MINNEHAHA CREEK
WATERSHED DISTRICT

JANUARY 23, 2023 DRAFT

LONG LAKE CREEK ROADMAP

CONTENTS

EXECUTIVE SUMMARY

Since 2018, the Cities of Long Lake, Medina, and Orono; Long Lake Waters Association (LLWA); and Minnehaha Creek Watershed District (MCWD or District) have been working together towards a common goal of improving water quality within the Long Lake Creek (LLC) Subwatershed. The partners aim to restore five impaired lakes in the system to meet state water quality standards, providing fishable and swimmable lakes that underpin the quality of life in their communities.

To support this effort, the MCWD has led the development of a science-driven implementation roadmap. This involved first conducting a subwatershed assessment to identify the water resource issues, the drivers causing the issues, and implementation strategies to address them. From there, the MCWD worked with the partners to identify project opportunities, evaluated their cost-effectiveness, and developed an implementation strategy and project recommendations to achieve the water quality goals.

Of a total 59 projects evaluated, 34 are recommended for advancement based on their high cost-effectiveness and feasibility to implement. The Roadmap categorizes these projects into short, mid, and long-term priorities based on the following implementation strategy:

1. **Regional Treatment:** Prioritize implementation of regional treatment projects in the near-term for the largest water quality improvement
2. **Landscape Projects:** Implement additional projects on the landscape as opportunities and capacity allow to further reduce external nutrient loading
3. **Internal Load Management:** Address internal nutrient loading from the lake sediments once sufficient progress is made to reduce external nutrient sources

Enhancement and addition of regional treatment is recommended as the first priority because these projects can treat a large drainage area while more dispersed, localized treatment is implemented over time. Two regional treatment projects have been identified as top priorities for near-term implementation:

1. **County Rd 6 Pond:** Retrofit of an existing MCWD-owned pond with a filter bench to enhance treatment of the two large northern tributaries to Long Lake.
2. **Holbrook Park:** Regional stormwater management in a Long Lake-owned park to treat a large portion of the downtown area, which produces the highest runoff volume and nutrient loading per unit area.

If completed in total, these 34 projects are estimated to achieve the reductions required for Wolsfeld Lake, Long Lake, and Tanager Lake to meet water quality standards. Achieving water quality standards for Holy Name Lake and School Lake may require biological management within those systems, the load reductions for which are difficult to estimate and will require ongoing monitoring. The total cost for implementing this suite of projects is estimated at $10.5 million.

Each of the partners has an important role to play in executing this strategy. The cities, to achieve the load reductions assigned by the state, have the responsibility to implement projects and best practices on the landscape. As such, the pace and scale of implementation will be largely driven by each city. The MCWD will provide technical and financial support to cities for implementation of projects on the landscape through its new Land & Water Partnership program. The MCWD will also lead the implementation of projects to address internal loading and retrofits to existing MCWD-owned ponds. The LLWA will support the implementation of capital projects by continuing to build awareness and support in the community. The LLWA can also build community capacity for local action such as the implementation of residential best practices.

Based on discussions with the cities, it is assumed that implementation will be largely dependent on funding support from grants or other sources. Projects that are identified in this Roadmap will be strong candidates for a variety of state and regional grant programs as well as MCWD's new Land & Water Partnership program. The District will continue to coordinate with the partners and provide recommendations for the funding strategy with the goal of leveraging the maximum amount of external funding.

This Roadmap provides a data-driven strategy and suite of projects that could be implemented to restore the five impaired lakes in this system. Undoubtedly, there will be projects in the Roadmap that will not be implemented, and there will be new opportunities that will arise. Therefore, it will be important for the partners to continue to coordinate and remain adaptive as they work together toward achieving their shared water quality goals. The MCWD plans to continue convening the partners, at least annually, to maintain a shared strategy and set of priorities for the partnership to advance.

Restoration of these impaired lakes will require long-term commitment and investment by the partners. By working together to establish a shared implementation strategy and prioritize the highest impact and most cost-effective projects, the partners will be able to leverage each other's resources, build community support, and have greater success in securing grant funding to support the work.

INTRODUCTION

PURPOSE

The Cities of Long Lake, Medina, and Orono; Long Lake Waters Association (LLWA); and Minnehaha Creek Watershed District (MCWD or District) have agreed to work together towards a common goal of improving water quality within the Long Lake Creek (LLC) Subwatershed. The partners aim to restore five impaired lakes in the system to meet state water quality standards, providing fishable and swimmable lakes that underpin the quality of life in their surrounding communities.

To support this effort, the District has led the development of a science driven "implementation roadmap" that identifies the highest-impact and most feasible projects to achieve this vision. By working together to develop and follow a shared implementation plan, the partners will be able to leverage each other's resources and have greater success at securing grant funding to support the work.

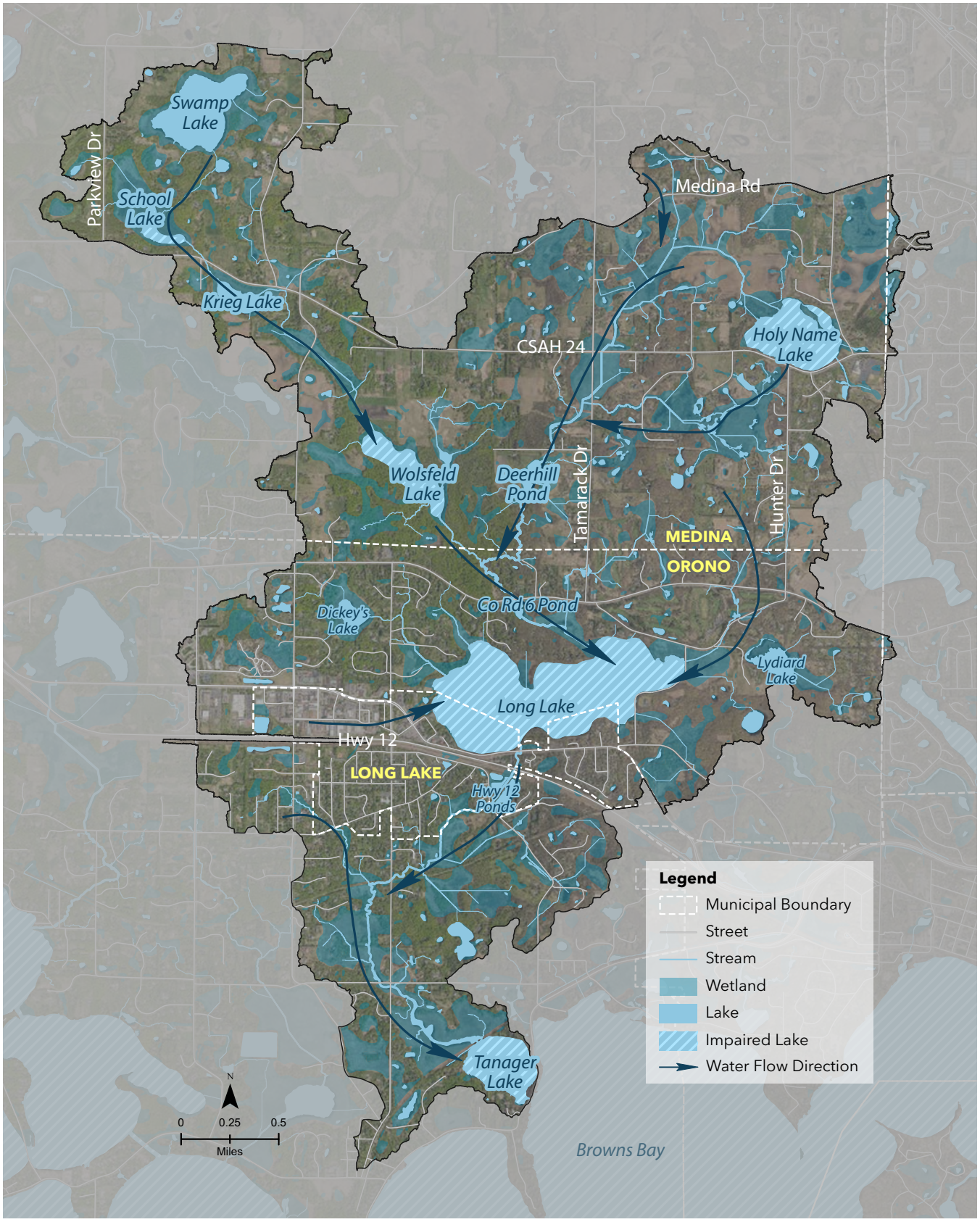
BACKGROUND

Five lakes within the LLC Subwatershed are impaired for excess nutrients: Holy Name, School, Wolsfeld, Long, and Tanager. In 2014, the MN Pollution Control Agency (MPCA) completed the Upper Minnehaha Creek Watershed Total Maximum Daily Load (TMDL) Study which set pollutant reduction goals needed to meet water quality standards so that each lake is suitable for recreational use and can support aquatic life. The TMDL assigned load reduction requirements to the cities of Medina, Orono, and Long Lake that must be met as part of the cities' Municipal Separate Stormsewer System (MS4) permits.

In 2016, the three cities adopted resolutions to work together to pursue grant funding and implement projects to improve water quality and address TMDL requirements (Attachment A). The cities recognized that taking a coordinated and collaborative approach could increase their chances of success. In parallel LLWA, a non-profit entity composed of residents throughout the Long Lake Creek Subwatershed, formed to protect and enhance water quality within the subwatershed.

Between 2016 and 2018, the cities and LLWA began to engage the District in efforts to manage carp in Long Lake to improve water quality. As a regional unit of government spanning the three cities, the District assumed the role of convener to help coordinate and guide the efforts of the partnership. The group agreed that a holistic and data-driven approach was needed in order to identify and pursue the most cost-effective projects to improve water quality.

In 2018, with the support of the partners, the District obtained a $112,000 Accelerated Implementation Grant from the Board of Soil and Water Resources (BWSR). Through this grant, the District served as the technical and planning lead to conduct a subwatershed assessment, identify cost-effective projects and strategies to improve water quality, and develop a clear and actionable roadmap to guide implementation.



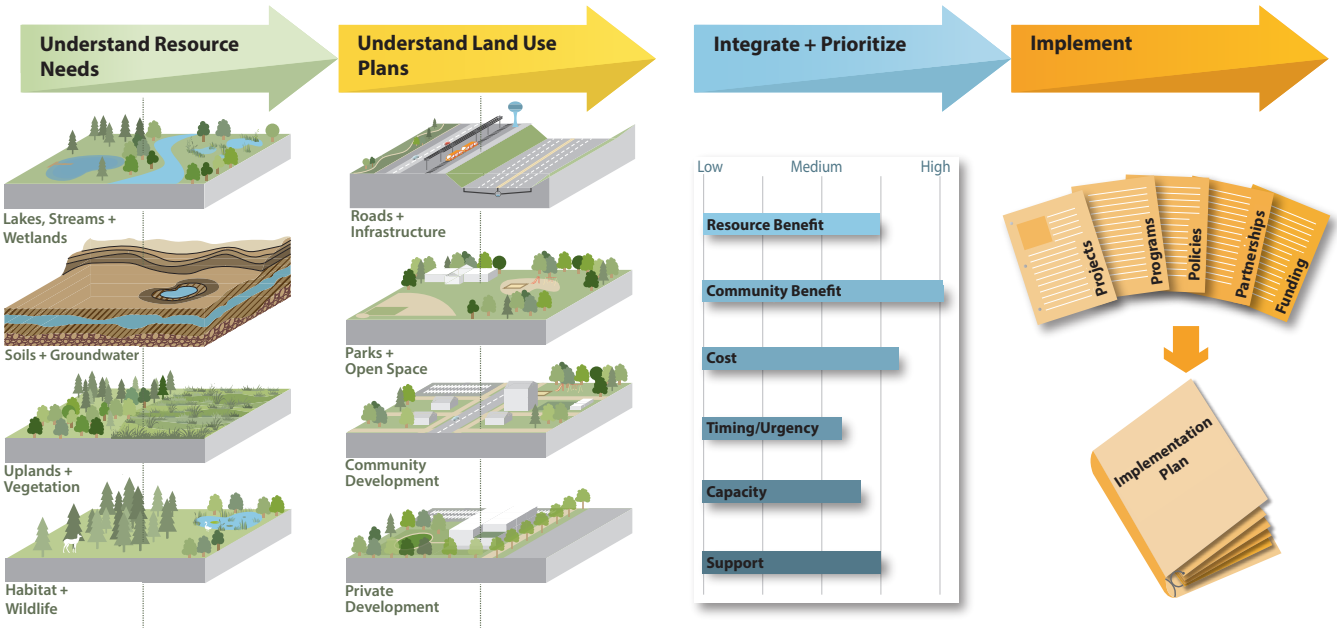
Subwatershed overview map

ROADMAP DEVELOPMENT

APPROACH

To develop the implementation roadmap, the District followed a 4-step approach:

1. Understand Resource Needs: Complete a natural resource assessment to understand issues and drivers of poor water quality
2. Understand Land Use Plans: Incorporate land use plans to identify opportunities for water quality improvement projects
3. Integrate + Prioritize: Integrate land use and natural resource understanding to evaluate and prioritize projects
4. Implementation Plan: Develop a plan that describes projects, roles, timelines, and funding sources



The following page summarizes work completed in each of these four steps. The subsequent sections describe the findings and recommendations from this process, first broken down by management unit, and then summarized in the Implementation Plan Summary section. Additional detail on the methodology, data, and findings from the subwatershed assessment can be found in the accompanying Technical Report.

UNDERSTANDING RESOURCE NEEDS

The first step in solving a water quality issue is understanding the underlying drivers of the problem. To diagnose the drivers of the impairments in the Long Lake Creek system, the MCWD conducted a subwatershed assessment that involved intensive water quality monitoring, analysis of in-lake conditions, ecological health assessments, and watershed modeling.

UNDERSTANDING LAND USE PLANS

Water quality improvements are often most cost-effective when integrated with land use changes such as redevelopment, road reconstruction, or park improvements. To identify opportunities to integrate projects that address major drivers of water quality into these land use changes, MCWD held work sessions with each partner to discuss local knowledge and land use plans. This included review and discussion of the following:

- City capital improvement plans
- Anticipated development/redevelopment
- Priorities and problem areas
- Existing stormwater treatment
- Landowner relationships

INTEGRATION + PRIORITIZATION

Based on the subwatershed assessment and city input, a suite of potential projects were identified, and a preliminary engineering analysis was conducted to develop load reduction and cost estimates to prioritize opportunities.

Projects were then categorized into short, mid, and long-range priorities based on the following:

- Prioritization of the most cost-effective projects
- Consideration of project feasibility, complexity, land ownership, and dependency on other projects/development
- Watershed management best practice of reducing upstream/external nutrient loads before managing internal loads for greater longevity and cost-effectiveness
- Assumption that implementation is primarily grant-dependent, and cities require time to allocate funds to match grants

IMPLEMENTATION PLANNING

To support the cities in project planning and implementation, the District developed recommendations for the implementation strategy, priority projects, roles, timelines, and funding sources.

FINDINGS & RECOMMENDATIONS

OVERVIEW

MANAGEMENT APPROACH

MCWD's approach for managing water resources includes characterizing issues, identifying causes (drivers), and outlining management strategies to achieve measurable change towards identified goals.

