Meadow Lake Nutrient TMDL
Implementation Plan

Wenck File #1240-76

Prepared for:

SHINGLE CREEK WATERSHED MANAGEMENT COMMISSION

MINNESOTA POLLUTION CONTROL AGENCY

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1.0 Introduction

The Meadow Lake Nutrient Total Maximum Daily Load (TMDL) Implementation Plan addresses nutrient impairments in Meadow Lake (27-0057), in the City of New Hope, Hennepin County, Minnesota, in the Shingle Creek watershed, which is part of the Upper Mississippi River basin (see Figure 1). The lake was placed on the State of Minnesota's 303(d) list of impaired waters in 2002 for impairment of aquatic recreation. Meadow Lake is a small, shallow urban lake with a surface area of about 11.8 acres and a fully developed watershed of about 103 acres. The lake is impaired by high concentrations of total phosphorus resulting in severe algal blooms, with summer average total phosphorus concentrations ranging from approximately 200 µg/L to over 250 µg/L in the years in which measurements were taken. For comparison, the numeric standard for Meadow Lake is 60 µg/L or lower.

The Shingle Creek Watershed Management Commission (SCWMC or Commission) has completed a Total Maximum Daily Load (TMDL) analysis for the Minnesota Pollution Control Agency (MPCA) and U.S. Environmental Protection Agency to quantify the phosphorus reductions needed to meet State water quality standards for nutrients in Meadow Lake in accordance with Section 303(d) of the Clean Water Act. The TMDL and Implementation Plan were prepared in cooperation with the City of New Hope.

The final step in the TMDL process is the development of an Implementation Plan that sets forth the activities that will be undertaken to reduce phosphorus loading to the lake. This Implementation Plan provides a brief overview of the TMDL findings; describes the principles guiding this Implementation Plan; describes the proposed implementation activities; and discusses sequencing, timing, and lead agencies and organizations for the activities.

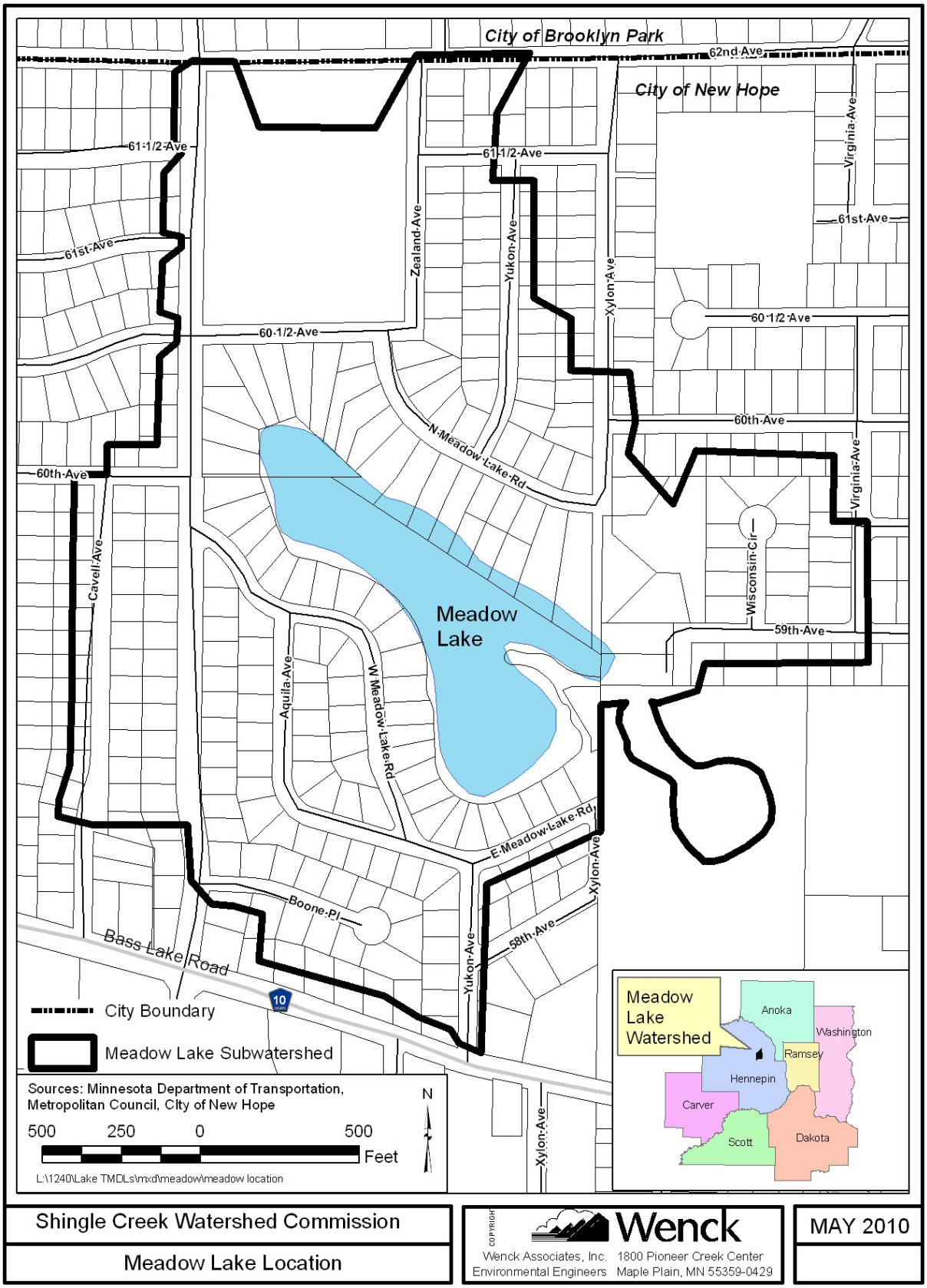

Figure 1. Meadow Lake location.

2.0 Meadow Lake TMDL Summary

The lake and its drainage area are located within the City of New Hope in the northwestern suburban Twin Cities metropolitan area. Meadow Lake outlets into a storm sewer that discharges to Bass Creek, a tributary of Shingle Creek, which itself is a tributary to the Mississippi River. A small pond on an abutting golf course designated P1.1A, which was a shallow bay of the lake before it was disconnected from the lake, is connected hydraulically to Meadow Lake by an equalizer pipe, but nearly all of the golf course drains east to storm sewer that discharges to Twin Lake. Pond P1.1A overflows into another golf course pond, P3.2, which discharges east to Twin Lake. (For more information on drainage please see the Meadow Lake Nutrient TMDL). Meadow Lake's 103 acre watershed is fully developed and about 103 acres in area. The lake is about 11.8 acres in size, with an average depth of 1.45 feet and a maximum depth of 3.6 feet. The lake is entirely littoral (shallow enough to support emergent and submerged rooted aquatic plants).

