Silver Lake TMDL Implementation Plan

May 2011

Primary Authors and Contributors

Rice Creek Watershed District
Matt Kocian

Emmons & Olivier Resources, Inc.
Jennifer Olson
Tom Miller

Minnesota Pollution Control Agency
Brooke Asleson

Table of Contents

List of Figures

List of Tables

1. TMDL OVERVIEW

This section is a summary of the derivation of the Total Maximum Daily Load (TMDL) allocations described in the TMDL report. For additional information please refer to the TMDL report.

1.1 Background

Silver Lake was listed as an impaired water by the Minnesota Pollution Control Agency (MPCA) on the 2002 303d list. The impaired use is aquatic recreation, with the stressor identified as "nutrient/ eutrophication biological indicators."

Silver Lake has a 678.6-acre, fully-developed watershed and is defined as a shallow lake according to the Minnesota Pollution Control Agency (MPCA). The Silver Lake watershed is located in the southwest portion of the Rice Creek Watershed District (RCWD) and is within the Upper Mississippi Watershed and lies entirely within the North Central Hardwood Forest Ecoregion. Portions of four cities and three counties are contained within the Silver Lake watershed (Figure 1).

There are six distinct major subwatersheds to Silver Lake in addition to the direct drainage area around the lake (Figure 2). Figure 2 also depicts areas within the Silver Lake watershed where stormwater is currently not treated. These areas could be the focus of stormwater management for water quality purposes.