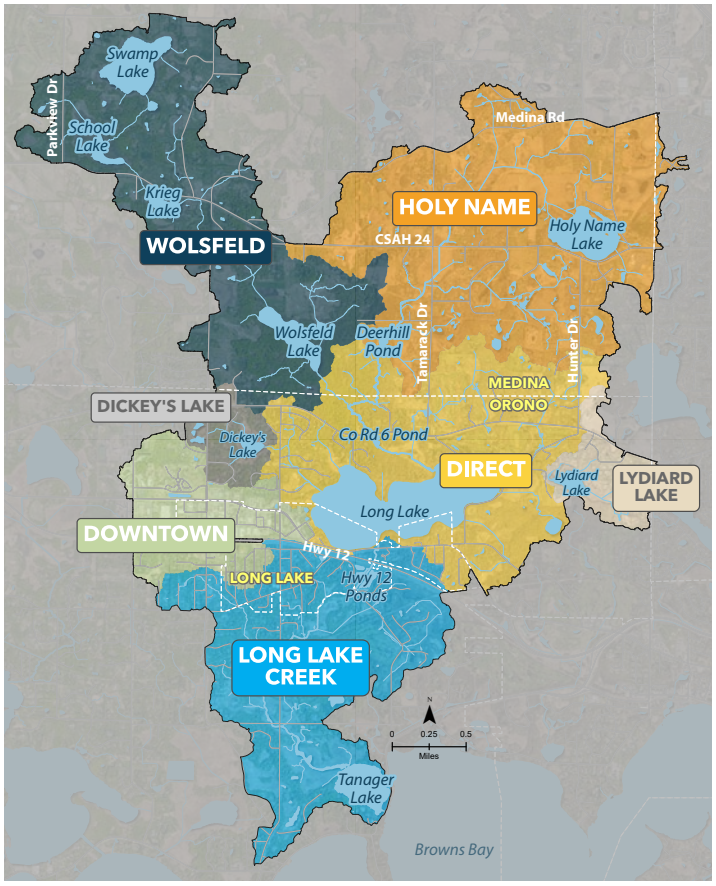
Typically, the underlying driver of in-lake issues such as degraded ecology, poor water quality, or excess flooding is caused by the introduction of human induced landscape change such as increased development or agricultural practices. Over time, many of the in-lake issues caused by land use change become drivers. For example, watershed phosphorus sources slowly increase phosphorus sediment release (internal phosphorus loading), which creates a positive feedback loop that further degrades water quality. Another example involves common carp. Common carp thrive in poor water quality systems, which means that degraded systems are more susceptible to carp establishment. However, their introduction can further degrade lake ecosystems.

Therefore, MCWD prioritizes projects that address the root cause of lake or stream degradation, which is typically excess runoff or nutrient loading from watershed sources. In-lake restoration such as alum treatments, biological manipulation, or stream restoration typically occur after the underlying issues are addressed to ensure any in-lake or stream restorations are successful.

MANAGEMENT UNITS

To facilitate the assessment, the 11.9 square mile subwatershed was broken into smaller management units (MUs) based on how water flows through the system and the unique landscape conditions and land uses present in each unit (see figure). The assessment focused primarily on the upper portion of the subwatershed, which drains to Long Lake. In 2011, MCWD completed a comprehensive study for the lower portion (Long Lake Creek MU) which took a similar approach to diagnose drivers of poor water quality and identify and prioritize projects. The findings from that study are incorporated into this Roadmap.

Dickey's Lake and Lydiard Lake were not included in the assessment since both have small drainage areas and are currently meeting water quality standards. Lydiard Lake is also a landlocked basin. Improvements to these systems would likely yield small benefits relative to the cost of the management activity.

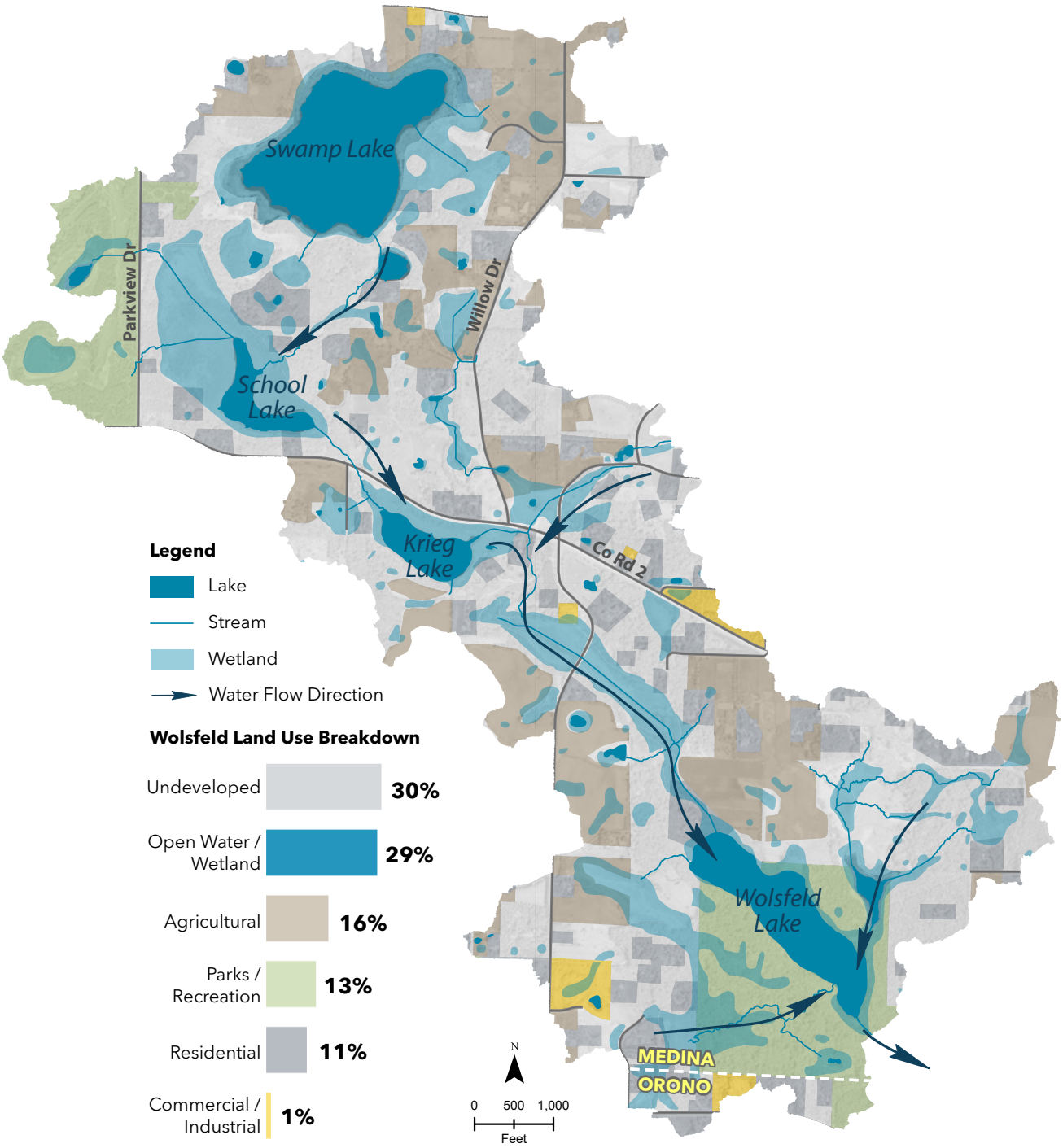


Management Units

The remainder of this section is organized by management unit, each split into the following three subsections:

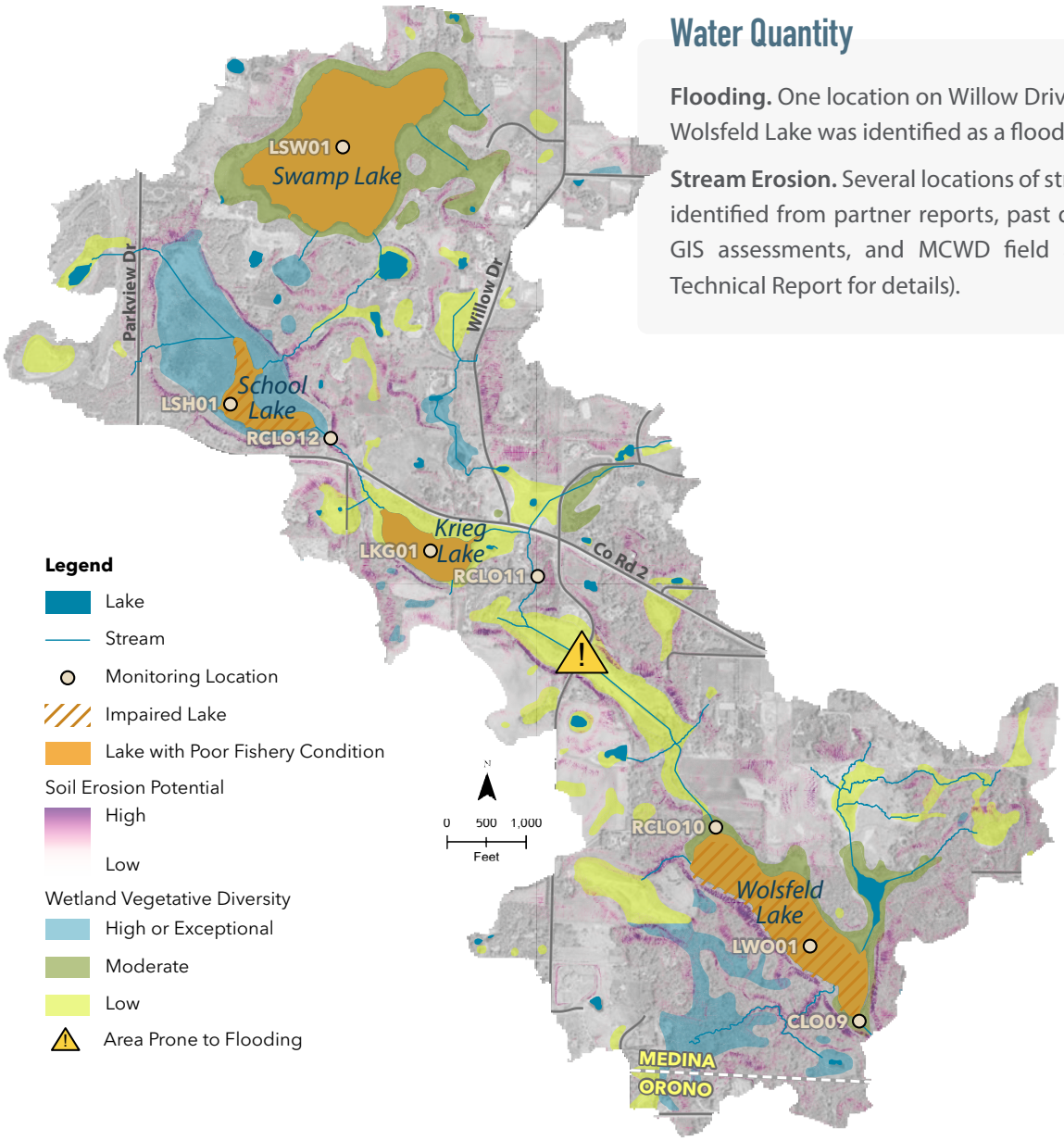
- **Issues**: Water resource issues are organized by water quality, water quantity, and ecological integrity. Condition information was compiled from community input, watershed modeling, historic water quality sampling, vegetation sampling, and fisheries sampling.
- **Drivers**: This section is organized by the two categories of underlying drivers that cause water resource issues: watershed-based drivers and in-lake drivers. Drivers were identified based on modeling, historic water quality sampling, field investigations, sediment sampling, wetland surveys, lake vegetation surveys, and fisheries sampling.
- **Strategies & Opportunities**: Management strategies and project opportunities are also organized into watershed and in-lake strategies. All projects are in the concept phase and require further feasibility assessment and engineering design. This section includes a table summarizing project opportunities and the associated costs and water quality benefits.

WOLSFELD MANAGEMENT UNIT



The Wolsfeld Management Unit (MU) encompasses 1,670 acres and represents the northwest drainage area of the subwatershed. It is located primarily in the City of Medina and includes a small portion of the City of Orono. It includes the impaired School and Wolsfeld Lakes as well as Krieg Lake and a large wetland referred to as Swamp Lake. Land use is primarily undeveloped, agricultural, and low-density residential. The MU includes two large natural and scientific preserve areas. The arrows on the map above represent the MU's drainage pathway.

ISSUES



Water Quantity

Flooding. One location on Willow Drive just upstream of Wolsfeld Lake was identified as a flood prone area.

Stream Erosion. Several locations of stream erosion were identified from partner reports, past diagnostic studies, GIS assessments, and MCWD field assessments. (see Technical Report for details).

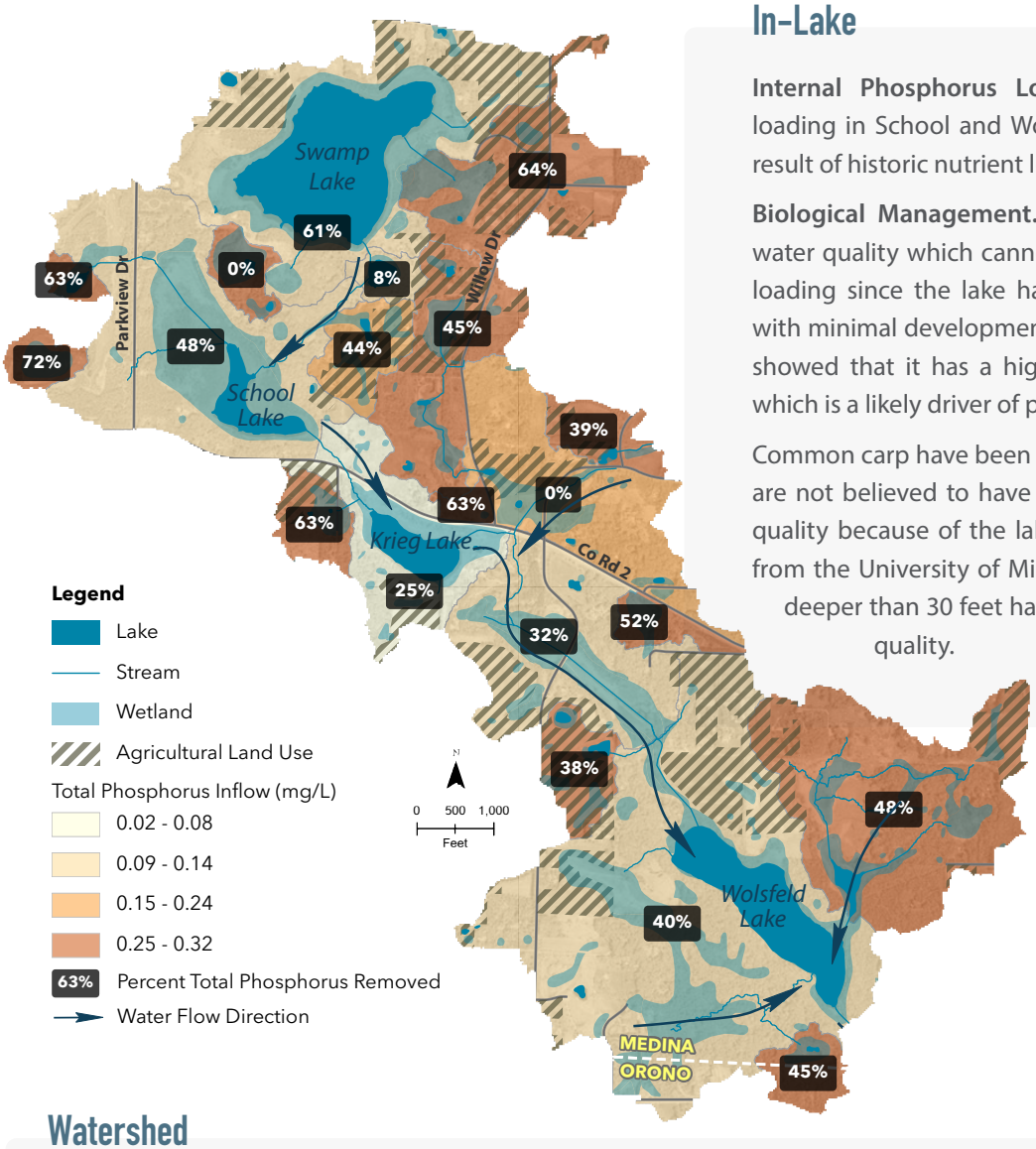
Ecological Integrity

Wetlands. 74 percent of wetlands have low or moderate vegetation diversity based on MCWD's functional assessment of wetlands.

Lakes. All lakes in this MU have poor or impaired fisheries and submerged aquatic vegetation (SAV) populations, based on low species diversity and/or dominance of vegetation/fish that thrive in poor water quality conditions.

Water Quality

Excess Nutrients. All four lakes within the MU (Swamp, School, Krieg, and Wolsfeld Lake) have excess phosphorus concentrations, which leads to poor clarity and summer algal blooms. Currently, School and Wolsfeld Lake are listed on the State of Minnesota impaired waters.



In-Lake

Internal Phosphorus Loading. Internal phosphorus loading in School and Wolsfeld Lakes is very high as a result of historic nutrient loading to both lakes.

Biological Management. Swamp Lake has very poor water quality which cannot be explained by watershed loading since the lake has a very small drainage area with minimal development. Fish surveys in Swamp Lake showed that it has a high biomass of black bullhead, which is a likely driver of poor water quality.

