Como Lake Management Plan

Capitol Region Watershed District
Saint Paul, MN

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Acronyms and Abbreviations

AAG	Agency Advisory Group
BMP	Best Management Practices
C	Community Actions
CACN	Como Active Citizen Network
Chl-a	Chlorophyll-a
CLMP	Como Lake Management Plan
CLP	Curly-leaf pondweed
CLSMP	Como Lake Strategic Management Plan (2002)
CRWD	Capitol Region Watershed District
DO	Dissolved oxygen
EPA	Environmental Protection Agency
FIN	Fishing in the Neighborhood program
FOC	Frequency of Occurrence
GIS	Geographic information system
L	Lake Actions
lbs/yr	Pounds per year
MNDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
NCHF	North Central Hardwood Forest
P	Phosphorus
P8	P8 watershed model
PAG	Public Advisory Group
RCPR	Ramsey County Parks and Recreation
RCPW	Ramsey County Public Works
SPPR	St. Paul Parks and Recreation Department
SPPW	St. Paul Public Works
TCMA	Twin Cities Metropolitan Area
TMDL	Total Maximum Daily Load
TP	Total phosphorus
µg/L	Micrograms per liter
W	Watershed Actions
WQS	Water Quality Standards

Executive Summary

Como Lake, a 70.5 acre shallow urban lake located in St. Paul's 348 acre Como Regional Park, is one of the most popular lakes in the region. Unfortunately, Como Lake has experienced poor water quality for decades due to excessive phosphorus and associated algal blooms. Algal growth has led to odor problems, reduced oxygen conditions in the lake, and winter fish kills. Phosphorus is the primary driver of water quality problems in Como Lake.

Como Lake has consistently exceeded the State shallow lake water quality standard in this region for phosphorus (60 µg/L). The long-term mean total phosphorus (TP) concentration in Como Lake is 173 µg/L, which is three times the State standard. Previous studies and analyses have determined that a 60% reduction in watershed TP loads, and a 95% reduction in internal TP loads will be required to meet the State water quality standard.

The characteristics of the watershed have significant influence on the amount of runoff and what pollutants are being delivered to the lake. Stormwater runoff carries excess pollutants like nutrients and sediment from the watershed to the lake, making the watershed a pollutant source. The Como Lake watershed (1,711 acres) includes portions of three cities (St. Paul, Roseville, and Falcon Heights) and has 13 major subwatersheds that generate runoff to an extensive network of storm sewer pipes that discharge directly to Como Lake through twenty-two storm sewer outlets. The watershed contributes a significant portion of TP to Como Lake in addition to other pollutants of concern including chloride, sediment, and trash.

Capitol Region Watershed District (CRWD) is committed to improving water quality in Como Lake. In 2002, the Como Lake Strategic Management Plan was developed, which sought to reduce phosphorus in Como Lake through watershed management strategies. Through this plan, the implementation of several structural watershed best management practice (BMP) projects have reduced external phosphorus loading to the lake by approximately 20% since 2002. Despite these efforts, water quality in Como Lake remains poor.

To better understand the major drivers of water quality in Como Lake, CRWD completed the *Como Lake Water Quality Drivers Analysis Study* in 2017 to identify the sources and mechanisms of internal phosphorus loading in the lake (LimnoTech 2017). Based on the extensive record of monitoring data, the study identified diffusive flux of sediment phosphorus and the invasive aquatic plant, curly-leaf pondweed, as the primary drivers of water quality in Como Lake. Understanding the sources and mechanisms of internal phosphorus loading in Como Lake was a critical step toward developing in-lake management strategies that would be most effective for improving water quality.

CRWD recognized the need for an updated lake management plan that reflects current water quality issues and identifies strategies for additional watershed and in-lake management to improve water quality in Como Lake. In response, CRWD has developed a revised Como Lake Management Plan (CLMP) with the goal of utilizing a holistic, adaptive management approach for achieving Como Lake water quality goals. The CLMP identifies in-lake and watershed management strategies that are based on the latest science, technology, and community input to serve as a framework for meeting water quality goals. The life of the plan is defined as 20 years (2019-2039) to allow enough time for Como Lake to respond to in-lake and watershed management actions and achieve ecological balance. Como Lake has been degraded for several decades and it will take significant effort and time to improve water quality.

The CLMP takes an adaptive management approach for improving Como Lake and its watershed. Adaptive lake management planning is an iterative and flexible method for improving a resource over time by learning from management outcomes during the process. Management actions will be implemented and regularly monitored to evaluate progress at interim milestones (every three years) so that the direction of the plan can be modified, if needed, to achieve desired goals and objectives.

Taking an adaptive management approach acknowledges that a lake is a dynamic living ecosystem that may not immediately or fully respond to management actions as predicted. An adaptive management approach accounts for the inherent uncertainty in the long-term response of Como Lake to management actions due to the complexity of issues contributing to Como Lake's water quality. Therefore, it is unrealistic to plan long-term management actions with a high degree of specificity. In the CLMP, several actions are recommended for short-term implementation in the first three-years while several long-term actions are also provided for future consideration pending the Lake's response to implementation activities in the near-term.

Annual monitoring and assessment will continue in order to measure progress towards water quality improvement. As part of the adaptive management planning process, CRWD and partners will use this data to critically evaluate progress toward water quality goals at three-year intervals. This approach will not only allow CRWD to change direction, but also builds in flexibility to account for changing environmental conditions such as climate change and emerging technologies that may be suitable for Como Lake. Through this reassessment, CRWD will update the CLMP short-term implementation plan every three years. This update will describe the success of implemented actions and then define a new set of actions to be implemented, as needed, over the next three-year cycle in the CLMP.

An important component of the CLMP development process was stakeholder engagement to establish goals and expectations for Como Lake. As part of the CLMP planning process, two stakeholder advisory groups were formed to ensure all interests and inputs were included in the development of the plan—the Agency Advisory Group (AAG) and the Public Advisory Group (PAG). Both groups met several times between 2018-2019 during the CLMP planning process to assist in identifying issues.

Six major themes of issues were derived from the AAG and PAG. Those themes were then combined with the State water quality standards to define five overarching goals with measurable objectives for the CLMP. Management goals set a vision for Como Lake, and associated objectives provide a mechanism to measure progress towards meeting those goals. The five overarching management goals for Como Lake and its watershed include:

- **Goal 1: Como Lake will be managed as an ecologically healthy, shallow lake.**
- **Goal 2: Maintain healthy shoreline areas that can support a variety of wildlife and contribute to the ecological health of Como Lake.**
- **Goal 3: Maintain a variety of year-round recreational opportunities that are appropriate for a shallow urban lake.**
- **Goal 4: Achieve strong sustained community engagement and stewardship to improve and protect Como Lake.**
- **Goal 5: Utilize the best science, partnerships, and resources to ensure successful implementation of the CLMP over the life of the plan (20 years).**

Recommended management actions are actual projects, programs, events, or organized efforts that will work toward achieving each CLMP goal and measurable objective. The CLMP proposes a combination of lake (L), watershed (W), and community-based (C) management actions to be carried out over the life of

the plan to achieve each goal. Lake management actions will seek to control internal phosphorus loads and enhance ecological integrity. Watershed management actions will include structural and non-structural BMPs that reduce phosphorus loads from stormwater runoff. Community-based management actions will work to help build stewardship of and pride in of Como Lake.

The recommended CLMP management actions will be implemented over the life of the plan using the adaptive management framework. Recommended actions are categorized by Short-term, Ongoing, or Long-term. The Short-term Implementation Plan identifies the specific projects, programs, and actions to be carried out in the near-term. Ongoing actions are recommended to occur frequently or annually throughout the 20-year life of the plan. Actions listed as Long-term (3-20 years) are provided for future consideration pending the outcomes of Short-term actions toward meeting the CLMP goals.

It will be challenging and costly to attain all of the goals and objectives of the CLMP. Due to the adaptive management approach being used for the CLMP, it is not possible to define a long-term (~20 year) project list with associated costs like would be done in a more typical management plan. However, the adaptive management approach will encourage cost-effective and timely decision-making. Regular updates to the implementation plan will incorporate stakeholder feedback and will include the improved details of Como Lake's response as well as costs and logistics.

CRWD will seek funding to implement management actions in the CLMP through grants and outside cost-share funding. Where known cost-share opportunities are lacking, partnerships may be developed for cost and workload sharing. Costs and responsibility will be shared with partners whenever possible. CRWD is committed to improving water quality in Como Lake and looks forward to working with local partners to implement the CLMP.

1 Introduction

1.1 Overview and Purpose

Como Lake, a 70.5 acre shallow urban lake located in St. Paul's 348 acre Como Regional Park, is one of the most popular lakes in the region (Figure 1). Unfortunately, Como Lake has experienced poor water quality for decades due to excessive phosphorus and associated algal blooms. Excessive algal growth has led to odor problems and reduced oxygen conditions in the lake, which has resulted in winter fish kills on numerous occasions. Water quality problems in Como Lake were first observed and documented in 1945 (Noonan 1998).

Capitol Region Watershed District (CRWD) is committed to improving water quality in Como Lake. In 2002, CRWD adopted the Como Lake Strategic Management Plan (CLSMP) to define an implementation plan for improving Como Lake water quality largely through watershed management strategies (CRWD 2002). Water quality improvement strategies focused on reducing phosphorus inputs, which is the key nutrient of concern in Como Lake. Through this plan, the implementation of several structural watershed best management practice (BMP) projects have reduced external phosphorus loading to the lake by 20% since 2002. Despite these efforts, water quality in Como Lake remains poor.

To better understand why water quality has not improved in Como Lake, CRWD completed the *Como Lake Water Quality Drivers Analysis Study* in 2017 to identify the sources and mechanisms of internal phosphorus loading in the lake (LimnoTech 2017). Based on the extensive record of monitoring data, the study identified diffusive flux of sediment phosphorus and the invasive aquatic plant curly-leaf pondweed as the primary drivers of water quality in Como Lake. Understanding the sources and mechanisms of internal phosphorus loading in Como Lake was a critical step toward developing management strategies that would be most effective for controlling internal loading and improving water quality.

To continue improving Como Lake, CRWD recognized the need for an updated management plan to expand upon efforts completed under the 2002 CLSMP and to reflect current water quality issues and drivers identified in the *Como Lake Water Quality Drivers Analysis Study*. In response, CRWD has developed a revised Como Lake Management Plan (CLMP) with the goal of utilizing a holistic, adaptive management approach for achieving Como Lake water quality goals.

Presented here, the CLMP identifies in-lake and watershed management strategies that are based on the latest science, technology, and community input to serve as a framework for meeting water quality goals. The life of the plan is defined as 20 years (2019-2039) to allow enough time for Como Lake to respond to in-lake and watershed management actions and achieve ecological balance. In addition, the CLMP is structured as an adaptive management plan (detailed in Section 1.2), so it will be adjusted every three years to account for the Lake's response to management.

In subsequent sections, the CLMP provides detail on management roles, partnerships, and the CLMP development process. The CLMP also includes a characterization of Como Lake and the watershed, water quality standards and reduction goals, historical management activities, management goals and associated actions, implementation activities and schedule, and financing opportunities.

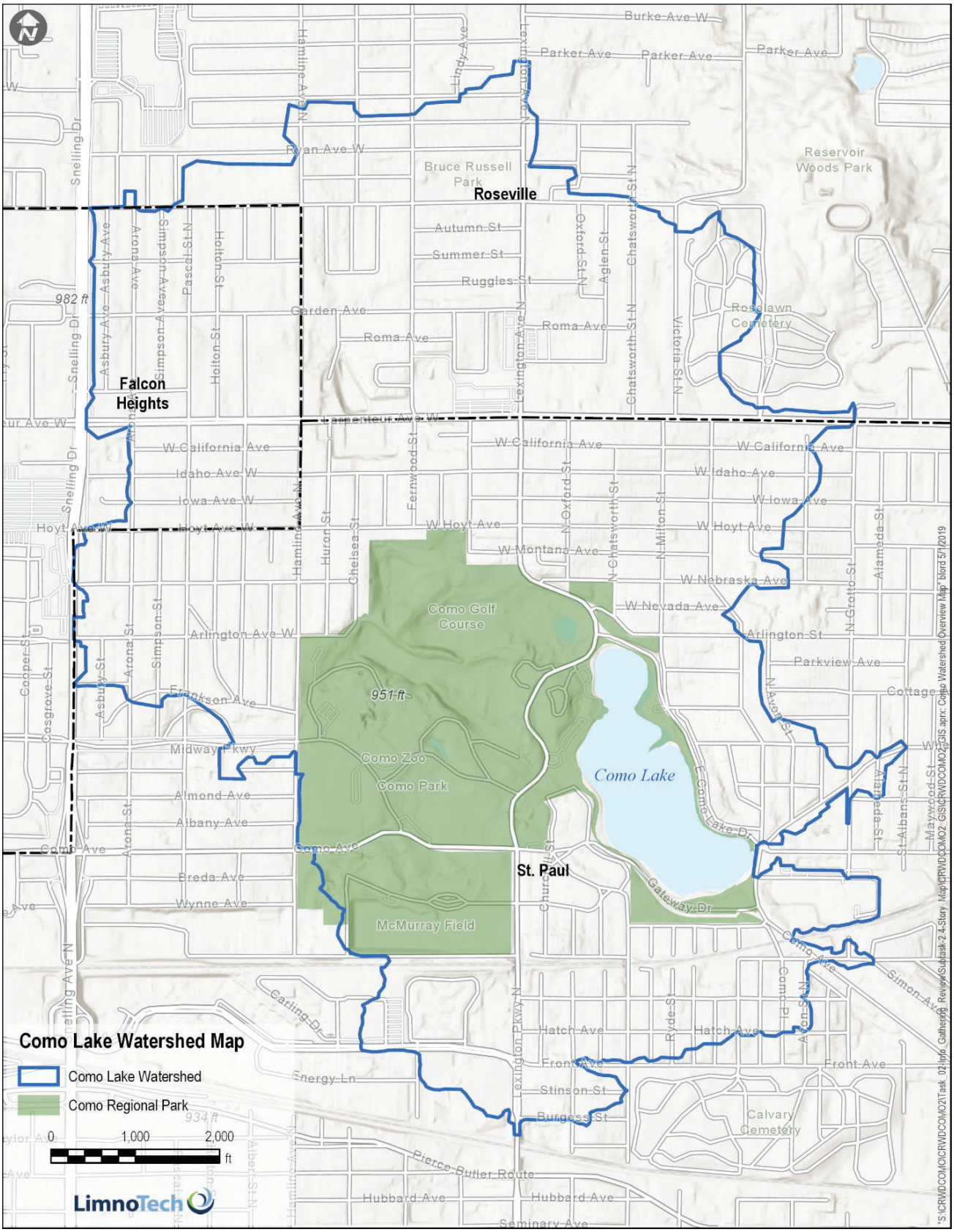

Figure 1. Como Regional Park, Como Lake, and the Como Lake watershed in St. Paul, MN.

1.2 Como Lake Management Plan Framework

Como Lake is a highly valued community resource that is managed by CRWD and local and state governmental partners. The water quality problems in Como Lake have persisted for decades, and as a result, it will take significant effort over the course of many years to achieve improvement goals. The primary purpose of the revised plan is to develop a holistic and adaptive lake management strategy that will be used as a framework for CRWD, local partners, and community stakeholders to improve Como Lake over time. CRWD's approach to adaptive management of Como Lake is described below.

1.2.1 Adaptive Management Approach

The CLMP is an adaptive management approach for improving Como Lake and its watershed. Adaptive lake management planning is an iterative and flexible method for improving a resource over time by learning from management outcomes during the process. Management actions will be implemented and regularly monitored to evaluate progress at interim milestones (every three years) so that the direction of the plan can be modified, if needed, to achieve desired goals and objectives. The adaptive lake management plan will be carried out over a twenty-year period (2019-2039) to allow enough time for the Lake to respond to in-lake and watershed management actions and achieve ecological balance.

Taking an adaptive management approach acknowledges that a lake is a dynamic living ecosystem that may not respond immediately or fully to management actions as predicted. An adaptive management approach accounts for the uncertainty with implementing management actions and builds in a framework for addressing it. Based on the latest science and other case studies, we can estimate how Como Lake will respond to management actions in the near-term. However, there is inherent uncertainty in the long-term response of Como Lake to management actions due to the complexity of issues contributing to Como Lake's water quality. Therefore, it is unrealistic to plan long-term management actions with a high degree of specificity. In the CLMP, several actions are recommended for short-term implementation in the first three years while several long-term actions are also provided to be considered in the future pending the Lake's response to implementation activities in the near-term. CRWD will update the CLMP short-term implementation plan every three years to define a new set of actions to be implemented over the next three-year cycle within the life of the plan.

Steps for Adaptive Management

Figure 2 illustrates the six key steps of the adaptive management plan framework, which is a cyclical and iterative process to be implemented over the defined life of the plan. The steps of the framework include (in order) a condition analysis, goal setting, the evaluation of actions, implementation, monitoring and evaluation, reassessing, and then adaptively managing by starting the cycle over again at an interim milestone (every three years).

For the CLMP, the first step in the planning process was to complete the 'Condition Analysis' of Como Lake to identify the drivers of water quality (Figure 2). In 2017, the *Como Lake Water Quality Drivers Analysis Study* (LimnoTech 2017) evaluated Como Lake's long-term chemical, biological and physical data to determine the primary drivers of water quality under current conditions. In 2018, an existing P8 watershed model was recalibrated to include the most recent subwatershed delineations, changes in land use conditions, and the numerous structural BMPS that have been constructed since the year 2000 (HEI 2018). P8 is a model used to simulate pollutant loading from urban watersheds that also estimates pollutant removal from stormwater treatment structures (e.g. stormwater ponds). These studies analyzed and documented the latest scientific understanding of water quality issues in Como Lake and its watershed (Section 2).

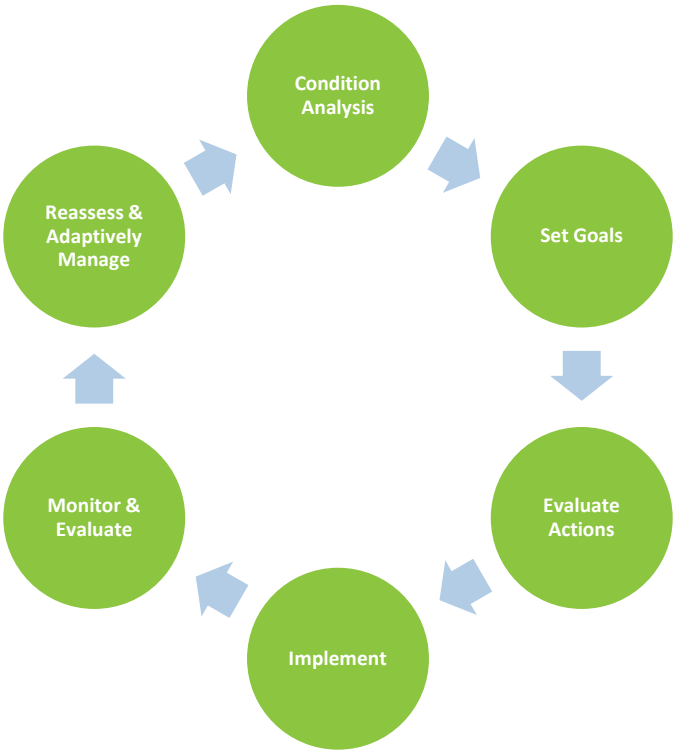

Figure 2. Adaptive Lake Management Planning Cycle.

The second step in the adaptive management planning process was to set goals for Como Lake (Figure 2). In addition to having a technical understanding of the Lake's issues and drivers of water quality, a successful lake management plan requires an understanding of the regulatory requirements and the goals and vision of the community. To learn about the community's concerns, CRWD held discussions for stakeholders to identify additional issues facing Como Lake from their perspective. This input was taken into consideration along with the regulatory requirements to develop management goals and objectives for the CLMP (Section 3), which serve as the basis for developing management actions to improve Como Lake.

Management actions are actual projects, programs, events, or organized efforts that will work toward achieving the goals and objectives of the CLMP. The third step in the adaptive management planning process (Figure 2) sought to evaluate and define what these actions are and how they would work toward achieving the goals and objectives when implemented (Section 4). The CLMP lays out three major categories of management actions, which include the following:

- **Lake Actions**: Actions that will be implemented in Como Lake to target lake-specific processes and pollutants.
- **Watershed Actions**: Actions that will be implemented in the Como Lake watershed to reduce pollutant loading to the lake.
- **Community Actions**: Actions that will require community support, provide education and outreach, and promote additional recreational opportunities to enjoy the lake and surrounding area.

Once actions have been evaluated and defined, the next step in the adaptive management planning process is implementation of those actions (Section 5). The first three years following adoption of the CLMP will require intensive implementation of management actions across all three categories to realize improvements in water quality. Phosphorus is the primary nutrient of concern in Como Lake, so early implementation of management actions that reduce external and internal phosphorus loading will be critical in order to improve water quality in Como Lake. Given that goal attainment will be a long, intensive process, actions have been further characterized in terms of schedule for implementation:

- **Short-term**: Actions that are recommended to be implemented within the first three years of CLMP adoption.
- **Ongoing**: Actions that are recommended to occur frequently or annually over the life of the plan.
- **Long-term**: Actions that are recommended for consideration pending evolution of short-term actions to meet goals.

The short-term, ongoing, and long-term management actions recommended in this plan provide a framework for what is needed to improve water quality in Como Lake. The details of how each action will be implemented will be further detailed in specific work plans that contain more prescriptive detail. Consequently, the CLMP describes what needs to occur, while additional work plans will be needed to describe how actions will be implemented.

Following the implementation of management actions, the next step in the adaptive management process is to monitor and evaluate the effectiveness of the actions (Figure 2). In the CLMP, monitoring efforts are included as actions in Section 4. Monitoring data will measure and confirm progress toward achieving the CLMP goals and will also provide basis for adjusting individual actions or the implementation plan as needed to support continued improvement of Como Lake.

The last step in the adaptive management process is to 'Reassess & Adaptively Manage' (Figure 2). The CLMP short-term implementation plan and monitoring data will be reviewed every three years by CRWD and partners to critically assess and document the Lake's response to implemented actions (Section 5). This step in the adaptive management planning process provides an opportunity to evaluate the Lake's response to initial actions, incorporate new lake and watershed management technologies and/or modify direction, if needed. This step allows for flexibility in planning and acknowledges that Como Lake is a complex living system that may not respond to actions as intended. It also accounts for changing environmental conditions, such as climate change, and makes room for future innovations that may be suitable for Como Lake. During the reassessment step, the CLMP short-term implementation plan will be updated for the next three years to define a new set of actions with will work toward achieving the CLMP goals and objectives.

The cycle of the adaptive management planning process will be carried out over the twenty-year life of the plan (2019-2039) to ensure goals and objectives are met.

1.3 Managing Como Lake—A Shared Responsibility

Como Lake has long been a beloved water resource in the region and has garnered prolonged and sustained stewardship. This stewardship is strongly supported by multiple segments of the Como Lake community. This takes many forms from individuals picking up trash around the Lake to a community group concerned with the condition of Como Lake petitioning the State of Minnesota to create the

Capitol Region Watershed District in 1998. Historically, there have been many groups/organizations within the community that have worked to improve Como Lake. A subset of those are described below.

1.3.1 Community Groups

Community-based groups have played a very critical role in developing and implementing initiatives to improve Como Lake. Community groups have been especially effective in uniting residents in the Como Lake watershed to promote stewardship and communicate the shared responsibility of residents in Como Lake's health. Prominent Como community groups include:

District 10 Community Council—The District 10 Community Council (District 10) is a City of St. Paul Planning District that covers a large portion of the Como Lake watershed. This council and specifically its Environment Committee has been integral in the management and improvement of Como Lake for the last 25 years. In the late 1990s, District 10 having been concerned about Como Lake's water quality and the lack of progress in improvement, petitioned the State of Minnesota to create the Capitol Region Watershed District to lead lake improvement efforts. District 10 has been instrumental in a number of key initiatives to improve Como Lake over the years, including rain barrel workshops, rain garden installations, shoreline restoration and many others.

Como Active Citizens Network—The Como Active Citizens Network (CACN) is group of concerned Como neighbors who meet and discuss issues related to the health of Como Lake. They further turn these discussions into action by organizing community actions, such as leaf cleanups, to reduce phosphorus in the Como Lake watershed. More recently CACN has turned their attention to chloride (salt) and its potential to impact Como Lake.

Other Groups—Other less formally-organized community groups beyond those listed above have participated in various aspects of work relative to Como Lake over the past several years, such as volunteer groups, school groups, church groups, and citizen volunteers. Activities have included leaf and trash clean-up events, raingarden maintenance, and wildlife observance.

1.3.2 Agency Groups

A number of agencies have helped with monitoring, planning, programming, funding, and construction of various elements related to Como Lake for the past several decades. Major efforts have previously been undertaken by the following agencies:

Ramsey County—Since 1984, Ramsey County has collected and analyzed water quality data for Como Lake. This extended record is integral to understanding the long-term trends and dynamics within Como Lake. It forms the basis for being able to understand what management strategies will work best in the lake. Additionally, Ramsey County has been a key partner in construction, operation and maintenance of watershed BMPs.