Figure 1. Silver Lake Location

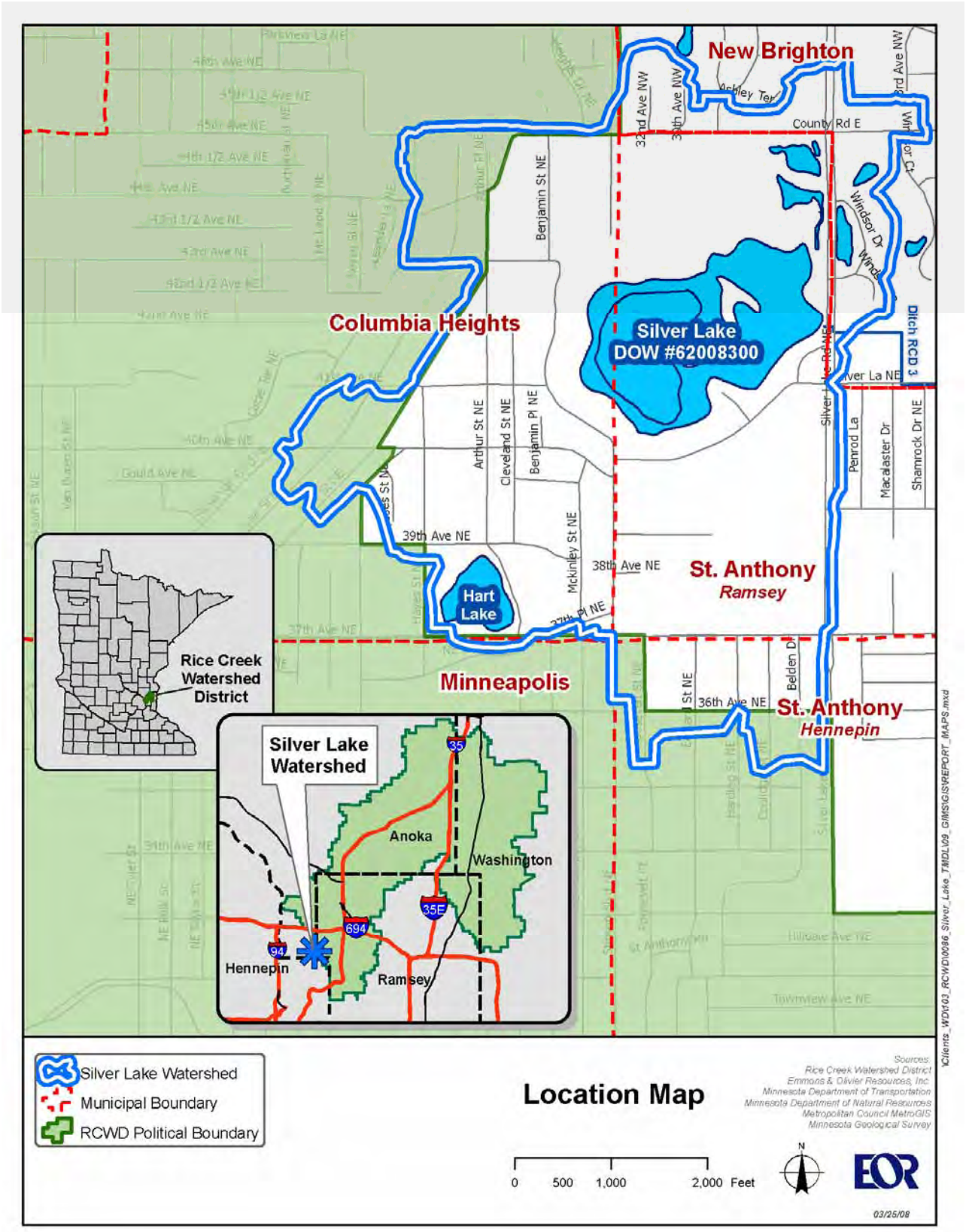
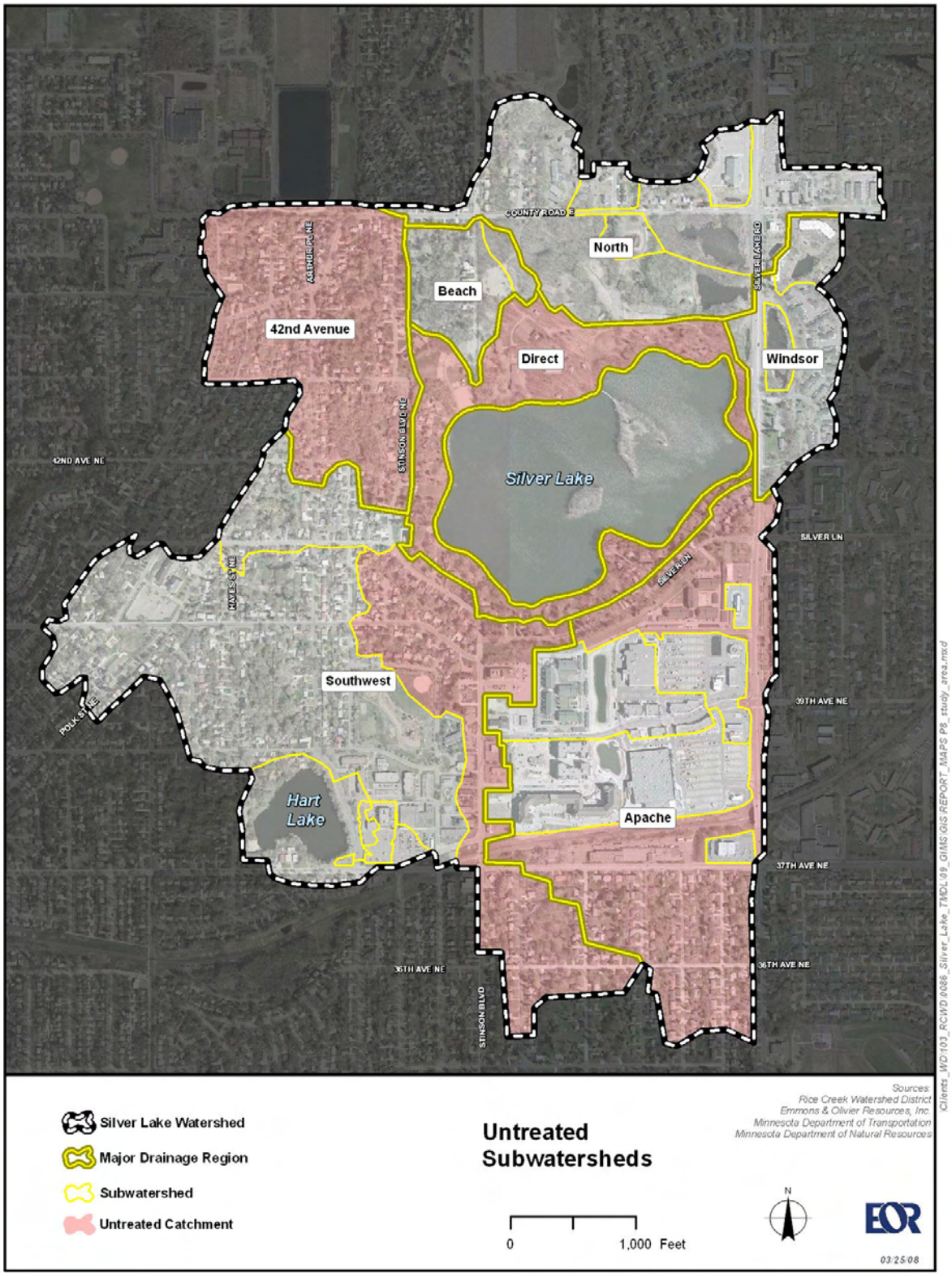