Common carp have been observed in Wolsfeld Lake but are not believed to have a significant impact on water quality because of the lake's depth. Based on research from the University of Minnesota, carp present in lakes deeper than 30 feet have little to no impact on water quality.

Watershed

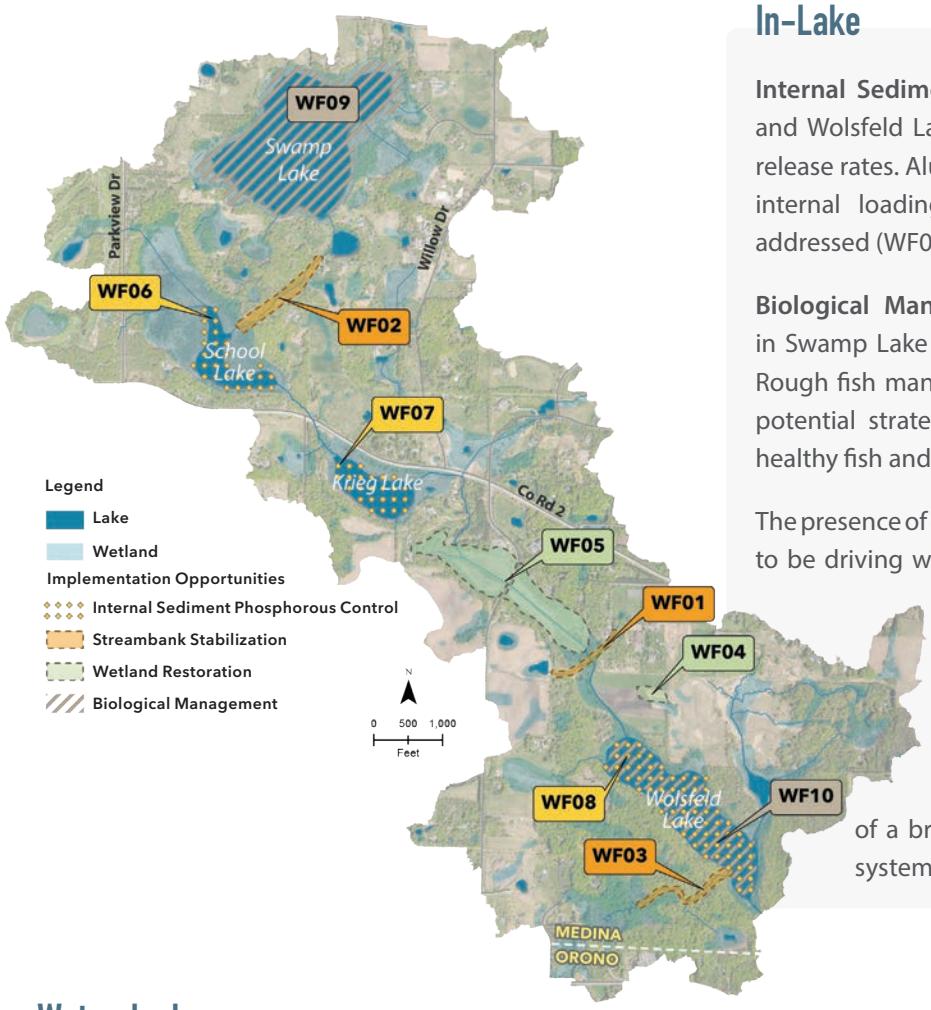
Erosion. Stream channel erosion is one of the greatest issues in this MU. Erosion is caused by natural geologic conditions, including steep slopes and erodible soil types.

Erosion is a contributing factor to flooding at Willow Drive based on field investigation. Tree branches and debris from stream erosion is building up downstream of the wetland at Willow Drive and restricting flow. This is the most likely cause of flooding since there were no other stormwater infrastructure issues observed in the area.

Stormwater Runoff. The Wolsfeld MU has the lowest runoff volume of all the MUs since the amount of impervious area is relatively low. However, phosphorus concentrations are high due to erosion and agricultural stormwater runoff. Agricultural land use is a common cause of elevated nutrient concentrations in stormwater runoff. In addition, bare soils on agricultural land during spring and fall storm events can lead to erosion and suspended sediment issues.

Altered Wetlands. The Wolsfeld MU has a few exceptional wetlands , however, the majority have moderate or low vegetation quality. Field and water quality investigations have shown that altered hydrology and excess nutrient loading is disrupting the wetlands' hydrology and nutrient cycling.

STRATEGIES & OPPORTUNITIES



In-Lake

Internal Sediment Phosphorus Control. School, Krieg, and Wolsfeld Lakes all have high sediment phosphorus release rates. Alum dosing could be completed to reduce internal loading once watershed erosion issues are addressed (WF06, 07, 08).

Biological Management. High nutrient concentration in Swamp Lake appears to be due to biological drivers. Rough fish management and whole lake drawdown are potential strategies that could be explored to restore healthy fish and aquatic vegetation communities (WF09).

The presence of carp in this subwatershed does not appear to be driving water quality issues in the impaired lakes, therefore, carp management has not been prioritized as a near-term strategy. However, since carp appear to be actively recruiting in the subwatershed and migrating to/from Tanager, future management may be considered as part of a broader strategy for the Lake Minnetonka system (WF10).

Watershed

Channel Stabilization. The assessment identified three opportunities to stabilize eroding channels or ravines to reduce nutrient loading (WF01, 02, 03). WF03 is located within the Wolsfeld Woods Scientific and Natural Area, where tree removal is prohibited, which limits the opportunity for a stabilization project. Stormwater Management strategies will focus on agricultural BMPs and areas upstream of eroding channels/ravines. Potential best practices for agricultural properties include alternative tile intakes, buffers, and manure management.

Stormwater Management. Stormwater management for this MU should focus primarily on agricultural best practices (e.g. alternative tile intakes, buffers, manure management) and reducing runoff to eroding channels/ravines.

Over time, some of the agricultural properties within this MU may be converted to rural residential use. This conversion is expected to reduce nutrient loading based on current regulatory standards and may present opportunities for partnership to achieve greater benefit.

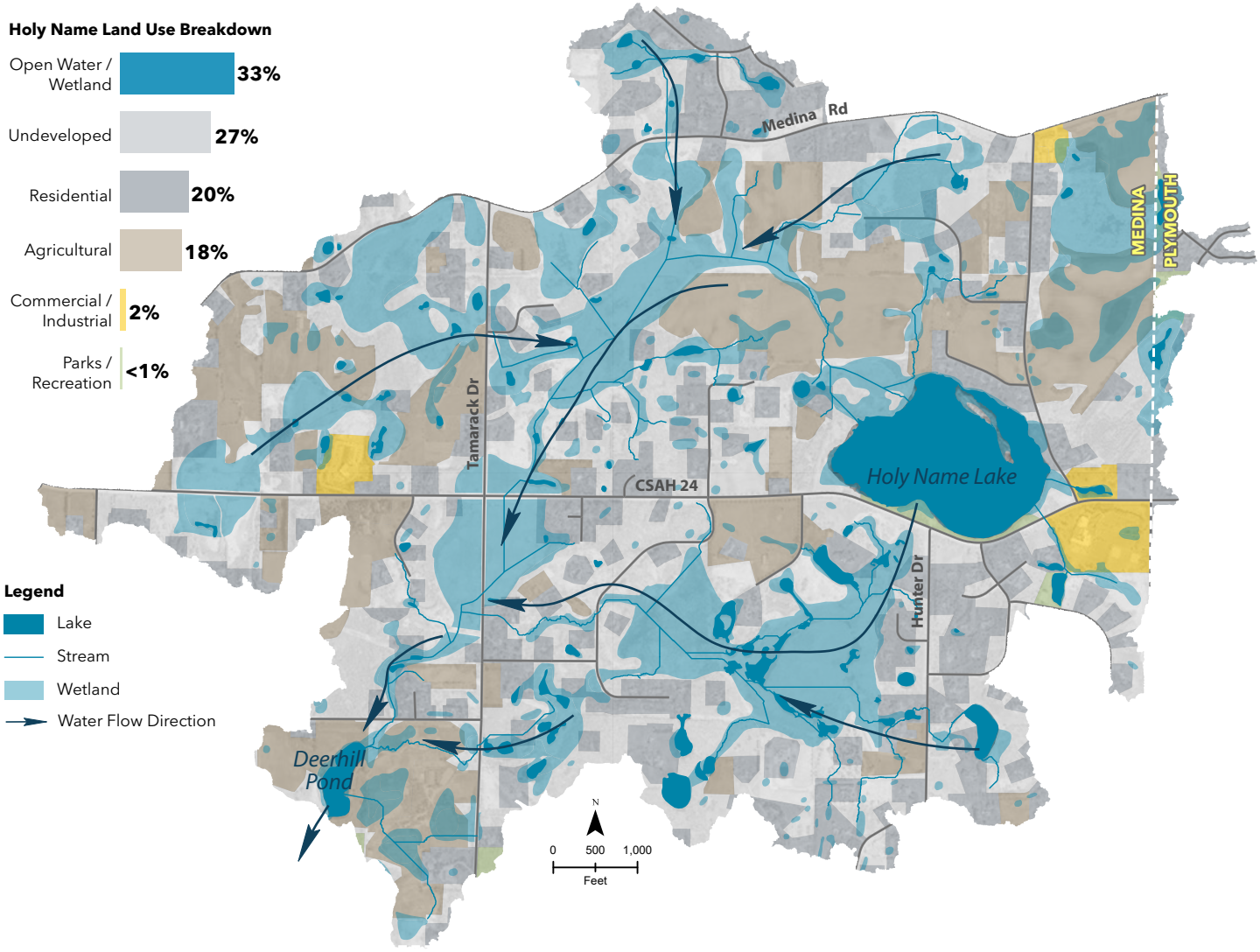
Wetland Restoration. Wetland restoration opportunities for this Roadmap are focused primarily on reducing nutrient loading to impaired lakes. Two opportunities have been identified (WF04, 05) which could involve hydrologic and vegetation restoration. WF04 should also be assessed for potential excavation of nutrient-rich sediment.

IMPLEMENTATION OPPORTUNITIES SUMMARY

WOLSFELD MANAGEMENT UNIT

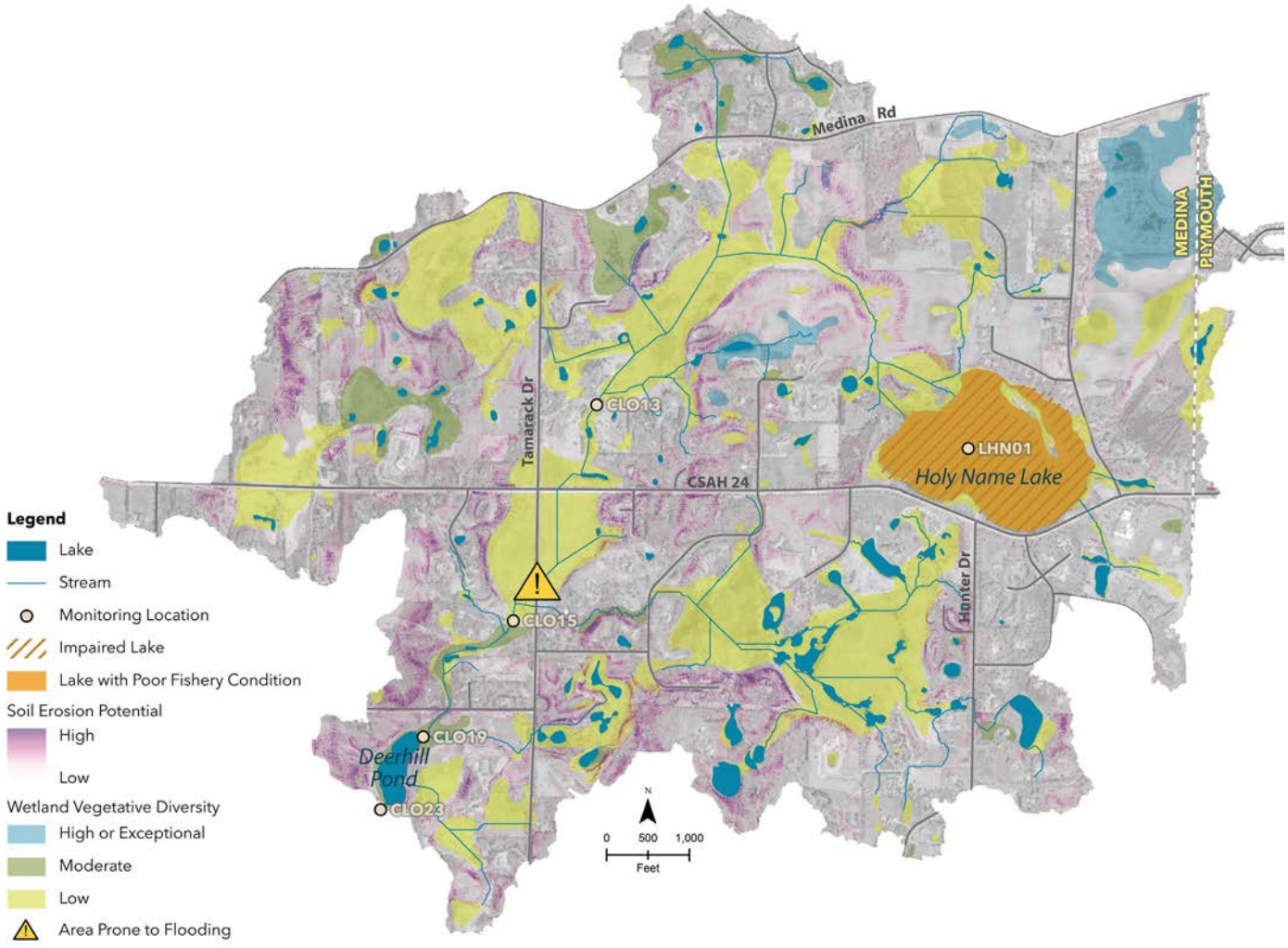
Project ID	Project Name	Location	Est. Load Reduction (lbs)	Est. Construction Cost	Lifecycle Cost/Benefit ($/lb/TP/30 year)	Timeline
Stream Channel & Ravine Stabilization						
WF01	Crosby Creek Ravines	Medina	31	$380,000	$719	Short-term
WF02	Swamp-School Corridor Improvements	Medina	7.2	$446,000	$2,065	Mid-term
WF03	Wolsfeld Woods Ravine	Medina	46	$290,196	$227	Mid-term
Wetland Restoration						
WF04	Crosby Wetland Restoration	Medina	12.7	$289,500	$1,154	Near-term
WF05	Willow Drive Wetland Restoration	Medina	18.5	$137,500	$336	Mid-term
Internal Sediment Phosphorus Control						
WF06	School Alum Treatment	In-Lake	92.7	$213,600	$77	Mid-term
WF07	Krieg Alum Treatment	In-Lake	TBD	$181,200	TBD	Mid-term
WF08	Wolsfeld Alum Treatment	In-Lake	60	$459,360	$255	Long-term
Biological Management						
WF09	Swamp Drawdown	In-Lake	TBD	$42,348	TBD	Mid-term
WF10	Wolsfeld Carp Management	In-Lake	TBD	$200,000	TBD	Long-term

HOLY NAME MANAGEMENT UNIT



The Holy Name Management Unit (MU) encompasses 2,008 acres and represents the northeast drainage area of the subwatershed. It is located primarily in the City of Medina and includes a very small portion of the City of Plymouth. This subwatershed contains one lake towards the east of the MU, Holy Name Lake. The MU is unique for its abundance of large and small wetlands. Land use consists primarily of undeveloped areas, single-family residential, and agricultural areas.

ISSUES



Water Quantity

Flooding. Flooding has been identified on Tamarack Road.

Water Quality

Excess Nutrients. Holy Name Lake is on the state list of impaired waters due to excess nutrients, but has been recently meeting standards.

Stream phosphorus concentrations at the headwaters of the Holy Name MU are over four times greater (450 µg/L) than the state water quality standard (100 µg/L), while the concentration near the outlet of the MU is 150 ug/L.

Ecological Integrity

80 percent of wetlands within the Holy Name MU have low vegetation diversity based on MCWD's functional assessment of wetlands.

Lakes. Holy Name Lake has poor vegetation species diversity and a fish population that is dominated by fish species that thrive in poor water quality conditions such as black bullhead and goldfish.