City of St. Paul Parks & Recreation—The City of St. Paul Parks and Recreation (SPPR) Department manages the land within Como Regional Park and is a major partner to CRWD for the collaboration and support of stormwater and lake improvement projects. This includes the critical riparian area around the lake as well as several hundred acres of parkland that drain to Como Lake. In addition to land management, SPPR department provides extensive amounts of recreational programming on, around and near Como Lake.

City of St. Paul Public Works—The City of St. Paul Public Works (SPPW)—Sewers manages much of the storm sewer infrastructure that delivers water from the Como watershed to Como Lake. SPPW—

Sewers has also been a key partner in implementing multiple stormwater BMPs in the Como Lake watershed.

Other Agencies—Other agencies that have provided assistance in monitoring, planning, programming, funding, and construction include: City of Falcon Heights, City of Roseville, Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, Minnesota Board of Water and Soil Resources, and Metropolitan Council.

1.3.3 Como Lake Management Plan Stakeholder Advisory Groups

An important component of the CLMP is engagement with the public and local partners to establish goals and expectations for Como Lake and evaluate lake management strategies that will achieve those goals. As part of the CLMP planning process, two stakeholder advisory groups were formed to ensure interests and inputs were included in the development of the plan—the Agency Advisory Group (AAG) and the Public Advisory Group (PAG).

Agency Advisory Group (AAG)

While CRWD is the lead agency of the CLMP, several local partners and state agencies participated in the AAG and provided valuable input during the planning process. AAG participants will continue to play vital roles during implementation of the CLMP. The AAG included participants from the following agencies:

- City of St. Paul
- City of Roseville
- City of Falcon Heights
- Minnesota Board of Water and Soil Resources
- Minnesota Pollution Control Agency
- Minnesota Department of Natural Resources
- Ramsey County Public Works
- Ramsey County Soil and Water Conservation District
- Ramsey-Washington Metro Watershed District
- Metropolitan Council

The first AAG meeting occurred on July 12, 2018, which outlined the CLMP purpose, process and schedule. The group also identified the major issues, goals, constraints and expectations for Como Lake from the agency perspective.

The second AAG meeting occurred on November 8, 2018, which discussed the major issues identified in the first meeting as well as those described by stakeholders in the first PAG meeting. The AAG also reviewed a draft set of goals and objectives that would work towards the identified issues and provided feedback on the feasibility of a suite of potential in-lake and watershed management actions that would address the major issues in Como Lake.

The third and final AAG meeting occurred on March 27, 2019 and focused on reviewing the Draft Como Lake Management Plan. AAG members asked questions and provided comment on the draft plan both at the meeting and through an online form during a 4-week comment period.

Public Advisory Group (PAG)

Local community members and Como Lake users were invited to join the PAG and participate in an extensive stakeholder engagement process to help guide and inform the CLMP. Community members

were invited to participate in the PAG meetings through direct email, social media invitations, press releases, distribution of postcards, and recruitment events where CRWD staff spoke directly to users around Como Lake on July 20th and 26th, 2018.

Invitation materials included web links to CRWD's website and the Como Lake Management Plan website that included additional materials and information related to Como Lake and the planning process.

The first PAG meeting was held on the evening of August 9, 2018 at the Como Lakeside Pavilion. The purpose of the first PAG meeting was to provide an update on the status of Como Lake and the planning process for the CLMP and give participants the opportunity to share with CRWD their concerns, hopes, and expectations for Como Lake.

Participants were asked three questions and provided anonymous responses to the following questions:

1. What draws you to or excites you most about Como Lake?
2. What do you think are the major issues or concerns for Como Lake today?
3. Looking forward, what hopes do you have for a healthy Como Lake?

Following the first PAG meeting, an online survey was created with the same three questions providing an opportunity for those not in attendance to give feedback. The online survey was advertised through email distribution, social media networks, CRWD's website and the Como Lake Management Plan website. The online survey was available through September 7, 2018. Over 800 responses were received from 200+ respondents between the PAG meeting, the online survey, and the recruitment events.

All of the input from the July recruitment events, August PAG meeting, and online survey was compiled into the *Stakeholder Input Summary* (Appendix A) to identify major themes and inform the development of management goals and objectives for the CLMP (Section 3).

The second PAG meeting was held on the evening of December 6, 2018 at the Como Lakeside Pavilion where the following information was provided to all interested stakeholders:

- Summary of issues concerning Como Lake that were expressed at the first PAG meeting and how those issues shaped goals and objectives for lake management.
- Summary of watershed modeling results with estimated phosphorus load reductions from existing and future BMPs.
- Lake management actions under consideration (Appendix B) that would address excess phosphorus in the sediments, curly-leaf pondweed, and fisheries management.

Participants formed small groups for discussion and were asked to anonymously respond to three questions related to the presented potential lake management actions:

1. What do you like?
2. What do you dislike?
3. What is missing?

By using open-ended questions, a wide range of comments could be received that focused less on generating "yes" or "no" responses to the proposed management strategies, and more on identifying the criteria by which the participants were evaluating them. Having the supporting information for *why* participants felt the way they did provides valuable feedback on participants' desires and concerns so they could be best addressed during the development of the CLMP. Following the PAG meeting, the

public was given the opportunity to provide further feedback on the draft goals and measurable objectives through an online form.

The third and final PAG meeting was held on March 28, 2019 at the CRWD office. The focus of this meeting was to review the Draft Como Lake Management Plan with the PAG and to answer questions and receive comments. The PAG was also invited to provide comment on the draft plan through an online form during a 4-week comment period. The draft plan and the online form were made available via email and the Como Lake Management Plan website.

2 Lake & Watershed Characterization

2.1 Shallow Lake Ecology

Como Lake is a shallow urban lake with a maximum depth of 15.5 feet and over 97% littoral area. In Minnesota, shallow lakes are characterized as having aquatic plants and water depths generally less than 15 feet (MDNR 2017a). Clear, shallow lakes with low nutrient concentrations are typically dominated by submersed aquatic plants. Shallow lakes with excessive nutrient loading often transition to a turbid state dominated by algae that no longer supports a healthy aquatic plant community (Wetzel 2001; Scheffer 2004; MSU 2010). Shallow lakes may oscillate between the clear and turbid states over time depending on environmental factors, but typically seek a state of equilibrium in one of the two states. Currently, Como Lake exists as a stable turbid lake.

Eutrophication describes the condition of a waterbody that has been overly enriched with nutrients (i.e. phosphorus and/or nitrogen) leading to the excessive growth of algae. Lakes will accumulate phosphorus in lake bottom sediments or in aquatic vegetation, which can be released into the water column under certain conditions. Phosphorus that is recycling within a lake ecosystem through biological, chemical and physical processes is referred to as internal loading. There are four primary sources of internal phosphorus loading in shallow lakes:

1. Diffusive sediment flux of dissolved phosphorus: Through complex reduction-oxidation chemical reactions, and typically under low oxygen conditions, dissolved phosphorus can release from the sediments into the water column.
2. Aquatic plant senescence: Upon senescence of aquatic plants, or plant die-off and decay, phosphorus bound in cellular structures is released into the water column.
3. Wind-driven sediment resuspension: Strong wind forces can cause sediment disturbance which can physically release dissolved phosphorus from sediment.
4. Bioturbation: Sediment disturbance by fish behavior (e.g. foraging, nest-building) can physically release dissolved phosphorus from sediments.

These four internal loading sources result in dissolved phosphorus becoming available for algae to consume and grow. The *Como Lake Water Quality Drivers Analysis Study* determined that diffusive sediment flux of phosphorus and aquatic plant senescence, particularly curly-leaf pondweed (CLP), are the primary sources of internal phosphorus loads in Como Lake, so management efforts should focus on reducing these sources (LimnoTech 2017).

Diffusive flux of phosphorus from the sediments differentially impacts water quality in shallow lakes compared to deep lakes because of differences in water mixing regimes between the two types of lakes. Deep lakes develop a vertical temperature gradient (i.e. stratification) where well-mixed surface waters (epiliminion) are warmer than the colder, denser bottom waters (hypolimnion). The zone of transition between the epilimnion and the hypolimnion is referred to as the thermocline. This thermal stratification is usually stable in deep lakes until forces such as wind cause the stratified layers to mix completely. This mixing event is referred to as “turnover” and typically occurs in spring and fall. Shallow lakes, in contrast, can also develop a thermocline, but it tends to be weak and easily disrupted by wind causing the entire lake to mix several times a year. Because of the frequent mixing in shallow lakes like Como Lake, phosphorus that diffuses from the sediments becomes available to surface algae during optimal growth conditions (i.e. extended sunlight and high temperatures) leading to summer algal

blooms. In contrast, diffusive flux of sediment phosphorus in deep lakes will be sequestered to the bottom waters, and mostly unavailable to surface algae until the lake mixes in spring or fall. Consequently, diffusive flux of phosphorus from sediments in shallow lakes can be a significant driver of water quality.

Due to the timing of its decay, CLP can be a significant source of phosphorus to lakes. CLP is an invasive aquatic plant that tends to die-off and decay in late June in the Upper Midwest, which results in a large release of phosphorus that becomes available for algal uptake. This early season pulse of phosphorus occurs when light and temperature conditions are optimal for algae growth, which can lead to algal blooms. In contrast, most native aquatic plants die-off in late summer when daylight is shorter and daily maximum temperature is lower. Not only is CLP a source of phosphorus, it also causes significant ecological damage to shallow lakes in the Upper Midwest (Section 2.2.4).

Reversal of the turbid, algal-dominated state to a clearer, native aquatic plant-dominated shallow lake is challenging and costly. Once phosphorus is reduced to the extent that algal blooms are no longer persistent and CLP is reduced significantly, the water in Como Lake will be clear enough for light penetration that can support an abundant, diverse, native aquatic plant community. Aquatic plants are critical for a shallow lake and serve many important ecological functions including habitat for fish and zooplankton, sediment stabilization, and nutrient uptake. Given that the majority of Como Lake is less than 5 feet deep, it is highly likely that native vegetation will colonize much of the shallow areas once the water is clearer and the CLP is not the dominant aquatic plant species. Consequently, management of the aquatic plant community in Como Lake will require ongoing maintenance in order to enhance ecological function while also balancing community needs for the Lake.

2.2 Como Lake Characterization

Como Lake is a 70.5 acre shallow lake located in St. Paul's 348 acre Como Regional Park and is one of the most popular lakes in CRWD. Como Regional Park is one of the most frequently visited parks in the Twin Cities Regional Parks System with approximately 5.4 million visitors in 2017 (Metropolitan Council 2018). The lake is frequented by residents and visitors who come for various forms of outdoor recreation, including running/walking, fishing, and boating. Non-motorized, car top carried boats and electric trolling motors are allowed on the lake for fishing and recreation purposes. The lake does not offer swimming opportunities and does not have a public boat launch.

2.2.1 Historical and Current Morphometry

Como Lake was formed in an ice-block depression and rests on glacial till with a mix of soils. Throughout recorded history, Como Lake has been altered from its original shape and depth. Recent sediment borings indicate that Como Lake may have been shallower and could have been a wetland (CRWD 2002). In 1847, survey records indicate that the Lake was approximately 120 acres, compared to its 70.5 acres today. In 1895, the City of St. Paul dredged Como Lake to increase its depth from five to fifteen feet to reduce "swampiness" (CRWD 2002). The assumption is that "swampiness" at that time indicates conditions representative of wetlands. Como Lake continually diminished in size in the early 1900s, and notably, was drained by officials in 1923 to preserve the Lake by sealing the bottom. Following the draining, pumps and a dam were installed to increase water levels (CRWD 2002). In addition, the surrounding storm sewer drainage system have developed considerably, transforming Como Lake's contributing watershed to be significantly larger than the pre-settlement condition.

Currently, Como Lake has a large watershed to lake area ratio of 24:2, which indicates that the watershed strongly influences the lake through runoff from the surrounding area. Como Lake is

characterized as a shallow lake and has a maximum depth of 15.5 feet and mean depth of 6.5 feet and (Table 1; Figure 3). The littoral area, where the depth of the lake is shallow enough to allow sunlight to penetrate to the lake bottom, occupies over 97% of the lake area. The Como Lake hydraulic residence time, or the total length of time water entering the lake remains in the lake, is approximately 8 months.

Table 1. Existing morphometric characteristics of Como Lake.

Surface Area (acres)	Maximum Depth (ft)	Littoral Zone (%)	Volume (acre-ft)	Watershed Area (acres)	Watershed Area : Lake Area Ratio
70.5	15.5	97%	469	1,711	24:2

Figure 3. Bathymetry map of Como Lake showing depth contours and water quality (WQ) sampling stations (historical station labels shown in parentheses).

2.2.2 Water Quality in Como Lake

Como Lake has experienced water quality problems associated with frequent algal blooms and occasional fish kills for decades. Poor water quality was first recorded in 1945. Excessive nutrient loading, particularly phosphorus, is the primary cause of Como Lake's water quality problems. Consequently, Como Lake was listed on the State's 303(d) list of impaired waters for nutrients in 2002 and a Total Maximum Daily Load (TMDL) was developed in 2010 (EOR 2010). Additional detail on the Como Lake nutrient TMDL is provided in Section 2.4. Excessive nutrients like phosphorus leads to nuisance algal blooms, so reducing and controlling phosphorus in Como Lake is a top management priority.

Since phosphorus is the primary nutrient of concern and the major driver of water quality in Como Lake, the CLMP gives considerable discussion elsewhere in this report on the sources, impacts, and management of phosphorus. However, phosphorus is not the only pollutant of concern in Como Lake. Other pollutants of concern include chloride, sediment, trash, and mercury.

Chloride has emerged as a pollutant of concern to Como Lake as a result of winter deicing practices. Chloride, or road salt, is applied to streets in the Como Lake watershed during the winter months and flushes into the lake through snowmelt runoff and spring rainfall. Year-round monitoring has shown an increase in chloride concentrations in Como Lake overtime because, once in dissolved form, chloride cannot be removed from water and accumulates over time. As chloride accumulates in the lake, it can become toxic to freshwater aquatic life (plants, fish, macroinvertebrates). In addition, chloride can influence the thermal dynamics of a lake and can interfere with lake mixing (MPCA 2016b).

In 2014, Como Lake was listed as impaired for chloride by the Minnesota Pollution Control Agency (MPCA) because seasonal average chloride concentrations in the lake were not meeting the state standard of 230 µg/L (MN Statute 7050.0222). However, the impairment listing of Como Lake for chloride is not unique to the Twin Cities metro area. Road salt application has had a significant regional effect with several other metro lakes also listed as impaired. In 2016, the MPCA finalized the Twin Cities Metro Area (TCMA) Chloride TMDL to address 39 waterbodies in the 7-county metropolitan area that exceed chloride levels considered safe for freshwater ecosystems (MPCA 2016). That same year, the MPCA released the TCMA Chloride Management Plan to provide a framework for implementation of the TMDL (MPCA 2016). Management actions for chloride reduction in the CLMP are based on the MPCA (2016) framework.

Sediment (silt, sand, clay) entering Como Lake from the watershed is also problematic because it accumulates in the lake, subsequently reducing lake volume, creating sediment deltas, and burying aquatic habitat on the lake bottom. Excess sediment can also damage fish gills and inhibit food foraging on the lake bottom for many fish species. In addition, other pollutants such as phosphorus and heavy metals can be transported to the Lake while chemically bound to sediment particles. Como Lake does not currently exceed criteria for turbidity from sediment, but given the correlation to other pollutants of concern and impacts on water quality, the CLMP contains actions that address excess sediment loading.

Lastly, Como Lake was added to the MPCA's list of impaired waterbodies for mercury in 1998. Atmospheric deposition of mercury from power plant emissions is uniform across the state of Minnesota and has led to mercury impairment of water and fish in many waterbodies across the state (MPCA 2007). Consequently, the state of Minnesota developed the Minnesota Statewide Mercury TMDL in 2007, which was approved by the United States Environmental Protection Agency (EPA). Mercury emission reduction goals are being addressed at state and regional scales and are being addressed through the Implementation Plan for Minnesota's Statewide Mercury TMDL (MPCA 2009); therefore, it is not considered in this management plan.

Water Quality Monitoring

Starting in 1984, water quality samples are collected in Como Lake every two weeks throughout the growing season (May through October) by Ramsey County Public Works (RCPW). These water quality samples are collected from the surface and bottom waters at the deepest spot in the Lake. Samples are analyzed by RCPW for the following parameters: total phosphorus (TP), soluble reactive phosphorus, chlorophyll-a (Chl-a), nitrate, ammonium, total Kjeldahl nitrogen, turbidity, and chloride. Secchi depth is also measured during each sampling event along with depth profiles of dissolved oxygen (DO), temperature, pH, and conductivity. Phytoplankton and zooplankton samples are also taken from the lake surface waters. In addition, chloride is measured bi-weekly during the winter ice-covered period at the deepest point in the lake.

In 2017, CRWD began measuring continuous DO with sensors at three monitoring locations in the Lake (Figure 3) to measure anoxia near the sediment surface. The sensors were generally deployed from May through October in 2017 and 2018 in order to measure temporal and spatial patterns in anoxia. Quantification of the spatial extent and temporal extent of anoxia in the Lake facilitates estimation of the diffusive flux of phosphorus from the sediments.

Water Quality Standards

Como Lake is regulated by the shallow lake eutrophication standards for the North Central Hardwood Forest (NCHF) Ecoregion (MN Statute 7050.0222). Eutrophication is the condition where a waterbody has been overly enriched with nutrients leading to excessive algal blooms. In most Minnesota lakes, algae are phosphorus limited. Chl-a is a measurement of algal biomass. The biological response to more phosphorus is higher algal production, and therefore, higher concentration of Chl-a. Secchi depth is a measure of water clarity and can be used as a proxy for estimating the amount of algae in a lake. Consequently, the MPCA developed numeric eutrophication standards for both shallow and deep lakes in Minnesota that integrates all three parameters. For shallow lakes, the State standards specify that the growing season (June-September) average TP concentration must be less than 60 µg/L, Chl-a must be less than 20 µg/L, and Secchi Depth (measure of water clarity) must be greater than 1 meter (Table 2).

Table 2. MPCA shallow lake eutrophication standards for the NCHF ecoregion.

Eutrophication Standards for Como Lake		
TP (µg/L)	**Chl-a (µg/L)**	**Secchi depth (m)**
≤ 60	≤ 20	> 1.0

For impairment determination of a lake, Minnesota assesses TP, Chl-a, and Secchi data collected during the summer season with summer-average calculations limited to the upper 3 meters of the water column. A lake is considered impaired under MPCA standards if it exceeds the standard for TP concentration and either the Secchi disk depth or Chl-a concentration. Como Lake has annually exceeded shallow lake eutrophication standards for TP and Chl-a, but has met the standards for Secchi depth on occasion (Figure 4). Reduction in TP is critical for reducing Chl-a for regulatory purposes and for improving water quality Como Lake.

Water Quality Trends

Table 3 shows the long-term average (1984-2018) TP, Chl-a and Secchi depth for Como Lake's growing season (May – September). It should be noted that the MPCA defines the growing season for impairment determination as June 1 through September 30 (MN Statute 7050.0150). CRWD defines the summer growing season as May through September, which is representative of the start of the growing season relative to typical ice out and the period of data collection in Como Lake. Impairment determination, however, follows the MPCA definition for the growing season. The long-term mean TP is nearly three times greater than the water quality standard, while the mean Chl-a standard is 1.7 times the water quality standard. Table 3 also lists the growing season averages for the past 10 years (2008-2018), which are consistent with the long-term average, confirming that poor water quality in Como Lake has persisted for decades with little sign in improvement.

Table 3. Growing season averages for total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth in Como Lake for the period of record (1984-2018) and the last ten years (2008-2018).

Parameters	TP (µg/L)	Chl-a (µg/L)	Secchi depth (m)
Period of Record (1984-2018) Growing Season Average (May - Sept)	174	34.2	1.4
10-year (2008-2018) Growing Season Average (May - Sept)	168	32.8	1.0

Figure 4 shows the mean annual TP, Chl-a, and Secchi depth for the same period of record (1984-2018). Mean TP and the biological response variables (Chl-a and Secchi depth) show considerable inter-annual variability in the period of record (1984-2018). As Noonan (1998) noted, these parameters exhibit a cyclical pattern over time in response to variability in annual nutrient loading and management actions. Chl-a and Secchi depth are highly correlated to TP, so annual patterns are expected to be similar among these parameters.

Long-term trends in epilimnetic (surface waters) and hypolimnetic (bottom waters) TP are shown in Figure 5. Mean epilimnetic TP far exceeds the shallow lake TP standard, which applies to the epilimnion. Hypolimnetic TP is considerably higher than epilimnetic TP in all years and is likely the result of significant internal phosphorus loading from the bottom sediments (LimnoTech 2017). There is considerable inter-annual variability in epilimnnetic and hypolimnetic TP. These trends are a function of higher precipitation in some years leading to more phosphorus loading from the watershed as well as higher diffusive flux of sediment phosphorus in some years. Diffusive flux of sediment phosphorus is controlled primarily by the spatial and temporal extent of anoxia which also varies among years. In some years, a peak in the hypolimnetic TP appears to also cause a peak in epilimnetic TP (e.g. 2001 and 2012). However, this direct influence is challenging to disentangle from additional external phosphorus loading that occurs within the same year as well. A more detailed discussion on phosphorus trends and drivers can be found in LimnoTech (2017).

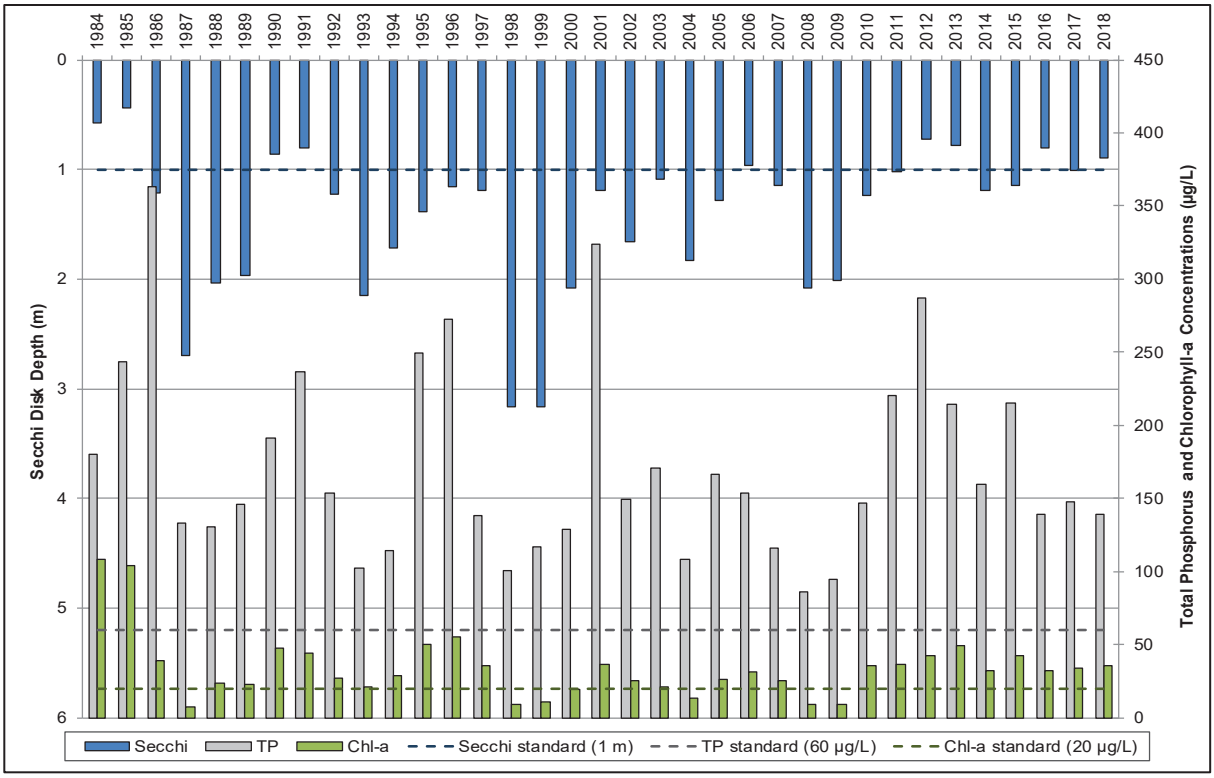

Figure 4. Summer mean total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi depth in Como Lake (1984-2018).