2.1 CURRENT WATER QUALITY

Historic water quality is presented in Figures 2, 3, and 4. Meadow Lake does not meet state standards for total phosphorus concentration, chlorophyll-a, or clarity as measured by Secchi depth. There is limited data available. Summer average total phosphorus concentration in Meadow Lake ranges from approximately 200 µg/L to over 250 µg/L in the years in which measurements were taken (Figure 2). For comparison, the numeric standard for Meadow Lake is 60 µg/L or lower.

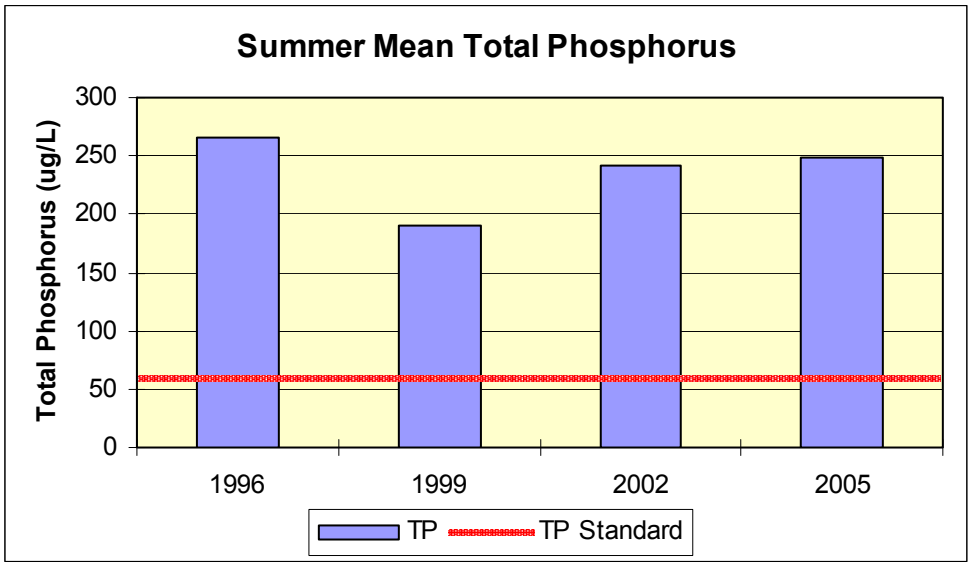

Figure 2. Summer (June 1 –September 30) mean total phosphorus concentrations for Meadow Lake.

More variability is observed in chlorophyll-a concentration than total phosphorus concentration. Chlorophyll-a concentration ranges from approximately 100 µg/L to nearly 200 µg/L with the

highest concentration occurring in 2002 (Figure 3). In 2005, the chlorophyll-a concentration was approximately 68 µg/L. The numeric standard for Meadow Lake is 20 µg/L or lower for chlorophyll-a.

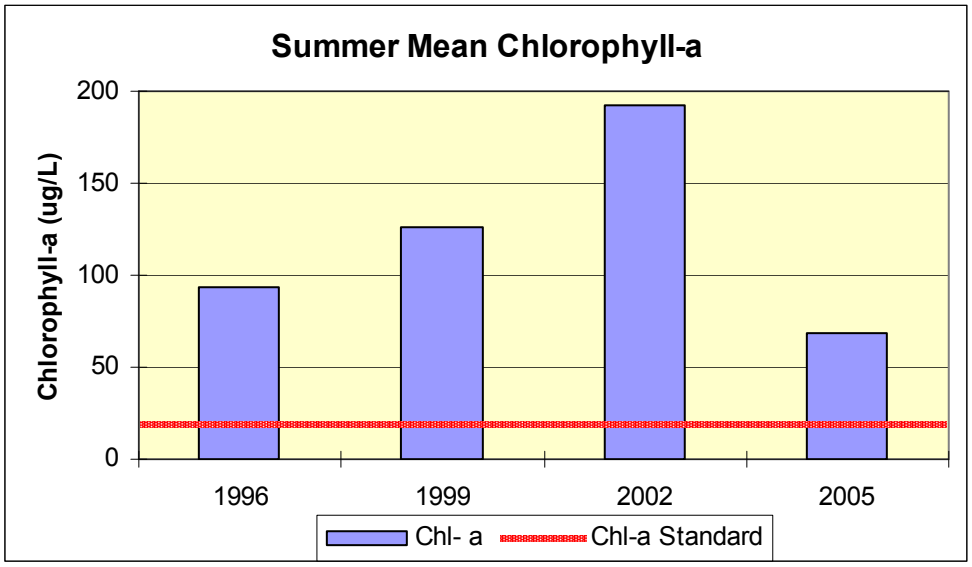

Figure 3. Summer (June 1 –September 30) mean chlorophyll-a concentrations for Meadow Lake.

Water clarity, as measured by Secchi depth, ranges from approximately 0.3 meters to 0.45 meters (Figure 4). The worst clarity occurred in 2002 which coincides with the high chlorophyll-a concentration observed in that year. In 2005, the water clarity was the best of the years in which measurements were taken at nearly 0.45 meters. The numeric standard for Meadow Lake is 1.0 meter of clarity or more as measured by Secchi depth.

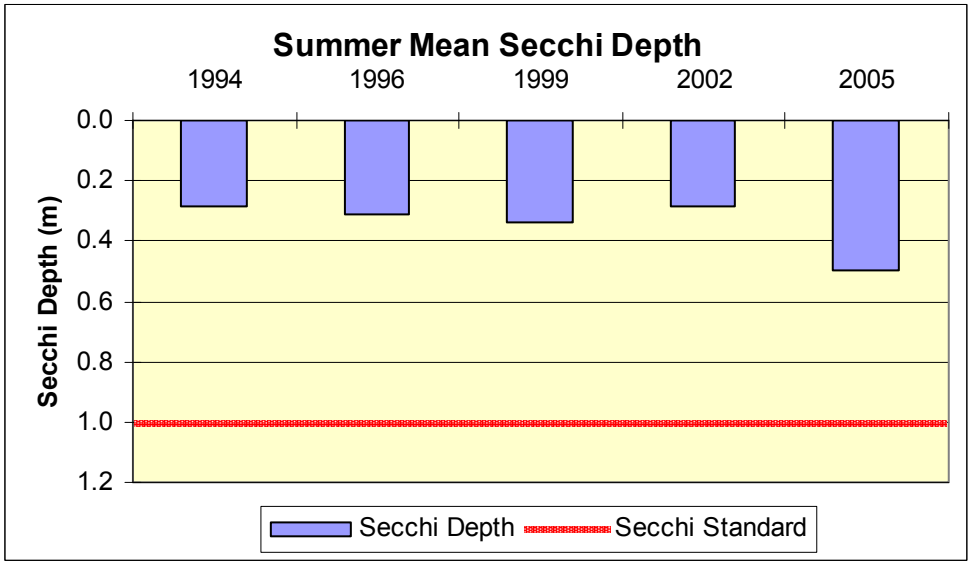

Figure 4. Summer (June 1 –September 30) mean Secchi depth (meters) for Meadow Lake.