DRIVERS

Watershed

Stormwater Runoff. Watershed modeling in this MU identified agricultural areas as the primary contributor of phosphorus to streams, lakes, and wetlands. Stormwater runoff volume is relatively low here due to little impervious cover and many wetlands that provide storage and treatment for stormwater runoff.

The MCWD constructed a regional stormwater treatment pond (Deerhill Pond) at the outlet of this MU in the 1990's which continues to provide treatment by reducing total phosphorus by 6 percent prior to reaching Long Lake. The large number of existing wetlands and MCWD's Deerhill Pond appear to be effective, as phosphorus concentrations are reduced from 450 µg/L at the outlet of Holy Name to 150 µg/L at the outlet of the MU.

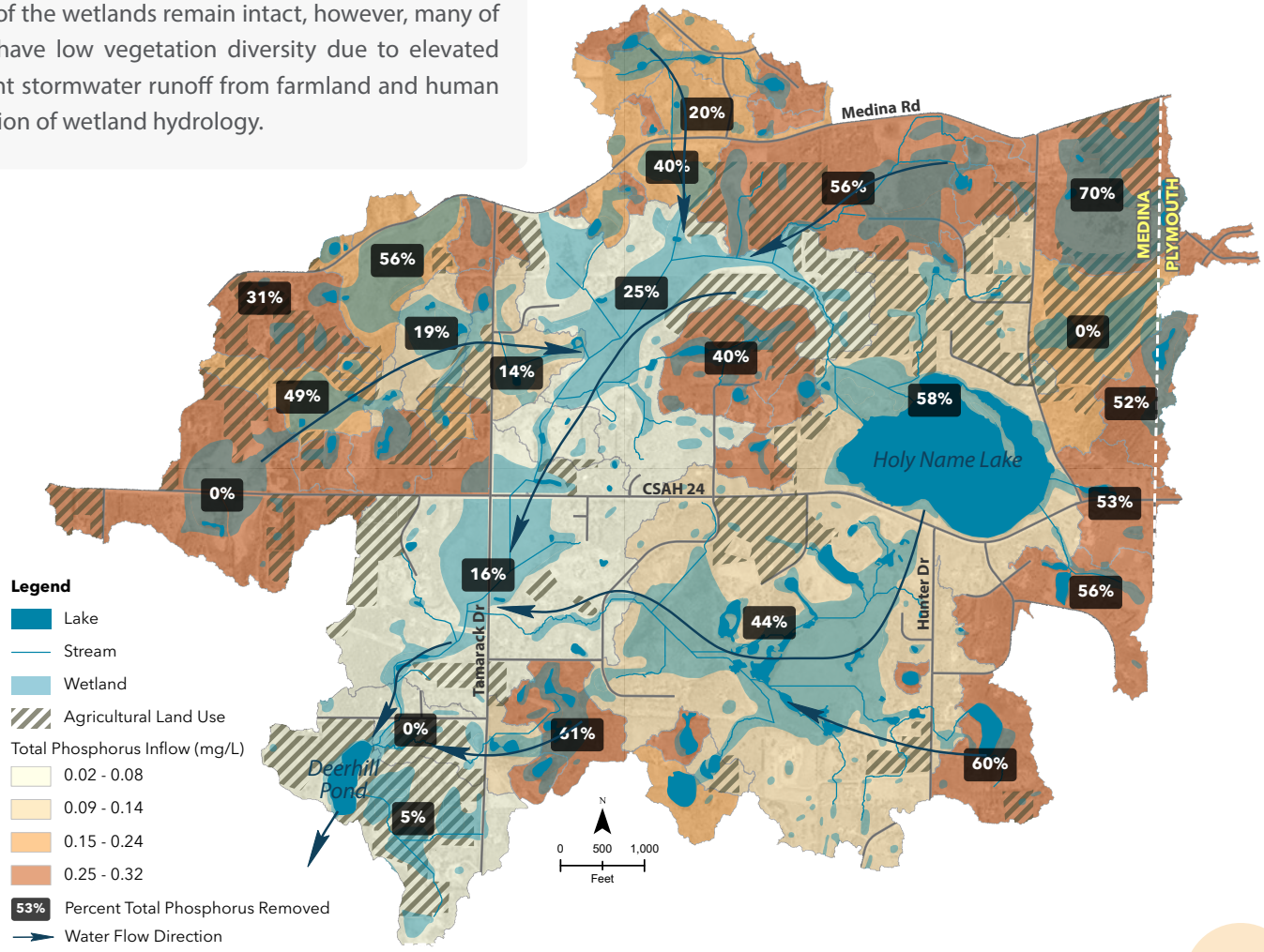
Altered Wetlands. The Holy Name MU is unique since many of the wetlands remain intact, however, many of them have low vegetation diversity due to elevated nutrient stormwater runoff from farmland and human alteration of wetland hydrology.

In-Lake

Internal Phosphorus Loading. Internal loading in Holy Name Lake is elevated, which is a result of historic watershed nutrient loading and represents approximately 40 percent of the total phosphorus load.

Biological. The role of fish in shallow lakes such as Holy Name is much greater than deeper lakes such as Wolsfeld or Long Lake since they can resuspend sediments throughout the entire lake. Therefore, the presence of black bullhead and goldfish could be a driver of poor water quality and low submerged aquatic vegetation species diversity.

Holy Name Lake also has a history of drastic shifts in water quality, which is common in shallow lakes that are being flipped between a clear water and turbid water state by a combination of nutrient and biological drivers.



STRATEGIES & OPPORTUNITIES

Watershed

Stormwater Management. The District's regional treatment at Deerhill Pond could be evaluated for retrofit potential to increase treatment effectiveness to benefit downstream Long Lake (HN03).

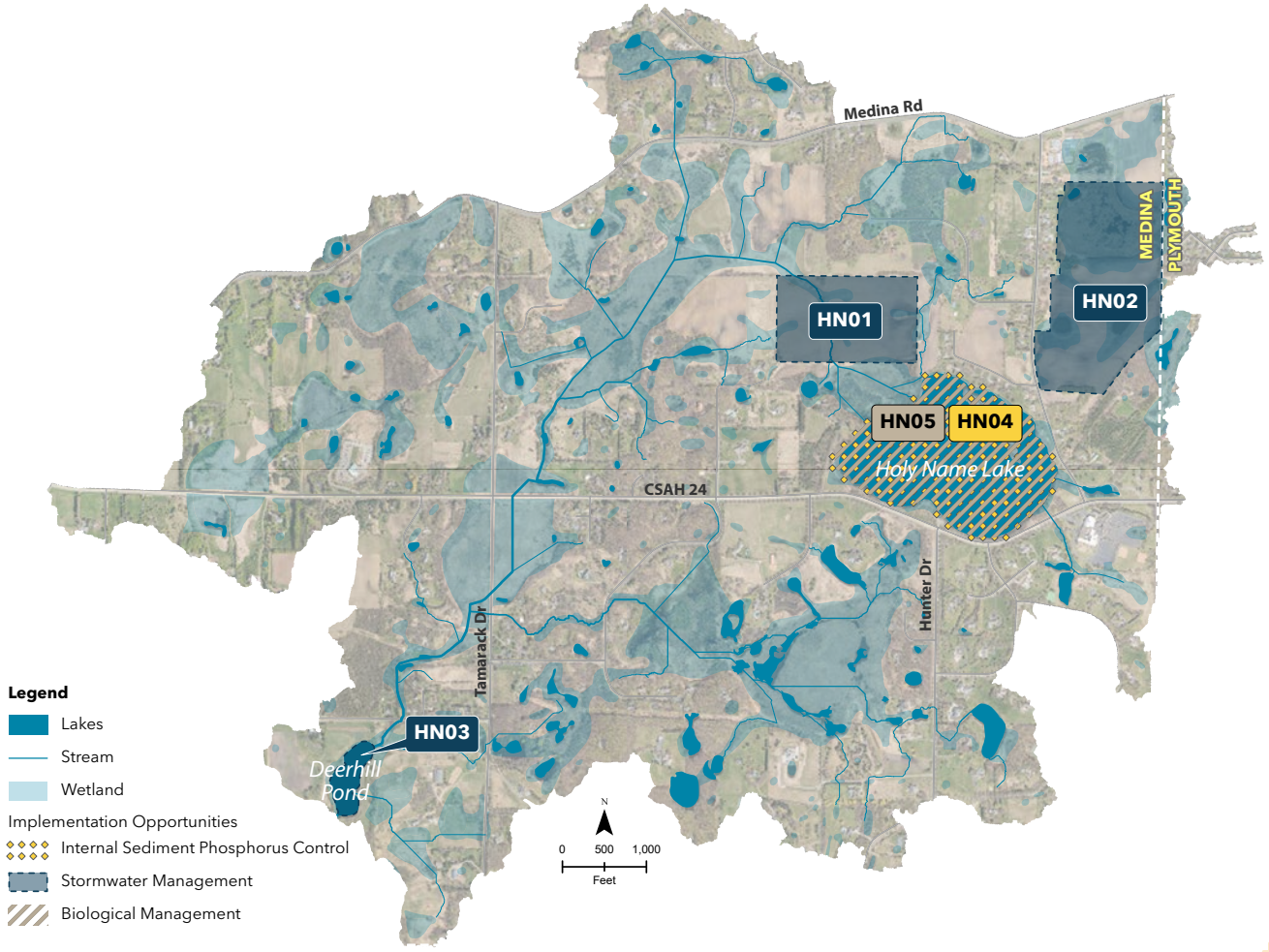
There are several properties in the MU that are in agricultural use. Potential best practices that could be explored with property owners include wetland restoration, alternative tile intakes, buffers, and manure management.

Some of the agricultural properties within this MU are starting to be converted to rural residential use. This conversion is expected to reduce nutrient loading based on current regulatory standards and may present opportunities for partnership to achieve greater benefit. Load reduction benefit for two sites that were undergoing development during this assessment have been quantified (MD06, MD08).

In-Lake

Internal Sediment Phosphorus Control. Alum treatment at Holy Name Lake is recommended to reduce internal loading (HN04).

Biological Management. Given the presence of black bullhead and goldfish in Holy Name Lake, rough fish management could be considered if other efforts to reduce external and internal nutrient loading are not sufficient to restore the lake to meeting water quality standards (HN05).

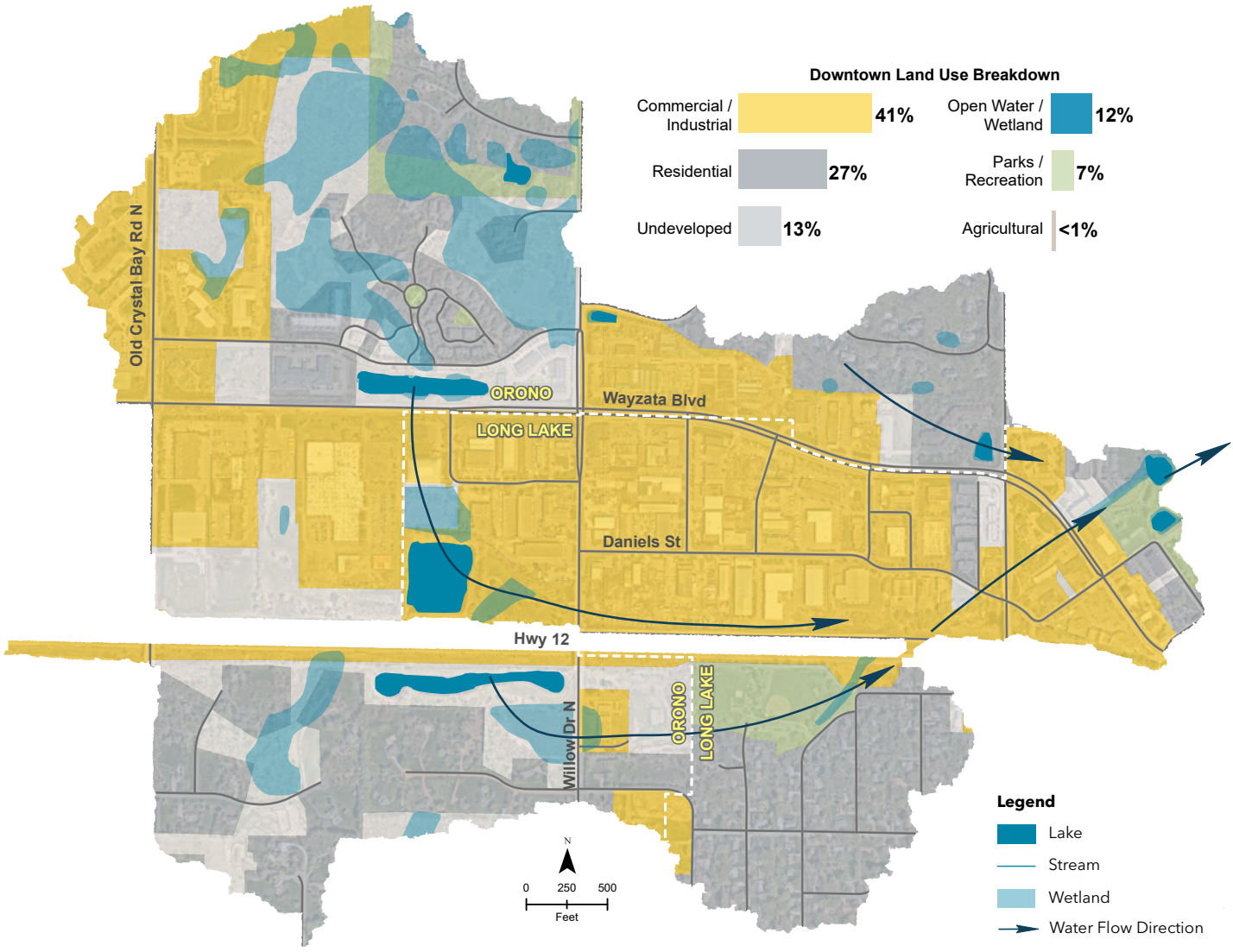


IMPLEMENTATION OPPORTUNITIES SUMMARY

HOLY NAME MANAGEMENT UNIT

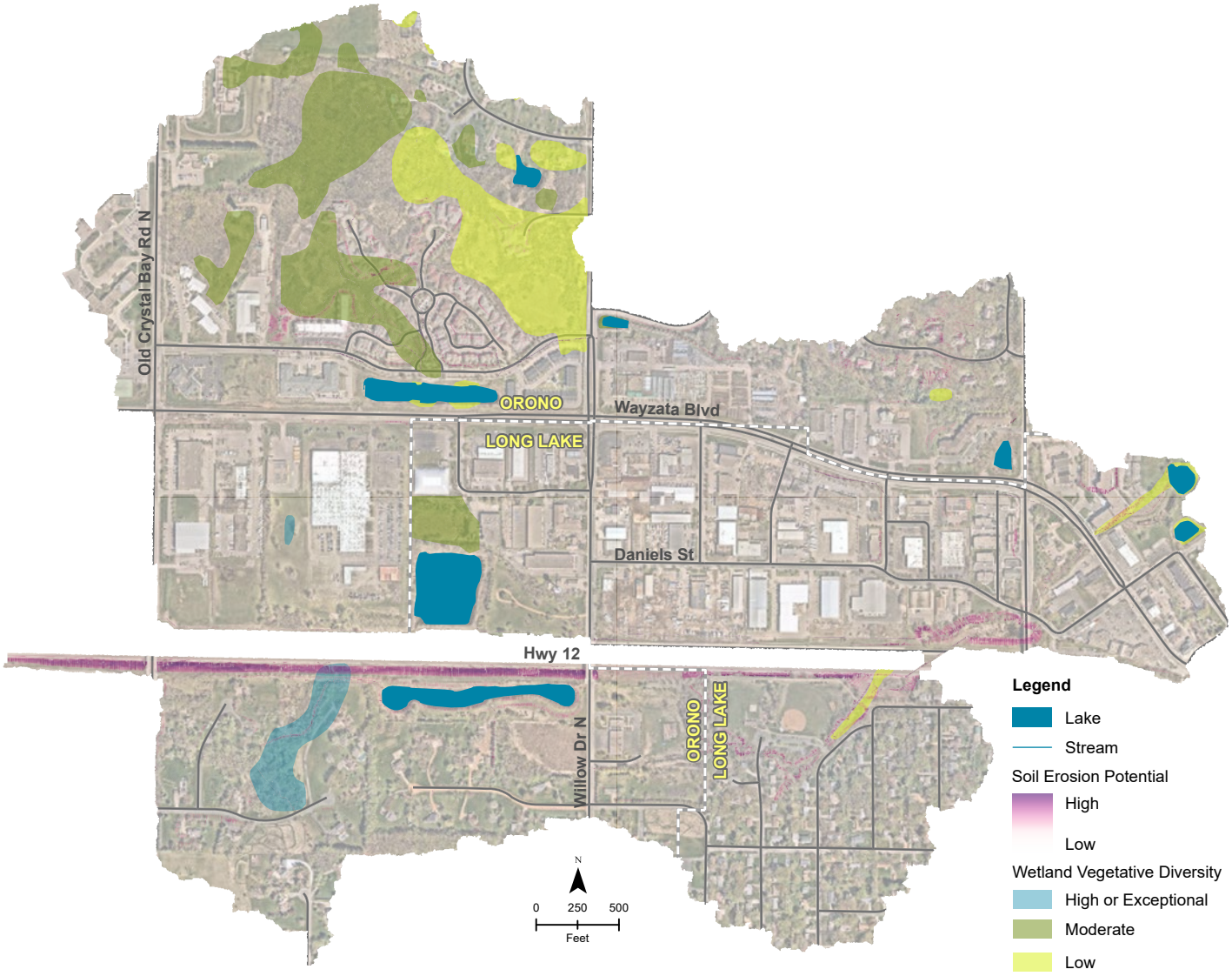
Project ID	Project Name	Location	Est. Load Reduction (lbs)	Est. Construction Cost	Lifecycle Cost/Benefit ($/lb/TP/30 year)	Timeline
Stormwater Management						
HN01	Holy Name Estates Development	Medina	11.4	N/A	N/A	Completed
HN02	Preserve of Medina	Medina	22.4	N/A	N/A	Near-term
HN03	Deerhill Pond Retrofit	Medina	11.8	$157,400	$725	Long-term
Internal Sediment Phosphorus Control						
HN04	Holy Name Alum Treatment	MCWD	69.6	$163,200	$78	Mid-term
Biotic Management						
HN05	Holy Name Rough Fish Management	In-Lake	TBD	TBD	TBD	Long-term