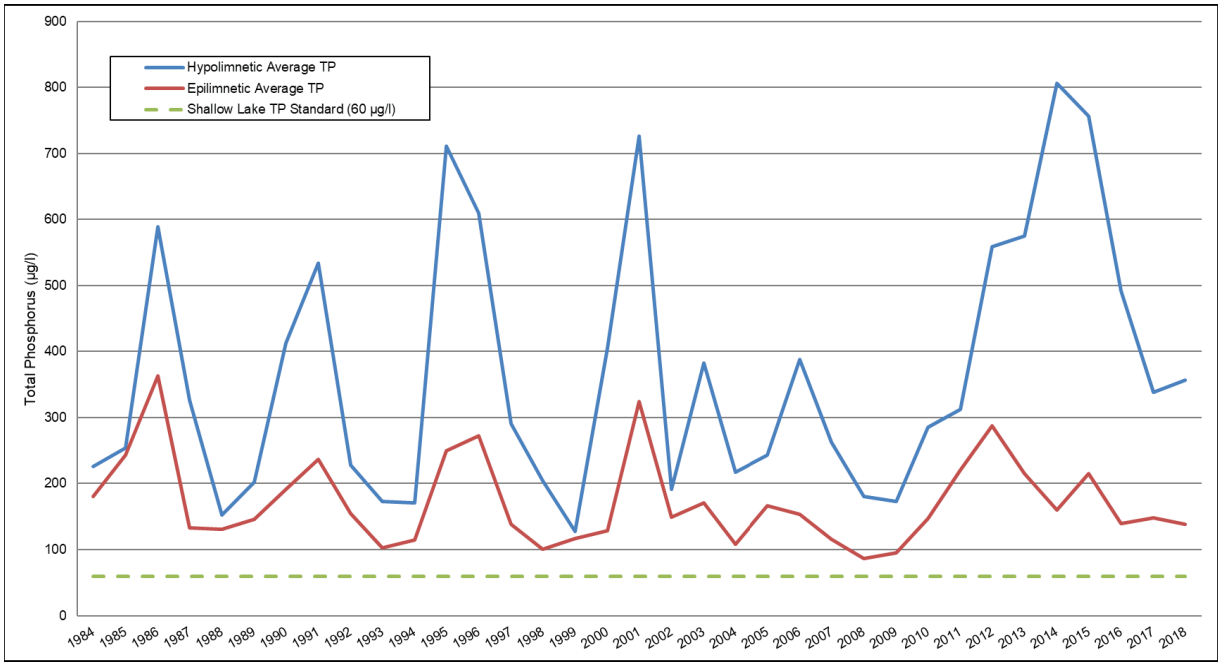

Figure 5. Epilimnetic and hypolimnetic total phosphorus (TP) for the years 1984-2018.

Drivers of Water Quality

Based on an extensive analysis of the long-term chemical, biological and physical data, the *Como Lake Water Quality Drivers Analysis Study* was completed in 2017 (LimnoTech 2017). The results of that study confirmed that external and internal phosphorus loading are the primary drivers of water quality in Como Lake. Diffusive flux of sediment phosphorus and release of phosphorus from senescence of curly-leaf pondweed (CLP) are the major internal loading mechanisms in Como Lake. An imbalanced fishery (i.e. forage fish/planktivorous dominated fishery) is also a contributing factor to poor water quality in Como Lake. Achieving water quality goals (see Section 3) in Como Lake will require a substantial reduction in external phosphorus loading through watershed BMPs. Reduction in internal loading will require either removal or inactivation of phosphorus in the sediments and considerable reduction in CLP density.

2.2.3 Lake Bottom Sediments

Diffusive flux of phosphorus from the lake sediments is a significant source of phosphorus and a primary driver of water quality problems in Como Lake. Under anoxic conditions, phosphorus can be released into the overlying water, which then becomes available for algal growth. Unless diffusive flux of phosphorus from the Lake sediments is significantly reduced, water quality improvements will not be possible in Como Lake (LimnoTech 2017).

The *Como Lake Water Quality Drivers Analysis Study* (LimnoTech 2017) found hypoxic to anoxic conditions in Como Lake that can persist throughout the summer growing season. Data analysis indicated that DO is rapidly depleted at the deepest monitoring station following a mixing event, which suggests high rates of sediment or hypolimnetic oxygen demand. High oxygen demand is usually indicative of large amounts of organic matter, which would be expected in a highly productive lake such as Como Lake. In addition, these summer anoxic patterns were prevalent in historical data (1991-1993) at the shallow monitoring stations. To better understand DO patterns at the deepest and shallow stations, CRWD installed continuous DO sensors and loggers to monitor DO conditions throughout the summer growing season. These data confirmed that Como Lake exhibits hypoxic and anoxic conditions throughout the summer at multiple depths for extended durations. The consequence of this is that anoxic conditions drive phosphorus release from the sediments.

Based on data available at the time, LimnoTech (2017) estimated internal phosphorus loads to be in the range of 293-819 lbs P/year with the high range of variability due to the uncertainty in the temporal and spatial extent of anoxia in Como Lake. The continuous DO data collected by CRWD in 2017 and 2018 helped to constrain these estimates resulting in approximately 369-371 lbs P/year from diffusive sediment flux. An updated water quality model for Como Lake will be needed to confirm annual internal loading and the 2010 TMDL reduction goals (Section 2.4). This model should include the revised subwatershed model results, recent monitoring data, and rates of sediment phosphorus flux measured from intact sediment cores.

2.2.4 Aquatic Vegetation

Aquatic plant surveys have been conducted periodically in Como Lake since 2005. Since 2013, multiple surveys per summer were conducted where in prior years, only a single annual survey was conducted. In recent years, CLP was the dominant, abundant plant observed especially in late Spring/early Summer. An example is shown in Figure 6, which shows the biovolume of aquatic vegetation (i.e. % occurrence) on May 31, 2018. The red areas indicate 100% coverage by aquatic vegetation, which was dominated by CLP.

CLP (*Potamogeton crispus*) is an invasive aquatic plant that is incredibly problematic for lake managers and nearly impossible to eradicate once it has become established. It is capable of growing under ice and often outcompetes native vegetation to quickly become the dominant aquatic plant species. In this region, it tends to die off and decay in mid- to late-June, which releases phosphorus back into the water column during optimal algal growth conditions (i.e. high midsummer temperature and sunlight). As a result, it can fuel summer algae blooms in Como Lake. CLP was first observed in Como Lake in the early 1990s and now dominates the aquatic plant community.

Of the native aquatic plant community in Como Lake, the following species are present: Canadian waterweed (*Eleodea canadensis*; a.k.a. American waterweed or pondweed), sago pondweed (*Potamogeton pectinatus*)(leafy pondweed (*Potamogeton foliusus*), coontail (*Ceratophyllum demersum*) Flatstem pondweed (*Potamogeton zosteriformis*), and filamentous algae (*Spirogyra/Cladophora* species). Muskgrass (Chara species), greater duckweed (*Spirodela polyriza*), lesser duckweed (*Lemna minor*) and wild celery (*Valisneria Americana*) have also been observed but typically in low density. In general, the density of the native pondweeds, duckweeds, coontail and filamentous algae tends to increase following CLP die-off in mid- to late-June.

Aquatic plants serve important functions in shallow lakes which includes habitat for fish and zooplankton, nutrient uptake, and stabilization of sediments. Another feature of shallow lakes is that sunlight can penetrate through the water column thereby supporting growth of aquatic vegetation. In algal-dominated shallow lakes, the lack of water clarity typically limits growth of aquatic plants. Following implementation of actions that reduce phosphorus, associated growth of algae, and the density of CLP, Como Lake should exhibit clearer water than it does currently. Under these new conditions, the native aquatic vegetation community can be expected to proliferate. While establishment of a native macrophyte community is a goal for Como Lake (see Section 3), some native species can also grow to nuisance conditions (e.g. coontail, Chara species, waterweed) and will need to be managed accordingly to prevent overabundance. As a result, ongoing monitoring and maintenance of the aquatic plant community in Como Lake will be necessary.

Aquatic plants, including CLP, have historically been mechanically harvested in Como Lake for recreational purposes to maintain paddling lanes or clear areas near the fishing piers. CLP is a rooted submerged aquatic plant that propagates via rhizomes and buds called turions, which can spread quickly. The rooted portions are not collected during mechanical harvesting so the plant will return each year and the data reflect that pattern. Additional management actions such as herbicide treatments will be required to reduce CLP density in Como Lake. Once density is reduced, management of the native aquatic plant community using mechanical harvesting may be required. These conditions will be evaluated and maintained accordingly as part of the adaptive management process.

Management strategies that target long-term reductions in CLP should be a top priority for management of the aquatic plant community in Como Lake. Long-term monitoring will be necessary to monitor abundance of CLP and establishment of native plant species following the implementation of CLP management activities.

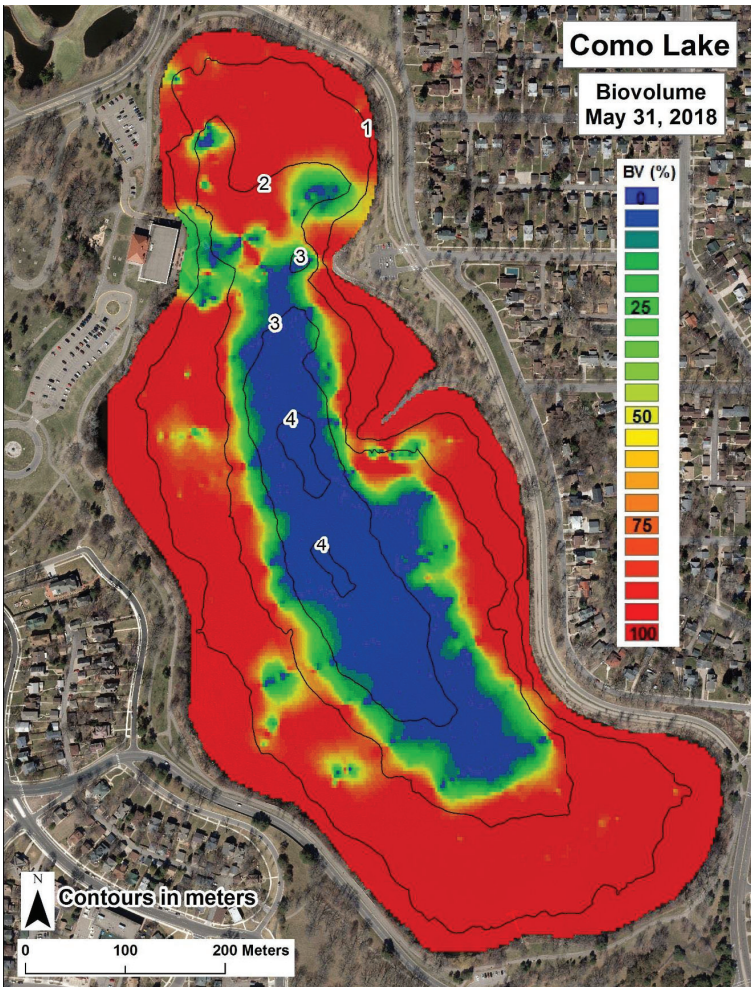

Figure 6. Biovolume (% occurrence) surveys of aquatic macrophytes in Como Lake from May 31, 2018. The red areas represent curly-leaf pondweed (CLP).

2.2.5 Fisheries

Fish surveys have been conducted in Como Lake periodically since 1976, primarily by the Minnesota Department of Natural Resources (MNDNR) with some supplemental sampling sponsored by CRWD. Fisheries management for Como Lake began in the 1980s. Frequent winter fish kills prompted the installation of an aeration device in October 1985. At that time, the fish community was dominated by omnivores and rough fish, which included goldfish, black bullhead, and common carp. Bullhead and carp can significantly impact water quality by resuspending sediments through feeding behavior which releases dissolved phosphorus into the water column. Rotenone was applied to the lake in 1985 to kill the existing rough fish community, then restocked with bluegill, walleye and largemouth bass as part of a biomanipulation strategy to improve water quality (Noonan 1998). Biomanipulation intends to create changes in the lake ecosystem through manipulation of the fish community. Often this technique is employed in an effort to shift a lake from a turbid, algal dominated state to a clear, macrophyte dominated state using the fish community. The goal of this strategy is to increase the zooplankton community capacity to significantly graze on algae. As Noonan (1998) reported, Como Lake responded positively to the biomanipulation and shifted to a clearer water state for a brief duration. However,

external and internal phosphorus loads persisted, so the lake shifted back to a turbid state. Biomanipulation can produce a positive response, but typically requires ongoing maintenance and must be used in conjunction with other nutrient reduction and control strategies for sustained improvements in water quality.

Currently, Como Lake is stocked by the MNDNR through their Fishing in the Neighborhood (FIN) Program (MNDNR 2017b), which aims to increase angling opportunities in urban lakes. The species stocked historically by the MNDNR include bluegill, channel catfish, largemouth bass, walleye and yellow perch. On October 1, 2018, MNDNR stocked Como Lake with 293 lbs of walleye in an effort to increase the population of top predators. Total annual fish abundance measured during surveys since 2001 is shown in Table 4. Total fish abundance was highest in 2001 and 2006 and lowest in 2014. Prior to recent walleye stocking, the fish community has been dominated by black crappie followed by black bullheads or bluegill sunfish since 2006.

The fish community in Como Lake has few top predators (e.g. walleye, northern pike), and is dominated by planktivorous forage fish (e.g. sunfish, black crappie) due to combination of low predation pressure, historical stocking practices, and likely recreational fishing pressure (LimnoTech 2017). As a result, cascading effects on the zooplankton community have been observed (LimnoTech 2017). The term trophic cascade refers to the process where changes in the upper trophic levels impacts lower trophic levels, ultimately affecting algal density. The zooplankton community in Como Lake is dominated by small-bodied zooplankton, which is a result of predation pressure by planktivorous fish preferentially consuming large-bodied zooplankton like *Daphnia*. The consequence of this is that small-bodied zooplankton are less efficient grazers than large-bodied zooplankton so the existing zooplankton community in Como Lake is not effectively reducing algal density.

Table 4. Total abundance of fish species surveyed through trap nets and gill nets in Como Lake.

	Number of Fish Caught Per Survey Effort Per Year					
	2001	**2006**	**2011**	**2014**	**2015**	**2016**
Black Bullhead	71	603	71	14	190	155
Black Crappie	162	47	271	121	233	258
Bluegill Sunfish	4	329	236	6	2	106
Brown Bullhead	1	0	0	0	1	0
Channel Catfish	1	0	18	3	10	3
Common Carp	0	0	0	0	1	0
Golden Shiner	690	12	2	18	6	4
Green Sunfish	0	6	0	0	0	0
Hybrid Sunfish	1	4	9	0	2	11
Largemouth bass	0	0	1	0	0	0
Northern Pike	104	65	49	15	20	7
Pumpkinseed	0	17	29	4	0	3
Walleye	0	20	5	6	19	2
White Sucker	13	1	3	0	3	0
Yellow Bullhead	81	31	33	0	12	0
Yellow Perch	8	5	14	13	1	3
Total / Survey	1136	1140	741	200	500	552

2.2.6 Wildlife

Como Lake supports a variety of wildlife and serves as a habitat sanctuary amidst a densely urbanized area. Throughout the year, several species of mammals, reptiles, birds and pollinators can be observed at Como Lake. The presence, diversity, and abundance of wildlife can be an indicator of Como Lake's ecological integrity. Future efforts should work toward documenting these species over time to assist in assessing the ecological health of Como Lake.

One effort toward assessing wildlife at Como Lake was a turtle study conducted in 2011 by the Como Community Council and District 10. The study evaluated turtle populations in Como Lake by species type. From May 1, 2011 through August 23, 2011, volunteers observed 2052 Painted Turtles and 47 Snapping Turtles basking in and around the lake (District 10 2011). In May, June and July 2011, Como Zoo personnel and volunteers set traps to capture turtles to record characteristics. During that time, 118 Painted Turtles and 32 Snapping Turtles were caught, measured, sexed and released. Although only two species were identified during the study, Como Lake appeared to have a robust turtle population as of 2011.

2.3 Como Lake Watershed

The Como Lake watershed has a total area of 1,711 acres and includes portions of the cities of St. Paul, Roseville, and Falcon Heights (Figure 7). Runoff from 13 major subwatersheds (Figure 8) drains off the land to an extensive network of storm sewer pipes that discharge directly to Como Lake through twenty-two storm sewer outlets.

2.3.1 Watershed Boundaries

The Como Lake watershed includes the total area of land draining to the lake (1,711 acres). The watershed boundary was determined using GIS mapping and takes into consideration the local topography and drainage networks surrounding Como Lake.

Thirteen major subwatersheds within the Como Lake watershed were also defined (Figure 8). A subwatershed is a localized drainage area within a greater watershed that drains to the lake. The Como Lake subwatershed delineations (Como A-M) were determined using GIS and are based on 1) topography, 2) storm sewer discharge points (outfalls) to Como Lake, and 3) the subsurface storm sewer network extending upstream of the discharge point. The storm sewer networks in the Como watershed are complex, particularly in the Como B subwatershed. Under normal flow conditions, all of Como B subwatershed discharges through one outfall to Como Lake. Under high flow conditions, overflow from the Como B subwatershed main pipe is routed to four separate outfall pipes that discharge directly to Como Lake.

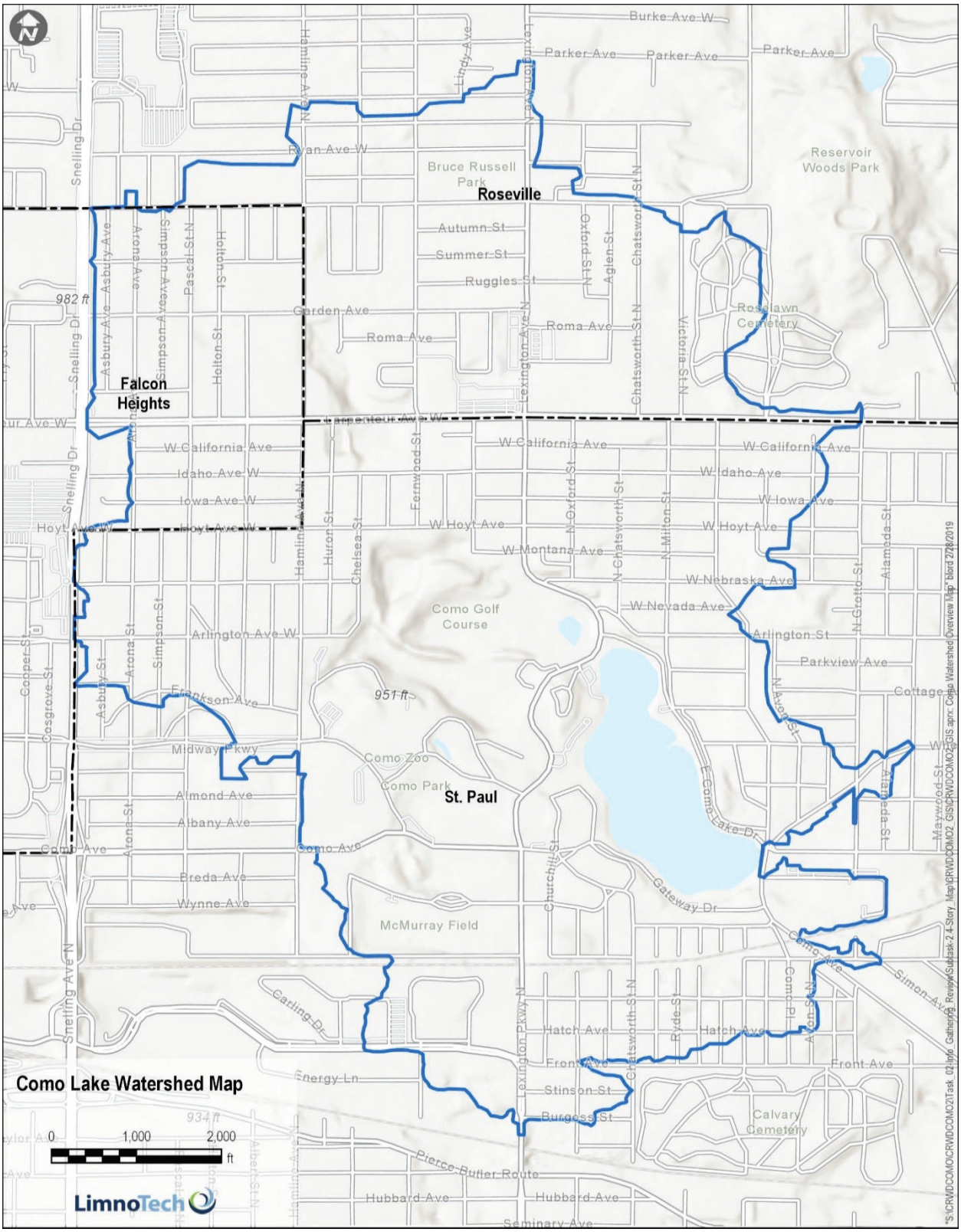

Figure 7. The Como Lake watershed (1,711 ac) includes areas of St. Paul, Falcon Heights, and Roseville.

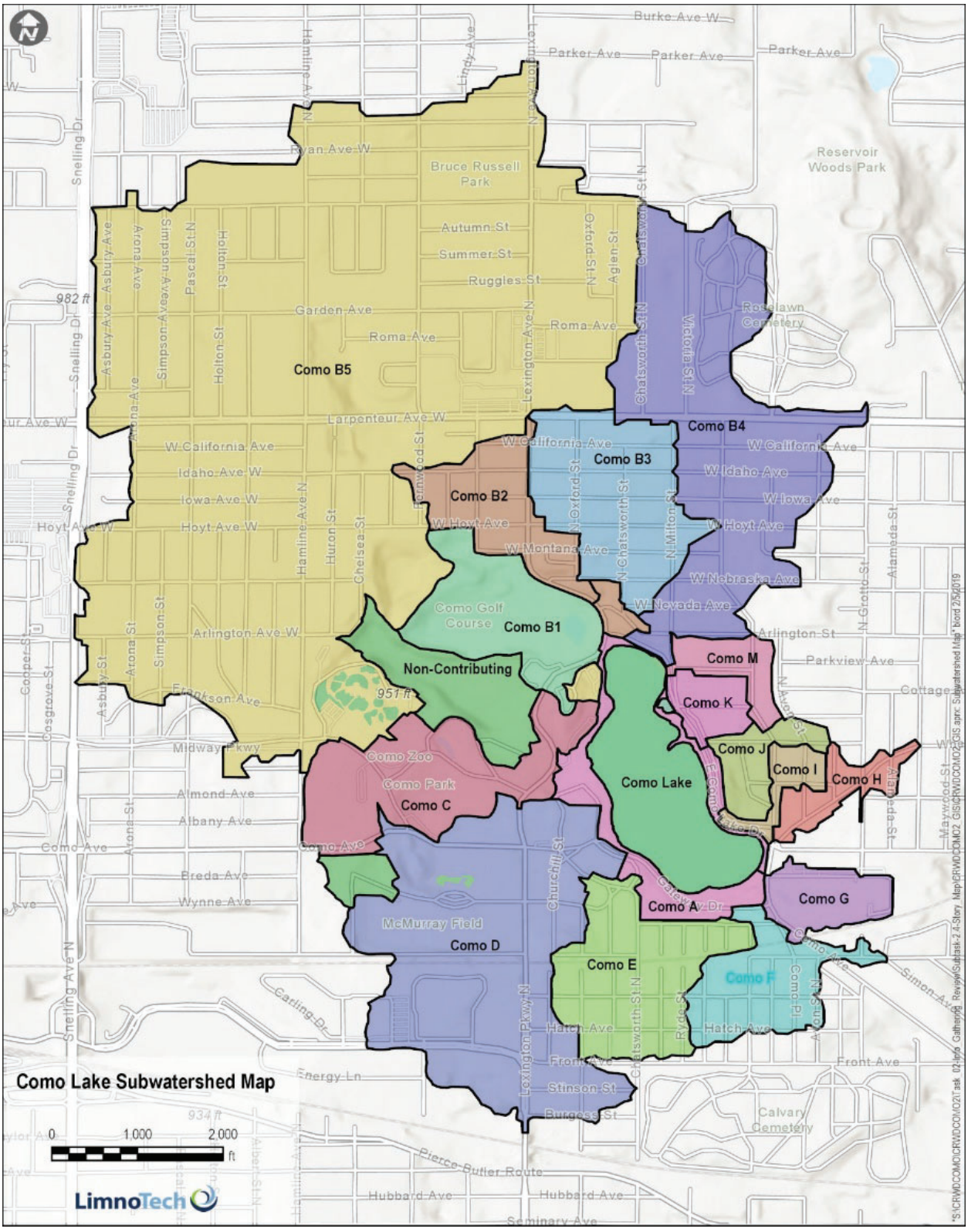

Figure 8. The thirteen major subwatersheds (Como A-M) in the Como Lake watershed (HEI, 2018).

2.3.2 Watershed Pollutant Sources & Pathways

Stormwater runoff carries excess pollutants like nutrients and sediment from the watershed to the lake, making the watershed a pollutant "source". The characteristics of the watershed have significant influence on the amount of runoff and what pollutants are being delivered to the lake. Phosphorus is the primary pollutant of concern from the Como Lake watershed. Figure 9 illustrates watershed processes and pollutant pathways typical to the Como Lake watershed, including:

A) **Pollutant Sources**: Includes trash, leaves, grass clippings, soil, animal waste, fertilizers, automobile fluids, road salt, and other chemicals—anything present on the landscape that can be flushed into a storm drain by rain or snowmelt.

B) **Runoff**: Occurs when rain or snowmelt flows off the landscape, picking up pollutants and other material on its path. In urban environments, impervious surfaces like roofs, driveways, parking lots, sidewalks, and roads prevent water from soaking into the ground as it naturally would, causing stormwater runoff to generate and flow into storm drains.