2.2 PHOSPHORUS LOAD SOURCES

Modeling data was used to develop a phosphorus budget for Meadow Lake. The budget suggests that both internal and external phosphorus loads are significant factors in determining water quality in the lake. The primary sources of external phosphorus are sediment and nutrients from stormwater runoff from the watershed conveyed through storm sewers and discharged from the six storm sewer outfalls into the lake. Internal loading can be a result of sediment anoxia where poorly bound phosphorus is released in a form readily available for phytoplankton production and from die-off of curly-leaf pondweed.

2.3 REQUIRED PHOSPHORUS LOAD REDUCTIONS

Wasteload and load allocations to meet State standards indicate a phosphorus load reduction of about 82% would be required to consistently achieve a total phosphorus concentration of 60 µg/L, which would meet the state standard. This Implementation Plan details the activities the stakeholders in the lake's watershed plan to undertake to attain that reduction.

2.3.1 Allocations

All TMDLs have a Wasteload Allocation (WLA) that includes permitted discharges such as industrial point and regulated stormwater discharges. The Load Allocation (LA) in TMDLs includes phosphorus load from non-permitted sources, such as internal loading or atmospheric deposition. Stormwater discharges are regulated under the State of Minnesota's National Pollutant Discharge Elimination System (NPDES) General Permit, and are considered wasteloads. The City of New Hope is the only permit holder discharging to Meadow Lake. The unique NPDES permit number assigned to New Hope is MS400039. The City of New Hope has committed to implement Best Management Practices (BMPs) to reduce nutrient loading in Meadow Lake. The City cooperated in developing the TMDL and Implementation Plan and will continue to work with the ongoing Commission Technical Advisory Committee (TAC) to identify and implement BMPs.

The pollutant load from construction stormwater is considered to be less than 1 percent of the TMDL and difficult to quantify. Consequently, the WLA includes pollutant loading from construction stormwater sources. Construction stormwater activities are considered in compliance with provisions of the TMDL if they obtain a Construction General Permit under the NPDES program and properly select, install, and maintain all BMPs required under the permit, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit. There are no known municipal or industrial wastewater dischargers in the watershed.

2.3.2 Implementation Focus

The focus in implementation will be on reducing the annual phosphorus loads to Meadow Lake through structural and nonstructural BMPs. The load and wasteload allocations are shown in Table 1.

Table 1. Meadow Lake TMDL total phosphorus allocations expressed as daily and annual loads.

Wasteload TP Allocation		Load TP Allocation		Margin of Safety	Total Phosphorus TMDL	
(kg/day)	(kg/yr)	(kg/day)	(kg/yr)		(kg/day)	(kg/yr)
0.025	9.0	0.019	6.8	Implicit	0.044	15.8

Load allocations by source are provided in Table 2. No reduction in atmospheric loading is targeted because this source is impossible to control on a local basis.

Table 2. Meadow Lake TMDL total phosphorus daily and annual loads partitioned among the major sources.

	Source	Total Maximum Daily TP Load (kg/day)	Total Maximum Daily TP Load (kg/yr)	Current Load (1996-2005 Average) (kg/yr)	Load Reduction (kg/year)
Wasteload	Watershed Load	0.025	9.0	52.6	43.6
Load	Atmospheric Load	0.003	1.1	1.1	-
	Internal Load	0.016	5.7	33.9	28.2
	TOTAL LOAD	0.044	15.8	87.6	71.8
82% Load Reduction					

It should be noted that the current load and the estimated load reduction requirements were computed prior to the significant external load reduction BMPs that were installed by the City of New Hope in 2006 (see page 5.1 for a description).

3.0 Implementation Plan

3.1 TMDL AND IMPLEMENTATION PLAN PROCESS

The activities and Best Management Practices (BMPs) identified in this Implementation Plan are the result of a series of Technical Advisory Committee (TAC) and stakeholder meetings led by the Shingle Creek Watershed Management Commission (SCWMC). The TAC included stakeholder representatives from local cities, Minnesota Department of Natural Resources (DNR), the Metropolitan Council, the United States Geological Survey (USGS) and the Minnesota Pollution Control Agency. All meetings were open to interested individuals and organizations. Technical Advisory Committee meetings to review this and other lake TMDLs in the watershed were held on December 8, 2005, February 10, 2006, March 9, 2006, and June 27, 2007.

The general TMDL approach and general results of TMDLs were presented to seven City Councils in May and July 2006. A public meeting was held March 5, 2009 to review the findings of the TMDL with lakeshore property owners and to take public input on the development of this Implementation Plan.

This Implementation Plan was distributed to the City of New Hope and Mn/DOT for review and posted on the SCWMC website www.shinglecreek.org for public review and comment. This Implementation Plan was reviewed by the TAC at its April 30, 2009 meeting. On May 14, 2009 the Shingle Creek Watershed Management Commission reviewed the draft Implementation Plan and all comments received and approved this Plan.

3.2 IMPLEMENTATION PLAN PRINCIPLES

Through the discussion of policies and practices, current activities, and ongoing research, the stakeholders developed principles to guide development and implementation of the phosphorus load reduction plan. These principles, in no order, include:

1. Restore Biological Integrity

The Commission, City of New Hope, and residents recognize the importance of a healthy biological community in the lake to provide internal controls on water clarity. To that end, the stakeholders agree to work cooperatively to restore the biological community in this lake, including fish, plants, and zooplankton.

2. Control Internal Load

It is recognized that a significant portion of the phosphorus load in Meadow Lake is a result of internal loading and that the internal load must be addressed to successfully improve water quality. Consequently, the stakeholders agreed to work cooperatively to reduce internal phosphorus loading in the lake.

3. Retrofit BMPs in the Watershed As Opportunities Arise

New Hope, as the sole MS4 in the watershed discharging to Meadow Lake, understands that nutrient loading must be reduced, but that options for retrofitting BMPs are limited. Nutrient-reduction BMPs have already been incorporated into street projects in this neighborhood, and the city will evaluate opportunities such as other street projects or redevelopment to add or upsize BMPs.

4. Foster Stewardship

City staff, especially maintenance staff, will be provided opportunities for education and training to better understand how their areas of responsibility relate to the protection and improvement of water quality in the lake.