Figure 2. Silver Lake Watershed and Untreated Areas



1.2 Lake Water Quality

Silver Lake is a eutrophic lake. Total Phosphorus (TP) concentrations have improved since the 1980s, with annual means ranging from approximately 48 to 70 µg/L within the last ten years. The improvement in TP does not appear to have led to improvements in chlorophyll-*a* concentrations and transparency has fluctuated up and down since the 1980s. Table 1 summarizes the in-lake water quality data between 1997 and 2006, in comparison to the applicable State standard.

Table 1. Lake Water Quality Summary

	Growing Season Mean (June – September)	Eutrophication Standard, Shallow Lakes
TP (µg/L)	63	< 60
Chlor-*a* (µg/L)	40	< 20
Secchi depth (m)	0.94	> 1.0

1.3 Existing Loads

The three categories of phosphorus loads to Silver Lake are watershed runoff, internal loading, and atmospheric deposition. Phosphorus loads from each of these sources were modeled and used as input into the lake response model (Table 2).

Table 2. Phosphorus Loading Summary

Source	Phosphorus Load [lbs/growing season]	Percent Total Load
Watershed	239.7	74%
Atmospheric Deposition	19	6%
Internal	65	20%

Table 3 summarizes the subwatershed loading by major watershed as illustrated in Figure 2.

Table 3. Phosphorus Loading by Subwatershed

Major Subwatershed	Area [acres]	Annual Volume [acre-feet]	Annual TP Load [lbs/year]
Apache	148.05	171.74	101.33
Southwest	205.14	123.79	83.93
42nd Avenue	71.09	26.57	25.21
Beach	18.92	4.52	3.15
North	80.14	21.04	4.48
Windsor	30.65	21.76	7.03
Direct	52.1	15.23	14.53
Total to Silver Lake	*606.1*	*384.66*	239.7

1.4 Assimilative Capacity

The lake response model (Bathtub) was used to estimate the assimilative capacity of the lake (Table 4). The model was calibrated to observed in-lake water quality data using a 1997 through 2006 average. The assimilative capacity represents the total phosphorus load that can be delivered to the lake while the lake maintains water quality standards, and is equal to the TMDL of the lake.

The assimilative capacity is based on the lake meeting the TP standard, provided that either the chlorophyll-*a* or Secchi standard is also being met. To reach the long-term in-lake water quality goal of 60 µg/l TP, the total annual phosphorus load to the lake must not exceed 308 lbs/yr, a reduction of 5%. At this concentration, both the chlorophyll-*a* and the Secchi depth will also improve. Secchi depth will meet State standards.

Table 4. Silver Lake Assimilative Capacity

Model Scenario	Total Load to Lake during Growing Season [lbs]	Total Daily Load to Lake [lbs]	% Reduction Relative to Existing[1]
Existing	325	0.89	--
Assimilative Capacity at Eutrophication Standard (60 µg/L)	308	0.84	5%

[1] Existing refers to 2007

1.5 TMDL Allocations

The TMDL allocations are summarized in Table 5. The stormwater sources (municipal separate storm sewer systems (MS4s), construction stormwater, and industrial stormwater) were given a categorical Waste Load Allocation (WLA). The categorical WLA covers all stormwater sources; the load reductions identified by the WLAs will need to be met by this group as a whole, but individual WLAs are not specified. There are seven MS4s with WLAs in the Silver Lake TMDL. The load allocations for Silver Lake consist of atmospheric deposition and internal loading.