C) **Stormwater Flows to Lake**: Sewers function as underground streams to collect and convey stormwater— they prevent localized flooding by moving runoff from the landscape downstream. Storm sewers flow into Como Lake, and as a result transfer runoff carrying pollutants from the landscape directly to the lake.

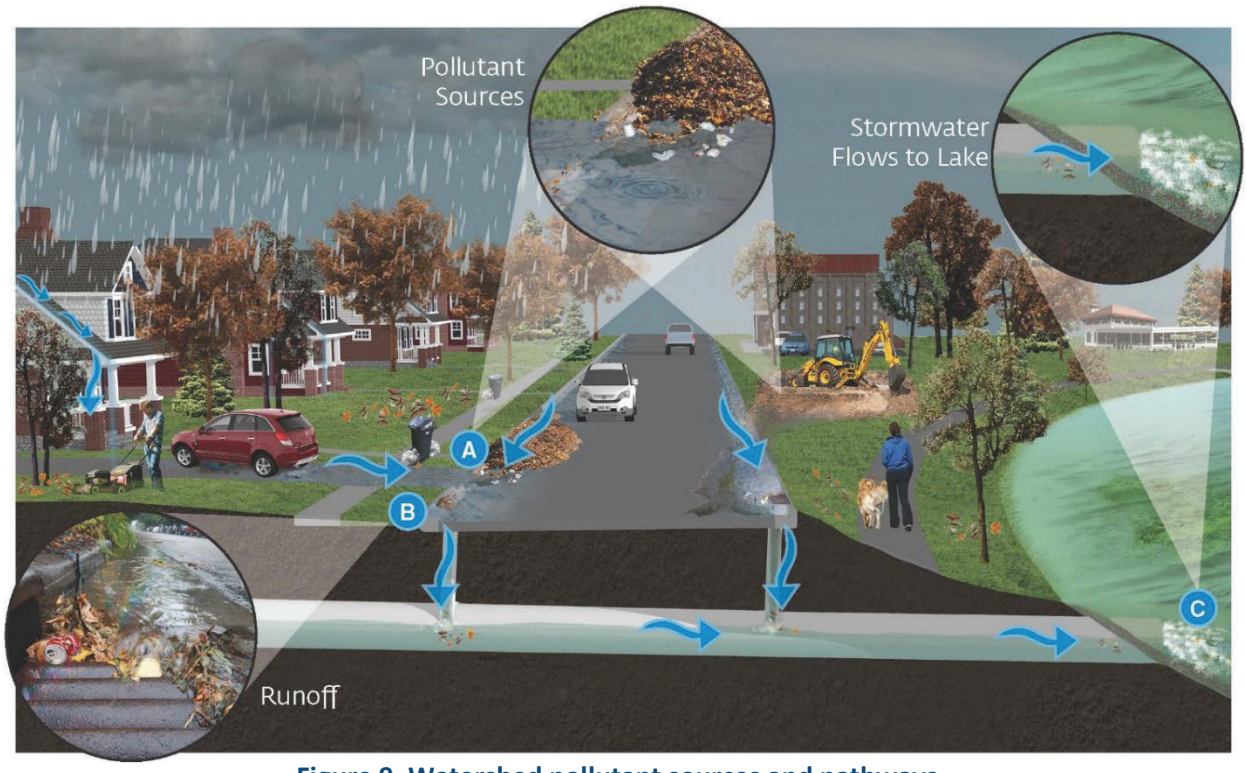

Figure 9. Watershed pollutant sources and pathways.

2.3.3 Watershed Characteristics

The landscapes of all 13 major subwatersheds within the Como watershed are directly connected to the lake. Understanding the characteristics of each Como Lake subwatershed is important for managing runoff to Como Lake because each behave differently depending on their topography, soil types, vegetation, land use, hydrology, impervious areas, and anthropogenic activities.

Topography

The Como Lake watershed resides in a hilly post-glacial landscape. Over 10,000 years ago, glaciers left behind a rolling landscape typical in this region of Minnesota. Prior to urban development, the landscape consisted of isolated wetlands with small localized watersheds. While the topography in the Como watershed is relatively moderate, it still plays a major role in determining flow pathways and watershed connection to the lake.

Soil Types

Soil types influence watershed flow pathways and infiltration rates. Following the retreat of the glaciers, the landscape was dominated by mixed glacial till soils. At present, soils in the Como Lake watershed are largely urban/unknown with some group A, A/D and B soil types due to soil disturbance related to urban development (Figure 10). Many areas in the watershed are not characterized and are likely dominated by fill brought in during urbanization and development of St. Paul. The majority of identified soils demonstrate a moderate potential for infiltration.

Vegetation

The Como Lake watershed resides in the North Central Hardwoods Forest (NCHF) ecoregion. The NCHF ecoregion is characterized by temperate broadleaf and mixed forests. Prior to urban development, the Como Lake watershed was predominantly oak openings and barrens. The current vegetation regime is dominated by diverse temperate species typical of residential areas, street boulevards, and parkland areas.

Climate

The climate classification for the Como Lake watershed is “Dfa”, or Hot Summer Continental Climate. The average annual precipitation is 31.5 inches per year. June is typically the wettest month with an average of 4.8 inches per month. February is typically the driest month with an average of 0.8 inches per month. Snow occurrence is on average 49.2 inches per year (www.weatherbase.com).

Land Use

Early development (early 1800s) of the Como Lake watershed primarily consisted of agricultural land use. As development pressure expanded north in St. Paul, land use changed from agricultural to urban as roads, homes, and businesses were built.

Currently, the primary land use type in the Como Lake watershed is Single-Family residential (Figure 11). Secondary to residential, the watershed also includes large areas of parkland with Como Regional Park and the Como Golf Course. There are isolated areas of commercial, institutional, railway, and office areas, but they make up a small portion of the overall watershed land use.

With dense urban development in the Como Lake watershed, a large portion of the watershed area consists of impervious surfaces (40%), which includes roads, parking lots, driveways, sidewalks, and rooftops—any type of hard surface that water cannot infiltrate through, which has significant impacts

on the watershed hydrology. Additionally, golf courses can have a negative impact on water quality because of their use of fertilizers and other turf management methods. The Como Golf Course is responsibly managed to prevent these types of activities from impacting Como Lake. Fertilizer use is minimized, or not used at all, and the Como Golf Course has incorporated several BMPs to manage stormwater generated around or from the area.

Hydrology

Prior to development, the Como Lake watershed was dominated by small isolated wetlands and depressions that collected runoff from localized areas. Because of this, the Como Lake watershed was much smaller in area than it is today and the majority of the runoff never reached the lake.

With urban development and the loss of localized wetlands, the Como Lake watershed expanded by connecting far reaching areas of the region to the lake with artificial drainage networks, or storm sewers, effectively increasing the total amount of water reaching Como Lake. Currently, the drainage area of Como Lake is dominated by impervious surfaces and artificial drainage networks that collect and convey stormwater runoff as direct inputs to the lake. With 40% impervious surfaces in the watershed, runoff is generated during storm and snowmelt events and piped directly to the lake through 22 storm sewer outfalls. There are no stream or rivers flowing into the lake from the Como Lake watershed.

Anthropogenic Activities

Human activities in the Como Lake watershed also have an impact on the lake because of the watershed connectivity. Activities like lawn maintenance, dog walking, sidewalk deicing, automotive maintenance, and trash management can all influence water quality as the remnants from these activities are flushed off the landscape into the lake.

2.3.4 Stormwater Runoff Monitoring & Quality

To measure the volume and quality of stormwater entering Como Lake from the surrounding watershed, CRWD annually monitors three major subwatershed outlets (Como B, Como C, and Como D). Area-velocity sensors and automated water quality sampler stations are installed near the outfall locations to the lake. The stations continuously measure discharge and take flow-paced samples during storm events. Samples are analyzed for a suite of water quality parameters, including nutrients, metals, solids, and bacteria. From this data, total annual discharge volumes and pollutant loads can be calculated to better understand watershed phosphorus contributions to Como Lake.

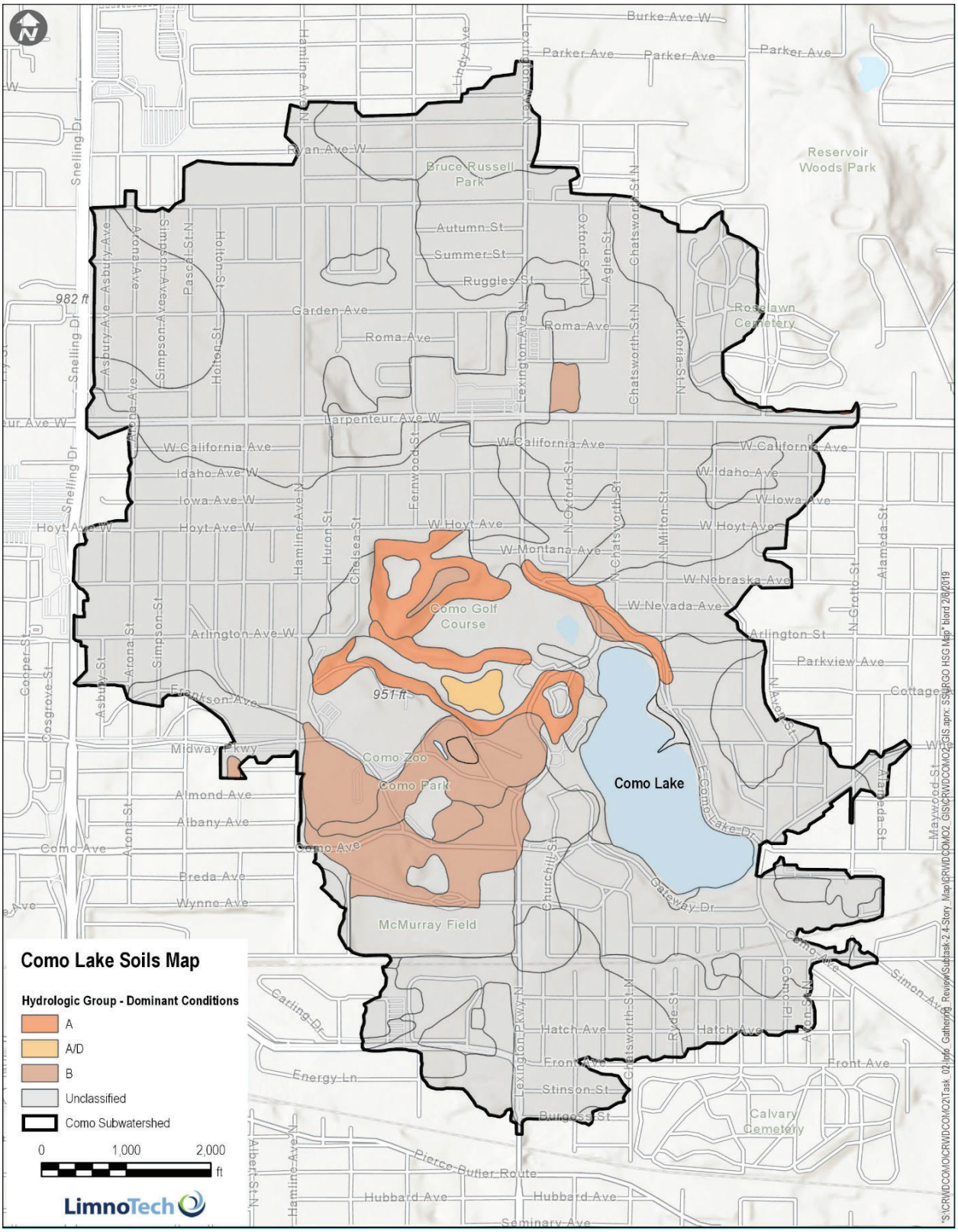

Figure 10. Hydrologic soil groups in the Como Lake watershed.

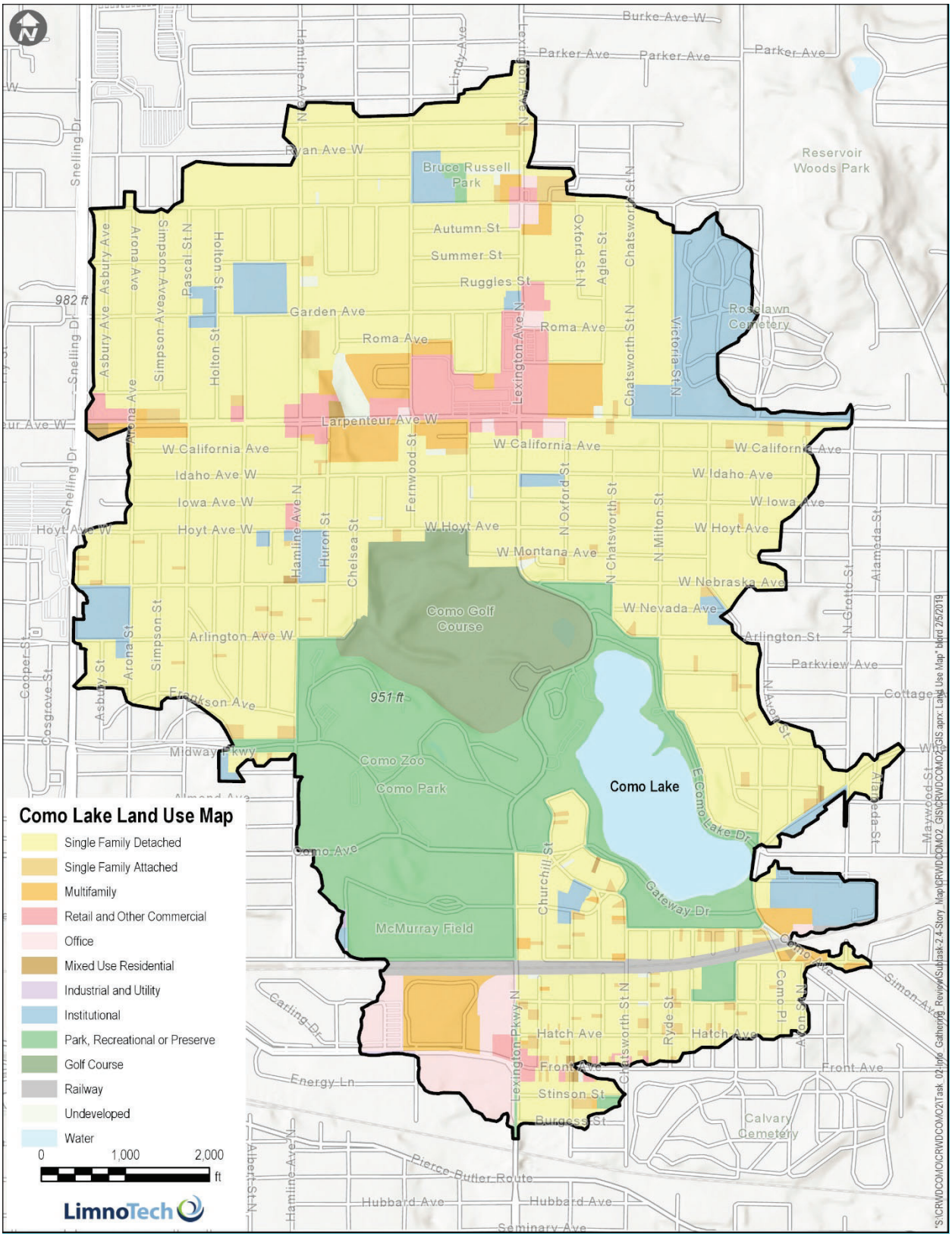

Figure 11. Existing land use in the Como Lake watershed.

2.3.5 Watershed Modeling & Pollutant Loads

To fully calculate the phosphorus load contribution to Como Lake from the surrounding watershed, the P8 Model was utilized in addition to monitoring. The P8 Model is specific to urban watershed and considers all of the factors that drive the hydrology and pollutant sources unique to the Como Lake watershed, such as those described above. The modeling also takes into account structural and non-structural BMPs in the watershed and their estimated annual load reduction capacity.

The original P8 modeling of the Como Lake watershed was completed in 2000 for the TMDL and the 2002 CLSMP. Since then, there have been changes in land use and other model input parameters in the Como Lake watershed. In addition, technology improvements (i.e. improved GIS layers) have resulted in a greater capability to fine-tune the watershed model. To ensure that the best estimates of watershed loads were utilized in the CLMP, a P8 model recalibration was completed fall 2018 (HEI 2018). The model recalibration includes the most recent land use conditions and considers the numerous structural BMPS that have been constructed since the year 2000.

From the P8 model recalibration, updated TP load estimates were determined from the Como Lake watershed for year 2018. Table 5 provides a summary of the Como subwatershed model calibration outputs for TP loads to Como Lake. The table includes subwatershed name (Como A-M), subwatershed area, baseline TP load (year 2000), and current TP load (year 2018). “Baseline TP Load (Year 2000)” refers to modeled Como subwatershed TP loads in the year 2000 and only includes watershed BMPs that were installed before the year 2000. The “Current TP Load (Year 2018)” refers to present-day modeled TP loads and includes load reductions achieved through BMPs installed since the year 2000. Table 4 also lists TP load reductions achieved since 2000 by BMPs (Baseline TP Load - Current TP Load = TP Reduction (lbs)) and the percent TP load reduction achieved (Current) for each subwatershed since baseline conditions.

The subwatersheds of Como B (Como B2-B5) are grayed in Table 5 to reflect the complex drainage system that changes outfall location depending on the flow condition. Figure 12 is a schematic of generalized flow routing in the Como B subwatershed to help illustrate how overflow is routed through four separate outfalls during certain flow conditions. Under normal flow conditions, all of Como B subwatershed discharges through one outfall to Como Lake. Under high flow conditions, overflow from the Como B subwatershed main pipe is routed to four separate outfall pipes that discharge directly to Como Lake. It is important to understand the Como B subwatershed flow routing during overflow events because the model outputs for TP loads are directly affected. For the model recalibration effort, the Como B subwatershed flow routing was factored into the watershed loading calculations.

The newly modeled TP load reduction estimates show that from 2000 through 2018, a 20% reduction in watershed TP load has been achieved through BMPs, or 143 lbs/year (Table 5).

Table 5. Model subwatershed TP loads to Como Lake – Baseline, current and reductions (HEI 2018).

Subwatershed	Overflow Subwatershed	Subwatershed Area (Acres)	% of Total Como Watershed Area	Baseline TP Load (Year 2000) (lbs)	Current TP Load (Year 2018) (lbs)	TP Reduction (lbs)	TP Reduction %
Como A	--	36.6	2%	11.2	11.2	0	0%
Como B[a]	--	1173.9	69%	388.8	294.1	94.7	24%
--	Como B2	51.3	3%	11.5	11	0.5	4%
--	Como B3	78.8	5%	10.2	10.2	0	0%
--	Como B4	177.4	10%	32.2	32.2	0	0%
--	Como B5	814.8	48%	31.6	16.5	15.1	48%
Como C	--	80.8	5%	20.9	18.1	2.8	13%
Como D	--	195.3	11%	98.3	92.5	5.8	6%
Como E	--	72.2	4%	41.3	41.3	0	0%
Como F	--	44.5	3%	25.6	15.6	10	39%
Como G	--	20.7	1%	16.2	6.2	10	62%
Como H	--	17.8	1%	10.5	9.5	0.9	9%
Como I	--	11.7	1%	6.3	3.2	3.1	49%
Como J	--	19	1%	10	10	0	0%
Como K	--	15.4	1%	8.1	8.1	0	0%
Como L	--	0.5	0.03%	0	0	0	0%
Como M	--	16.9	1%	9.4	9.4	0	0%
Total				**732.1**	**589.1**	**142.9**	**20%**

[a] Como B subwatershed has four overflow subwatersheds that discharge to separate outfalls during certain flow conditions. See Como B schematic for flow routing.

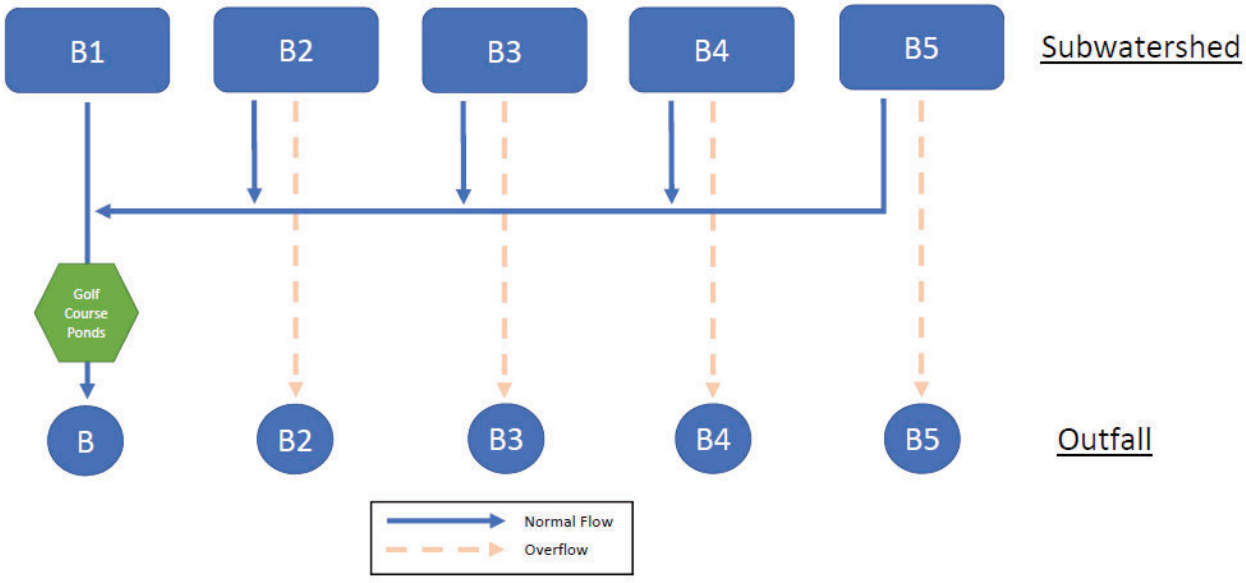

Figure 12. Schematic of generalized flow routing for the Como B subwatershed.

2.4 Como Lake Water Quality Standards & Regulations

Como Lake is subject to federal nutrient loading regulations in order to protect water quality. The federal Clean Water Act mandates that a TMDL needs to be developed for impaired waters in order to determine the maximum amount of nutrient loading that a waterbody can receive from all sources and still maintain water quality standards. A TMDL is implemented by the MPCA on behalf of the EPA.

In 2010, the 2002 CLSMP was reformatted to comply with TMDL requirements. The 2002 CLSMP and TMDL determined that a 60% reduction in external loads of TP, and a 95% reduction in internal loads of TP are required to meet State water quality standards. External TP loads are from watershed runoff being delivered to Como Lake through storm sewers. Internal TP loads refers to sources or mechanisms within the lake that recycle phosphorus.

Annual masses of external and internal phosphorus loads were determined in the 2002 CLSMP and TMDL based on modeling from 2001. In 2018, recalibration of the model slightly changed the total masses (in lbs) of TP load reduction required, however, the 60% external TP load reduction and the 95% internal TP load reduction remain unchanged in this current plan because they were determined to remain valid for achieving Como Lake water quality standards (Table 5). Following the adoption of the CLMP, CRWD will work with the MPCA and EPA to update the Como TMDL based on the latest and more accurate estimates of internal and external loading in Como Lake.

Table 6. Como Lake TMDL Load Reduction Targets.

TP Source	Target Load Reduction (%)
Internal TP Load	95%
External TP Load	60%

2.4.1 Internal TP Load Reduction Targets

To meet the 95% reduction in internal TP loads, multiple interrelated drivers of internal loading must be addressed. As described in Section 2.2, the primary drivers of internal loading in Como Lake are diffusive flux from bottom sediments, the presence of CLP, and an imbalanced fishery. Managing each of these sources individually but in consideration of the others will help in working toward a 95% reduction. Diffusive flux is the largest source of the internal TP load, so addressing the bottom sediments first with management will be a key first step to lead the way in being able to manage CLP and the fishery.

While the 95% internal TP load reduction target has remained the same, the total annual internal TP load in lbs/year has likely changed since it was modeled for the 2010 TMDL based on the analysis of internal phosphorus sources completed in LimnoTech (2017). Load reductions calculated in the 2010 TMDL were based on the Wisconsin Lake Modeling Suite (WiLMS), which is a screening-level lake water quality model used to evaluate in-lake water quality (CRWD 2002; EOR 2010). This water quality model should be re-calibrated to include the revised P8 watershed load estimates and direct sediment core measurements of diffusive sediment P flux to confirm the internal load reduction required to meet the in-lake TP target of 60 µg/L.

2.4.2 External Load Reduction Targets

To address watershed TP loads from the greater Como Lake watershed and meet the 60% TMDL load reduction target, it is best to approach management on a subwatershed-by-subwatershed basis so that higher contributing subwatersheds can be identified and prioritized for projects. In addition, the implementation of BMP projects in a fully developed watershed are largely dependent on opportunities presenting themselves. Thus, CRWD will also approach watershed management on a project-by-project basis in all Como subwatersheds as BMP project opportunities become available. This strategic approach will result in a cumulative watershed TP load reduction necessary for meeting Como Lake water quality goals. Significant watershed management has already occurred, so future work will build upon progress made to date.