5. Communicate with the Public

Public education should take a variety of forms, and should include both general and specialized information, targeted but not limited to:

- General public
- Elected and appointed officials
- Lakeshore residents
- Lake users
- Property owners and managers

3.3 IMPLEMENTATION PLAN

The stakeholders agree that implementation will be a joint effort, with the SCWMC taking responsibility for ongoing coordination, general education and monitoring activities and the City of New Hope taking responsibility for BMP implementation. New Hope will incorporate BMPs into its Storm Water Pollution Prevention Program (SWPPP), which addresses the six Minimum Control Measures found in the MS4 General Permit, and will work with the SCWMC to periodically assess progress toward advancing the implementation principles detailed above. New Hope will report its annual TMDL Implementation Plan activities to the SCWMC, and the Commission will summarize those activities into its own Water Quality Monitoring Annual Report. This framework is illustrated in Figure 5 below.

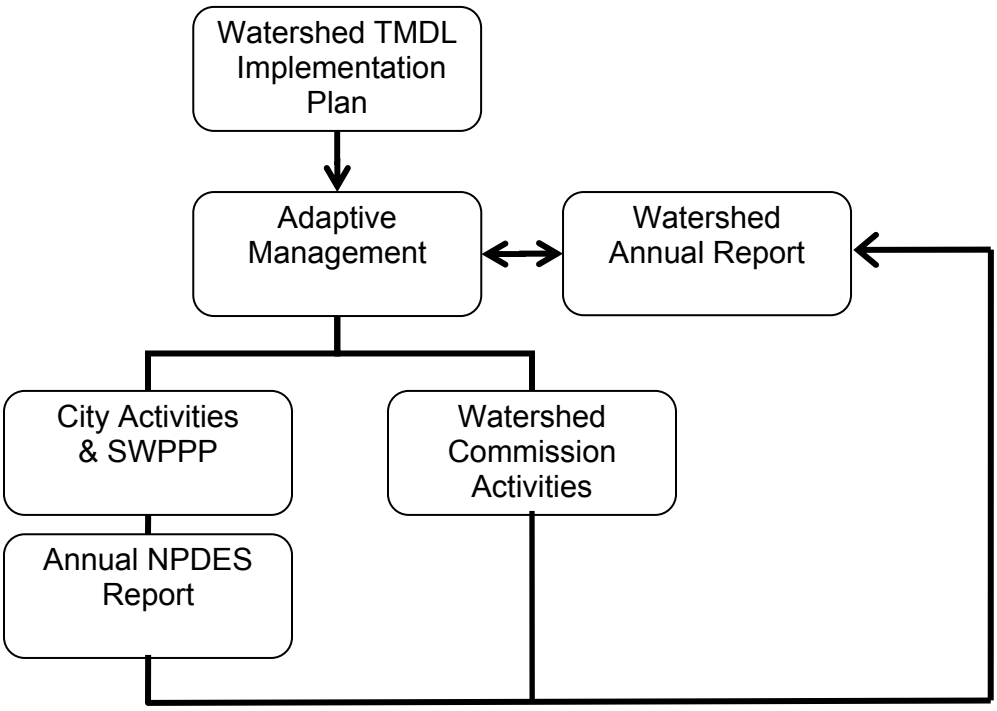

Figure 5. Implementation framework.

3.3.1 Implementation Approach

The impairment to Meadow Lake developed over time as the watershed draining to the lake urbanized. As the watershed developed, the native prairie and savanna was cleared to support farming. Over the past century the farms and remaining undeveloped land were converted to residential use, increasing the volume of runoff and the amount of pollutants conveyed to the lake, slowly degrading water quality. Just as this degradation took many years, improvement will take many years through ongoing retrofit of the watershed with BMPs as well as eventual redevelopment of existing land uses with lower-impact development and stormwater treatment. However, it is likely that it will take several decades to see any significant redevelopment in this subwatershed.

The TMDL study and this Implementation Plan identify general improvements to reduce external and internal phosphorus loading. Some of these actions are nonstructural and could be undertaken at any time, such as increased street sweeping or shoreline restoration, and some are structural actions that would be completed as part of a construction or redevelopment project. These are "short term" actions that could be accomplished in the next 10-20 years. However, these projects alone will not be sufficient to achieve water quality goals for this lake. An essential "long-term" component of this Implementation Plan is to routinely retrofit BMPs in this fully developed watershed as redevelopment or construction activities provide opportunities.

As the City cycles through its street reconstruction program, it now routinely includes treatment BMPs such as stormwater detention ponds and underground treatment devices where possible. These incremental reductions will over time add up to a significant external load reduction.

As mentioned, a long-term type of external load reduction is redevelopment. The watershed draining to the lake developed prior to the development of Shingle Creek watershed development rules and standards and therefore there hasn't been adequate treatment of stormwater. As this area redevelops over time, the redevelopment will be required to abstract some stormwater and treat the balance of the runoff before discharging it to the lake. Depending on the nature of the development or redevelopment, it may be possible to provide even more phosphorus load reductions by "upsizing" treatment above and beyond the minimum required by the rules or to create new regional treatment opportunities.

3.3.2 Implementation Strategies

Implementation will focus on controlling both external and internal loading. Some significant Best Management Practices have recently been undertaken by New Hope as part of a recent street reconstruction project, so some of the required external load reduction has already taken place. Because internal load is also an important factor internal load management activities could be initiated early in the Implementation Program. An important part of the internal load strategy is restoring and maintaining biological integrity and associated impacts to water quality through management of the aquatic plant community, fishery, and macroinvertebrate and zooplankton assemblages. However, biomanipulation may not provide all the internal load reduction that would be required. Additional work is necessary to evaluate the feasibility of other internal load reduction options such as a whole-lake drawdown.

The following sections discuss the general BMP strategies that were identified in the TMDL process to reduce phosphorus load, restore ecological integrity, and meet state water quality goals for these lakes; the general sequence of implementation activities; and the stakeholders who would take the lead in implementing each activity. BMP strategies are listed below and described in more detail in Sections 4 and 5 of this Plan.

<u>External Load Best Management Practice (BMP) Strategies</u>

- Add BMPs as opportunities arise to decrease runoff from the watershed and increase stormwater treatment.
- Increase infiltration and abstraction in the watershed.
- Increase frequency of street sweeping.
- Encourage shoreline restoration to improve runoff filtration.

<u>Internal Load Best Management Practice (BMP) Strategies</u>

- Conduct aquatic plant, fish, zooplankton, and phytoplankton surveys.
- Prepare and implement an aquatic vegetation management plan.
- Restore a balanced fishery.
- Evaluate a lake drawdown and other potential internal load management projects and implement feasible and cost-effective options.