DOWNTOWN MANAGEMENT UNIT



The Downtown Management Unit (DMU) encompasses 518 acres and represents the western drainage area of Long Lake. It is located primarily in the City of Long Lake and the City of Orono. The headwaters of the DMU are located in the northwest corner of the MU, which consists of residential areas that are surrounded by large wetlands and undeveloped areas. Land use transitions into industrial and commercial as water moves southeast through the MU, which ultimately outlets at Nelson Lakeside Park. While the MU does not contain any lakes, MCWD's Functional Wetland Assessment (Wenck, 2003) identifies 19 wetlands.

ISSUES



Water Quantity

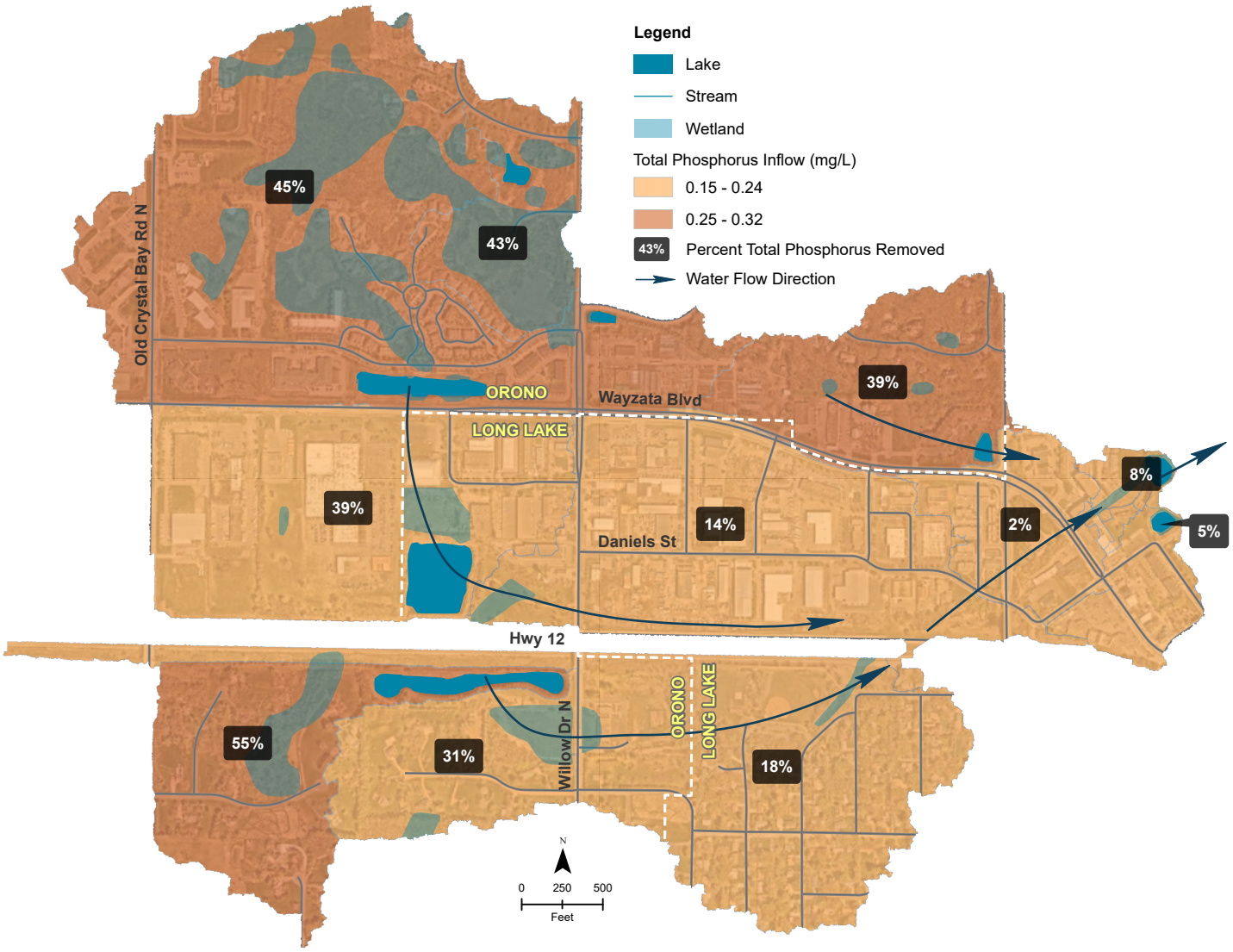
Runoff Volume. The Downtown MU has nearly four times the volume of runoff per unit area compared to the other MUs in this subwatershed assessment.

Water Quality

Excess Nutrients. Average phosphorus concentrations in stormwater runoff from the Downtown MU are 300 µg/L, which is three times greater than the State water quality standard for streams (100 µg/L).

Ecological Integrity

Wetlands. The northwest portion of the MU has several wetlands with low or moderate vegetation diversity. Other wetlands in the MU were likely replaced by development.



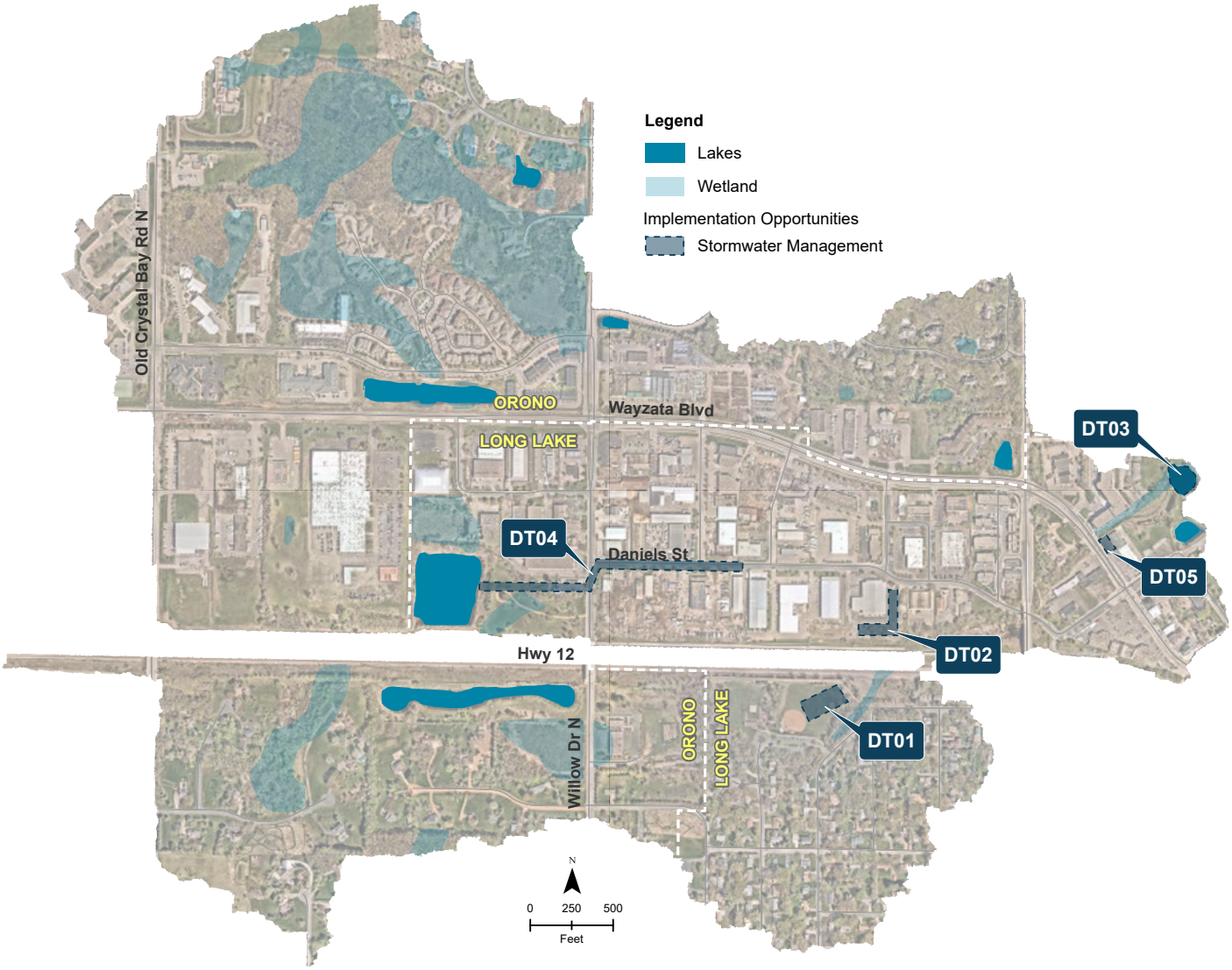
Watershed

Stormwater Runoff. The Downtown MU's elevated phosphorus concentrations and runoff volumes are caused by the high amount of impervious land use and the lack of stormwater treatment in the central portion of the MU.

The elevated runoff volume and phosphorus concentrations from this MU result in it having the largest phosphorus load to Long Lake even though it is much smaller than other MUs such as the Wolsfeld or Holy Name MUs.

The combination of highly impervious areas with very little stormwater treatment is the primary reason that the Downtown MU has the greatest pollutant load to Long Lake.

STRATEGIES & OPPORTUNITIES



Watershed

Stormwater Management. While there is some existing treatment within the MU, particularly in Nelson Lakeside Park, there is not adequate treatment capacity for the volume of runoff. Additional stormwater management practices are recommended to reduce the volume and pollutant load leaving this MU.

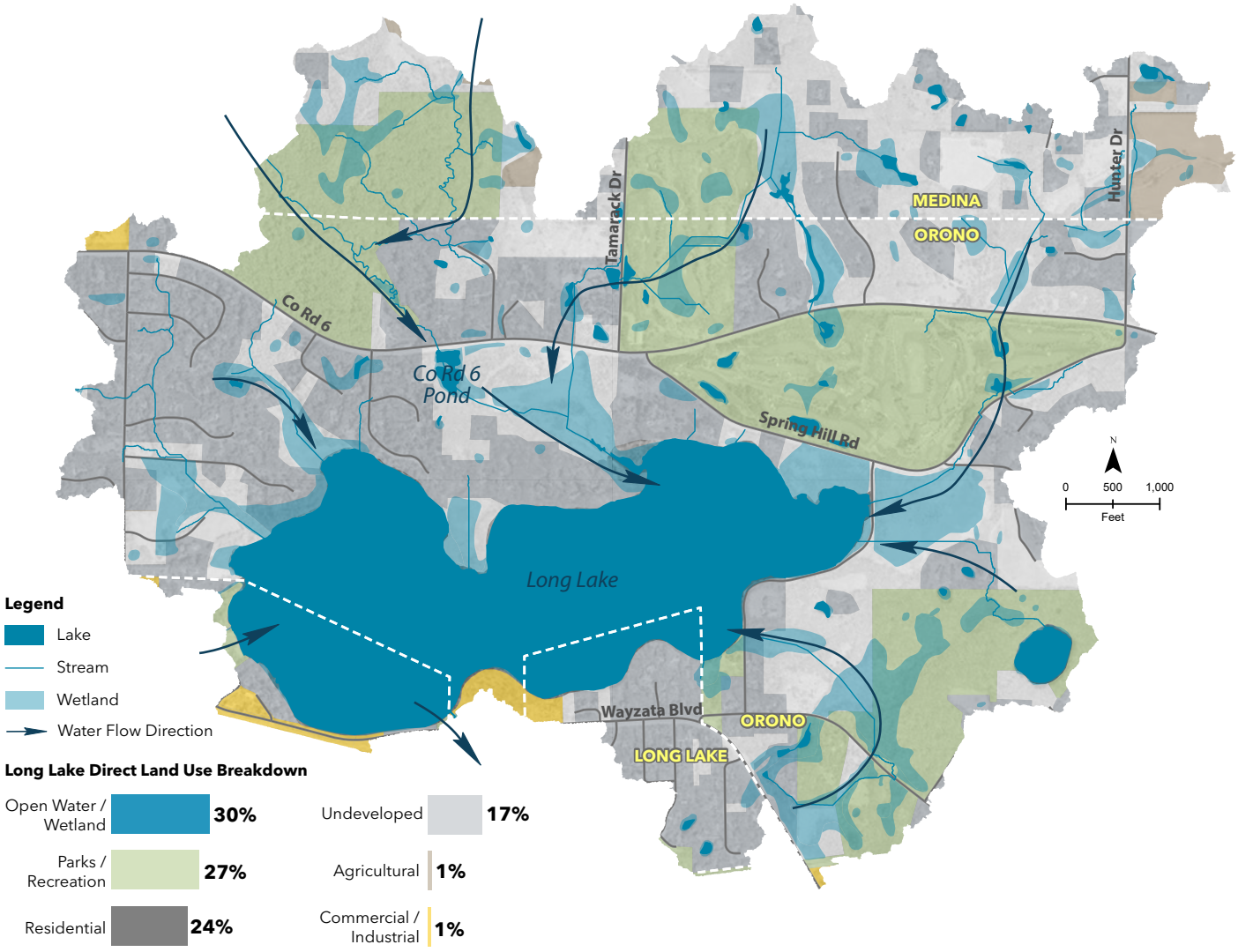
Several stormwater management opportunities have been identified within the MU, including some that are on public property (DT01, 02, 03, 04) and others that could be explored in tandem with future redevelopment (DT05).