Table 5. TMDL Allocations

Source		% Allocation	TMDL [average lbs/day]
Load Allocation		24.4%	0.21
Wasteload Allocation - Stormwater		65.2%	0.55
MS4	Permit #		
Anoka County	MS400066		
Columbia Heights	MS400010		
Hennepin County	MS400138		
Minneapolis	MN0061018		
New Brighton	MS400038		
Ramsey County Public Works	MS400191		
St. Anthony Village	MS400051		
Construction stormwater	Various		
Industrial stormwater	No current permitted sources		
Margin of Safety (MOS)		10.4%	0.09
Total		**100%**	**0.84**

2. TARGET LOADS

The stormwater WLAs are further broken down into target loads for each MS4 (Table 6). Target loads were derived through a set of stakeholder input meetings. Target loads are set to existing modeled loads for the majority of the regulated sources with the exception of St. Anthony and Columbia Heights. Existing loads from Anoka County, Hennepin County, Minneapolis, New Brighton, and Ramsey County Public Works were very small compared with existing loads from Columbia Heights and St. Anthony, and much of the runoff is treated in existing stormwater facilities. The MS4s agreed to focus reductions in Columbia Heights and St. Anthony, as there were already planned projects and programs in place within those communities to address the needed reductions. St. Anthony and Columbia Heights target loads were determined by dividing the remaining allowable load proportionally according to the area of each community (54% and 46% of the watershed, respectively).

Table 6. Silver Lake Target Stormwater Loads

Permit Name or Source	Permit Number	Existing Load (lbs/yr)[1]	Target Load		Reduction (lbs/yr)
			lbs/yr	lbs/day	
Anoka County	MS400066	0.9	0.9	0.002	0
Columbia Heights	MS400010	92.5	85.7	0.23	6.8
Hennepin County	MS400138	0.7	0.7	0.002	0
Minneapolis	MN0061018	0.3	0.3	0.0008	0
New Brighton	MS400038	7.7	7.7	0.02	0
Ramsey County Public Works	MS400191	5.9	5.9	0.02	0
St. Anthony Village	MS400051	131.4	100	0.27	31.5
Total		*239.4*	*201.2*	*0.55*	*38.2*

[1] Based on modeling years 2006-2007

3. IMPLEMENTATION PARTNERS AND PLANNING

3.1 RCWD Leadership Role

Due to the active role that the RCWD has played in the development of the Silver Lake TMDL, it is recommended that the RCWD take on a dual role of documenting progress toward achieving the load reductions, as well as documenting changes in Silver Lake water quality. The RCWD will also organize and convene an Implementation Work Group, made up of responsible parties (MS4 permit holders) and other implementation partners.

Implementation Work Group

It is recommended that RCWD convene and lead an implementation work group consisting of interested implementation partners identified in *Section 3.2*. This effort includes:

- Initiating and chairing the formation of a TMDL Implementation Work Group
- Identifying key parties for participation in the work group
- Developing a means to assess current loading by MS4s and help prioritize areas and potential actions within MS4s to reduce loads
- Developing an appropriate tool, that will be consistent with MPCA NPDES permit requirements to track load reductions by MS4s to determine progress toward achieving load reductions
- Assessing the current RCWD monitoring program and adjusting it, if needed, to better detect possible changes resulting from implementation actions
- Evaluating the need for specific monitoring of Best Management Practices (BMPs) installed at specific sites
- Reporting routinely on the progress made toward achieving the water quality goals for the Silver Lake

The implementation work group would convene as described under *Chapter 5: Adaptive Management*.

3.2 Implementation Partners

Multiple partners will be involved in this implementation process, and a coordinated effort will be needed to successfully carry out the implementation plan. The RCWD will lead the coordinated effort to improve the water quality in Silver Lake. The RCWD will work closely with a core group of partners on data collection and project implementation. The RCWD will coordinate and lead meetings with implementation partners. These core partners include:

Core Implementation Partners:

- Board of Water and Soil Resources (BWSR)
- Cities of Columbia Heights, St. Anthony, and New Brighton
- Minnesota Department of Natural Resources (DNR)
- Minnesota Pollution Control Agency (MPCA)
- Ramsey County
- Ramsey Conservation District
- Anoka Conservation District

- Rice Creek Watershed District
- Silver Lake Association
- Three Rivers Park District (TRPD)

3.3 Funding Opportunities

Funding for implementation activities will come primarily from the MS4 capital improvement plans and state, watershed and federal funding sources as they become available.