3.3.3 Sequencing

Some of the above activities may be undertaken immediately, while others would be implemented as opportunities arise. In general implementation will proceed according to the following sequence of activities:

First Five Years

- Continue monitoring the lake.
- Continuously update the watershed SWMM and P8 models.
- Evaluate ways to refine street sweeping practices to maximize pollutant removal.
- Conduct or update aquatic vegetation, fish, phytoplankton, and zooplankton surveys.
- Develop and implement an aquatic vegetation management plan.
- Encourage lakeshore property owners to plant or widen native buffers on their shoreline.
- Implement BMP retrofits as opportunities such as street and utility reconstruction arise.
- Implement BMP and restoration demonstration projects as opportunities arise.
- Evaluate options for internal load control, such as a whole-lake drawdown.
- Implement an internal load control project.

Second Five Years and Subsequent Permit Cycles

- Continue monitoring the lake.
- Evaluate progress towards goals including inventorying implemented BMPs and activities and subsequent water quality improvement.
- Amend the Implementation Plan as necessary based on progress.
- Implement BMP retrofits as opportunities arise to continue to reduce external loading.
- Work with the DNR to restore a balanced fishery.

3.3.4 Stakeholder Responsibilities

The primary stakeholders in this Plan are the Shingle Creek Watershed Management Commission (SCWMC) and the City of New Hope. In addition, property owners in the watershed and the Meadow Lake Association have a role to play in implementing BMPs both on their private properties and within the watershed. The Meadow Lake Association is developing a Lake Management Plan to guide their implementation activities and partnerships. The SCWMC Education program will provide residential and non-residential property owners and managers with information on BMPs that would have the most impact on improving water quality.

Table 3 shows which stakeholders will take the lead in implementing the various activities identified in this Plan.

Table 3. Implementation activity by stakeholder.

Actor	Stormwater	Internal Load	Aquatic Vegetation	Aquatic Life	Monitoring/ Reporting
SCWMC	• Provide focused education and outreach • Solicit and fund Demonstration Projects • Prepare grant applications to implement BMPs • Evaluate ways to refine street sweeping practices	• Measure internal loads • Prepare feasibility reports and make recommendations on internal load strategies in partnership with the City of New Hope	• Evaluate and make recommendations for aquatic vegetation management for curly-leaf pondweed (CLP) • Identify potential shoreline restoration projects	• Work in partnership with the DNR to manage the fishery to maintain a beneficial community	• Continue CAMP citizen water quality monitoring • Conduct periodic in-depth lake monitoring • Monitor aquatic vegetation, zooplankton, and phytoplankton every five years or as necessary • Collect implementation data from stakeholders annually • Prepare an annual report on monitoring and activities.
City of New Hope	• Provide focused education and outreach • Implement BMPs to reduce TP loads as opportunities arise • Conduct routine pond inspections for maintenance • Perform pond maintenance as necessary per inspection results • Sweep streets at least twice annually	• Consider and implement internal load reduction strategies	• Consider aquatic vegetation management for CLP • Consider shoreline restoration projects	• Work in partnership with the DNR to manage the fishery to maintain a beneficial community	• Report implementation activities to SCWMC annually
Property Owners	• Implement volume and pollutant load reduction practices		• Implement shoreline restoration projects		• Participate in volunteer monitoring
Lake Association	• Promote volume and pollutant load reduction practices and educate property owners • Undertake demonstration projects		• Promote shoreline restoration and educate property owners • Undertake demonstration projects • Partner with the City on vegetation management for CLP	• Partner with the City, DNR, SCWMC, and other partners on aquatic life management issues	

3.4 ADAPTIVE MANAGEMENT

The load allocations in the TMDL are aggressive goals for nutrient reduction. Implementation will be conducted using adaptive management principles. Adaptive management is an iterative approach of implementation, evaluation, and course corrections (see Figure 6). It is appropriate here because it is difficult to predict the lake response to load reductions. Future conditions and technological advances may alter the specific course of actions detailed in this Plan. Continued lake water quality monitoring and course corrections responding to monitoring results offer the best opportunity for meeting the water quality goals established in this TMDL and Implementation Plan.

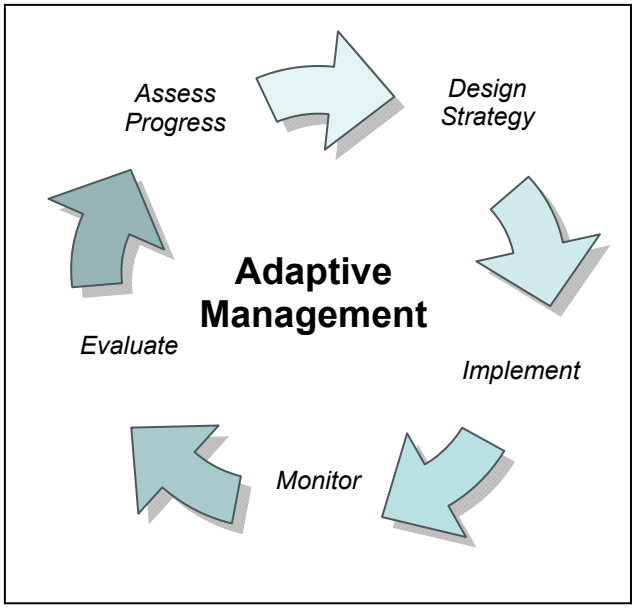

Figure 6. Adaptive management.

3.4.1 Interim Milestones

Lakes may take years to respond to phosphorus load reduction activities in the watershed and make progress toward the in-lake water quality standards. Interim measures to assess the progress of this TMDL include the following:

- Number and types of new Best Management Practices retrofit into the watershed
- Frequency and extent of additional priority street sweeping undertaken each year
- Number of redevelopment projects in the watershed that incorporate new or oversized load reduction and volume management
- Completion of feasibility studies to reduce internal lake phosphorus loading
- Completion of aquatic vegetation, fish, and zooplankton surveys
- Number of informational pieces made available to property owners in the watershed on small BMP practices, lakeshore restoration, and other load reduction and habitat improvement practices

These milestones will provide information about documenting the progress towards achieving the TMDL likely even before we are able to show improvement in the water quality of Meadow Lake. Monitoring of lake water quality is discussed in Section 4.3.

4.0 Watershed Commission Activities

The SCWMC has agreed to take the lead on general coordination, education, and ongoing monitoring. The Commission will also collect MS4 annual NPDES reports and other information from the stakeholders and compile BMP activities undertaken by all parties. This information will be incorporated into the Commission's annual Water Quality Report. The following activities will be conducted by the SCWMC.