IMPLEMENTATION OPPORTUNITIES SUMMARY

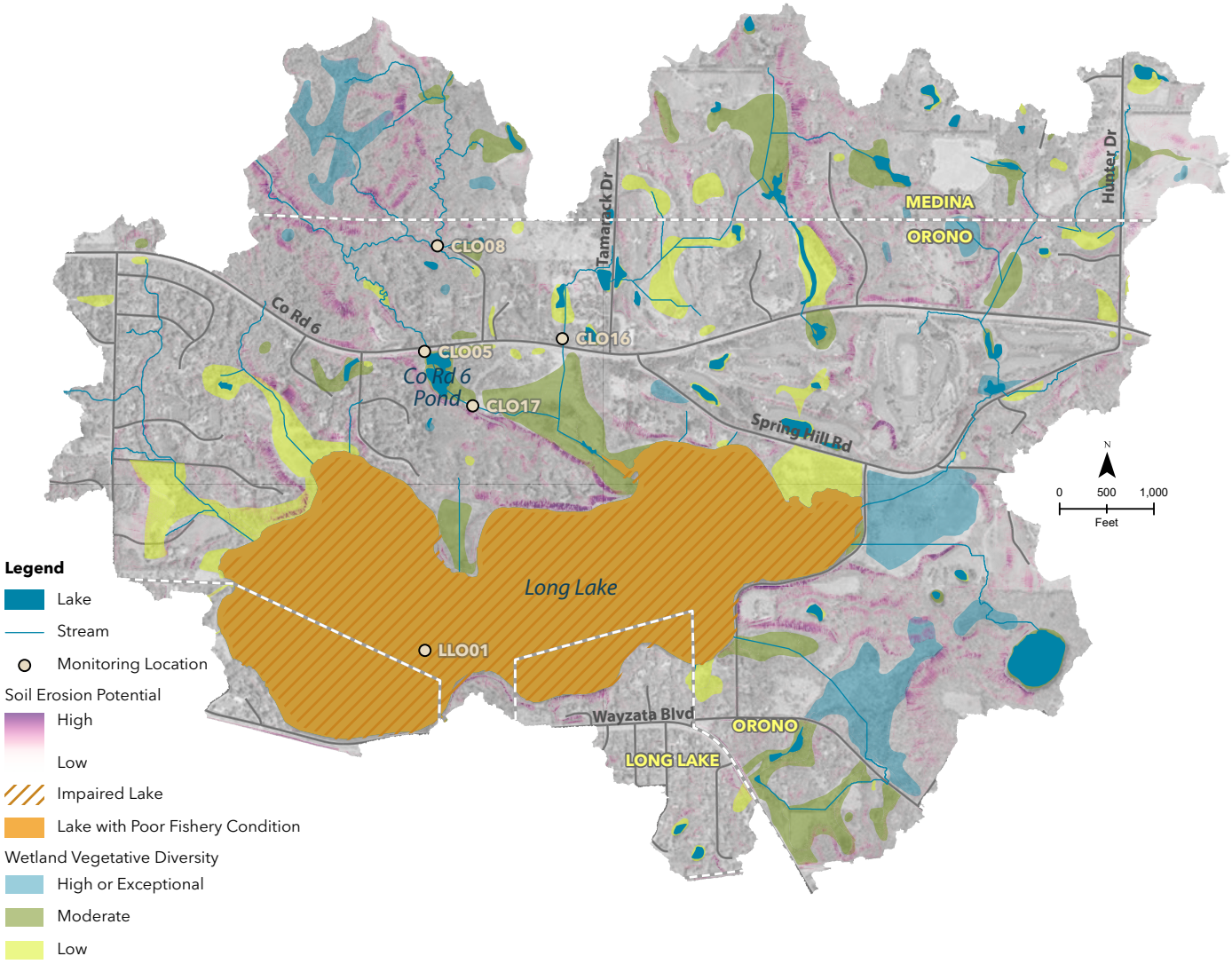
DOWNTOWN MANAGEMENT UNIT

Project ID	Project Name	Location	Est. Load Reduction (lbs)	Est. Construction Cost	Lifecycle Cost/Benefit ($/lb/TP/30 year)	Timeline
Stormwater Management						
DT01	Holbrook Park	Long Lake	34.7	$1,292,867	$1,278	Short-term
DT02	Long Lake Public Works	Long Lake	27	$1,148,258	$1,463	Mid-term
DT03	Nelson Park North Pond Retrofit	Long Lake	10.8	$524,483	$1,729	Mid-term
DT04	Daniels Street Reconstruction	Long Lake	6.9	$621,502	$3,002	Long-term
DT05	fitHAUS Property	Long Lake	8.5	$369,065	$1,597	Development-dependent

LONG LAKE DIRECT MANAGEMENT UNIT



The Long Lake Direct Management Unit (MU) encompasses 1,667 acres that surround Long Lake. Parts of the Cities of Medina, Orono, and Long Lake are within this MU. Residential uses and the Spring Hill Golf Club are the primary developed land uses. The remaining land uses in the Direct MU consists of undeveloped areas, preservation areas, and parks. Over a quarter of the land area is covered by water bodies – 284 acres of which is Long Lake, and a total of 243 acres of wetlands.



Water Quantity

Erosion. Several locations of stream erosion were identified through desktop assessment (see Technical Report for details).

Water Quality

Excess Nutrients. Long Lake is impaired for excess phosphorus, which leads to poor water clarity and summer algal blooms.

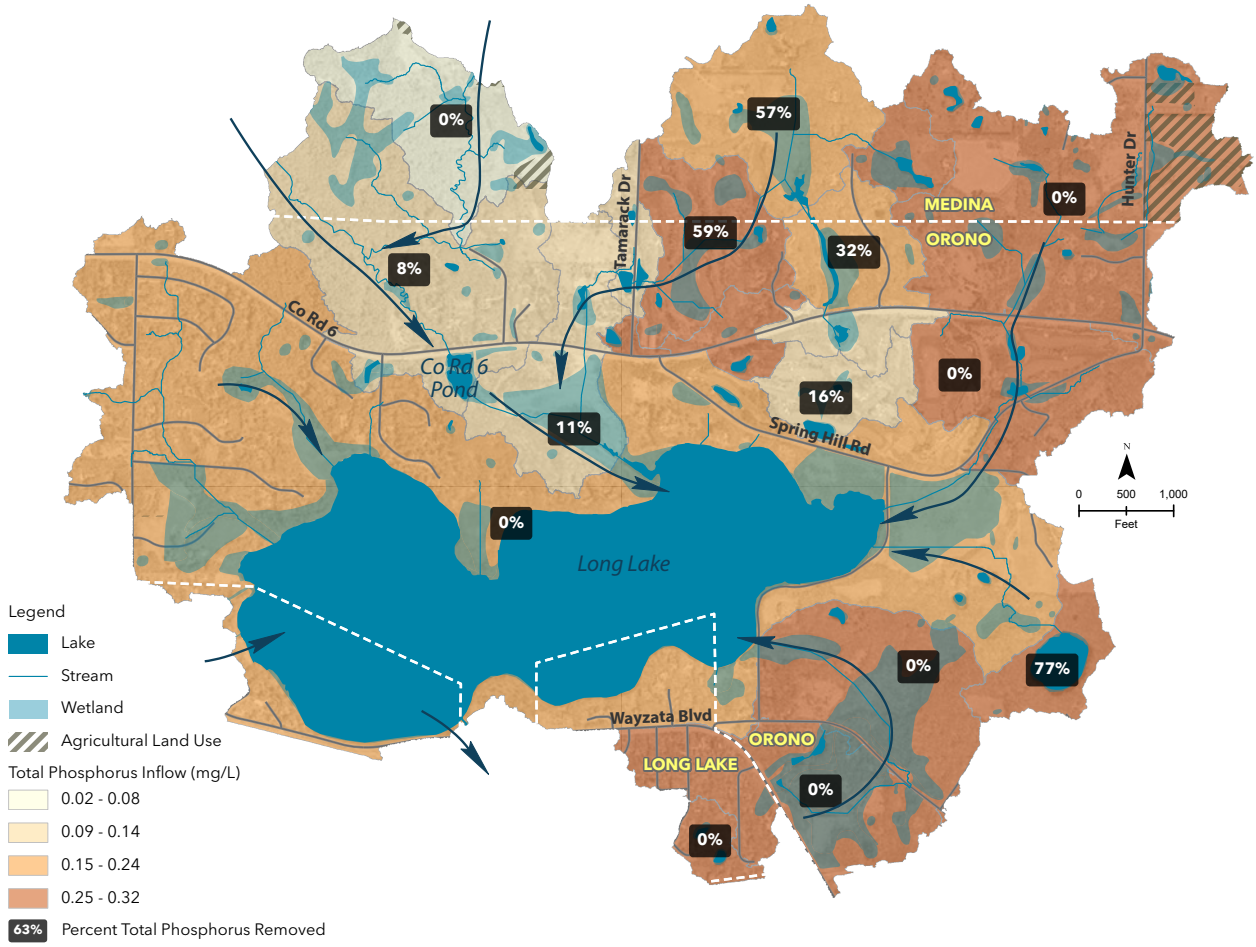
Several small stream inlets that drain to Long Lake Creek Subwatershed have phosphorus concentrations that exceed the State of Minnesota phosphorus standards.

Ecological Integrity

Lakes. Long Lake has poor or impaired fisheries and aquatic submerged vegetation (SAV) populations based on low species diversity and/or dominance of vegetation/fish that thrive in poor water quality conditions.

Wetlands. 72 percent of wetlands have low or moderate vegetation diversity based on MCWD's functional assessment of wetlands.

DRIVERS



Watershed

Stormwater Runoff. Watershed modeling and field monitoring in the Direct MU identified residential and golf course stormwater runoff as a contributor of phosphorus to Long Lake.

The MCWD constructed a regional stormwater treatment pond (Co Rd 6 Pond) at the confluence of the two upstream tributaries in the 1990's which continues to provide treatment by reducing total phosphorus by 38% prior to reaching Long Lake.

Altered Wetlands. Elevated nutrient stormwater runoff from and human alteration of wetland hydrology are the primary drivers of low species diversity of wetlands in this system.

Erosion. Geographic assessment of erosion identified natural geologic conditions including steep slopes and highly erodible soils as the primary drivers of erosion.

In-Lake

Internal Phosphorus Loading. Internal loading in Long Lake is elevated, which is a result of historic watershed nutrient loading and represents approximately 48% of the total phosphorus load.

Biological. Common carp have been observed in Long Lake, but are not believed to have a significant impact on water quality because of the lake's depth. Based on research from the University of Minnesota, carp present in lakes deeper than 30 feet have little to no impact on water quality.

STRATEGIES & OPPORTUNITIES

Watershed

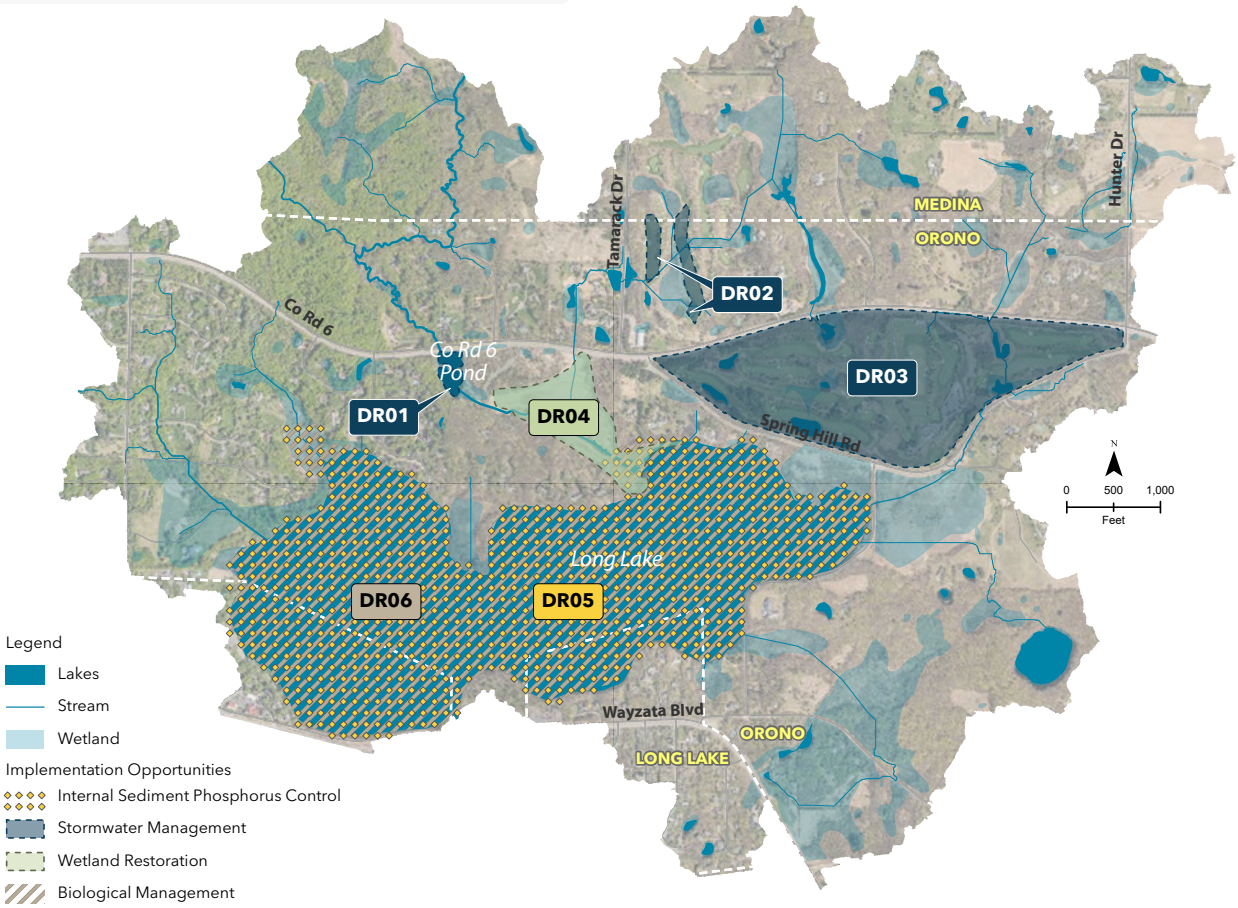
Stormwater Management. Retrofit of the existing, District-owned County Rd 6 regional treatment pond is recommended. Enhancing the pond with a filter bench could increase nutrient removal from the upper subwatershed before entering Long Lake (DR01).
Spring Hill Golf Club covers a large portion of the MU, and monitoring data from downstream of this area (Tamarack Rd) show elevated phosphorus concentrations. Evaluation of treatment opportunities, such as reuse or filtration of stormwater from existing ponds/wetlands, is recommended (DR02, 03).

Wetland Restoration. There is a large wetland at the confluence of the two tributary stream channels that collect drainage from the Wolsfeld and Holy Name MUs (DR04). Monitoring data shows that nutrient loading increases between the inlet and the outlet of this wetland, suggesting potential for water quality and ecological improvements.

In-Lake

Internal Sediment Phosphorus Control. Alum treatment in Long Lake is recommended (DR05). MCWD completed an alum treatment of Long Lake in the mid-1990s. Watershed loading should be reduced prior to investing in another alum treatment to increase longevity.

Biological Management. The presence of carp in this subwatershed does not appear to be driving water quality issues in the impaired lakes, therefore, carp management has not been prioritized as a near-term strategy. However, since carp appear to be actively recruiting in the subwatershed and migrating to/from Tanager, future management may be considered as part of a broader strategy for the Lake Minnetonka system (DR06). MCWD will continue to monitor the water quality and vegetation response to recent carp management efforts led by the LLWA.