Through the Como Lake watershed model recalibration in 2018, the TP load contribution from each subwatershed were calculated to identify which subwatersheds were the lowest and highest contributors of TP to Como Lake. Implementing BMP projects in subwatersheds identified as high TP load contributors will be most effective toward meeting the 60% watershed load reduction target. Table 6 lists the cumulative baseline TP load (Year 2000) from all contributing subwatersheds to Como Lake, the total required load reduction (60% of the baseline TP load), and the total allocated load that will still meet state standards (40% of baseline TP load).

Table 7. Como Lake watershed baseline TP load from year 2000, the TP load reduction target (60%), and allocated watershed load. Note: the baseline TP load and allocated load listed differ from the 2010 TMDL because a model recalibration was completed in 2018.

Watershed TP Loads	Annual Load (lbs)
Baseline TP Load (Year 2000)	732
Required Watershed Load Reduction (60% of Baseline)	439
Allocated Load (40% of Baseline)	293

2.5 Historical Management Actions

Como Lake has experienced poor water quality conditions for several decades. The first record of algae blooms, fish kills, and odor problems was reported in 1947. Since then, multiple efforts to reduce pollutant loading to the Lake, and actions to manage the Lake directly have been implemented. The following sections provide a summary of historical lake and watershed management actions.

2.5.1 Historical Lake Management Actions

Several lake management actions have been implemented over time in effort to reduce algal and odor problems, reduce erosion, and manage aquatic vegetation. Table 8 shows a summary of notable lake management actions that have been implemented in Como Lake since the early 1980s.

Table 8. Summary of notable historical lake management actions.

Years	Action	Purpose
1980s	Rotenone (fish pesticide) and copper sulfate (algaecide) addition	Kill and remove rough fish populations (common carp) and control excessive algal growth
1985-present	Floating Aerators	Winter aeration of waters with low or no dissolved oxygen to prevent fish kills
2001-2002	Dredging	Reduce accumulated sediment deltas on the southwest side of the lake
2003 (multiple projects since 2003)	Shoreline Restoration	Stabilize shoreline, reduce erosion, replaced non-native vegetation with native species, increased wildlife habitat, and improved aesthetics for visitors.
2003 - 2018	Mechanical Harvesting	Maintain aquatic vegetation growth for boating lanes

2.5.2 Historical Watershed Management Actions

Since the adoption of the 2002 CLMSP, many structural BMP projects for reducing phosphorus loads from stormwater runoff have been constructed in the Como Lake watershed by CRWD and other partners. Structural BMPs are engineered systems that are designed to capture and treat stormwater runoff on the landscape such as a rain garden, an underground infiltration system, or a stormwater pond. In the Como Lake watershed, structural BMP projects that have been constructed through 2018 cumulatively treat 20% of the watershed runoff. Table 9 provides a summary of the documented BMPs by project type that have been constructed in the Como watershed through 2018.

Table 9. The total number of documented structural BMP project types that have been constructed in the Como watershed through year 2018 by CRWD and partners.

BMP Type	# BMP Projects (through Year 2018)
Raingardens	43
Stormwater Ponds	7
Pervious Pavement	3
Underground Infiltration	20
Native Buffer Plantings	3
Total	**76**

There have been a few notable structural BMP projects constructed in the Como watershed since 2000 by CRWD and partners. The most significant project was the Arlington-Pascal Stormwater Improvement Project that was constructed in 2006 in the Como B subwatershed with the goal of addressing localized flooding issues and reducing TP from stormwater flowing to Como Lake. This project was completed in partnership with multiple municipalities and included the construction of 8 raingardens, 8 underground infiltration trenches, a large underground infiltration system, and a regional stormwater pond. Table 10 lists all major BMP projects in the Como watershed, including the Arlington-Pascal Project.

Table 10. Major structural BMP projects constructed in the Como watershed since 2000 by CRWD and partners.

Project Name	Sub - Watershed Location	Year	Project Description	Agency(s)
Arlington-Pascal Stormwater Improvement Project	B	2006--2007	Installation of 8 rain gardens, 8 infiltration trenches, 1 large underground infiltration system treating runoff from a 217-acre residential area	CRWD, St. Paul, Falcon Heights, Roseville
Como Golf Course Pond	B	2007-2008	Pond storage increased and native buffer installation	CRWD, St. Paul
Como Regional Park Pool Rain Gardens	D	2011	4 rain gardens treating runoff from pool parking lot	St. Paul
Como Park Senior High School	G	2017	Installation of a large underground infiltration system underneath the football field	CRWD, St. Paul Public Schools
Stewardship Grant Residential Rain Gardens	All	2005-2018	21 residential rain gardens installed through CRWD's Stewardship Grant program	CRWD, residents

In addition to structural BMPs, significant efforts have occurred over time to reduce Como watershed TP loads through non-structural projects or practices. Non-structural practices focus on source management, such as proper disposal of pet waste, leaf clean-up efforts, storm drain debris clearing, street sweeping, or education on best practices. Phosphorus reductions through non-structural practices have been achieved through participation and promotion from partners, including efforts from community groups such as District 10 and the Como Active Citizen Network (CACN). Notable efforts include annual neighborhood leaf clean-up events by CACN, participation in the Adopt-a-Drain program by District 10, and fall street sweeping by the City of St. Paul.

3 Issues and Goals

Building on the issues identified in the *Como Lake Water Quality Drivers Analysis Study* (LimnoTech 2017) and the recalibrated P8 watershed modeling (HEI 2018), members of the AAG and PAG were also asked to provide input on issues facing Como Lake from their perspective. Once the issues were identified, CRWD worked with the AAG and PAG to develop management goals for Como Lake to provide direction on how and when to address the identified issues. This section discusses the issues of concern for Como Lake that were identified by stakeholders, the five goals that were established to address those issues, and the development of objectives for each goal.

3.1 Identification of Issues of Concern

Identification of the primary issues with Como Lake and the surrounding watershed is key to developing a set of goals and measurable objectives. As discussed in Section 1.3, AAG members were asked to identify the major issues facing Como Lake and the surrounding watershed from the agency perspective. Additionally, the PAG and community members provided input on what draws them to Como Lake, the major issues facing Como Lake today, and their hopes for a healthy Como Lake. Opportunities to provide feedback included the first PAG meeting, conversations at the Lake, and an online survey, which resulted in nearly 800 comments from participants. The responses referenced the full experience of the area, challenges, and the breadth of social, environmental, and economic issues and opportunities.

Table 11 lists the issues that were identified by both the AAG and the PAG and represent the causes of water quality problems in Como Lake (e.g. phosphorus loading) and associated effects (e.g. algae blooms) as well as others pertaining to user experience. Issues that were shared by both the AAG and the PAG include:

- Phosphorus loading/pollution runoff (internal and external loading)
- Other pollutants chloride, sediment, trash
- Algae blooms
- Odor and aesthetics
- Invasive species (i.e. curly-leaf pondweed)/excessive aquatic vegetation/loss of plant diversity
- Imbalanced food web/loss of animal diversity/fisheries management
- Dense urban environment/population growth
- Balancing cost-effectiveness

Table 11. Issues Identified by Agency Advisory Group (AAG) and Public Advisory Group (PAG).

Agency Advisory Group Issues	Public Advisory Group Issues
Water quality: • Phosphorus loading • Hypoxia/anoxia • Algal blooms • Odor/aesthetics • Meeting TMDL reduction goals • Shallow urban lake • Other pollutant loading (e.g. chloride) • High summer water temperatures ***Watershed/Land Use:*** • Ultra-urban development • Stormwater inputs • Meeting TMDL reduction goals ***Other:*** • Expectations versus Cost • Uncertainty • Funding • Climate change	***Water quality:*** • Pollution from runoff • Algae blooms • Odor/aesthetics • Loss of plant and animal diversity • Invasive species/curly-leaf pondweed • Excessive aquatic plants/weeds ***Watershed/Land Use:*** • Overgrown vegetation (referring to shoreline plantings) • Overuse • Traffic/noise/light pollution* ***Other:*** • Cost-effective measures needed • Bold actions needed • Instability in pavilion business* • Too few non-summer recreation opportunities • Under-involved community • Safety* • Population growth* • Lack of political will or willingness by the City to take action* • Impact of water quality on parkland and nearby trails.

**Issues that will be addressed outside of the CLMP/by other agencies*

3.2 Goals and Measurable Objectives

Management goals set a vision for Como Lake, and the associated objectives provide a mechanism to measure progress towards meeting those goals. Establishment of goals and measurable objectives is critically important to guide and identify management actions.

To begin establishing the goals of the CLMP, input on Como Lake issues from the AAG, the PAG, and other stakeholders were qualitatively analyzed to identify major themes. The six themes emerged that served as the basis for development of goals and measurable objectives. The six major themes identified are:

1. A healthy lake where users are confident in interacting with the water.

2. A safe and accessible park that balances use of the area with a peaceful experience and healthy environment.
3. A diverse, healthy habitat that can support a variety of wildlife, including pollinators, birds, fish, and amphibians.
4. An active, engaged community that protects and cares for Como Lake.
5. Amenities that allow for various kinds of recreation throughout the year.
6. A stable venue that remains affordable and supports community vitality.

These six major themes were combined with the State water quality standards required under the TMDL as well as consideration of what is achievable for an urban shallow lake ecosystem to define five overarching goals for the CLMP. For each of the five goals, measurable objectives were developed to define the criteria for meeting those goals. The draft goals and objectives statements were reviewed and commented on by the AAG and PAG members through an online survey. Comments were incorporated into the goals and measurable objectives and then finalized.

Once goals and objectives were finalized, management actions were recommended for each objective. Management actions are actual projects, programs, events, or organized efforts that will work toward achieving each goal and measurable objective. The recommended management actions that were developed (Section 4) were further categorized into lake, watershed and community-related actions. These categories serve as the organizational framework for identification and implementation of actions as part of the CLMP.

3.2.1 Selected Goals and Measurable Objectives

The following goals and objectives were selected for adaptive management of Como Lake and its watershed. The goals are intended to be broad in scope while the objectives are measurable and are intended to help track progress in meeting the stated goals. The goals and objectives are not listed in order of priority or occurrence.

Goal 1: Como Lake will be managed as an ecologically healthy, shallow lake.

An ecologically healthy, shallow lake is one where phosphorus levels are maintained at sufficiently low levels (60 µg/L or lower) to minimize algae nuisances, the rooted aquatic plant community is dominated by a diverse assemblage of native species, and a balanced aquatic food web is maintained.

- Objective 1A: Meet and maintain in-lake total phosphorus concentrations at ≤ 60 µg/L (summertime, surface water average).
- Objective 1B: Reduce the internal phosphorus load by approximately 95%.
- Objective 1C: Reduce the watershed phosphorus load by approximately 60%.
- Objective 1D: Reduce other nonpoint source pollutants from entering Como Lake (e.g. chloride, trash, sediment).
- Objective 1E: Reduce CLP to < 10% Frequency of Occurrence (FOC) during period of peak abundance (typically June).
- Objective 1F: Establish and maintain native aquatic vegetation to exceed these criteria: species richness > 8 with at least 3 species having FOC > 20%.

- Objective 1G: Establish and maintain a fishery with balanced populations of piscivorous, planktivorous, and benthivorous fish.

Goal 2: Maintain healthy shoreline areas that can support a variety of wildlife and contribute to the ecological health of Como Lake.

- Objective 2A: Maintain areas of native vegetation along the shoreline to capture surface runoff, minimize shoreline erosion, and promote wildlife habitat.

Goal 3: Maintain a variety of year-round recreational opportunities that are appropriate for a shallow urban lake.

- Objective 3A: Continue to provide fishing opportunities.
- Objective 3B: Provide areas suitable for non-motorized boating.

Goal 4: Achieve strong sustained community engagement and stewardship to improve and protect Como Lake.

- Objective 4A: Engage and support existing groups and community members that have worked to improve and protect Como Lake.
- Objective 4B: Engage new groups and citizens in efforts aimed at improving and protecting Como Lake.
- Objective 4C: Increase citizen knowledge and understanding of Como Lake.

Goal 5: Utilize the best science, partnerships, and resources to ensure successful implementation of the CLMP over the life of the plan (20 years).

- Objective 5A: Provide a structured adaptive management approach to effectively and efficiently adjust management actions through the life of the plan.
- Objective 5B: Engage multiple partners and utilize funding sources to implement the CLMP.

4 Recommended Management Actions

Shallow urban lakes often have numerous water quality issues and Como Lake is no different. Como Lake has been in poor health for decades, so it will take significant effort and time to achieve water quality goals. Through holistic, adaptive management, a combination of watershed and in-lake management actions will be required to improve water quality in Como Lake.

Recommended management actions are actual projects, programs, events, or organized efforts that will work toward achieving each goal and measurable objective in the CLMP (Section 3). The recommended management actions describe *what* needs to occur to achieve the goals and objectives, but do not provide instruction on *how* each action should be carried out. Instead, many of the actions listed will require a standalone work plan that details how the action will be implemented, estimated costs, timeline, and expected outcome.

A combination of lake, watershed, and community-based management actions to be carried out over the life of the plan will be required to achieve each goal and objective. Lake management actions will seek to control internal phosphorus and other symptoms of a turbid shallow lake. Watershed management actions will include structural and non-structural BMPs that effectively reduce phosphorus loads from stormwater runoff. Community-based management actions will work to help build stewardship of and pride in of Como Lake.

The following sections describe the recommended lake, watershed, and community-based actions. Letters have been assigned to each category throughout this plan, such that “L” indicates lake management actions, “W” indicates watershed management actions, and “C” indicates community-based management actions.

4.1 Lake Management Actions

While some lake management actions have been implemented in Como Lake before, more work in the Lake is needed to meet current goals for a healthy shallow lake. Due to the complexity of issues facing Como Lake, there is not one single action that will improve water quality in the Lake. Instead, a comprehensive management approach that implements several actions in the short-term, and over time, will be required to meet management goals and ultimately achieve a healthy Como Lake.

4.1.1 Evaluation of Possible Lake Management Actions

A matrix of possible lake management actions was developed as part of the evaluation process (Appendix B). The compiled actions have been applied elsewhere with outcomes and expectations well-documented (Holdren et al. 2001; Cooke et al. 2005; Osgood and Gibbons 2017; Osgood et al. 2017). Possible actions were listed based on their ability to address the primary issues in Como Lake. Selection criteria was based on suitability for a shallow lake, reliability of success, expected duration (i.e. period of action effectiveness), relative cost and return on investment, and pros and cons of each management action. The matrix of possible in-lake management actions was shared with the AAG and PAG. Both groups provided valuable feedback that was incorporated in the selection of recommended management actions.

4.1.2 Recommended Lake and Shoreline Management Actions

This section describes lake management actions that are designed to address issues related to four specific categories: in-lake phosphorus management, aquatic vegetation management, fisheries management, and shoreline management.

In-lake Phosphorus Management

Phosphorus is the primary driver of water quality in Como Lake (LimnoTech 2017). The TMDL has indicated that internal phosphorus loads must be reduced by 95% to meet State shallow lake water quality goals. Lake management actions that reduce diffusive flux of phosphorus from the sediments must occur in the early implementation of the CLMP in order to improve water quality in Como Lake. This section contains recommended actions specifically related to in-lake phosphorus management.

L1. Update lake water quality model. Previous studies have indicated a range of internal phosphorus loading rates depending on method of calculation and assumptions inherent in those calculations. It is highly recommended that the Como Lake water quality model be updated with the revised subwatershed loads developed in 2018, direct sediment core P flux measurements collected in 2016, and recent observed monitoring data. The lake water quality (WiLMS; Section 2.4.1) model should be re-calibrated to validate load reduction targets calculated in the 2010 TMDL and to estimate phosphorus load reduction from alum treatment(s). The revised water quality model should be used to update the 2010 TMDL, which needs to incorporate new data collected and the updated watershed model since the TMDL was adopted.

L2. Alum application to inactivate sediment phosphorus. Apply alum to inactivate mobile sediment phosphorus and mitigate internal phosphorus loading. The alum dose should be based on water column TP and phosphorus fractions from sediment cores (i.e. iron-bound phosphorus, loosely-bound phosphorus, and labile organic phosphorus). It is highly recommended that an alum application be applied as soon as possible pending available resources. Ideally, the initial alum application should be applied in late spring before the period of high summer internal loading. However, alum could also be applied in fall. It is generally advised to avoid applying alum during an algal bloom because it can interfere with the alum settling to the sediments. Alum can be applied within a couple of weeks following an herbicide treatment for CLP control (see action L5 below).

Depending on Como Lake's response to alum in the first three-year interval of the adaptive management plan, additional supplemental alum application strategies may be needed to meet management objectives, which has been included as an action below (L4). In-lake phosphorus reduction in response to the initial alum application will need to be monitored through ongoing water quality sampling throughout the first three years of the adaptive management plan. In addition, external phosphorus loading will continue to be significant in the near-term, so additional alum applications may be needed to intercept water column phosphorus concentrations from external sources.

When applied appropriately, alum poses little risk to aquatic life. In poorly buffered waters, the addition of alum can cause increases or decreases in pH. Below a pH of 6, free aluminum can persist, while above a pH of 9 other hydroxides could form, both of which can be toxic to wildlife. Therefore, it is important to evaluate the alkalinity (a measure of the chemical buffering capacity) of the lake water prior to application. The appropriate alum dose should be based on

calculations that includes the phosphorus concentrations in both the water and sediment as well as the alkalinity to minimize adverse impacts.

It should be noted that dredging Como Lake sediment was carefully considered as a lake management action. At this time, dredging of Como Lake sediments is not recommended due to the uncertainty in costs, which are estimated to be an order of magnitude more expensive than alum. Adding to the uncertainty in costs for dredging is the potential for special disposal requirements of lake sediments, an issue that would be driven by contaminated sediments.

L3. Continue bi-weekly in-lake water quality sampling. Continue bi-weekly in-lake water quality sampling to measure progress. At a minimum, measured parameters should include epilimnetic and hypolimnetic TP, soluble reactive phosphorus, Chl-a, and turbidity. While the limiting nutrient in Como Lake is typically phosphorus, total nitrogen, ammonium and nitrate should be frequently monitored in the epilimnion and hypolimnion as well to continue to monitor as this nitrogen also influences algal production. Bi-weekly surface measurements of Secchi depth should be collected with the above parameters along with DO and temperature profiles. Continuous DO monitoring should be maintained to measure indirect influence of implemented actions on anoxia.

L4. Supplemental alum applications. The expectation is that in-lake phosphorus concentration will decrease following an initial alum application to inactivate sediment phosphorus. However, given the long-term record of external phosphorus loading and burial of phosphorus in the sediments, a maintenance application may be required within a few years of the initial application. This condition will be assessed through ongoing monitoring activities and will be evaluated annually as part of the adaptive management plan.

Aquatic Vegetation Management

The aquatic vegetation community in Como Lake is dominated by CLP with low diversity of other native macrophytes. Mechanical harvesting has historically been implemented in Como Lake to control CLP with a focus on clearing areas for recreation (i.e. near fishing piers and paddling lanes). This management technique only targets the upper portion of CLP with the root system largely unaffected allowing the CLP to propagate each year. There are no documented cases of CLP eradication to-date, so maintenance will be an ongoing challenge with current control strategies. Given the abundance of CLP in the Lake, an aggressive management strategy in the first three years (or more) of CLMP implementation will be required to get CLP under control. Once CLP is under control, management efforts can focus on establishment of a diverse, native aquatic plant community. The following management actions pertain to the aquatic plant community.

L5. Herbicide treatment to control curly-leaf pondweed. CLP is extremely difficult to control, but herbicide treatment has demonstrated the greatest success to date for reducing CLP density. Even with herbicide treatment, eradication is highly unlikely once it has been established in a lake. Therefore, ongoing management of CLP using herbicides will be required. When appropriately applied, herbicide treatments have shown the greatest success with management of CLP to date.

Ongoing research at the University of Minnesota's Aquatic Invasive Species Research Center have shown that herbicide treatments are very effective at reducing CLP abundance. Herbicides are widely used as a CLP management tool by MNDNR (including many Twin Cities Metro Area Lakes) and Wisconsin DNR. It is highly recommended that low-dose, large-scale (≥ 30 acres) herbicide treatments are applied in early May annually for the first 3-5 years of implementation.

A pre-herbicide treatment delineation of CLP will need to be conducted 2-4 weeks before a planned herbicide treatment. The expectation is that a large portion of the lake area can be treated per year with similar large-scale treatments in other areas annually for the first 3-5 years of implementation. However, depending on pre-treatment delineation, repeated treatments in the same area may be required. It is expected that abundance of CLP will be reduced considerably if large-scale herbicide treatments occur annually for the first few years of implementation.

L6. Develop and implement lake vegetation management plan. Collaborate with MNDNR to develop and implement a long-term lake vegetation management plan (LVMP) to establish and maintain a healthy and diverse, native aquatic plant community. The plan should also consider strategies to keep CLP under control following initial herbicide treatments, which may also require periodic, small-scale herbicide treatments. Mechanical harvesting of native vegetation may also be required to prevent nuisance growth conditions following CLP control (see Section 2.2.4). These elements need to be included in the lake vegetation management plan.

L7. Conduct annual aquatic vegetation surveys. Conduct point-intercept surveys to measure aquatic vegetation species abundance and density 2-3 weeks following herbicide treatment (June) and late-season (late-July or early-August).

Fisheries Management

Recent studies have found that Como Lake has an imbalanced fishery. That is, the Lake is dominated by planktivorous fish with few top predators. Planktivorous fish tend to preferentially feed on large-bodied zooplankton, which reduces their overall capacity to graze on phytoplankton. A more balanced fishery in Como Lake will have an abundance of top predators (i.e. walleye and northern pike) that can limit over-population of planktivorous fish that exert predation pressure on the zooplankton community. With less predation pressure on the zooplankton community, they will more effectively graze on algae which will contribute to improved water quality and overall ecological health of Como Lake. The following actions are recommended to address the imbalanced fishery in Como Lake.

L8. Develop long-term targets for balanced fishery. Collaborate with MNDNR to develop and implement a "Como Lake Fisheries Management Plan" that defines long-term targets for a diverse, ecologically balanced fishery that can also support and sustain recreational fishing for the community. Attainment of long-term targets will be achieved through stocking practices and potentially through catch-and-release practices to maintain a community of top predators. These approaches should be evaluated as part of the Como Lake Fisheries Management Plan. The Como Lake Fisheries Management Plan should be regularly updated and assessed as part of the ongoing adaptive management of Como Lake.

L9. Conduct fish surveys. Complete regular fish surveys every 2-3 years or as needed to determine species abundance and diversity, and to measure progress of efforts to meet and sustain long-term targets for a balanced fishery. The MNDNR typically conducts fish surveys in Como Lake every five years. Depending on the MNDNR survey rotation, supplemental fish surveys may be needed in the early years of the adaptive management plan.

Shoreline Management

Since the 2002 CLSMP, several shoreline stabilization projects have been implemented. However, there are areas along the shore that need additional stabilization and/or may provide opportunities to meet additional management goals and objectives (e.g. reduce trash loading or provide additional fishing

locations). The actions below are recommended to assess and document current shoreline conditions and develop plans for management based on those conditions.

L10. Conduct shoreline assessment. A shoreline assessment is the first step in development of a Shoreline Management Plan (discussed below), which should be completed early in the implementation of the CLMP. In collaboration with the City of St. Paul, a shoreline assessment should be conducted to identify the following:

- Erosional areas (current and susceptible).
- Existing shoreline vegetation composition (density, diversity of native and non-native species).
- Quality of wildlife habitat (species types, availability, and needs).
- Areas where the shoreline vegetation buffers widths could be expanded to maximize capture of surface runoff.

L11. Develop and implement shoreline management plan. In collaboration with the City of St. Paul, develop and implement a "Como Lake Shoreline Management Plan" that emphasizes native plant diversity, wildlife habitat, shoreline stabilization, and capture of surface runoff. Using information obtained in the shoreline assessment, the shoreline management plan should incorporate steps to implement priority actions, which include:

- Implement shoreline vegetation improvement and/or reinforcement to stabilize erosional areas and promote wildlife habitat.
- Maintain areas of shoreline vegetation that allow for visual and physical access to Como Lake from the shoreline through vegetation.
- Where needed and feasible, replace nuisance non-native vegetation with native vegetation.

L12. Engage volunteers and local partners in shoreline management. Identify opportunities to engage volunteers and local partners to assist with shoreline vegetation management projects based on specifications in the Shoreline Management Plan (e.g. Adopt a Shoreline Volunteer Program).

4.2 Watershed Management Actions

To achieve Como Lake water quality goals, TP loads being transported to the Lake from the watershed through stormwater runoff must be addressed in addition to the internal phosphorus load. To address TP loads from the Como Lake watershed, it is best to approach management on a subwatershed-by-subwatershed basis so that higher contributing subwatersheds can be identified and prioritized for projects. In addition, the implementation of BMP projects in a fully developed watershed are largely dependent on opportunities presenting themselves. Thus, CRWD will also approach watershed management on a project-by-project basis in all Como Lake subwatersheds as BMP project opportunities become available. This strategic approach will result in a cumulative watershed TP load reduction necessary for meeting Como Lake water quality goals. This section identifies future watershed management actions for achieving Como Lake water quality goals.