4.1 GENERAL COORDINATION

4.1.1 Coordination

One of the primary Commission roles in managing the watershed is serving as a coordinator of water resource policies and activities. The Commission will continue in that role in the implementation of this TMDL. General activities now undertaken by the Commission will be continued or expanded as the Commission moves from management planning to implementation coordination. These are activities that are included as part of the Commission's general administrative budget and no additional cost is expected from their implementation:

- Provide advice and assistance to member cities on their implementation activities.
- Research and disseminate information on changing BMP technology and practices.
- Collect annual implementation activity data.
- Recommend activities such as vegetation or fishery management, partnering with the DNR.
- Periodically update the Commission's Capital Improvement Program (CIP).
- Maintain the watershed SWMM and P8 models.
- Conduct public hearings on proposed projects.
- Share the cost of qualifying improvement projects.

Estimated Cost: Ongoing activity
Funding Source: General operating budget, county levy for project share

4.1.2 Annual Report on Monitoring and Activities

An annual report on phosphorus load reduction activities is necessary under the adaptive management approach established in the TMDL. Each year the Commission will collect from the MS4 permittees in the watershed (including the City of New Hope for this TMDL) a listing of the activities undertaken in the previous year. This report will summarize those activities and provide the permittees the necessary information for their annual NPDES reports. The report will detail BMP implementation, associated load and volume reductions, and current monitoring data to evaluate activity effectiveness. At the end of each five year period this report will include an assessment of progress and identify any revisions to the Implementation Plan. This report will be a part of the Commission's annual Water Quality Monitoring Report. The format and content of the Water Quality Monitoring Report is being revised to include reporting on the three stream TMDLs and 13 lake TMDLs in the watershed.

Estimated Cost: $10,000-12,000
Funding Source: General operating budget (currently budgeted at $10,000)

4.1.3 Rules and Standards

In early 2008 the Commission directed its Technical Advisory Committee (TAC) to review and if necessary recommend revisions to the current rules to address the effectiveness of the regulatory program in meeting the TMDL requirements. The TAC reviewed the current pollutant removal performance standard and current infiltration requirement to determine if a more stringent rule was necessary. The TAC concluded that the current pollutant removal standards of 85% total suspended solids (TSS) and 60% phosphorus removal combined with the existing 0.5" infiltration standard were sufficiently stringent without being overly burdensome. The Commission will keep abreast of regulatory trends and consider future rules and standards revisions if so warranted.

Estimated Cost: $2,000
Funding Source: General operating budget for Management Plan activities (current budget is $3,000)

4.1.4 Establish Performance Standards

As a part of this and other TMDL Implementation Plans the City of New Hope will be implementing various BMPs to reduce phosphorus load and stormwater volume. Stakeholders will report load reductions made by each BMP to the Commission, which will track progress toward meeting load reductions throughout the watershed.

Stakeholders will have varying levels of information and data about these BMPs. In some cases estimating the load reduction will be part of the BMP design process. For example, load reductions for a new or enhanced pond can be calculated using standard modeling techniques. However, many other types of BMPs such as rain gardens, reforestation, reductions in impervious pavement, etc. have an impact that is more difficult to calculate. The Commission has directed its Technical Advisory Committee (TAC) to review literature, the State Stormwater Manual, and other guidance from Minnesota and other states to help provide guidance to the cities for estimating performance values for various BMPs. For example, a typical residential rain garden might be credited with reducing phosphorus by X kilograms per unit area annually. Or, an underground treatment device of Brand X would be assigned specific removal efficiencies. The MPCA is exploring establishing such standards, as are other watershed management organizations.

Estimated Cost: $3,000
Funding Source: General operating budget for Engineering Administration activities (current budget is $41,000)

4.2 EDUCATION

4.2.1 Public Education and Outreach

The Commission operates an ongoing education and outreach program that is managed by the standing Education and Public Outreach Committee (EPOC). The EPOC is a group comprised of city staff, Commissioners, and watershed resident volunteers that develops and implements educational materials and programming.

The Commission in fall 2007 undertook a professional opinion survey to better understand what people know and how public education and outreach can most effectively communicate how individual property owners can impact water quality through the implementation of individual Best Management Practices in the watershed. The EPOC developed recommendations for the Commission for implementation in 2009 and beyond.

The Minnesota and Wisconsin Departments of Natural Resources and the Universities of Minnesota and Wisconsin Extension Service have prepared numerous fliers and brochures on various topics relating to lake management that can be made available to target audiences at city meetings, block club and National Night Out gatherings, and other opportunities. Links to this information are posted on the Commission's and cities' web sites. The EPOC has also developed specialty brochures focused on groups such as apartment and small commercial building managers.

Estimated Cost: Ongoing activity
Funding Source: General operating budget for Education activities (current budget is $28,700)

4.2.2 Public Official and Staff Education

There is a need for city, county and state officials and staff to understand the TMDL process and the proposed implementation activities so that they can effectively make regulatory, budget and programming decisions and conduct daily business. Resources such as self-study lake management background information from Water on the Web ("Understanding Lake Ecology"), Project NEMO (Nonpoint Education for Municipal Officials), UW Extension ("Understanding Lake Data") and other sources would provide basic information about lake ecology to help staff, Councils and Commissions make informed decisions about lake management.

Estimated Cost: $500
Funding Source: General operating budget for Education activities (current budget is $28,700)

4.2.3 Presentations at Meetings

Awareness of lake management can be raised through periodic presentations at meetings of lake associations, homeownership associations, block clubs, garden clubs, service organizations, senior associations, advisory commissions, City Councils, or other groups as well as displays at events such as remodeling fairs and yard and garden events. "Discussion kits" including more detailed information about topics and questions and points for discussion could be made available to interested parties. The Commission's annual education budget assumes staff attendance at three presentations or events per year such as staffing booths at events.

Estimated Cost: $1,000
Funding Source: General operating budget for Education activities (current budget is $28,700)

4.2.4 Demonstration Projects

Property owners may be reluctant to adopt good lake management practices without examples they can evaluate and emulate. A few demonstration projects have been completed in the watershed through outside grants and from the Commission's Education and Implementation Grant program, including a shoreline restoration project in a park on Middle Twin Lake in Brooklyn Center and a shoreline restoration and a rain garden in a park on Ryan Lake in Minneapolis. The Commission will encourage demonstration projects so property owners can see how a project or practice is implemented and how it looks. Examples might include planting native plants; planting a rain garden; restoring a shoreline; managing turf using low-impact practices such as phosphorus-free fertilizer, reduced herbicides and pesticides, and proper mowing and watering techniques; and improving drainage practices with redirected downspouts and rain barrels. The estimated cost of this activity is highly variable. The Commission annually budgets $20,000 for grant matching and small projects. The Commission will evaluate appropriate activities and develop guidelines for funding demonstration projects from this budget. The Meadow Lake Association has expressed an interest in undertaking some demonstration projects in shoreline restoration, rain gardens, and other small practices.