Clean Water Act Section 319 Programs – Financial assistance is provided to address non-point source water pollution, including the study of water bodies with pollution problems, development of action plans, and implementation of the action plans. These funds can not be used to fulfill National Pollutant Discharge Elimination System (NPDES) stormwater permit requirements.

Minnesota Clean Water Legacy Program – Passage of the Clean Water, Land and Legacy Amendment in 2008 made funding available for TMDL implementation activities. Four state agencies are involved in distributing the funds: the Board of Water and Soil Resources (BWSR), the Minnesota Pollution Control Agency (MPCA), the Minnesota Department of Agriculture (MDA) and the Minnesota Department of Natural Resources (DNR).

RCWD Water Quality Cost-Share - The RCWD has created a dedicated cost-share grant program to assist landowners with the implementation of BMPs aimed at improving the quality of surface waters within the District. In many cases, the RCWD can cost share up to 50% of total project costs.

RCWD Urban Stormwater Remediation Cost-Share - Cost-share funding is available to assist counties, cities, villages, townships, school districts, libraries, colleges and universities, and other public and private entities located within the RCWD to incorporate water quality improvement practices into redevelopment, roadway and storm sewer improvement projects in 2009.

RCWD Direct Funding – In addition to funding the Cost-Share programs, the RCWD sets aside direct funding every year for TMDL Implementation. These funds can be used to initiate projects independently, or (preferably), in cooperation with Core Implementation Partners.

In-Kind Contributions – Many of the actions will be implemented by municipalities, TRPD, and the RCWD using in-kind funding and capital improvement plans. Landowners can also participate through in-kind activities.

4. IMPLEMENTATION ACTIVITIES

Lake restoration activities can be grouped into two main categories: those practices aimed at reducing external nutrient loads, and those practices aimed at reducing internal loads. The focus of restoration activities depends on the lake's nutrient balance and opportunities for restoration. In a shallow lake such as Silver Lake, the first step in the restoration is to control the external loads. This discussion separates the management strategies into practices addressing watershed load and internal load.

4.1 Wasteload Allocation Reduction Activities

The watershed strategies being used to meet the TMDL include urban retrofitting and redevelopment, management, and regulatory controls. The wasteload allocation requires an estimated reduction of 40 lbs/yr TP from existing conditions.

Urban Retrofitting and Redevelopment

Retrofits are proposed within the Silver Lake subwatershed to assist in achieving the TMDL. As redevelopments are presented, additional improvements will be explored by the communities and the RCWD. During redevelopment, municipalities are required to meet RCWD stormwater infiltration rules (see *Regulatory Controls* section below). The RCWD is prepared to work with municipalities to enhance required infiltration projects (i.e. fund enhancements to go "above and beyond" requirements of RCWD rules). These retrofits may include but are not limited to the projects outlined below, raingardens, water quality ponds, and existing pond improvements.

Columbia Heights Boat Ramp Improvements

A boat ramp, owned by the City of Columbia Heights, currently includes a regional water quality pond. Modeling indicates that this pond currently provides 42% removal of total phosphorus for the contributing drainage area (northern portion of the Southwest Subwatershed). Opportunities exist for enhancing the total phosphorus removal efficiency, including expanding the area and/or depth, adding additional filtration components, or a skimmer device.

Silverwood Park Improvements

Three Rivers Park District is planning the redevelopment of Silverwood Park, located on the north and east shores of Silver Lake, to include a variety of water quality treatment features. Runoff from the visitor center, associated parking and the greater site area will drain via a treatment train of stormwater features prior to discharge to Silver Lake. The treatment train includes pervious pavers, cisterns, seven biofiltration basins, one stormwater pond, and the existing eastern wetlands and stormwater pond. In addition, water quality benefits will be realized from parallel swales seeded with deep-rooted native vegetation that treat runoff from the entrance drive prior to discharge to biofiltration basins. Additional improvements to address shoreline erosion are also planned.

Silver Lake Beach Park Improvements

The City of Columbia Heights has drafted plans for site improvements to Silver Lake Beach Park. Water quality improvements include two infiltration basins and a vegetated swale with intermittent ponding. The large central infiltration basin will treat runoff from the proposed

entrance drive and parking area as well as runoff from small storm events over 12.5 acres of residential development. The second infiltration basin will receive overflow from the large basin and will treat runoff from contributing areas. The vegetated swale will provide intermittent water quality ponding for an additional small drainage area. In addition, water quality benefits will be provided by overall impervious surface reduction and conversion of portions of mowed turf to native plants. The improvement will result in TP removal from the beach watershed and portions of the direct subwatershed.