4.2.1 Watershed Phosphorus Management Actions

To meet the long-term 60% phosphorus watershed load reduction goals over the life of the plan, a Como Watershed TP Load Reduction Plan (Table 12) was developed based on subwatershed modeling load estimates.

From the loading estimates in Table 12, subwatersheds needing TP management to meet the load reduction goals were identified and prioritized. Four categories of TP load reduction methods were defined, including both potential structural and non-structural BMPs to be implemented in the future: 1) Potential Structural – Identified, 2) Potential Structural – Unidentified, 3) Future Permit BMPs, and 4) Potential Non-Structural. Definitions of each of these four categories are listed in Table 12.

It is important to note that in a highly developed urban watershed, finding opportunities to implement watershed management actions are limited and are dependent on opportunities presenting themselves through the initiation of other projects (e.g. street reconstruction or building redevelopment, land use changes, landscape redesign, partnerships, funding sources, and the planning of non-structural activities).

Under each category of TP load reduction methods from the Watershed TP Load Reduction Plan (Table 12), the following watershed management actions were identified to address watershed TP loading and to meet the 60% watershed load reduction goal by subwatershed. Achieving each of the watershed management actions presented here will rely heavily on partnerships with municipalities, residents, and businesses in the Como Lake watershed. Partnerships will allow for collaboration when opportunities arise so multiple interests can be fulfilled on a project.

Table 12. Watershed Total Phosphorus (TP) Load Reduction Plan to be implemented over the 20-year life of the management plan.

		Subwatershed													
		Como A	Como B	Como C	Como D	Como E	Como F	Como G	Como H	Como I	Como J	Como K	Como L	Como M	All
Baseline TP Load (Year 2000) (lbs)		11.2	474.3	20.9	98.3	41.3	25.6	16.2	10.5	6.3	10.0	8.1	0.0	9.4	**732.1**
TP Load Reductions (lbs)	Existing Practices (Year 2018)	0.0	110.3	2.8	5.8	0.0	10.0	10.0	1.0	3.1	0.0	0.0	0.0	0.0	**143.0**
	Potential Structural - Identified[a]	0.0	130.8	8.9	47.1	31.8	1.2	0.0	2.6	0.0	2.5	2.0	0.0	2.4	**229.3**
	Potential Structural - Unidentified[b]	?	?	?	?	?	?	?	?	?	?	?	?	?	**0.0**
	Future Permit BMPs[c]	0.0	45.4	0.0	33.3	0.0	0.6	1.7	0.0	0.0	0.0	0.0	0.0	0.0	**81.0**
	Potential Non-Structural[d]	0.8	28.4	2.0	3.8	1.9	1.6	0.6	0.9	0.7	1.4	1.1	0.0	1.6	**44.9**
	Reduction Subtotal	*0.8*	*314.9*	*13.8*	*90.0*	*33.8*	*13.4*	*12.3*	*4.5*	*3.8*	*3.9*	*3.1*	*0.0*	*3.9*	***498.3***
Total Target TP Load (lbs)		10.4	159.4	7.1	8.3	7.5	12.2	3.9	6.0	2.5	6.1	5.0	0.0	5.5	**233.8**
Total Target Reduction (%)		7%	66%	66%	92%	82%	52%	76%	43%	61%	39%	39%	0%	42%	**68%**

[a]Projects evaluated in existing feasibility studies

[b]Unforseen or unplanned future opportunities. E.g. curb cut rain gardens, innovative practices

[c]Estimated future redevelopment projects subject to CRWD rules

[d]Reduction estimates based on enhanced street sweeping studies. Actual practices may vary.

Table 13. Four categories of watershed TP load reduction methods.

TP Load Reduction Method	Description	Project Examples	Assumptions for Determining TP Load Reduction
1. Potential Structural – Identified	Potential projects identified in existing feasibility studies	See Appendix C for a list of identified projects from feasibility studies by subwatershed	Estimated using TP load reduction targets (lbs/year) for each project as identified in feasibility studies
2. Potential Structural – Unidentified	Unforeseen or unplanned future structural BMP opportunities in the Como watershed	Curb cut rain gardens or the development of innovative BMP practices; future feasibility studies	Could not be estimated, currently unknown. Listed as question marks (?) and will be filled in as it becomes available
3. Future Permit BMPs	Future potential redevelopment projects in the Como subwatershed that could be subject to CRWD's permitting rules	BMPs installed in the Como watershed as redevelopment occurs	All parcels ≥1 acre identified (parkland and existing structural BMPs exempted). Of those parcels, 50% (or 35 parcels) assumed to be developed over the next 20 years. Of those 35 parcels, each were assumed to have 70% impervious area and a structural BMP installed with a removal rate of 1.6 lbs/acre
4. Potential Non-Structural	TP load reduction estimate for non-structural BMP practices	Street sweeping, storm drain maintenance, community leaf cleanups	An average TP load reduction estimate from enhanced street sweeping studies were used as a representative value for load reduction by non-structural practices. Rates calculated using representative value and total directly connected impervious fraction

Potential Structural – Identified

Several feasibility studies have been completed by CRWD and other partners in effort to identify locations or opportunities for potential structural BMP projects in the Como watershed. Appendix C lists all potential BMP projects identified in existing feasibility studies in each Como subwatershed (B-M). The BMP type and the estimated TP load reduction target (lbs/year) of each project are also listed Appendix C. The total estimated TP load reduction target (lbs/year) for each subwatershed was summed and the total was placed in the Watershed TP Load Reduction Plan (Table 12) to subtract from the baseline load.

The majority of the potential structural projects listed in Appendix C were identified as part of the *Como Park Stormwater Inventory and Watershed Analysis* (HEI 2016) and the *Como Regional Park Stormwater Master Plan* (HEI 2017). The following action is recommended to achieve implementation of the potential structural projects that have been identified in feasibility studies through 2018:

> **W1. Implement potential structural projects identified in feasibility studies.** Collaborate with partners to implement identified projects (Appendix C) in existing feasibility studies. Based on the calculated estimations, TP Load reductions from 'Potential Structural-Identified' have the potential to be significant with 229 lbs/year, or 31% of the total watershed TP load (Table 12).

Potential Structural – Unidentified

The 'Potential Structural-Unidentified' method accounts for load reductions achieved through unforeseen or unplanned future structural BMP opportunities. This category also accounts for TP load reductions gained by future innovative structural BMPs discovered through research. In addition, feasibility studies that identify potential structural BMP opportunities in the Como watershed will continue to be developed in the future.

The TP load reductions to be achieved by potential unidentified structural practices in the Watershed TP Load Reduction Plan (Table 12) could not be estimated because they are currently unknown. Therefore, the load reduction estimates are accounted for in the Watershed TP Load Reduction Plan as question marks (?) and will be filled in as opportunities come available. The following actions are recommended to achieve load reductions from unidentified structural BMPs:

> **W2. Seek out and implement potential structural BMP project opportunities in the Como Lake watershed not currently identified.** Collaborate with partners to identify new opportunities as they become available and strategically implement in key locations, such as the placement of curb cut boulevard raingardens during a street reconstruction project.
>
> **W3. Support research to seek out innovative stormwater management practices**. Research and development on innovative stormwater practices is ongoing and continues to evolve. Encourage and provide support to research seeking to develop new and innovative stormwater practices.
>
> **W4. Complete a feasibility study for a runoff treatment facility to treat watershed runoff flowing to Como Lake**. The feasibility study should explore the effectiveness of alum treatment facilities, spent lime, and other innovative technologies. This potential future action depends upon progress to reduce external/watershed loads and response of the Lake to in-lake management actions. The feasibility of existing practices (e.g. spent lime filters) and/or new innovative treatments should be considered at that time as well.

Future Permit BMPs

CRWD implements a set of Board adopted rules through the Permitting Program that regulate development and redevelopment projects to ensure that stormwater runoff from construction sites

does not adversely affect District water resources. According to CRWD's Water Quality and Stormwater Management Rules (CRWD 2015), a permit is required for any land development project that disturbs one acre of land or greater, or 10,000 square feet in area and adjacent to a water body (Rule C). For development projects that meet the criteria for Rule C, permittees are required to fulfill three standards pertaining to stormwater management on their site as part of the project: 1) Rate Control—runoff rates cannot exceed existing runoff rates; 2) Volume Reduction—stormwater runoff volume reduction must be achieved onsite in the amount of 1.1 inches of runoff from the total impervious surfaces; and 3) Water Quality—effective non-point source pollution reduction BMPs to achieve 90% pollutant removal from the runoff generated by 2.5 inch rainfall or annually.

Any future development or redevelopment project within the Como watershed will present an opportunity to enact CRWD's Rule C which will assist in working toward TP load reduction goals. The following actions are recommended to achieve load reductions from future permit BMPs:

> **W5. Implement CRWD permitting rules as they apply**. Enact Rule C—Stormwater as future development or redevelopment projects occur in the Como watershed. TP load reductions from 'Future Permit BMPs' have the potential to be significant with 81 lbs/year, or 11% of the total watershed TP load.

Potential Non-Structural

Non-structural practices in the Como Lake watershed are an effective method for reducing TP loading in stormwater flowing to the lake. Non-structural practices focus on source management, such as proper disposal of pet waste, leaf clean-up efforts, storm drain debris clearing, or street sweeping. The success of non-structural practices for reducing watershed TP are reliant on participation from both municipal and community partners. It is also important to invest in research that aims to understand the effectiveness of non-structural practices so efforts can be better coordinated.

Potential non-structural practices were included in the Watershed TP Load Reduction Plan (Table 12) and target TP load reductions by subwatershed were estimated. Based on the calculations, TP load reductions from potential non-structural practices are estimated to be 45 lbs/year, or 6% of the total watershed TP load. The following actions are recommended to assist in achieving load reductions from non-structural practices:

> **W6. Support research on the effectiveness of non-structural practices.** Support research that aims to better understand the benefits of leaf removal and street sweeping as TP load reduction strategies.
>
> **W7. Enhance spring and fall street sweeping efforts in the Como watershed.** Coordinate efforts with municipal partners to evaluate and implement a "Como Watershed Street Sweeping Plan" that prioritizes streets for sweeping based on subwatershed load reduction potential, tree species type (leaf phosphorus content, typical leaf drop timing), source potential, and logistics.
>
> **W8. Support the community in implementing non-structural practices in the Como watershed.** Support and promote community efforts for leaf removal, storm drain cleanup, and other TP reduction strategies, e.g. Adopt-a-Drain, leaf disposal assistance, supplies, education/outreach, or event coordination.
>
> **W9. Provide educational opportunities to Como area residents on non-structural practices.** Promote best practices to residents through education and outreach in partnership with CACN, District 10, and other groups.

4.2.2 Other Non-point Source Pollutant Management Actions

While phosphorus is the primary pollutant of concern to Como Lake, there are additional non-point source pollutants that affect water quality and overall lake health. The most significant non-point source pollutants in addition to phosphorus are chloride, trash, sediment, and other pollutants contained in stormwater runoff. The implications of each of these pollutants to Como Lake and strategies for reducing them from the watershed are listed below.

Chloride

Addressing chloride issues are complex due to the need to balance public safety on icy roads with the negative water quality implications. The following actions are recommended to assist in managing chloride in the Como Lake watershed:

W10. Promote best winter deicing practices to the community. Promote best winter salt use and deicing practices to residents and business owners through education and outreach in the Como Lake watershed.

W11. **Collaborate with agency partners to promote best deicing practices and support innovations in deicing methods.** Continue to work with local partners to promote best practices for snow removal and deicing to reduce road salt application on streets and roads in the Como Lake watershed. Support research on innovative deicing methods and technologies that are more efficient, less impactful on water quality, and promote cost-savings.

W12. Evaluate and implement options for regulating deicing practices for private applicators. Explore options for requiring private road salt applicators to become an MPCA Certified Applicator by taking the MPCA's Smart Salting Training classes.

W13. Routinely monitor and analyze chloride concentrations in Como Lake and at storm sewer outlets. Continue to perform routine sampling (April-October) of chloride in the lake and at key storm sewer outlets discharging to the lake and report upon results. Routine sampling of chloride should occur in the winter months (November-March) during ice-on periods.

Trash

Trash entering Como Lake from watershed runoff is problematic because it can have negative impacts the aquatic ecosystem and the overall lake aesthetics. The reduction of trash in Como Lake can be achieved through a combination of prevention in the watershed and direct removal from the lake. The following actions are recommended to assist in preventing and removing trash in the watershed and Como Lake:

W14. Improve trash management within the immediate vicinity of Como Lake. Coordinate with the City of St Paul to develop and implement an improved Trash Management Plan to reduce litter within the immediate vicinity of Como Lake and explore innovative BMP technologies aimed at capturing trash before it reaches the Lake.

W15. Coordinate with community groups to develop a plan for reducing trash from the watershed. Include strategies that focus on trash prevention, removal, and best practices through educational opportunities and organized neighborhood trash clean ups.

W16. Implement an annual trash removal event in and around the lake. Coordinate volunteers and community groups to assist in removing trash in the lake and along the shoreline.

W17. Maintain stormwater BMPs in the watershed to ensure performance for removing trash from stormwater. BMPs will need to be inspected regularly to determine when maintenance is required. Maintenance will include regular clean outs of pre-treatment devices and the BMPs.

Sediment

Strategies for managing sediment from the watershed are the same as those proposed for watershed TP reduction through structural and permit BMPs (see Actions W1, W5, W17). Since structural BMPs are receiving stormwater runoff from the watershed, they are able to capture the majority of the other entrained pollutants in addition to TP. Action W18 under 'Watershed Monitoring' is recommended for observing reductions in sediment from the Como watershed from BMP projects.

Watershed Monitoring

Monitoring watershed runoff is critical for quantifying watershed pollutant loads and serves as a way to observe pollutant reductions over time as projects are implemented. Since 2007, CRWD has been monitoring the outlets of three major Como subwatersheds for flow and pollutants during rain and snowmelt events. The data has been used to validate the watershed P8 model and understand more about the pollutants entering Como Lake. CRWD is committed to continuing subwatershed monitoring into the future. The following action is recommended to continue monitoring and assessing subwatershed loads in the Como watershed:

W18. Monitor and assess subwatershed loads to Como Lake. Monitor discharge, phosphorus, sediment, and other pollutants at key storm sewer outlets discharging to the lake and estimate subwatershed loads. Monitoring data should be used to confirm load estimates from watershed model. Monitoring should prioritize subwatersheds with minimal or highly variable observed data, subwatersheds identified as high TP load contributors from the model, and subwatersheds where BMP implementation has occurred to evaluate progress on watershed load reduction from existing and future watershed BMPs. The lake and watershed models will need to be updated in the future if observed watershed loads deviate significantly from predicted.

4.3 Community Actions

While the previous two sections of the CLMP discuss actions in the lake and watershed, community-based actions are equally as important to the success of the CLMP. These actions work to help build stewardship of and pride in Como Lake from both individuals and groups within the community. Upon successful implementation of the CLMP, visitors to Como Lake will be able to more confidently interact with Como Lake. That interaction can take the form of fishing, boating, walking around the lake, sitting near the lake, etc. This category of actions is grouped into 3 sub-categories: Recreation actions, Education & Outreach actions, and Partnership actions.

4.3.1 Recreation

Recreation is the most significant way people interact with Como Lake. Como Regional Park brings many visitors to Como Lake in all seasons. These visitors recreate in many ways such as: walking/running, bird watching, photography, kayaking, stand-up paddle boarding, fishing, and others. One of the most significant values the community has expressed about Como Lake is related to recreation in and around the Lake, which was identified through the PAG engagement process. As such, it is important that management actions in the CLMP facilitate, improve and celebrate recreational activities at Como Lake.

The following actions are recommended to assist in promoting and maintaining recreational activities on Como Lake:

C1. Enhance and maintain existing fishing areas. Enhance and maintain existing fishing areas around Como Lake, i.e. Pavilion dock, fishing pier, Duck Point, and Compass Point.

C2. Identify locations for additional designated fishing areas. In conjunction with the shoreline assessment (Action L11), identify potential locations for additional designated fishing areas and establish stable, designated, shore-fishing sites for individuals or small groups.

C3. Host annual community fishing event. Coordinate with MNDNR's Fishing in the Neighborhood Program to host an event that is focused on teaching youth and the community how to fish, how to identify fish species, and the basics of fish ecology.

C4. Provide access for non-motorized boating. Continue to provide and maintain designated access points for non-motorized boats.

C5. **Maintain clear channels for non-motorized boating**. Using mechanical harvesting, maintain clear channels for non-motorized boating, particularly in heavily vegetated areas near the Pavilion and fishing pier. Efforts to maintain clear channels for non-motorized boating will need to be carefully evaluated on an annual basis to ensure that management actions do not interfere with progress towards Goal 1, Objective 1F.

C6. Develop and implement on-the-water educational opportunities for people recreating on Como Lake. Create on-the-water educational opportunities for people recreating on Como Lake, such as a "Como Lake Water Trail" that includes interpretive installations in the lake.

C7. Work with the City of St. Paul to provide year-round water-related recreational activities to bring people to Como Lake. Every season brings recreational opportunities to Como Lake, including non-motorized boating and fishing in the summer to ice skating, cross-country skiing, and ice fishing in the winter. Develop strategies for promoting and supporting recreational activities for all seasons.

4.3.2 Education & Outreach

Public support through sustained community engagement and stewardship is critical for the improvement and projection of Como Lake. Having committed community groups and members that can help further the initiatives of the CLMP and support the work of CRWD and its partners is essential for success. Information, education and understanding of Como Lake, its issues, and the work to improve it form the foundation that supports stewardship. Outreach to the many different communities and user groups provides an opportunity to increase the number and diversity of the people working to improve Como Lake. The following actions are recommended to achieve education and outreach objectives:

C8. Conduct annual educational workshops or events on watershed and lake protection. CRWD will coordinate and host at least one annual workshop or event that supports current Como Lake initiatives for existing community groups as well as new audiences.

C9. Develop and install a Como Lake Water Quality Kiosk. A kiosk will be developed, installed and maintained at an outdoor location near the Pavilion, and will serve as the primary information hub for Como Lake. The kiosk will communicate information relevant to Como Lake's water quality and on-going improvement efforts, e.g. science, information, updates, real-time data, available activities, maps.

C10. Develop and install new educational signage around Como Lake. Signage will be installed at key locations to enhance user experience and understanding of the lake's ecosystem, its history, shoreline improvement efforts, and other lake improvement projects. Identify at least two additional languages in which to display or print educational information.

C11. Develop educational resources about Como Lake for school groups and community groups. Educational resources will be developed that can be offered to school groups or others for use in learning more about Como Lake's history, water quality ecosystem, and lake improvement efforts.

C12. Incorporate art and other media as an alternative communication method of Como Lake's water quality. Art and other media can help engage citizens who might not otherwise be engaged in the work to improve Como Lake's water quality. This work will need to be coordinated with the City of St. Paul to ensure that it is complimentary to other park programming and art installations.

C13. Provide regular updates on Como Lake to the community. CRWD will coordinate and submit regular updates (e.g. blogposts, social media content, press releases, and/or reports) on Como Lake water quality, current projects, or other relevant information to Como Active Citizen Network (CACN), District 10, and other community groups and members to distribute to their networks.

C14. Regularly participate in meetings of existing community groups. CRWD will regularly participate in meetings of existing community groups to stay updated on community group initiatives and to provide updates on Como Lake water quality improvement efforts.

C15. Support an existing community group(s) in their hosting of at least one event each year. Events hosted by existing community groups offer an excellent opportunity to communicate information on Como Lake to citizens of the District. These events, although not necessarily water focused, can be an opportunity for CRWD to engage citizens who might not otherwise have exposure to information about Como Lake.

C16. Provide resources (informational and/or supplies) for volunteer groups in the Como Lake watershed to support their initiatives (e.g. Master Water Stewards, CACN, neighborhood teams).

C17. Identify and partner with new community institutions in Como Lake improvement efforts. New institutions in the community may include schools, faith groups, cultural groups, or businesses. Provide new institutions with opportunities to engage with Como Lake and participate in water quality improvement efforts.

C18. Target outreach to recreational users of Como Lake and Como Park. Engage with various individuals or user groups utilizing Como Lake and Como Park, e.g. walkers, runners, bikers, dog owners, boaters, anglers, skiers, birders, etc.

C19. Provide a Como Lake comprehensive online resource to allow the public to access information and updates about Como Lake. CRWD will continue to host a website that includes a wealth of information on Como Lake, including its history, current water quality conditions, monitoring data, watershed information, and community resources. A comprehensive online location for this information will help educate and inform the community about Como Lake.

C20. Document history, personal stories, and values linked to Como Lake. Coordinate and develop programming to research, document, and share the history, stories, and value of Como Lake.

C21. Develop and launch a citizen science campaign with Como area residents, schools, and community groups. Citizen science offers an excellent opportunity to engage community groups and individuals in helping collect critical data to help guide management decisions for Como Lake. Additionally, it provides a meaningful way for individuals to observe and learn more about Como Lake.

4.3.3 Partnerships

No one agency can implement the CLMP and improve Como Lake alone. Partnerships are a key component to addressing the many issues facing Como Lake and meeting long-term goals for improvement. Several agencies and community groups have done significant work relative to Lake and/or watershed improvement projects and programs. Continued partnering and coordination between these agencies and groups will remain a key component to most efficiently and effectively implement the CLMP. New partners will also be important to ensure efforts can be linked to all segments of the Como Lake community. Partnerships can also include funding arrangements that most cost-effectively implement the CLMP. The following actions are recommended to support partnerships:

C22. Partner with agencies and community groups to complete the actions in the Como Lake Management Plan. Partnerships and cooperative efforts are integral to successful implementation of the CLMP since improving the lake is dependent on multiple partners.

C23. Conduct annual meeting with agency partners. Coordinate and host an annual meeting with agency partners (e.g. "Como Lake Agency Management Team") to report upon progress, projects, results, and next steps. This group will be able to regularly document progress towards meeting goals and serve as the mechanism for implementing the Adaptive Management Approach.

C24. Regularly evaluate potential opportunities for outside funding/financing sources to implement the CLMP including grants, cost-sharing, in-kind contributions, and loans.

4.4 Recommended Actions Summary

In total, fifty-four actions have been recommended for lake, watershed, and community to meet the goals of the CLMP. A summary table of all fifty-four recommended actions can be found below (Table 14). In addition to listing all of the actions, Table 14 indicates which goals and objectives each action achieves. The timing of each action has also been identified as short-term (0-3 years), ongoing, or long-term (3-20 years).

Because of uncertainty in how the Lake will respond and the need for management to be flexible beyond the first three years of plan adoption, the schedule for implementing the recommended actions have been temporarily structured using the following time period definitions:

- **Short-term (0-3 years)**: Actions that are recommended to be implemented within the first three years of CLMP adoption.
- **Ongoing**: Actions that are recommended to occur frequently (in some cases annually) over the life of the plan. Some ongoing actions may be efforts that are currently occurring from previously established programming.

- **Long-term (3-20 years)**: Actions that are recommended for consideration pending evolution of the short-term actions to meet goals. Long-term actions will be evaluated every three years as future options for the short-term implementation plan.

The time period definition listed for each action in Table 14 will change every three years along with the update of the Short-Term Implementation Plan.

Table 14. Summary of Recommended Management Actions (L = Lake; W = Watershed; C = Community; Obj = Objective).