Estimated Cost: Varies based on the type of activity
Funding Source: General operating budget for grant match/demonstration projects (current budget is $20,000)

4.3 ONGOING MONITORING

4.3.1 Water Quality Monitoring

The SCWMC will lead monitoring and tracking of the effectiveness of activities implemented to reduce nutrient loading in the watershed. This monitoring will continue to be detailed in the Commission's Annual Water Quality Monitoring Report. The Commission will continue to participate in the Metropolitan Council's Citizen Assisted Lake Monitoring Program (CAMP). Through this program, citizen volunteers monitor surface water quality and aesthetic conditions biweekly. Each year four to six lakes in the Shingle Creek watershed are monitored in this manner. This program is also a useful outreach tool for increasing awareness of water quality issues. The estimated cost of this monitoring is $6,500 annually, and is included in the Commission's existing Monitoring budget. Meadow Lake is scheduled to be monitored through the CAMP program every three years.

Estimated Cost: $6,500 annually
Funding Source: Monitoring budget for CAMP monitoring (current budget is $6,500)

The Commission will also periodically (every 4-5 years) conduct a more detailed analysis of water quality, collecting biweekly data on lake surface, water column, and bottom conditions.

This data will provide a more detailed picture of lake response to BMP activities and will help determine necessary "course corrections" as part of the Adaptive Management philosophy guiding this Implementation Plan.

As described above, the Commission annually publishes a Water Quality Monitoring Report that compiles and interprets monitoring data from the lakes, streams, and wetlands in the watershed. The monitoring data collected by the Commission and other agencies will be analyzed to determine the linkage between BMP implementation and water quality and biotic integrity in Meadow Lake, and to assess progress toward meeting the Total Maximum Daily Load and in-lake phosphorus concentration goals. This detailed monitoring is not part of the Commission's existing Monitoring budget. As the Commission completes its current cycle of management planning in 2010 with the Wetland Management Plan, that annual budget ($15,000) will be reallocated to more extensive lake monitoring.

Estimated Cost: $7,000 – 10,000
Funding Source: Reallocated operating budget for management plans (current budget is $15,000)

4.3.2 Other Monitoring

A baseline aquatic vegetation survey has been completed for Meadow Lake and should be updated every 4-5 years as part of the more detailed water quality assessment described above. Zooplankton sampling has not been conducted. Research being conducted by the University of St. Thomas and the DNR on various shallow lakes in the Metro area included a baseline fishery assessment for Meadow Lake. The estimated cost of this monitoring is $2,000-3,000 per lake. Neither type of monitoring is routinely part of the Commission's existing Monitoring budget. As the Commission completes its current cycle of management planning in 2010 with the Wetland Management Plan, that annual budget ($15,000) will be reallocated to more extensive lake monitoring.

Estimated Cost: $2,000-3,000
Funding Source: Reallocated operating budget for management plans (current budget is $15,000)

The Commission will work together with the DNR to determine the optimum strategy for monitoring the fish community.

Estimated Cost: To be determined
Funding Source: To be determined

The Commission will explore funding opportunities to research or pilot monitoring of BMP effectiveness.

Estimated Cost: To be determined
Funding Source: To be determined

5.0 Stakeholder Activities

While the SCWMC will coordinate implementation of the Meadow Lake TMDL, the City of New Hope, the Lake Association, and other stakeholders ultimately will implement the identified BMPs. Table 3 in Section 3 of this report shows the lead agencies for each of the stakeholder activities. Not all stakeholders will undertake all these activities. Those activities for which the City will take the lead will be incorporated into its NPDES Stormwater Pollution Prevention Program (SWPPP), and implementation actions will be reported annually.

The following are the general BMP implementation activities that will be most effective in restoring water quality in Meadow Lake to state standards and an estimate of their cost. Refer to Section 3 of this report for information regarding sequencing and lead agencies.

5.1 REDUCE EXTERNAL LOAD

5.1.1 Retrofit BMPs to Add Stormwater Treatment in the Watershed

Much of the Meadow Lake watershed developed prior to the implementation of watershed rules and standards requiring treatment of stormwater runoff. Some treatment has been added as redevelopment or street projects provided opportunities. For example, in 2006, New Hope installed grit chambers and a large curb cut rain garden to treat runoff as part of a project to reconstruct streets in the neighborhood adjacent to the lake. Additional treatment Best Management Practices (BMPs) will be sought across the watershed as those opportunities continue to arise. Treatment options include but are not limited to:

- New or enhanced stormwater ponding.
- Infiltration basins, underground storage and infiltration, cisterns and other store and re-use devices and other types of abstraction such as native vegetation or reforestation.
- In-line or off-line treatment devices such as hydrodynamic separators, filters, and vaults.
- Rain gardens and biofiltration.

Other projects would be implemented as opportunities arise, such as through street reconstruction projects and redevelopment. Examples of potential BMPs include detention ponds, native plantings, swirl separators, and trash collectors. These small practices are effective in removing debris, leaf litter, and other potential pollutants. Depending on the type of BMP, location, easement requirements, and other factors, costs can range from $5,000 for a trash collector to $250,000 or more for a detention pond. The number of BMPs necessary to achieve the required phosphorus load reduction is unknown and is dependent on the types of opportunities that arise. As the City reconstructed streets in this neighborhood in 2006 and installed BMPs as part of that project, the City will look to long-term redevelopment to make significant new load reductions and retrofit small practices on individual lots to make ongoing reductions in the interim. Load removals might range from a fraction of a pound per year for small practices to 5-10 pounds per year for a detention pond treating a large subwatershed.

Estimated Cost: Varies by specific project
Funding Source: City, SCWMC through county levy, grant funds

5.1.2 Increase Infiltration in Watershed

The Meadow Lake watershed is fully developed, with limited opportunities for redevelopment. The City of New Hope will incorporate infiltration and other abstraction strategies into city improvement projects where possible as opportunities arise. The Shingle Creek Watershed Management Commission is currently evaluating the strategic use of porous pavement on city streets to reduce snow and ice buildup and thus reduce the need to apply road salt. As that technology develops and the price comes down there may be a benefit to using porous pavement in strategic locations to enhance infiltration. The soils in the lake's watershed are heavier soils with a greater clay content, so it may be difficult to achieve significant infiltration without soil engineering and underdrains. The cost of this strategy varies depending on the BMP, and may range from a single property owner installing an individual rain garden to retrofitting parks and open space with native vegetation rather than mowed turf. The Meadow Lake Association has identified increased infiltration as a strategy to promote to the property owners in the lake's watershed. The Commission's Education and Outreach Committee regularly provides education and outreach information to member cities on these topics for publication in city newsletters, neighborhood and block club fliers, and the city's website. Load removals might range from a fraction of a pound for a small infiltration practice such as a rain garden to a few pounds per year for a regional infiltration basin or strategic porous pavement application.

