a small treatment area.
- Spent lime treatment can remove both particulate and dissolved phosphorus.

Spent Lime Sample

spent lime filtration chamber to remove dissolved phosphorus before discharge to Lake Cornelia. Figure 2 shows the predicted improvements in summer-average phosphorus concentrations in all three lakes as a result of the spent lime/CC17 treatment chamber, in combination with the alum and curly-leaf pondweed treatments. While the incremental improvement resulting from the watershed BMP is not significant, reducing the external phosphorus loading will also increase the longevity of the alum treatment (and therefore the frequency of repeat treatments) and reduce future build-up of phosphorus in lake bottom sediments.

Another potential watershed management practice for consideration is an expanded **street sweeping program**. Study results show that a weekly street sweeping program can result in reliable and consistent reductions in phosphorus removal from stormwater runoff. However, this nonstructural BMP only showed moderate improvements in lake water quality, similar to other watershed management practices. An expanded street sweeping program to target residential streets or streets and/or commercial parking lots not already treated by BMPs could be considered further.

Other recommended watershed management practices that landowners can implement include rain gardens, shoreline buffers, redirection of gutter downspouts, clean-up of grass clippings, and participation in the adopt-a-drain program.



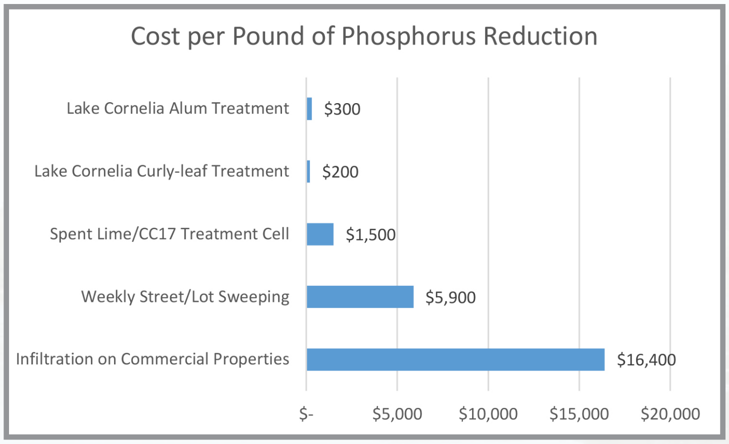
Street sweeping can help reduce the amount of pollutants that reach the lakes from stormwater runoff.

Water moves through the spent lime filtration chamber to remove phosphorus before discharge to Lake Cornelia.

IMPLEMENTING COST-EFFECTIVE IMPROVEMENTS

COST EFFECTIVENESS OF POTENTIAL MANAGEMENT PRACTICES

The management practices evaluated as part of this study span a wide range of treatment scales, costs, and effectiveness. A cost-benefit analysis was completed for the modeled management practices to compare the cost effectiveness in terms of dollars per pound of phosphorus reduction achieved. As shown in the bar graph below, the in-lake management practices (alum treatment and curly-leaf pondweed management) have the lowest cost per pound of phosphorus reduction achieved, indicating they provide the greatest overall cost effectiveness. Of the watershed management practices evaluated, the spent lime/CC17 treatment chamber is the most cost effective, with a cost per pound of phosphorus reduction considerably lower than that of weekly street sweeping or underground stormwater infiltration systems on commercial properties.



Cost comparison of various management practices in terms of dollars per pound of phosphorus reduction achieved to North Lake Cornelia during the time period of April through September.

PLANNING-LEVEL COST ESTIMATES FOR RECOMMENDED MANAGEMENT PRACTICES

Planning-level cost estimates for the recommended management practices are provided in the table below. These costs are intended to assist in evaluating and comparing potential management practices but should not be considered as absolute values. All estimated costs are presented in 2019 dollars and include costs for engineering and project administration.

Recommended Management Practice	Planning-Level Cost Estimate
Lake Cornelia Alum Treatment	$161,000
Lake Cornelia Curly-leaf Pondweed Management (annual cost)	$12,000[3]
Spent Lime/CC17 Treatment Chamber upstream of Lake Cornelia	$588,000
Lake Cornelia Direct Oxygen Injection System to Reduce Winterkill	$122,000[1,2]
Lake Edina Curly-leaf Pondweed Management (annual cost, as needed)	$20,000[1]

[1] Recommended management practice not specifically included in the lake modeling or cost-benefit analysis

[2] Costs for additional monitoring or implementation of management activities to reduce the bottom-feeding fish population not included.

[3] Cost estimate reflects costs for recent annual curly-leaf treatments conducted by the City of Edina.

Prepared by Barr Engineering Co.