Category	Action #	Short-term (0-3 years)	Ongoing	Long-term (3-20 years)	Associated Goal/Obj
Lake (L)					
Phosphorus Management	L1	Update lake water quality model			1A, 1B, 1C
	L2	Alum application to inactivate sediment phosphorus			1A, 1B
	L3		Continue bi-weekly in-lake water quality sampling		1A, 1B, 1C, 1D
	L4			Supplemental alum applications	1A, 1b
Aquatic Vegetation	L5	Herbicide treatment to control curly-leaf pondweed			1E
	L6	Develop and implement lake vegetation management plan			1E, 1F
	L7		Conduct annual aquatic vegetation surveys		1E, 1F
Fisheries	L8	Develop long-term targets for balanced fishery			1G
	L9		Conduct fish surveys		1G
Shoreline	L10	Conduct shoreline assessment			2A
	L11	Develop and implement shoreline management plan			2A
	L12		Engage volunteers and local partners in shoreline management		2A
Watershed (W)					
Phosphorus Management	W1		Implement potential structural projects identified in feasibility studies		1A, 1C, 1D, 5B
	W2			Seek out and implement potential structural BMP project opportunities in the Como Lake watershed not currently identified	1A, 1C, 1D, 5B
	W3		Support research to seek out innovative stormwater management practices		1A, 1C, 1D, 5B
	W4			Complete a feasibility study for a runoff treatment facility to treat watershed runoff flowing to Como Lake.	1A, 1C, 5A
	W5		Implement CRWD permitting rules as they apply		1A, 1C
	W6		Support research on the effectiveness of non-structural practices		1C, 1D
	W7	Enhance spring and fall street sweeping efforts in the Como watershed			1A, 1C, 1D, 5B
	W8		Support the community in implementing non-structural practices in the Como watershed		1C, 1D, 4A, 4B
	W9		Provide educational opportunities to Como area residents on non-structural practices		1C, 1D, 4A, 4B, 4C
Chloride Management	W10		Promote best winter deicing practices to the community		1D, 4A, 4B, 4C
	W11		Collaborate with agency partners to promote best deicing practices and support innovations in deicing methods		1D, 4C, 5B
	W12			Evaluate and implement options for regulating deicing practices for private applicators	1D, 4A, 4B, 4C, 5B
	W13		Routinely monitor and analyze chloride concentrations in Como Lake and storm sewer outlets		1D, 5A
Trash Management	W14	Improve trash management within the immediate vicinity of Como Lake			1D, 5B
	W15			Coordinate with community groups to develop a plan for reducing trash from the watershed	1D, 4A, 4B, 4C

Category	Action #	Short-term (0-3 years)	Ongoing	Long-term (3-20 years)	Associated Goal/Obj
	W16		Implement an annual trash removal event in and around the lake		1D, 4A, 4B, 4C
	W17		Maintain stormwater BMPs in the watershed to ensure performance for removing trash from stormwater		1D
Watershed Monitoring	W18		Monitor and assess subwatershed loads to Como Lake		1A, 1C, 1D
Community (C)					
Recreation	C1			Enhance and maintain existing fishing areas	3A
	C2			Identify locations for additional designated fishing areas	2A, 3A
	C3		Host annual community fishing event		3A
	C4		Provide access for non-motorized boating		3B
	C5		Maintain clear channels for non-motorized boating		3B
	C6			Develop and implement on-the-water educational opportunities for people recreating on Como Lake	3A, 3B, 4C
	C7			Work with the City of St. Paul to provide year-round water-related recreational activities to bring people to Como Lake	5B
Education & Outreach	C8		Conduct annual educational workshops or events on watershed and lake protection		4A, 4B, 4C
	C9	Develop and install a Como Lake Water Quality Kiosk			4C
	C10	Develop and install new educational signage around Como Lake			4C
	C11			Develop educational resources about Como Lake for school groups and others	4C
	C12		Incorporate art and other media as an alternative communication method of Como Lake's water quality		4A, 4B, 4C
	C13		Provide regular updates on Como Lake to the community		4A, 4B, 4C, 5A
	C14		Regularly participate in meetings of existing community groups		4A, 4B, 4C
	C15		Support an existing community group(s) in their hosting of at least one event each year		4A, 4C
	C16		Provide resources (informational and/or supplies) for volunteers		4A, 4B, 4C
	C17		Identify and partner with new community institutions in Como Lake improvement efforts		4B, 4C
	C18		Target outreach to recreational users of Como Lake and Como Park		4A, 4B, 4C
	C19		Provide a Como Lake comprehensive online resource to allow the public to access information and updates about Como Lake		4C, 5A
	C20		Document history, personal stories, and values linked to Como Lake		4C
	C21		Develop and launch a citizen science campaign with Como area residents, schools, and community groups		4A, 4B, 4C
Partnerships	C22		Partner with agencies and community groups to complete the actions in the Como Lake Management Plan		5A, 5B
	C23		Conduct annual meeting with agency partners		5A, 5B
	C24		Regularly evaluate potential opportunities for outside funding/financing sources		5B

5 Implementation

CRWD is taking an adaptive management approach for managing Como Lake and its watershed. The adaptive management framework is described in detail in Section 1.2.

Attainment of management goals to improve water quality in Como Lake will be challenging, costly, and will occur through long-term implementation of actions recommended in this plan. Measurable objectives associated with each management goal provide a way for CRWD and partners to evaluate progress towards goal attainment. Through ongoing monitoring and assessment, CRWD will conduct a thorough evaluation every three years to determine progress towards meeting stated goals and adjust the Short-term Implementation Plan at that time. It is anticipated that this three-year evaluation interval will occur throughout the life of the twenty-year plan. The implementation schedule allows for some flexibility to determine how the Lake will respond to management actions in the short-term, while also ensuring some accountability for monitoring progress over time.

5.1 Short-term Implementation Plan

The Short-Term Implementation Plan is a regularly developed plan (every 3 years) that defines the specific projects, programs and actions for the next three years (Table 15). These items are much better defined due to the timeframe for implementation and the details of cost, timing, and lead and supporting agencies are known. This Short-term Implementation Plan is the primary tool to implement the adaptive management plan.

Table 15 is first Short-Term Implementation Plan (effective 2019-2021) and was developed as part of the planning process and adoption of the CLMP. The Short-Term Implementation Plan includes short-term and on-going recommended actions detailed in Section 4. It further lists each actions schedule, estimated cost, lead agency, and partners. The costs of some actions are listed as “Included in Baseline”, which means that the cost of this action is already included in on-going CRWD projects or programs that has already occurred and will continue into the future.

Future short-term implementation plans will be developed every three years via the adaptive management assessment process. In the third and final year of each short-term implementation plan the following assessment process will be completed:

1. An assessment of progress towards each of the 5 goals and 15 measurable objectives.
2. An assessment of the success of implementation of the actions in the short-term implementation sections will be completed.
3. Based upon these assessments, CRWD and partners (by way of the Como Lake Agency Management Team) will develop, review and finalize the next 3-year Short-term Implementation Plan.
4. The updated (new) Short-term Implementation Plan will be reviewed and coordinated with the public before it is finalized.

The process detailed above will be implemented with agency partners through Recommended Action C23, which states: “Conduct annual meeting with agency partners. Coordinate and host an annual meeting with agency partners (e.g. “Como Lake Agency Management Team”) to report upon progress,

projects, results, and next steps. This group will be able to regularly document progress towards meeting goals and serve as the mechanism for implementing the Adaptive Management Approach."

Table 15. Short-term Implementation Plan (2019-2021).

Category	Action #	Short-term & Ongoing (0-3 years)	Schedule	Estimated Cost	Lead Agency	Partners
Lake (L)						
Phosphorus Management	L1	Update lake water quality model	2019	$20,000	CRWD	
	L2	Alum application to inactivate sediment phosphorus	2020	$250,000	CRWD	
	L3	Continue bi-weekly in-lake water quality sampling	Ongoing	Included in Baseline	RCPW	CRWD
Aquatic Vegetation	L5	Herbicide treatment to control curly-leaf pondweed	2020 2021	$25,000 $20,000	CRWD	MNDNR
	L6	Develop and implement lake vegetation management plan	2019	$10,000	CRWD	MNDNR
	L7	Conduct annual aquatic vegetation surveys	Ongoing	Included in Baseline	CRWD	RCSWCD
Fisheries	L8	Develop long-term targets for balanced fishery	2019	$7,500	CRWD	MNDNR
	L9	Conduct fish surveys	Ongoing	Included in Baseline	CRWD	MNDNR
Shoreline	L10	Conduct shoreline assessment	2020	$10,000	CRWD	RCSWCD SPPR
	L11	Develop and implement shoreline management plan	2020	$15,000	CRWD	RCSWCD SPPR
	L12	Engage volunteers and local partners in shoreline management	Ongoing	Included under C16	CRWD	Community Groups
Watershed (W)						
Phosphorus Management	W1	Implement potential structural projects identified in feasibility studies	Ongoing	$1,100,000	CRWD	SPPR, SPPW, RCPW, others
	W3	Support research to seek out innovative stormwater management practices	Ongoing	Included in Baseline	CRWD	MPCA, Met Council
	W5	Implement CRWD permitting rules as they apply	Ongoing	None or Funding provided via other CRWD efforts	CRWD	
	W6	Support research on the effectiveness of non-structural practices	Ongoing	Included in Baseline	CRWD	MPCA, U of MN
	W7	Enhance spring and fall street sweeping efforts in the Como watershed	2021	$50,000	CRWD	SPPW, Community Groups
	W8	Support the community in implementing non-structural practices in the Como watershed	Ongoing	$5,000	CRWD	Community Groups
	W9	Provide educational opportunities to Como area residents on non-structural practices	Ongoing	$5,000	CRWD	Community Groups
Chloride Management	W10	Promote best winter deicing practices to the community	Ongoing	$5,000	CRWD	Community Groups
	W11	Collaborate with agency partners to promote best deicing practices and support innovations in deicing methods	Ongoing	Included in Baseline	CRWD	Multiple
	W13	Routinely monitor and analyze chloride concentrations in Como Lake and storm sewer outlets	Ongoing	Included in Baseline	CRWD	RCPW
Trash Management	W14	Improve trash management within the immediate vicinity of Como Lake	Ongoing	In-Kind Costs	SPPR	CRWD
	W16	Implement an annual trash removal event in the lake	Ongoing	$2,500	CRWD	SPPR, Community Groups
	W17	Maintain stormwater BMPs in the watershed to ensure performance for removing trash from stormwater	Ongoing	Required under other District/City programs	CRWD	Multiple
Watershed Monitoring	W18	Monitor and assess subwatershed loads to Como Lake	Ongoing	Included in Baseline	CRWD	
Community (C)						
Recreation	C3	Host annual community fishing event	Ongoing	$2,500	CRWD	SPPR, DNR
	C4	Provide access for non-motorized boating	Ongoing	Included in existing park programing	SPPR	CRWD
	C5	Maintain clear channels for non-motorized boating	Ongoing	$20,000	SPPR	CRWD, MNDNR
Education & Outreach	C8	Conduct annual educational workshops or events on watershed and lake protection	Ongoing	$2,500	CRWD	Community Groups
	C9	Develop and install a Como Lake Water Quality Kiosk	2020	$20,000	CRWD	SPPR
	C10	Develop and install new educational signage around Como Lake	2020	$20,000	CRWD	SPPR

Category	Action #	Short-term & Ongoing (0-3 years)	Schedule	Estimated Cost	Lead Agency	Partners
	C12	Incorporate art and other media as an alternative communication method of Como Lake's water quality	Ongoing	$5,000	CRWD	Multiple
	C13	Provide regular updates on Como Lake to the community	Ongoing	Included in Baseline	CRWD	
	C14	Regularly participate in meetings of existing community groups	Ongoing	Included in Baseline	CRWD	Community Groups
	C15	Support an existing community group(s) in their hosting of at least one event each year	Ongoing	$3,000	CRWD	Community Groups
	C16	Provide resources (informational and/or supplies) to volunteer groups	Ongoing	$2,000	CRWD	Community Groups
	C17	Identify and partner with new community institutions in Como Lake improvement efforts	Ongoing	Included in Baseline	CRWD	Community Groups
	C18	Target outreach to recreational users of Como Lake and Como Park	Ongoing	Included in Baseline	CRWD	SPPR
	C19	Provide a Como Lake comprehensive online resource to allow the public to access information and updates about Como Lake	Ongoing	Included in Baseline	CRWD	
	C20	Document history, personal stories, and values linked to Como Lake	Ongoing	Included in Baseline	CRWD	Community Groups
	C21	Develop and launch a citizen science campaign with Como area residents, schools, and community groups	Ongoing	$1,500	CRWD	Community Groups
Partnerships	C22	Partner with agencies and community groups to complete actions in the Como Lake Management Plan	Ongoing	Included in Baseline	CRWD	Multiple
	C23	Conduct annual meeting with agency partners	Ongoing	Included in Baseline	CRWD	Multiple
	C24	Regularly evaluate potential opportunities for outside funding/financing sources	Ongoing	Included in Baseline	CRWD	Multiple

5.2 Estimated Implementation Costs

Individual costs for the initial Short-Term Implementation Plan actions are detailed in Table 15 and have an estimated summed total cost of $2,385,266. During every three-year adaptive management cycle the plan for the actions to be implemented over the following three years will be determined. Cost estimates will be included for these items at that time.

To effectively implement the CLMP, it is important to have an estimated level of expenditure over the life of the plan. Due to the adaptive management approach being used for the life of the CLMP, it is not possible to define a long-term (~20 year) project list with associated costs like would be done in a more typical management plan. To estimate the total plan implementation cost, previous expenditures completed under the 2002 CLSMP were analyzed. Additionally, the planned costs for Como Lake initiatives in the 2010 CRWD Watershed Management Plan were analyzed. During the previous 10-year planning period, average annual costs of $540,700 were incurred for Como Lake management actions.

Based on previous work and its associated costs and what major projects and programs are anticipated in this CLMP, it is estimated the average annual cost of implementation is $700,000. This would result in extrapolated costs over the life of the plan (20 years) of $14,000,000. The distribution of these costs are summarized in Figure 13 and show level of investment by recommended action category.

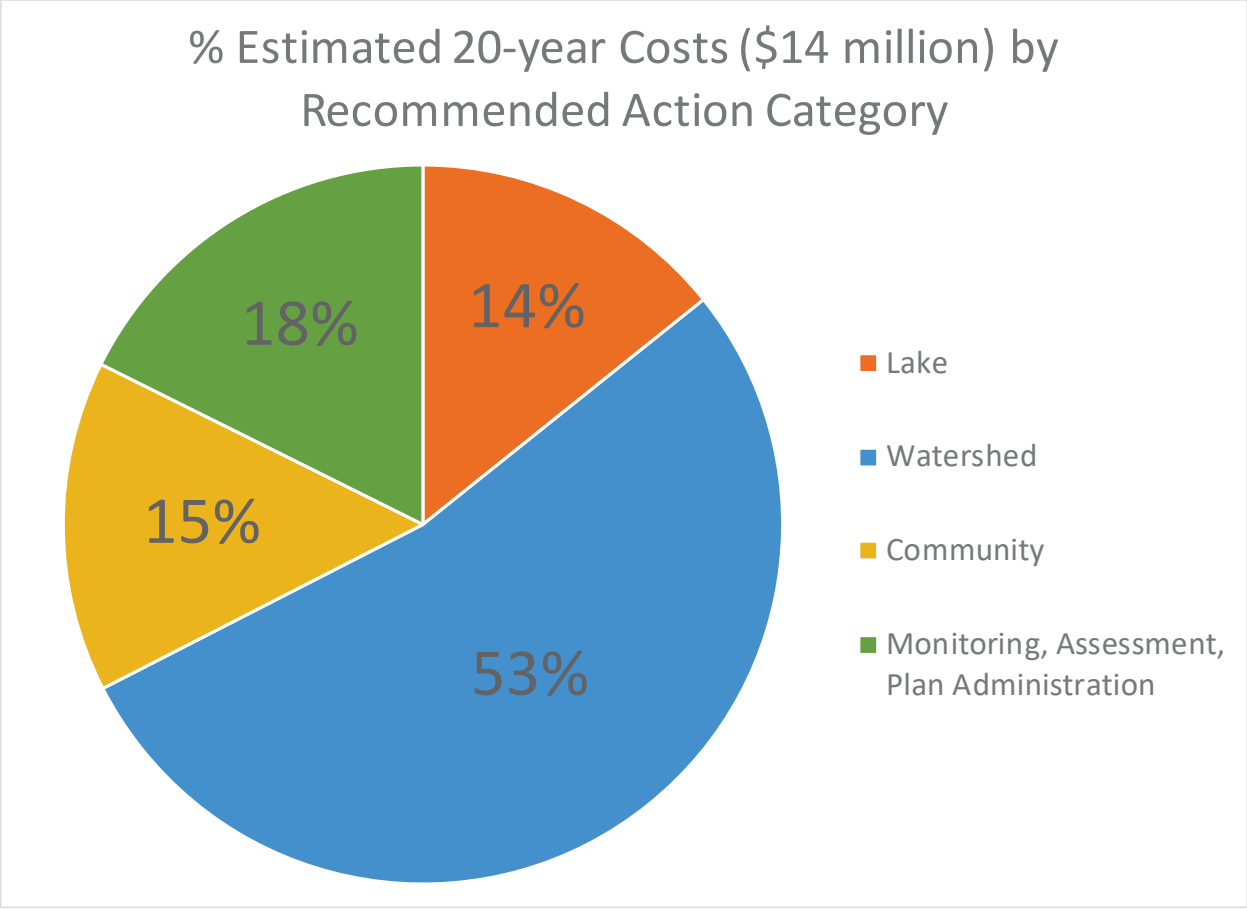

Figure 13. Percent distribution of estimated 20-year costs ($14 million) of actions by category.

This estimated 20-year implementation cost is detailed in Figure 14. These costs include baseline community, monitoring, and plan administration actions already being done and expected to continue as well as new expenditures. These costs should be viewed as forecasts of expected level of investment and not exact costs at the exact year it shown. Inflation is not included in the estimates. These estimates are important to give decision makers and the public a shared expectation about the level of investment needed to fully implement the CLMP.

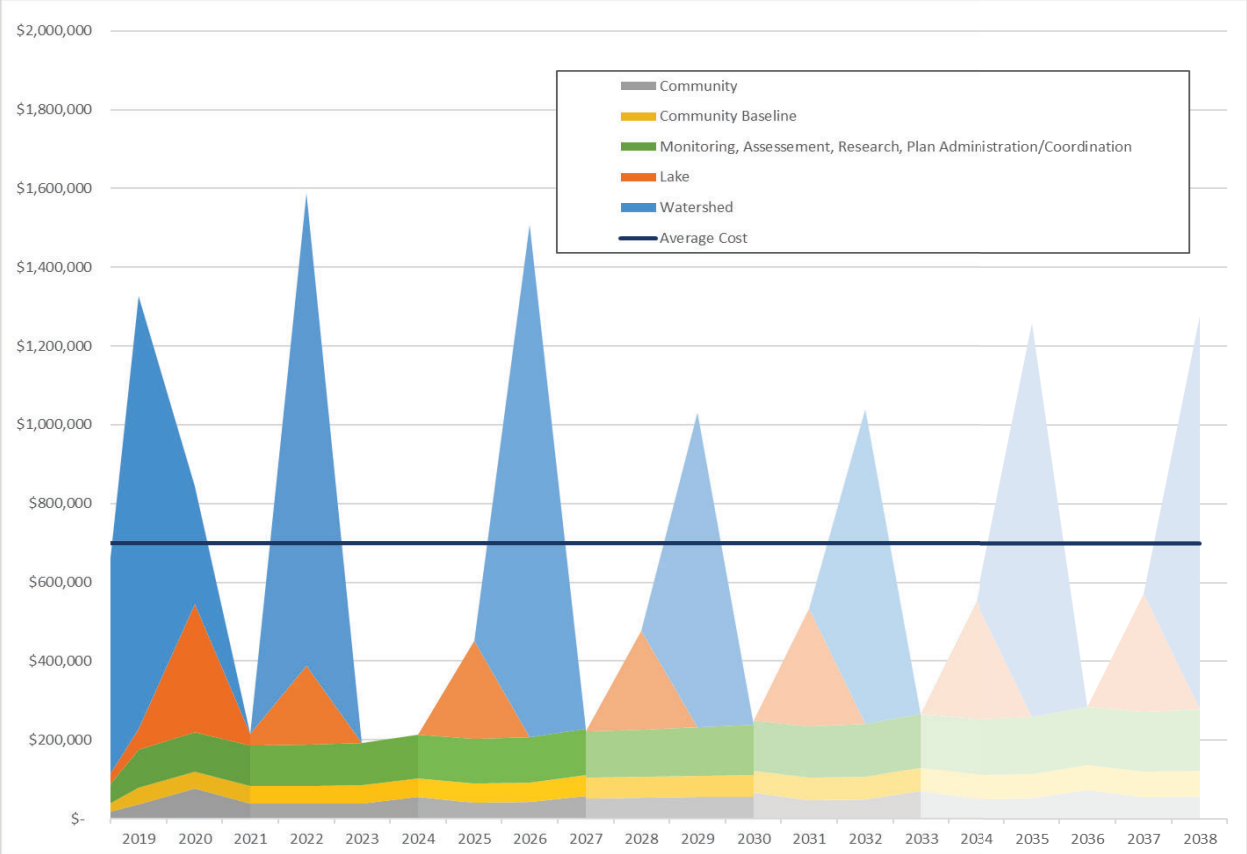

Figure 14. Estimated 20-year costs for implementation of the Como Lake Management Plan.

5.3 Financing

This section of the CLMP describes financing options, including tax levy and other sources of revenue that will be utilized to implement the CLMP. The District will seek implementation funding for Como Lake Management Plan actions through grants and outside cost-share funding. Where known cost-share opportunities are lacking, partnerships may be developed for cost and workload sharing. Costs and responsibility will be shared with partners whenever possible.

In the Twin Cities Metropolitan Area, watershed districts have the authority to levy an ad valorem tax (a tax on all taxable parcels in the District that is based on property value) to pay for the costs of implementing their watershed management plan. These authorities are granted in MN Statutes 103B

and 103D. These costs include the District's administration, programs, projects, and capital improvement projects. The District also has the authority to finance large capital projects by selling bonds or securing loans.

The District will fund implementation of the CLMP using four primary sources of revenue:

1. Property tax levy
2. Grant funds
3. Local partner cost-sharing funding
4. Bonds and loans

The District's financing approach for operational actions (administration and programs) will be used to fund the costs primarily through the annual levy. However, typically 5% is raised through grants, fees, interest income, and local cost-share funding. The financing approach for capital improvement projects is planned to be 25% through the annual levy and 75% through grants, loans, and bond proceeds. Small capital improvement projects (less than $250,000) will be financed through the annual levy. Larger projects will have the costs spread to the long-term benefitting parties through financing via bonds and loans. CRWD will seek local partner cost-share funding for capital improvement projects of all sizes to off-set the District's contributions. Current and past bond issues, loans and grants and their original amounts are listed below.

Grants and loans will likely remain a small (15%) percentage of CRWD's funding sources. The District will continue to apply for grants and loans to offset project costs whenever possible and cost effective. However, grant and loan programs change frequently as existing grant/loan amounts and priorities change, new grant and loans become available, and existing programs are terminated. The District will also seek partnerships, or cost-sharing, to distribute a portion of project costs to all the benefitting organizations.

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Appendix A: Stakeholder Input Summary

Stakeholder Input Summary

Como Lake Management Plan:
Goals, Expectations, Challenges and Opportunities

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INTRODUCTION

Capitol Region Watershed District (CRWD) is developing an updated Como Lake Management Plan to improve the health of Como Lake using the best science and extensive community input. Involving the community early and often in this process is intended to ensure that the final plan is developed with a shared understanding of both historical and current conditions, as well as a vision of what a healthy Como Lake looks like.

To gather initial public input for the plan, CRWD utilized three different methods designed to expand beyond traditional engagement. This was done to reach people where they were most comfortable and able to participate, and to include those who have not engaged with CRWD efforts in the past:

- **"Pop-up" conversations at the lake on July 26 and 27:** CRWD staff engaged lake users on the paths around the lake, asking them to stop to provide responses to the questions.
- **Public Advisory Group (PAG) meeting on August 9:** Interested community members participated in a series of small group discussions centered on the questions.
- **Online survey that was open mid-August through early September:** For those unable to participate in the two other engagement options, the questions were provided through an online survey.

Comments included in the analysis were written by participants themselves through each of these three methods, and maintained verbatim throughout the analysis. Roughly 800 comments were received in total from nearly 200 respondents. All participants were asked the same three open-ended, solution-oriented questions:

1. ***What draws you to or excites you most about Como Lake?***
2. ***What do you think are the major issues or concerns for Como Lake today?***
3. ***Looking forward, what hopes do you have for a healthy Como Lake?***

The first question asks people to consider why they value the lake. Those values carried through the responses, tying answers to each other. Analysis of those responses was done using qualitative research methods, where comments were grouped by similar themes and then summarized to develop a single narrative of all comments from the nearly 200 participants. Goals and expectations held by stakeholders were most apparent in questions one and three, challenges largely in question two, and opportunities again in question three. While the questions were designed to deliver those results, to simply summarize by question would not adequately convey what respondents said on the whole. For that reason, this document is organized around the overarching goals and themes that emerged through the analysis of comments from all three engagement methods.