Shoreland Buffers and Restoration
Shoreland buffers can be used to treat direct drainage from properties adjacent to the lake. Buffers provide for wildlife habitat and filtering of stormwater pollutants and act as a filter for stormwater runoff from shoreland properties. These practices are targeted toward homes on the west and south shores of the lake where lawns extend down to the lakeshore.

Shoreline areas were identified where erosion was taking place along the east shore and on portions of the islands. Shoreland restoration work in these areas can stabilize the shores and prevent sediment from entering the lake and reduce the associated nutrients.

Apache Redevelopment
Existing ponding facilities within the Apache redevelopment area were designed to treat an additional four properties located east of Stinson Boulevard between the railroad tracks on the south and 40th Avenue NE on the north. These four properties are currently untreated and flow to the north along Stinson Boulevard, directly to the lake. As these properties redevelop, runoff will be directed to the existing Apache stormwater facilities and additional TP will be removed annually from watershed runoff in this area. Enhanced phosphorus removal through in-line chemical treatment could also be considered as part of redevelopment efforts.

Columbia Heights Road Reconstruction Rain Gardens
The City of Columbia Heights has reconstructed several roads within the watershed and has implemented small scale rain gardens to treat road runoff. Approximately seven rain gardens have been built or are proposed within the Silver Lake watershed. These rain gardens provide water quality treatment of previously untreated road drainage within a fully urbanized portion of the City. These improvements were required as part of a RCWD permit.

Road Reconstruction of Stinson Ave Retrofits
The City of Columbia Heights plans to reconstruct a portion of Stinson Avenue in the watershed in the next five years. It is anticipated that rain gardens or small scale water quality treatment practices will be used throughout the road reconstruction project to treat road runoff. These improvements will be required as part of a RCWD permit. It is possible that the RCWD could work with the City to enhance the raingardens and provide for more water quality treatment than required by RCWD permit requirements.

Neighborhood Scale Small Water Quality Retrofits
The watershed contains many residential areas that have untreated stormwater. Urban retrofits including rain gardens are a simple and cost effective method of achieving water quality

treatment in fully urbanized areas. This activity assumes that rain gardens or small water quality treatment facilities can be installed either in conjunction with road reconstruction activities or as part of a community retrofit project. A significant number of raingardens are needed to have a meaningful effect on water quality. A neighborhood retrofit study could be completed to identify select areas where water quality installations would be focused.

Management

Existing P-free fertilizer laws
Minnesota Statute (Chapter 18C) has been updated to include the Phosphorus Lawn Fertilizer Law (SF 1555), which went into effect in 2004 and restricts the use of fertilizer containing phosphorus in non-cropped land. Since this is a recent law, its full effect has not yet been observed. It is likely to decrease phosphorus concentrations in residential runoff according to a study done by the Three Rivers Park District (Vlach and Barten, 2007).

Education Program
A targeted education program could be used to provide information to residents near the lake on good housekeeping practices such as keeping lawn clippings and leaves off impervious areas, fertilizer management, the importance of aquatic macrophytes in the health of shallow lakes, and how homeowners can protect the lake. This education program could be coordinated by the RCWD.

Regulatory Controls

It is anticipated that existing regulatory controls will provide additional TP removal requirements needed to meet the TMDL as additional sites redevelop over the next 10-20 years.

RCWD Rules
Due to the fully developed nature of this watershed, improvements will be typically made during redevelopment projects. The existing RCWD Rules, adopted on February 13, 2008, include a stormwater management Rule (Rule C) that requires volume control to achieve District water quality goals. The RCWD will continue to permit new development and redevelopments into the foreseeable future, which should result in no new phosphorus loadings to the lake.

Rule C requires, among other things:

- Use of Better Site Design techniques from the MN Stormwater Manual
- Best management practices sized to infiltrate and/or retain the runoff volume generated within the contributing area by a two-year (2.8-inch) storm under the developed condition, or 0.8-inch for any undisturbed contributing impervious areas on the site (special provisions are made for roadways)

The complete watershed rules can be found on the Rice Creek Watershed District Website (http://www.ricecreek.org).