Estimated Cost: Varies by specific project
Funding Source: City, Commission's education program, lake association

5.1.3 Shoreline Management and Restoration

While shoreline restoration provides minimal pollutant load reduction it provides habitat, aesthetic, and shoreline stabilization benefits. Shoreline restoration can cost $30-50 per linear foot, depending on the width of the buffer installed. Meadow Lake contains about 3,500 linear feet of residential shoreline. Ideally about 75 percent of the residential and park shoreline would be native vegetation, with about 25 percent available for lake access. Accomplishing this goal would require planting buffers or enhancing existing buffers for about 2,625 feet of shoreline at a cost of about $78,750 to $131,250. Many residents have at least some shoreline buffer, often simply an unmowed area but in some cases they have a planted natural buffer. Education materials targeted to shoreline owners (for example, www.bluethumb.org), will be promoted to encourage voluntary shoreline restoration. The Meadow Lake Association has also targeted shoreline restoration as an activity to promote and is interested in undertaking demonstration projects. The City installed native plantings on the shore of Meadow Lake Park in 1995, but residents report that invasive species in the shoreline buffer may require the plantings to be restored or refreshed.

Estimated Cost: $130,500 – $217,500
Funding Source: Private property owners, city, grant funds

5.1.4 Street Sweeping

Newer street sweeping technologies are available that use high pressure to remove a greater percent of the small particles that can carry phosphorus to the lakes. There is a limited and varying amount of information and research from which to estimate load reductions from street sweeping. Studies in the Twin Cities Metro Area have ranged from 0.25 pounds per mile per year to 2-3 pounds per mile per year. The most systematic and scientific testing was performed by Selbig and Bannerman (2007) in Madison, WI for the USGS. Their findings suggest that high frequency, high efficiency sweeping could result in an annual phosphorus removal rate of 0.75 – 1 pound per mile per year. There are approximately 1.8 miles of street in the Meadow Lake subwatershed, so if the City undertook high frequency sweeping it could achieve 1-2 pounds of phosphorus removal per year. The City will consider how to increase the efficiency and effectiveness of street sweeping within the context of its overall sweeping program.

Estimated Cost: $100,000 to 200,000 per new sweeper, $65-85 per mile of additional sweeping
Funding Source: City

5.2 REDUCE INTERNAL LOAD

5.2.1 Internal Load Reduction Project

Chemical treatments of the sediments in shallow lakes such as Meadow Lake can be of limited effectiveness due to the high potential for disturbance of the seal of the chemical floc to the lakebed sediments and subsequent resuspension of sediments. The lake was treated with copper sulfide in about 1990 and with alum in 1995, both of which had limited and short-term effectiveness. Meadow Lake may be a good candidate for a water level drawdown. A drawdown would expose and consolidate the lake sediments and provide an opportunity for the native seed bank to reestablish a more beneficial aquatic vegetation community. Some additional chemical treatment such as a partial alum treatment of the unexposed sediments in the deepest parts of the lake may be necessary if the entire lake cannot be entirely drained. A partial drawdown was completed in winter 2006 to allow for dredging of excess material at the outfalls into the lake. The following year residents reported reduced levels of invasive aquatic vegetation and improved water clarity. A drawdown would be preceded by a feasibility study that included an assessment of the aquatic vegetation, fish, zooplankton, and macroinvertebrate communities and evaluating the various options for partial or full drawdown. The estimated cost of this option is $100,000, including a feasibility analysis and pre-drawdown biotic data collection.

Estimated Cost: $100,000
Funding Source: City, SCWMC through county levy, grant funds

5.3 BIOLOGIC INTEGRITY MANAGEMENT

5.3.1 Aquatic Plant Management

The SCWMC recognizes the importance of a healthy biological community in meeting water clarity goals, especially in shallow lakes. Aquatic plant management is a key aspect in maintaining a healthy shallow lake. Studies of water quality following whole-lake aquatic vegetation management have shown mixed but promising results, although it is difficult to establish a numerical link or a specific load reduction. There is some non-native curly-leaf pondweed in

Meadow Lake, although it is not currently present in nuisance levels. Filamentous waternet has been invasive and present at extreme nuisance levels in previous years. To establish and maintain a healthy lake system, an aquatic plant management plan should be developed, including an action plan for restoration of a beneficial aquatic vegetation community and management of non-native, invasive aquatic vegetation.

Estimated Cost: $2,000 each time to periodically update an aquatic plant survey; $3,000 to develop a management plan, and if necessary $5,000-10,000 for chemical treatment of curly-leaf pondweed each time the treatment is applied. The cost of such treatments is widely variable and dependent on the type of vegetation being treated and its extent. A whole-lake treatment may be able to be followed in subsequent years with less expensive, spot treatments.

Funding Source: City, lake association

5.3.2 Fish Population Management

Limited data on the fish community is available, but data that has been collected suggests that the lake does not currently support a balanced shallow lake fish assemblage. A healthy, clear-water shallow lake requires a fish community of predators and panfish, zooplankton, and aquatic vegetation, which all act to keep each other in balance. An academic study conducted in 2009 found primarily fathead minnows and shiners. A whole-lake internal load strategy such as a drawdown may further require restoration of the fish community. Unless there is an existing population of rough fish to control, fish population management is not a load-reduction activity but is necessary if the lake is to achieve a clear-water state. This activity is a partnership with the DNR and other potential entities to monitor and manage the fish and zooplankton population to restore and maintain a beneficial community.

Estimated Cost: varies depending on the necessary strategy(ies)
Funding Source: City, lake association, grant funds, DNR

5.4 TRACKING AND REPORTING

The City of New Hope will integrate BMPs into its SWPPP required by its NPDES General Permit for stormwater discharges. Activities will be tracked and reported in its annual NPDES report. A copy of the annual report will be made available to the Commission, which will then incorporate that information into the Commission's annual Water Quality Monitoring Report. Additional city staff time will be necessary to track and report on activities specific to this TMDL and Implementation Plan, however, it is difficult to estimate the magnitude of the additional level of effort.

Estimated Cost: Staff level of effort to be determined
Funding Source: City

Literature Cited

Selbig, W. and R, Bannerman, 2007. Evaluation of Street Sweeping as a Stormwater- Quality-Management Tool in Three Residential Basins in Madison, Wisconsin. US Department of the Interior, United States Geological Survey. Scientific Investigations Report 2007–5156.

Wenck Associates Inc. 2010. Meadow Lake Nutrient TMDL. Wenck Project 1240-22.