Contents

METHODOLOGY

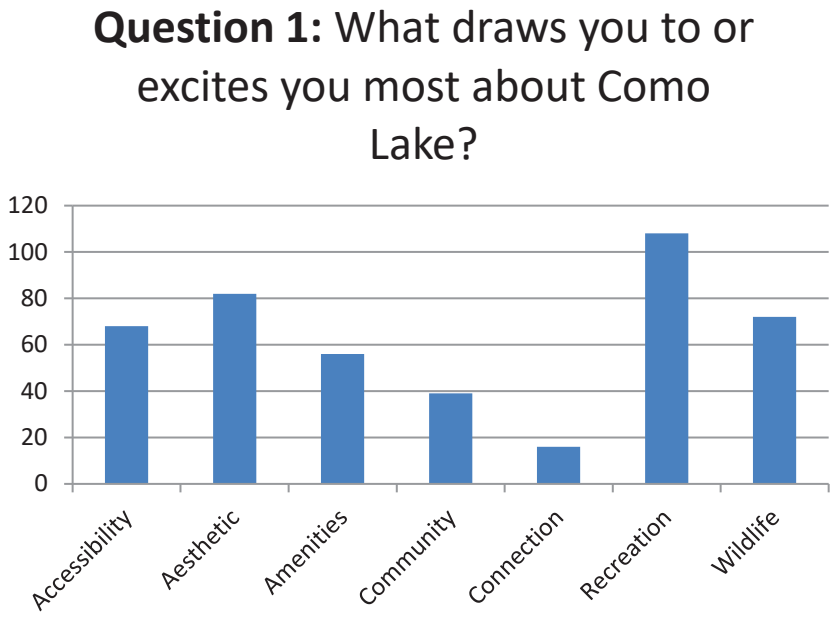
As mentioned above, all participant responses were recorded by the participants themselves through three different engagement methods. Roughly 800 comments were collected, and each was treated as an individual piece of data. To make sense of all the data and develop a single narrative, a qualitative analysis was used to identify major themes. The following four steps outline the process used:

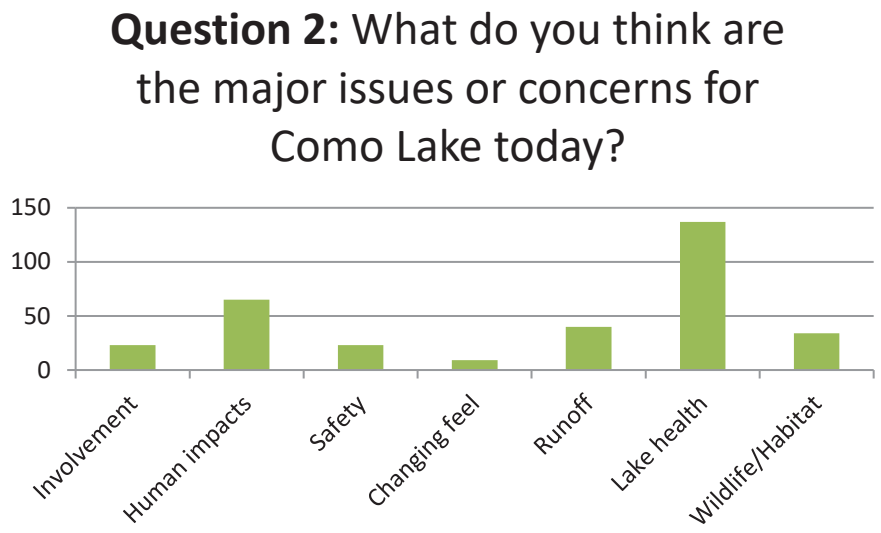
Step 1: Participant response coding

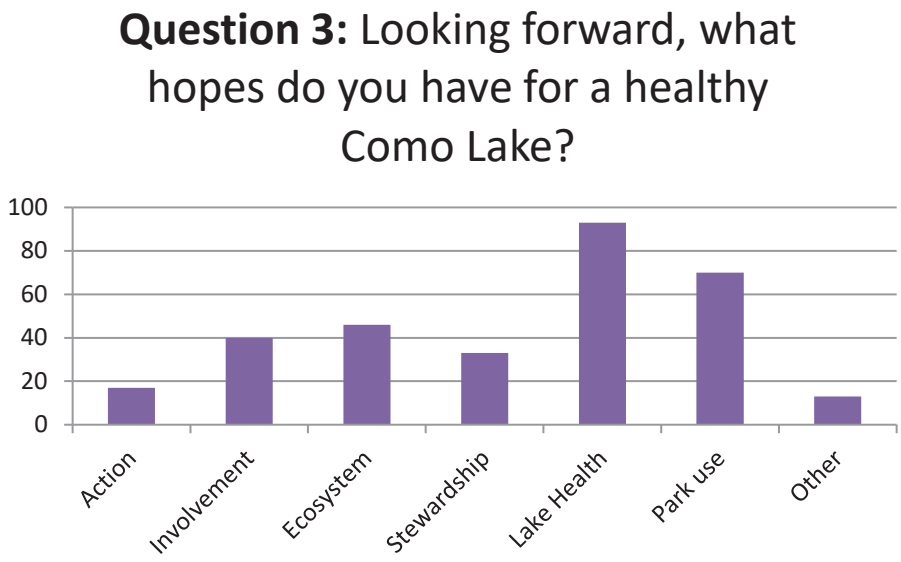
Coding is the process by which a comment's intended focus is identified. For example, the comments "Water quality, too many nutrients flow into it" and "Concerns about run-off infrastructure capacity" both received the code (or category) of "Runoff", whereas "Fish" and "Health for wildlife" were both coded as "Wildlife". Each individual comment from the PAG had already been coded by the participants. These codes were then used in assigning codes to comments from the Pop-up conversations and the survey. Where new codes were needed, new ones were created. Where a single comment had more than one intent or possible code, it was duplicated so that each comment only had one code. As many codes were similar in intent, some were merged together.

Step 2: Sorting the data

Responses from all three methods were combined by question into a single spreadsheet with their codes. Based on the codes, the data under each question was sorted so that similar comments appeared next to each other. This is the first time the responses from all three are mixed together, allowing for the emergence of a narrative across all stakeholder input. Below are a few graphs that show the breakdown by question of more general codes.







Step 3: Summarizing the data
The now sorted information was summarized to provide a narrative for each code. By summarizing by code, a clear narrative of each could develop, capturing the nuance of the comments as well as the input of the group as a whole.

Step 4: Writing the report
With each code under each question summarized, the different parts were stitched together to provide a full picture of the input received through the three different methods. As this stitching occurred, it was done so across the questions, resulting in some summaries being split or merged with others to create the report in the remaining pages of this document.

OVERVIEW OF GOALS AND THEMES

The questions asked of participants were intentionally broad in scope, so the answers that came back addressed more than just the health of Como Lake – they spoke to the full experience of the area, challenges, and the breadth of social, environmental, and economic issues and opportunities. Some of the items included are within the purview of CRWD, others are not. However, all are useful to inform management strategies to meet the goals identified in the final lake management plan.

As similar comments were grouped together, six broad categories emerged. These categories are summarized on the following pages. The corresponding goal statements for those different categories, in no particular order, are:

1. A healthy lake where users are confident in interacting with the water
2. A safe and accessible park that balances use of the area with a peaceful experience and healthy environment
3. A diverse, healthy habitat that can support a variety of wildlife, including pollinators, birds, fish, and amphibians
4. An active, engaged community that protects and cares for Como Lake
5. Amenities that allow for various kinds of recreation throughout the year
6. A stable venue that remains affordable and supports community vitality

Three overarching themes should be noted regarding these goals.

- First, it is abundantly clear that Como Lake is a beloved part of the community and people's daily lives.
- Second, while changes are requested and expected that would improve the health of the lake, there is a strong desire that those changes maintain the identity, feel, and history of the space.
- The third theme is less about the lake, and more about the approach. People are interested in seeing CRWD and the city take bold and cost-effective steps to improve the lake, and maintain the practices they implement.

"I can't imagine life without Como Lake and its surroundings. I go there every day since I moved into the neighborhood 21 years ago."

A challenge emerges where these three themes result in tension – something that will be discussed in the following pages.

GOAL 1

A healthy lake where users are confident in interacting with the water

People care deeply about Como Lake, and for many, their chief concerns are in reference to the health of the water body itself. Not surprisingly, given the purpose of the stakeholder engagement and the questions asked, this goal had the most discussion. The concern expressed in this goal is really embodied in two categories:

What's in the lake already

Murky water, imbalance, nutrient loading, algal blooms, and other issues are discussed at length, with the most discussion centering on those issues most obvious to passersby – the things you can see and smell like trash and odor from algae. These issues limit lake use and create a fear of interacting with the water. Among those willing to be on the water, there is increased concern about fish consumption from the lake and about the health of the plants and animals in the water. Additionally, the smell and color alone can keep boaters off the water altogether.

> ***"My toddler would love to splash around in it but I'm nervous to even let her put her toes in."***

Discussion around what is already in the lake is, most strongly, a call to improve the health of the lake, aimed first and foremost at doing something about the algae. Suggestions for the future include ideas such as dredging, management of aquatic plants, floating islands, and alum treatments.

What's entering the lake

Many respondents recognized that much of the challenge is in addressing the water entering the lake through runoff, and that managing runoff will take a community-wide response. The amount of paved surface sending runoff to the lake is mentioned at length, as well as what that water carries. Specific concerns include leaf litter, chemical applications for yards and the golf course, animal waste, and litter.

Given the nature of runoff, suggestions for how to manage the water entering the lake focus on both land that drains directly to the lake and surrounding community contributions to runoff to the storm sewer system. Doing something to address runoff is clearly a priority, but *how* to manage it may result in some tensions between community desires. Some comments alluded to the desire to see big, bold projects that would meet the challenge of pollution from runoff, while many comments call on the district to maintain the integrity of both more passive and more active ways to enjoy the lake.

Surrounding land draining directly to the lake

Referencing just the land immediately surrounding the lake, the suggestions in this area include an increase in rain gardens and vegetative buffers, more permeable surfaces, more trash and recycling receptacles, reductions in use of fertilizer and herbicides, and more water quality strategies that promote habitat.

Watershed flowing to lake through the storm sewer system

Since everything that happens on land impacts water, suggestions in this area are quite varied. In addition to the strategies considered for the land draining to Como, these more dispersed strategies include an enhanced street sweeping program, more green infrastructure and stormwater practices spread throughout the lakeshed, treatment of the water before it enters the lake, and broad community education that promotes stewardship and behavior change. Incentives and "education targeted at excess nutrient reduction" are also encouraged.

GOAL 2

A safe and accessible park that balances use of the area with a peaceful experience and healthy environment

For many people, what draws them to Como is the aesthetic. The "quiet solitude" and peace they experience, the ability to connect with nature, and the views granted by open space and sunsets keep people coming back day after day – some for close to 80 years. Quick access to natural settings and the feeling of immersing oneself in open space, especially in the core of an urban area, is important to many respondents.

"I can't get up to the cabin everyday so I come here"

For others, it is simply the accessibility of the lake that makes it one they visit time and again. The lake is right there, all times of the day and year. It is nestled in a residential area, close to businesses and schools, and near other amenities, often making it just a short walk away. As a free and public space that has both passive and active uses, people of all ages feel it is a welcoming place. There's a strong desire to see the lake and park continue to remain free and open to the public, accessible to all, with increased diversity. There is also hope that the experience treasured by many will continue to be available for future generations.

Yet, as a lake in an urban setting, Como gets used a lot – in the water, on the land immediately adjacent, and as a part of the regional park. Urban development and population pressure in the area have led to concerns about the impact of visitors and the surrounding community on the lake and landscape, and tension between increased use and this peaceful aesthetic. Traffic, noise, light pollution, land use, and litter are all specifically called out, along with general concerns of overuse impacting both the experience and the health of the lake. One respondent specifically mentions worry that use will become so high it will destroy "the peaceful atmosphere of the lake", while another specifically mentions that they do not want to see an increase in amenities that could make the lake feel more like those in Minneapolis.

"I feel safe running alone"

Many people's desire to go and enjoy Como is enhanced by a feeling of being safe while in the park. It's not a place where they anticipate danger. At the same time, others specifically discuss concerns about safety. There is mention of assaults, a mugging at the lake, and car break ins. There are also concerns about managing ice, repairing the paths, and fast-moving users on the paths. Already, there are issues with cyclists (and now scooters): biking on the wrong path or the wrong way on the correct path, or simply going too fast. Some paths are crowded or have overgrown vegetation. This has increased worry about collisions or comfort on the paths in general, especially if users are distracted. Increased lighting was specifically mentioned, but so too was concern about adding to light pollution. Likewise, additional signage was considered, along with requests for fewer signs altogether since they're perceived as taking away from the experience.

Maintaining the feel of the space and accessibility, as well as improving safety, in the context of a growing population is recognized as something that will be difficult to balance. Improvements to the lake are also recognized as something that may enhance the allure of Como, and could make finding that balance even more difficult. Suggestions to achieve the desired balance were not really given, but the overall goal was discussed at length across the questions.

GOAL 3

A diverse, healthy habitat that can support a variety of wildlife, including pollinators, birds, fish, and amphibians

From migrating birds to frogs and turtles to bees and butterflies and even "scurrying rodents" – diverse wildlife (and the habitat to support it) is clearly a draw for many, and a priority for the future. In an urban setting, the amount of open space and the habitat Como provides is highly valued. For more than one person, it is described as an "oasis".

Many respondents mention appreciation for the plant diversity, the trees and shade, and the personal benefits of the natural setting. At the same time, there is a sense of loss of plant diversity, as well as a perception that the plants that *are* there are overgrown. Respondents mention that the dense and tall vegetation along the shore blocks views of the lake and encroaches and narrows already crowded paths.

> ***"Como Lake is an extremely valuable natural resource to me. It provides an ideal opportunity for walking and observing wildlife in an urban setting."***

As changes are made, those that add to biodiversity and habitat will be welcome, though there will be a strong desire to see it maintained and balanced with the ability to interact with the lake. Additionally, educational and community programming that highlights habitat should be considered, such as a bio-blitz or stewardship events.

GOAL 4

An active, engaged community that protects and cares for Como Lake

> ***"We need to get more people on board. We all Love our Como…but it will take all of us to keep it that way."***

Como Lake has a long history of involvement from the community, and today that involvement is seen through activities such as advocacy, rain garden plantings, leaf raking, Adopt-a-Drain, and more. However, there is a feeling that there is reduced public support for new projects, or a lack of awareness of the need to care for the lake. (Note: several respondents expressed that they didn't think there were – or were not aware of – issues with the lake. One even said they would be paying attention more now that the question had been asked.)There is a strong desire to increase understanding of the need to care for Como among visitors and neighbors, and empower them to take action. "We all should work on it" gets to the sentiment precisely.

To do so, a two-pronged approach is being suggested by the comments – one that is focused on non-resident visitor engagement, and the other targeted at the local community. For visitors, trailside engagement that helps people understand the impact of human activities on the lake and the role they can play as visitors are encouraged. Additionally, programmed events that speak to different environmental interests and engage people in stewardship activities are mentioned. For the local community, increased participation in personal actions is strongly suggested, as well as more community events like neighborhood-wide street sweeping or raking. Finding ways to involve the community in improving the health of the lake is also recognized as a way to increase not just understanding, but buy-in and interest in seeing change happen. Several respondents noted that this process was already building towards that goal, and encouraged more efforts like these.

GOAL 5

Amenities that allow for various kinds of recreation throughout the year

The existing amenities at Como Lake already promote active living with various opportunities for recreation for all ages, year round. On land, walking, running, biking, bird watching, dog walking, and other activities fill the paths and green spaces around the park. In the lake itself, fishing, canoeing, kayaking, and taking advantage of rental boats mean there is often activity on the water. Respondents love being able to easily get to and enjoy the park, and many go for a walk there every day. It's a part of their routine and traditions.

> ***"Diversity in recreation options and park/lake access results in greater diversity of users which represents the beautiful community we live in."***

With all this use comes wear and tear, and some amenities need to be improved. As changes are made, considering options that would lend themselves to non-summertime use (programmed or otherwise) is encouraged. Tensions discussed under Goal 3 should be considered here as well, in an effort to balance active and passive uses as well as balance recreation with environmental health.

GOAL 6

A stable commercial venue that remains affordable and supports community vitality

Como is more than just a lake destination. Entertainment (including plays and live music) at the Pavilion as well as a restaurant and event space draw people from nearby neighborhoods and across the metro. One respondent even mentions that the Pavilion is a "bona fide place to meet with friends". Continued change in ownership over the last several years has created instability and concern about the future of the site.

Respondents are interested in seeing the Pavilion continue to offer quality programming for all, and continue to contribute to Como Lake's reputation as a "top quality and destination lake". Additional opportunities in this area include permeable surfaces for new or retrofitted parking areas, as well as finding ways to leverage the interest in programming or offerings at the Pavilion to increase awareness of issues impacting the lake and opportunities to make a difference.

> ***"Continued community hub with diversity of activities, food choices, performances etc."***

SUMMARY

Community members, especially those who have been around for a while, recognize that efforts to protect and restore Como are paying off, even if the payoff isn't as big or fast as they hope. But change is happening, and the comments that led to the development of this document are full of ideas and new hopes about the future of the lake and how to get there.

"Como Lake has been with me my whole life and I want to see it cared for. I'm drawn by the plant life and trees around the lake, and the lights around the lake at night. Como Lake is a place for personal reflection, and bonding with family and friends."

The overwhelming tone of the roughly 800 comments is that of the importance of stewardship – including what has happened already, and that which will happen in the future. Many of the quotes in blue boxes throughout this report invoke this tone, as do the suggestions for future care of the lake. There is cautious optimism about the future health of the lake, evidenced by comments such as the following:

- "As a shallow urban lake totally fed by storm water at this point, Como Lake and its ecosystem present difficult challenges. Since its creation twenty years ago, the Capitol Region Watershed District has made great strides in improving the water quality of the Lake. My hope is that Como Lake will continue to be carefully managed using up-to-date "best practices" in an attentive and environmentally sensitive manner."
- "Considering it has always had issues, I have been here 40 years, I have noticed many projects and activities for years which have benefited the area."
- "We can dream…maybe someday we can swim in the lake"

There is also strong recognition that if the community is to realize the goals laid out in this document, it will take an all-hands-on-deck effort with CRWD, the city, park visitors, and neighbors all working in partnership. This solution-oriented outcome and recognition of the need for collaboration bodes well as an early step in the process to develop a new management plan for Como Lake.

This Wordcloud was generated using the verbatim individual participant responses from all three methods. The size of the word reflects the frequency with which that particular word was used. For instance, the words "water", "lake", "walking" and "beauty" were among the most used words by participants, whereas "meeting", "paddle", and "beach" were not used as often.

Appendix B: All Possible In-Lake Management Actions

Appendix B: Matrix of all possible in-lake management actions that were evaluated for application for Como Lake.

Management Action	Brief Description of Action	Target	Would this action work towards goals for Como Lake?	Reliability	Duration	Application	General Magnitude of Cost	Pros	Cons
Algaecides	Chemical application to kill standing stock of algae	Algae	yes	High	Short	Frequent-Seas	Medium	Immediate response; cost-effective	short duration, can promote Cyanobacteria growth, not a sustainable management action
Hypolimnetic aeration/oxygenation	Typically a mechanical system that circulates or oxygenates water to prevent anoxia.	Anoxia	yes	High	Short	Continuous	Medium-High	Effective at improving DO when designed correctly & maintained	Can be costly to maintain
Inflow/end-of-pipe chemical treatment (e.g. alum based compounds)	Treatment of stormwater with a chemical agent that binds with phosphorus before it enters the lake.	External P load	yes	Medium	Long	Continuous	High-Medium	Very effective at reducing P load to receiving waters	Need storage capacity / settling basin for flocculated water
Biomanipulation through Fisheries Mgmt (Long-term)	Altering of the biological community (typically fish) to increase abundance of predators or herbivores.	Food web	yes	High	Medium	Occasional	Low-HIgh	Improves ecological function; can reduce algal density through zooplankton feeding	Requires long-term maintenance; Ineffective w/o additional management actions in eutrophic lakes
Biomanipulation through Fisheries Mgmt (Short-term)	Altering of the biological community (typically fish) to increase abundance of predators or herbivores.	Food web	yes	Low	Medium	Seasonal	Low-Medium	Can improve fishery in short-term.	Short-term responses not expected
Drawdown	Drains large volumes of water for extended periods of time.	Food web	yes	Medium	Medium	Occasional	Low-High	Can be effective for macrophyte control	Can be costly and labor intensive.
Shoreline restoration/riparian management	May include bank stablization, erosion control, native plant, and/or habitat restoration actions.	Habitat, erosion control.	yes	High	Medium-	Variable	Low-High	Helps to reduce sediment inputs, improves ecological function.	Limited cons are action specific.
P coagulants (Alum & alum-based compounds)	Chemical application to the lake with a compound that binds with phosphorus in water column and phosphorus diffusing from sediments.	Internal P load	yes	High	Variable	Variable	Medium-low	Very effective and safe when dosed properly; well-tested, broadly applied and understood; cost-effective	Needs a buffer in alkaline lakes, which can add to cost. May need multiple applications depending on extent of eutrophication and sediment P. Often under-dosed; requires special handling
P coagulants (Ca & Fe)	Addition of metals salts binds with phosphorus making it unavailable to algae.	Internal P load	yes	High	Variable	Variable	Medium-low	Long-record of application/effectiveness; based on well understood geochemical reactions	Implications for pH and dissolved oxgen - requires special considerations; requires special handling
P coagulants (Other)	Addition of proprietary compounds (e.g. Phoslock) that bind with phosphorus making it unavailable to algae.	Internal P load	yes	High	Variable	Variable	Medium-low	Long-record of application/effectiveness; based on well understood geochemical reactions	Implications for pH and dissolved oxgen - requires special considerations; requires special handling
Dilution and flushing	Reducing the nutrient concentration by adding more water (dilution) and increases the water exchange (flushing).	Internal P load	yes	High	Short	Continuous	Low-High	Indirect control of internal P loading observed	Increased vertical mixing; decreased algal excretory products
Mechanical harvesting	Mechanical raking/removal of nuisance, rooted-vegetation.	Macrophyte control	yes	Medium	Short	Seasonal	Medium-High	Removes dense macrophyte growth in short-term	operationally difficult; expensive machinery for single lake use; usually requires mulitple applications; not effective from some macrophytes; not species selective
Native plant community restoration	Removal of nuisance vegetation and establishment of native vegetation.	Macrophytes	yes	Medium	Medium	Variable	Low	low-effort restoration, community egnagement opportunities	may require biotic and abiotic controls to be successful; more challenging when invasive species are problematic
Herbicides	Chemical application to kill nuisance / invasive macrophytes.	Macrophytes	yes	High	Short	Seasonal	Low-Medium	Some products can be selective	toxicity; public perception; predicting reemergent community; potential for oxygen depletion with decaying plant material
Dredging	Dredging and removal of sediments.	Reduced internal loading through removal of nutrient-rich sediments.	yes	Medium	Long	Rare	High	Removes P in sediment thereby reducting internal loading	Expensive, labor intensive
Microbes and enzymes	Typically proprietary compounds that claim to control algae or manipulate nutrients.	Algae	no	Untested	N/A	N/A	N/A		Unknown efficacy
Shading Dye	Addition of dye to lake to limit light penetration to control algal growth.	Algae	no	Untested	Medium	Seasonal	Low	reduces photosynthecally available light; non-toxic	May not control surface or shallow water blooms
Artificial Circulation	Typically a mechanical system that extends the depth of circulated water/prevents anoxia/stratification.	Anoxia	no	High	Short	Continuous	Medium	Effective at improving DO when designed correctly & maintained; chemical oxydation of reduced substances	Some adverse affects could include cyanobacteria promotion, resuspension of particulate P, reduced clarity
Hypolimnetic withdrawal	Removal of nutrient-rich hypolimnetic water.	Nutrient reduction	no	High	Long	Continuous	Medium	Reduced anoxic duration, removes nutrients from the system	Thermal imbalance, need storage capacity or treatment option for withdrawn water

Appendix C: Identified Potential Structural BMP Projects

Appendix C: Identified Potential Structural BMP Projects and TP Load Reductions from Existing Feasibility Studies

Potential Structural BMP Projects	BMP Type	Como TP Load Reduction Target (lbs/year)
Como B		
Golf Course Parking Lot Reconstruction	Filtration/Infiltration	1.8
Lexington & Como Blvd Intersection	Infiltration	2.6
Como Blvd Reconstruction - Regional Treatment[1]	Filtration/Infiltration	40.7
East Golf Course Ponds IESF	Stormwater Pond Retrofit	21.7
NW Golf Course Pond - IESF Bench	Stormwater Pond Retrofit	24.2
Golf Course Parking Lot Pond - IESF Bench	Stormwater Pond Retrofit	18.7
Zoo Combo - Filtration Basin & Infiltration Basin	Filtration/Infiltration	19.5
Como Pavilion North - Rain Gardens	Bioretention	1.6
	Subwatershed Total	**130.8**
Como C		
Como Pavilion south Regional 2 - Infiltration Stream and Underground Infiltration	Infiltration	8.9
	Subwatershed Total	**8.9**
Como D		
McMurray Field Capture and Reuse - Regional Treatment	Reuse/Infiltration	40.3
Lexington, Como & Horton Ave	Filtration/Infiltration	5.8
Median Rain Garden at Horton and Van Slyke	Bioretention	1.0
	Subwatershed Total	**47.1**

Como E		
Chatsworth St - Regional Treatment	Filtration/Infiltration	28.9
Median Rain Gardens at Argyle and Van Slyke	Bioretention	2.6
Rain gardens	Bioretention	0.3
	Subwatershed Total	**31.8**
Como F		
Nagasaki Road	Bioretention	1.2
	Subwatershed Total	**1.2**
Como H		
Como Blvd Reconstruction - Regional Treatment[1]	Filtration/Infiltration	2.6
	Subwatershed Total	**2.6**
Como J		
Como Blvd Reconstruction - Regional Treatment[1]	Filtration/Infiltration	2.5
	Subwatershed Total	**2.5**
Como K		
Como Blvd Reconstruction - Regional Treatment[1]	Filtration/Infiltration	2.0
	Subwatershed Total	**2.0**
Como M		
Como Blvd Reconstruction - Regional Treatment[1]	Filtration/Infiltration	2.4
	Subwatershed Total	**2.4**

[1]The Como Blvd reconstruction load reduction estimate is based on regional treatment encompassing multiple subwatersheds. The total estimated reduction was apportioned to each subwatershed based on its contributing area.