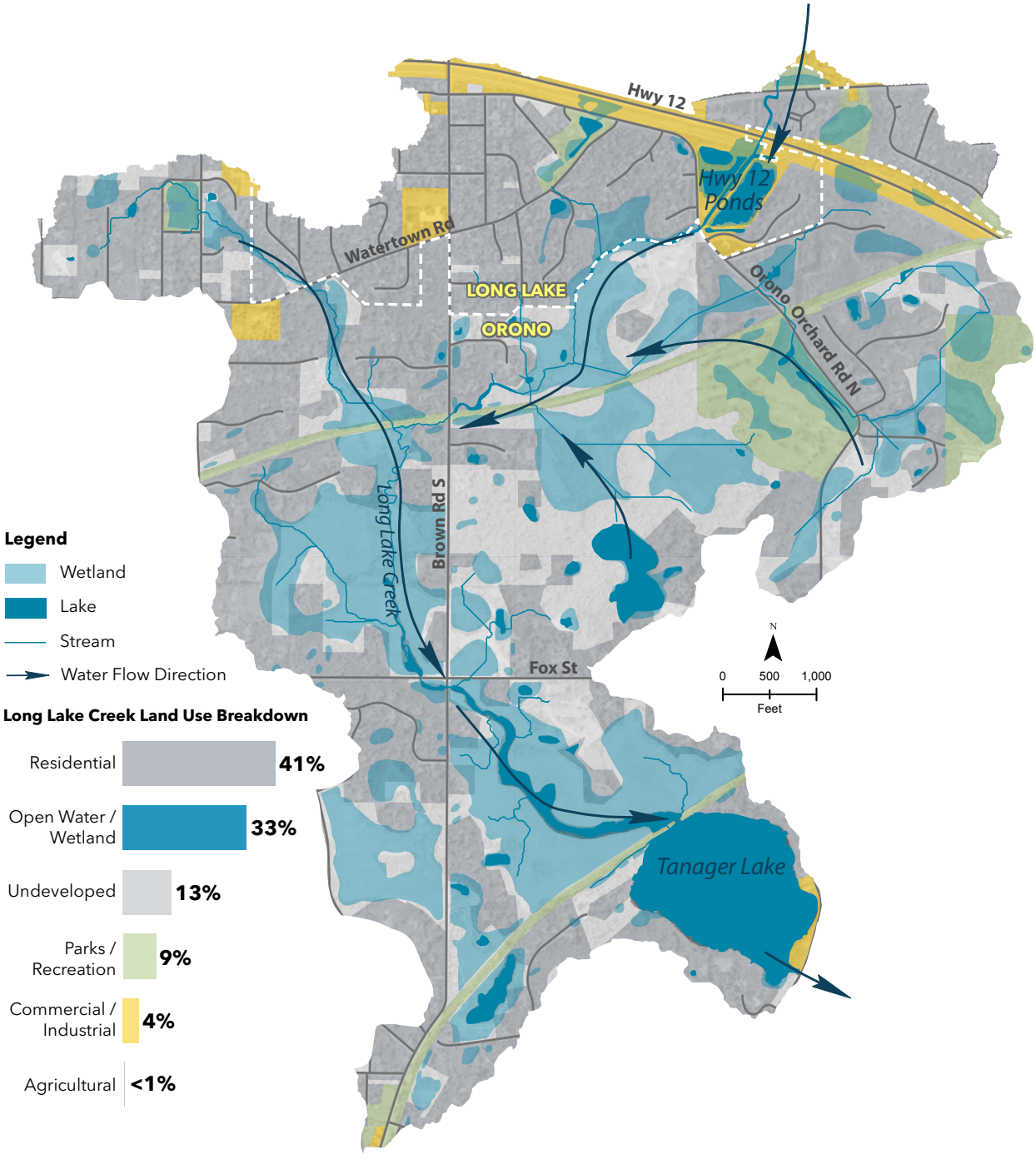


IMPLEMENTATION OPPORTUNITIES SUMMARY

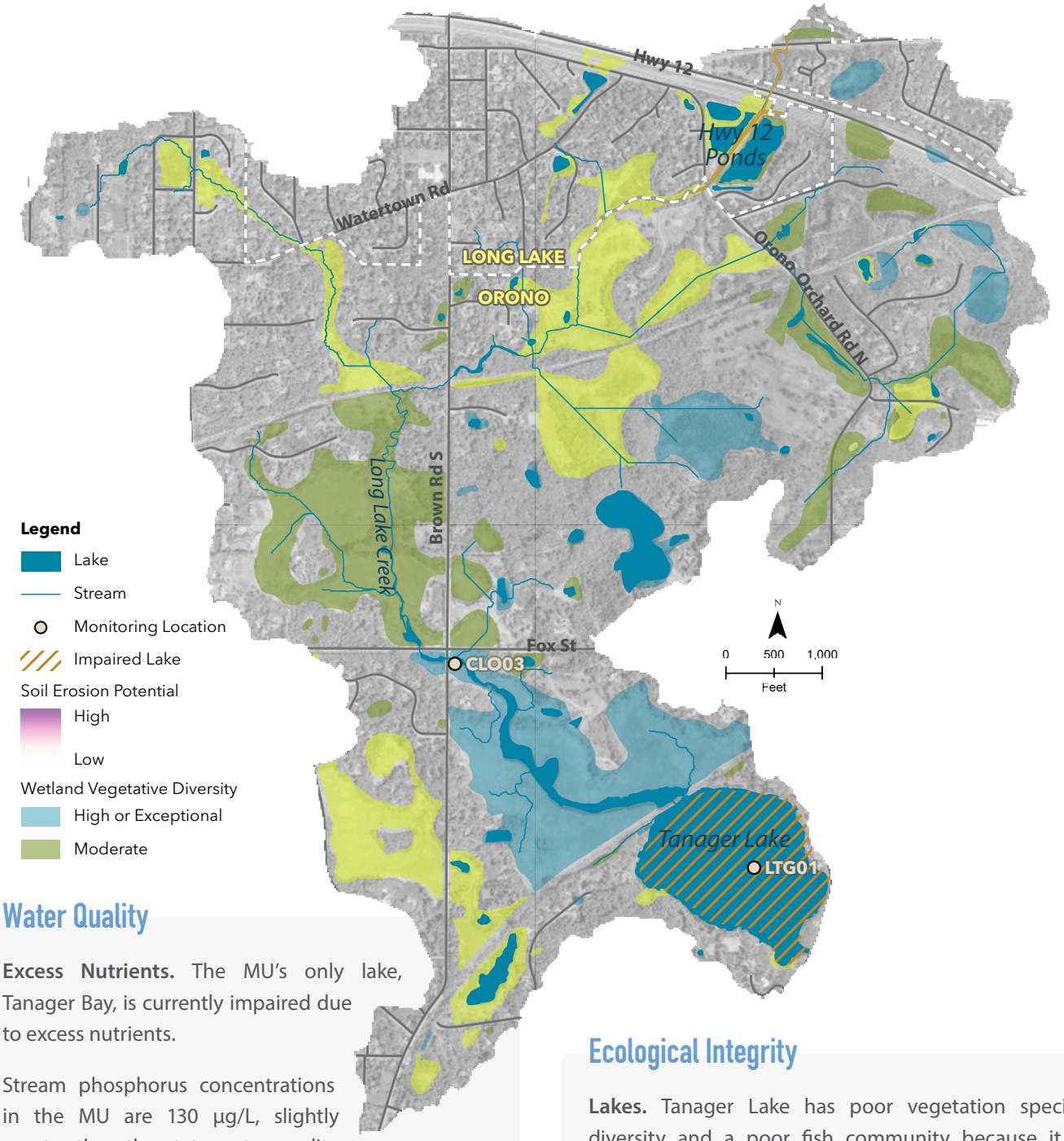
LONG LAKE DIRECT MANAGEMENT UNIT

Project ID	Project Name	Location	Est. Load Reduction (lbs)	Est. Construction Cost	Lifecycle Cost/Benefit ($/lb/TP/30 year)	Timeline
Stormwater Management						
DR01	CR 6 Pond Retrofit	Orono	42	$570,151	$809	Short-term
DR02	Spring Hill Golf Club Reuse (north)	Orono	9.8	$157,125	$872	Short-term
DR03	Spring Hill Golf Club Reuse (south)	Orono	40.3	$697,768	$578	Short-term
Wetland Restoration						
DR04	County Rd 6 Wetland Restoration	Orono	TBD	TBD	TBD	Long-term
Internal Sediment Phosphorus Control						
DR05	Long Lake Alum Treatment	In-Lake	273	$538,560	$66	Long-term
Biotic Management						
DR06	Long Lake Carp Management	In-Lake	N/A	$449,138	N/A	Long-term

LONG LAKE CREEK MANAGEMENT UNIT



The Long Lake Creek Management Unit (MU) begins at the outlet of Long Lake and is the headwaters of Long Lake Creek, which drains 1,436 acres that ultimately flows into Tanager Bay. This MU includes portions of the City of Long Lake and City of Orono. The land use in the northern portion of the MU is dominated by residential areas and the Orono public golf course, which transitions to undeveloped areas and wetlands in the southern portion of the MU.



Water Quality

Excess Nutrients. The MU's only lake, Tanager Bay, is currently impaired due to excess nutrients.

Stream phosphorus concentrations in the MU are 130 µg/L, slightly greater than the state water quality standard of 100 µg/L.

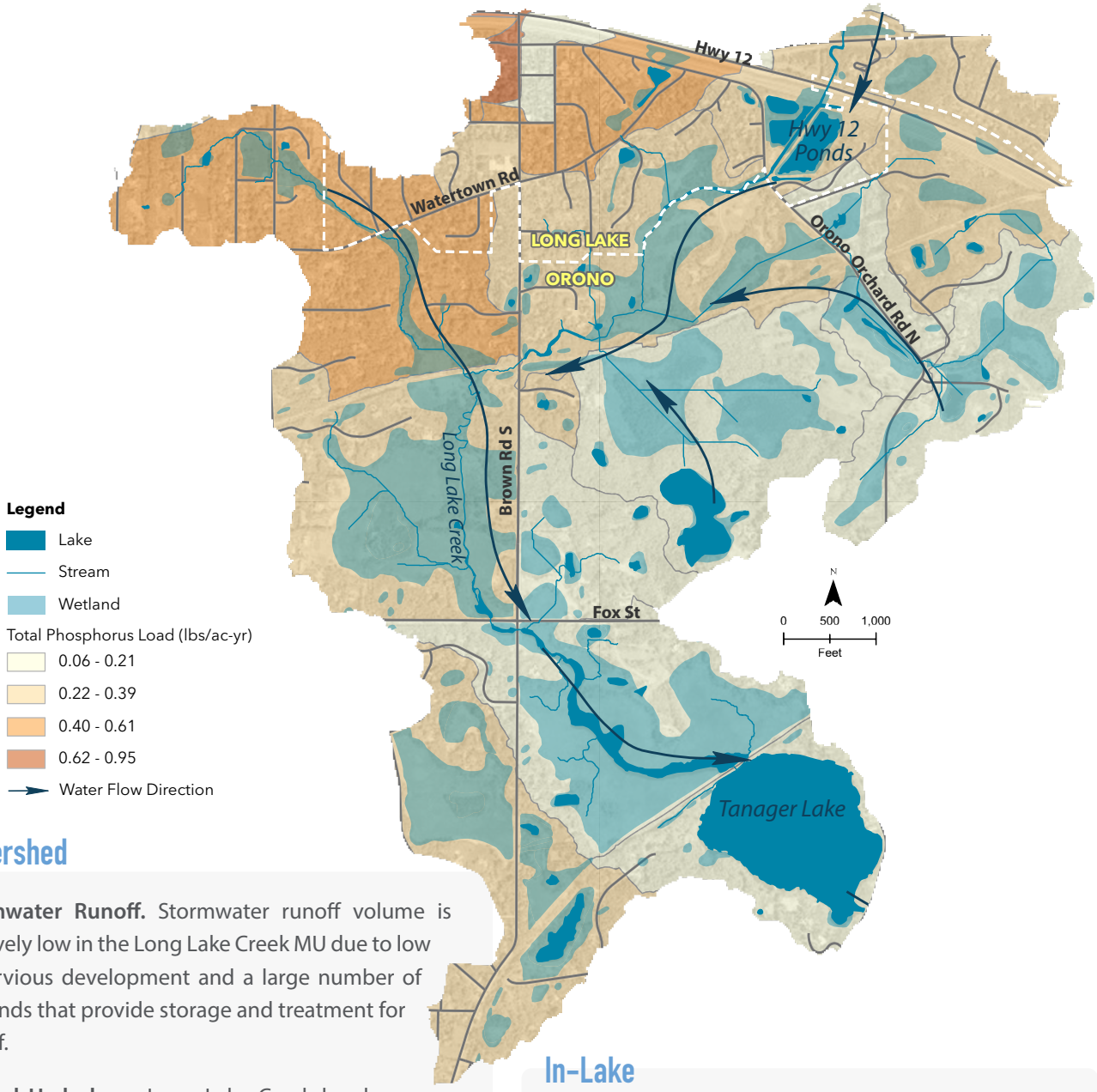
Water Quantity

Erosion. Stream erosion and unstable banks have been identified at several locations along Long Lake Creek.

Ecological Integrity

Lakes. Tanager Lake has poor vegetation species diversity and a poor fish community because it is dominated by fish species, such as common carp, that thrive in poor water quality conditions.

Wetlands. 69 percent of wetlands within this MU have low or moderate vegetation diversity based on MCWD's functional assessment of wetlands.



Watershed

Stormwater Runoff. Stormwater runoff volume is relatively low in the Long Lake Creek MU due to low impervious development and a large number of wetlands that provide storage and treatment for runoff.

Altered Hydrology. Long Lake Creek has been heavily altered since pre-settlement conditions from physical modifications to the channel locations, ditching, and increased runoff from impervious surfaces. Changes in hydrology and channel morphology have led to areas of streambank erosion.

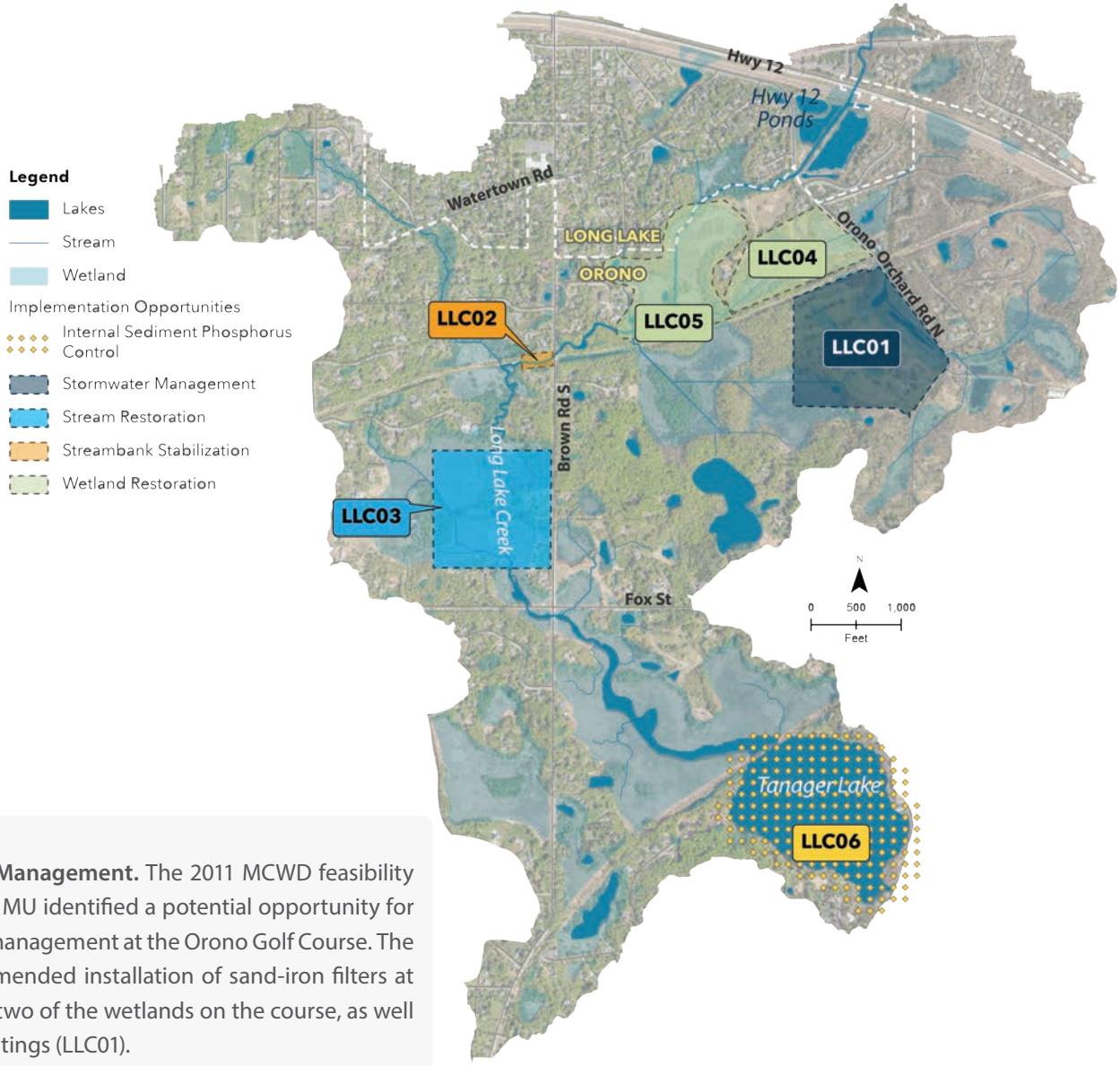
Altered Wetlands. This MU has a high percentage of wetland area, however, many of them have low vegetation diversity due to elevated nutrients in stormwater runoff from residential land use and human alteration of wetland hydrology.

In-Lake

Internal Phosphorus Loading. Internal loading in Tanager Lake is elevated as a result of historic watershed nutrient loading and represents approximately 20 percent of the total phosphorus load.

Biological. Common carp have been observed in Tanager Bay, but likely have a small impact on water quality since it is a deep lake. Recent University of Minnesota research shows that carp have insignificant impacts on water quality in lakes with depths greater than 15 feet.

STRATEGIES & OPPORTUNITIES



Watershed

Stormwater Management. The 2011 MCWD feasibility study for this MU identified a potential opportunity for stormwater management at the Orono Golf Course. The study recommended installation of sand-iron filters at the outlet of two of the wetlands on the course, as well as buffer plantings (LLC01).

Stream Restoration/Bank Stabilization. The 2011 study identified two priority opportunities for channel stabilization or restoration along Long Lake Creek (LLC02, 03). The proposed Reach 2 restoration involves re-meandering the stream channel back to its historic alignment.

Wetland Restoration. The 2011 study identified two priority opportunities for wetland restoration. Both of these wetlands have been ditched and partially drained, and the proposed projects involve restoring wetland hydrology and connection to the floodplain (LLC04, 05).

In-Lake

Internal Sediment Phosphorus Control. Alum treatment on Tanager Lake is recommended to address internal loading once sufficient progress is made on addressing loading from upstream lakes and other external nutrient sources (LLC06).

IMPLEMENTATION OPPORUNITIES SUMMARY

LONG LAKE CREEK MANAGEMENT UNIT

Project ID	Project Name	Location	Est. Load Reduction (lbs)	Est. Cost	Lifecycle Cost/Benefit ($/lb/TP/30 year)	Timeline
Stormwater Management						
LLC01	Orono Golf Course Wetland Improvements	Orono	11.2	$244,600	$949	Short-term
Streambank Stabilization/Restoration						
LLC02	Brown Road Outfall Stabilization	Orono	11.6	$58,800	$183	Mid-term
LLC03	Reach 2 Stream Restoration	Orono	30.1	$468,200	$573	Long-term
Wetland Restoration						
LLC04	Orchard Creek Wetland Restoration	Orono	4.9	$40,800	$359	Mid-term
LLC05	Long Lake Creek Wetland Restoration	Orono	36.8	$163,800	$182	Long-term
Internal Sediment Phosphorus Control						
LLC06	Tanager Lake Alum Treatment	In-Lake	164.7	$384,120	$78	Long-term

IMPLEMENTATION PLAN SUMMARY

IMPLEMENTATION STRATEGY

The purpose of the assessment was to provide a subwatershed-scale understanding of the issues and drivers throughout the system to identify the most cost-effective strategies and project opportunities for the partners to pursue. The project recommendations in this Roadmap are focused on projects that will make significant, measurable impact toward restoring the five impaired lakes in the subwatershed.

Based on the assessment findings, MCWD recommends a tiered implementation approach:

1. **Regional Treatment:** Prioritize implementation of regional treatment projects in the near-term
2. **Landscape Projects**: Implement additional projects on the landscape as opportunities and capacity allow to further reduce external loading
3. **Internal Load Management:** Address internal loading once sufficient progress is made to reduce external nutrient sources

REGIONAL TREATMENT

In the mid-1990s, the MCWD constructed three regional stormwater management ponds throughout the subwatershed: Deerhill Pond (treats drainage from the Holy Name MU), County Road 6 Pond (treats drainage from the Wolsfeld and Holy Name MUs), and the Nelson Lakeside Park Ponds (two ponds that treat drainage from the downtown area). The City of Long Lake installed additional treatment in the late 2000's via a low-flow bypass and filtration system within Nelson Lakeside Park.

While these practices are still functional and reducing nutrient loads to Long Lake, there is potential to retrofit the ponds for increased effectiveness. Given the high volume and nutrient load of runoff from the Downtown MU, it is also recommended that additional regional treatment be installed upstream of Nelson Lakeside Park to create a treatment train and increase overall effectiveness of the system.

Enhancement and addition of regional treatment is recommended as the first priority because these projects can treat a large drainage area while more dispersed, localized treatment is implemented over time. The opportunities identified are also under public ownership or easement, making it easier to move these projects forward quickly. Of the regional treatment options evaluated, the following two projects have been prioritized for near-term implementation because they provide the largest load reductions:

COUNTY ROAD 6 POND RETROFIT:

- **Description:** Retrofit of an MCWD-owned pond with a filter bench to increase effectiveness. Treats the largest drainage area of any project.
- **Metrics:** TP load reduction to Long Lake = 75 lbs/yr, construction cost = $525,000
- **Next steps:** MCWD is conducting a feasibility assessment for this project in winter 2022-23 and has budgeted for project design in 2023.

HOLBROOK PARK REGIONAL STORMWATER MANAGEMENT:

- **Description:** Regional stormwater management in a Long Lake-owned park. Treats a large portion of the Downtown MU, which produces the highest runoff volume and nutrient loading per unit area.
- **Metrics:** TP load reduction to Long Lake = 47 lbs/yr, construction cost = $1.3 million
- **Next steps:** The City of Long Lake and MCWD are working to determine roles and funding strategy with a goal of initiating feasibility work in 2023. The project is expected to receive $175,000 through BWSR's Watershed-Based Implementation Funding program.

LANDSCAPE PROJECTS

With plans for additional regional treatment underway, more localized projects can be implemented on the landscape over time. A total of 19 specific landscape project opportunities have been prioritized through the assessment and discussions with the partners, as outlined in the MU sections. These include stormwater management, streambank/ravine stabilization, and wetland restoration projects. A few of these are tied to development or infrastructure projects, so the timing will be opportunity-driven. The rest can be advanced based on city capacity to lead the projects and the partnership's ability to secure grant funding, as needed.

In addition to these known opportunities, the partnership should continue to seek new opportunities that align with the identified issues, drivers, and management strategies. This could include coordination between the partners on annual review of capital improvement plans and tracking of private development opportunities (e.g. sketch plan review). It could also include outreach and marketing to identify landowners who may be considering developing or selling their property or may have a resource issue they would like help addressing (e.g. erosion, flooding).

INTERNAL LOAD MANAGEMENT

All five of the impaired lakes, as well as Krieg Lake in the Wolsfeld MU, have elevated internal phosphorus loading and will likely require an alum treatment in order to meet water quality standards. Internal phosphorus loading from the sediments is due to the accumulation of nutrients from watershed runoff over time. Therefore, it is important to address the major sources of nutrient loading from the watershed before implementing in-lake treatment to ensure it is successful and has a lasting effect.

In addition, poor water quality often leads to poor aquatic vegetation, which leads to poor fish communities. To restore healthy biotic communities, the stressors must first be addressed. For this reason, the Roadmap generally recommends sequencing the work to first address watershed loading, then internal loading, then the biotic community.

As described in the MU sections, there are two lakes that are believed to be impacted by biological drivers – Holy Name Lake and Swamp Lake. Both are shallow systems with large populations of bottom-feeding fish (black bullheads and goldfish) that resuspend sediment. Water quality data for Holy Name indicate that the lake has been flipping between a turbid and clear water state over the years. These significant changes in water quality are an indicator of biological drivers. The lake is currently close to meeting water quality standards, so the recommendation is to implement projects to reduce external loading, then treat with alum, then monitor to see how the system responds to determine if biological management is needed.

Swamp Lake, a large wetland at the upstream end of the Wolsfeld MU, has very high TP concentrations and is a significant source of nutrients to downstream School Lake. Because Swamp and School Lakes have small and fairly undeveloped drainage areas, the opportunities for watershed load reduction are limited. For these reasons, MCWD is planning for additional assessment of Swamp Lake as a near-term priority.

ROLES

Each of the partners has an important role to play in executing this strategy. The following is a general characterization of roles for implementing the roadmap. Specific roles for the design, construction, maintenance, and funding of each project will be determined on a case-by-case basis and memorialized through cooperative agreements

Cities

As the regulated parties with assigned load reductions through the state TMDL, cities have the primary responsibility to implement projects and best practices on the landscape. As such, the pace and scale of implementation will be largely driven by each city.

MCWD

The MCWD will provide technical and financial support to cities for implementation of projects on the landscape. The MCWD will also lead the implementation of projects to address internal loading and any retrofits to existing MCWD-owned ponds.

LLWA

The LLWA will support the implementation of capital projects by continuing to build awareness and support in the community (e.g. relaying information, helping to convene and connect with residents, advising the partners on engagement efforts). The LLWA can also build community capacity for local action such as the implementation of residential best practices (e.g. raingardens, shoreline plantings, adopt-a-drain).

FUNDING

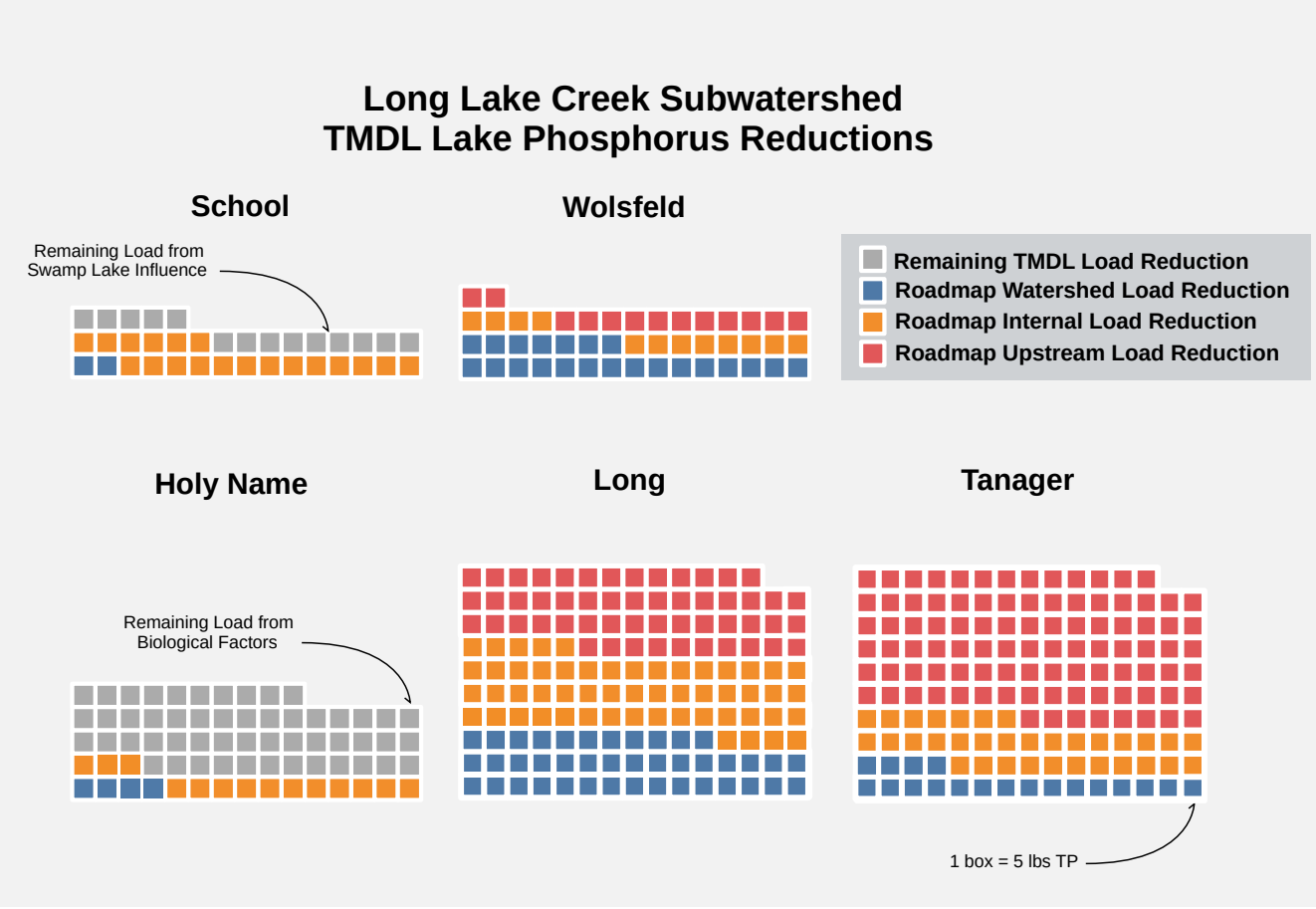
Based on discussions with the cities, it is assumed that implementation will be largely dependent on funding support from grants or other sources. The District will continue to coordinate with the partners and provide recommendations for the funding strategy with the goal of leveraging the maximum amount of external funding. This will involve evaluating the recommended projects (estimated benefits, costs, readiness to implement) against the potential grant sources (eligibility requirements, review criteria, available funds, timelines) to find the best matches.

Appendix C summarizes potential funding sources. Projects that are identified in this Roadmap will be strong candidates for a variety of state and regional grant programs as well as MCWD's new Land & Water Partnership program. This program is currently operating in a pilot phase and is scheduled for adoption in mid-2023. It is designed to provide funding and technical support for partner-led projects that align with MCWD goals and priorities by integrating them into the MCWD's Capital Improvement Plan. Most grants require a match, and it is recommended that the cities begin to dedicate funds or develop a strategy for contributing to grant matches.

PROGRESS TOWARD GOALS

Of the 59 projects evaluated, 34 are recommended for advancement based on their high cost-effectiveness and feasibility to implement. A full list of evaluated projects is included as Appendix B. The graph below shows the total load reductions required by the state to achieve water quality standards for each of the impaired lakes (total number of boxes) and the estimated progress that would be made by implementing the recommended projects (colored boxes). The different colors indicate the source of the reduction, including landscape projects (watershed load reduction), in-lake projects (internal load reduction), and improvements to upstream lakes (upstream load reduction).

If completed in total, these projects are estimated to achieve the TMDL reductions required by the state for Wolsfeld Lake, Long Lake, and Tanager Lake. The estimated percent progress toward the state requirements for School Lake and Holy Name Lake are 57 percent and 26 percent, respectively, with the remaining load attributed to biological drivers (as described in the previous section). Load reductions from biological management are difficult to estimate, so these have not been included in the graph.



The table below provides a breakdown of the state-required load reductions for each city, as well as internal load reductions, compared to the total estimated load reductions and construction costs for the 34 recommended projects. This provides a sense of the scale of implementation needed to restore the impaired lakes.

Location	Total Load Reduction Required by TMDL (lbs TP/yr)	Total Load Reduction from Recommended Projects (lbs TP/yr)	Number of Projects	Construction Cost
City of Long Lake	172	88	5	$3,956,175
City of Medina	237	161	8	$1,700,596
City of Orono	187	187	9	$2,227,525
In-Lake	625	660	12	$2,681,526
Total	1221	1096	34	$10,565,822

ONGOING PARTNERSHIP COORDINATION

This Roadmap provides a data-driven strategy and suite of projects that could be implemented to restore the five impaired lakes in this system. Undoubtedly, there will be projects in the Roadmap that will not be implemented, and there will be new opportunities that will arise. Therefore, it will be important for the partners to continue to coordinate and remain adaptive as they work together toward achieving their shared water quality goals. The MCWD plans to continue convening the partners, at least annually, to maintain a shared strategy and set of priorities for the partnership to advance.

One key area for ongoing coordination will be the identification of new project opportunities. The cities, through their land use authority and development review processes, are well positioned to track development activity that may present opportunities for stormwater management, wetland restoration, or streambank/ravine stabilization. As cities plan for their own infrastructure, parks, and facility improvements, these projects may also present opportunities to implement strategies from the Roadmap. The LLWA has a large membership of residents who are passionate about water resource protection who can also serve as a valuable network for identifying project opportunities. As opportunities are identified, MCWD can provide technical assistance to evaluate the potential costs and benefits.

At the annual meetings, the partners can revisit the implementation strategy, provide progress updates, identify any emerging opportunities, and develop shared priorities and a funding strategy for the coming year. As projects are implemented, MCWD will continue to monitor and track the progress, both in terms of estimated results from modeling and the measured response in the waterbodies. This will allow for ongoing adaptive management based on current data.

Restoration of these impaired lakes will require long-term commitment and investment by the partners. By prioritizing and focusing on the highest impact and most cost-effective project opportunities, the partners can build community support and momentum for ongoing efforts.

APPENDIX

2016 City Partnership Resolutions

Project Opportunity Tables and Maps

Grant Opportunities

Assessment Methodology, Data, and Findings