4.2 Load Allocation Reduction Activities

The internal load to Silver Lake was estimated at 65 pounds per year, or 20% of the total annual load. Although this percentage is relatively low, utilizing in-lake treatment strategies will help to meet the water quality goals for the lake. The load allocation requires an estimated reduction of 9 lbs/year from existing conditions.

Fisheries Management
The abundance of benthic fish, specifically carp and black bullhead, within Silver Lake, has fluctuated over the past 10 years. Carp are benthic feeders that forage in the lake bottom sediments, thus releasing phosphorus into the water column. They are also known to uproot and effectively eliminate native lake plants. Recent reports from landowners suggest that the carp population is high. However, a DNR fisheries survey shows relatively low numbers of carp. This apparent discrepancy could be resolved by undertaking a more detailed and targeted carp population survey. Should populations be deemed "significant", removal efforts should be considered. Carp removal activities in Silver Lake could be a reasonable management strategy as the lake is not connected upstream or downstream through natural waterways, creating an impediment to migration of carp from other sources.

The DNR fisheries survey indicates that Silver Lake is home to an extraordinarily high population of panfish (bluegill and black crappie). The crappie and bluegill populations are 2x and 3x higher, respectively, than the *upper end* of the DNR's "normal range" for lakes of this type. Additionally, the populations are made up of very small individuals. 90% of the bluegill are 5 inches or less. This "stunted" sunfish population is likely capable of reducing the zooplankton population. With no zooplankton to graze algae, algal growth is left unchecked.

A feasibility study should be conducted to determine the best option for fish management. Management options could include lake reclamation whereby the entire fish community is eliminated using a specific toxicant, aeration management to prevent winterkills, fish barriers, and physical removal alternatives such as harvesting. Special fishing regulations that promote piscivore populations might also be considered. Depending on the feasibility study's recommendations, activities may need to be conducted for several consecutive years.

Aquatic Macrophyte Management
Almost no aquatic macrophtyes were found within the lake during the summers of 2006 and 2008. In addition, lakeshore owners noted a significant change in the macrophyte community during the past decade. Previously, macrophytes were present within the littoral zone, but more recently all of the macrophytes appeared to die off. Shallow lakes depend on the aquatic macrophyte community to provide refuge for zooplankton and fish and maintain a healthy lake. It is possible that the Fisheries Management implementation activity above will result in establishment of an aquatic macrophyte community.

There could be several reasons why macrophytes are not established within Silver Lake including use of herbicides, abundance of rough fish which can cause uprooting of vegetation, lack of a viable seed bed, and sedimentation within the lake. A Lake Vegetation Management Plan (LVMP) should be developed to address long-term monitoring and management of aquatic

macrophytes in Silver Lake. The LVMP should address the establishment of a healthy macrophyte community which may require an evaluation of the seed bed to ensure adequate viability, and analysis of alternatives to establish macrophytes including lake drawdown, fish management, and transplanting of vegetation. Establishing a healthy macrophyte community will require education of the shoreland owners and other stakeholders as well as costs associated with implementation.

Chemical Treatment

Aluminum sulfate (alum) is a chemical addition that binds with phosphorus to form a non-toxic precipitate (floc). Alum removes phosphorus from the lake cycle so that it is not available for algal growth by forming a barrier between lake sediments and the water to restrict phosphorus release from the sediments. An in-lake alum treatment is proposed to treat the 47 feet deep area within the northwest portion of the lake. The hypolimnion in this area remains anoxic during the growing season and has measured concentrations of TP that are significantly higher than surface TP concentrations. The proposed alum treatment is not intended as a management step to reduce annual loading, but rather as a one time addition to get immediate in-lake results for a moderate cost if a funding entity is identified. Increased short-term water clarity can help long-term restoration efforts through increasing the light available to aquatic macrophytes. If an alum treatment is done, it should be done in concert with fisheries management strategies and macrophyte monitoring. The cost estimate is based on a one-time treatment of the deepest area in the lake.

4.3 Implementation Activity Summary

The estimated cost, phosphorus load reduction, timeline for implementation, and potential project participants are presented for each implementation action (Table 7). The pollutant load reduction for each type of project is defined as high, medium, and low, respective to the other projects identified for the lake.

Table 7. Implementation Activity Summary

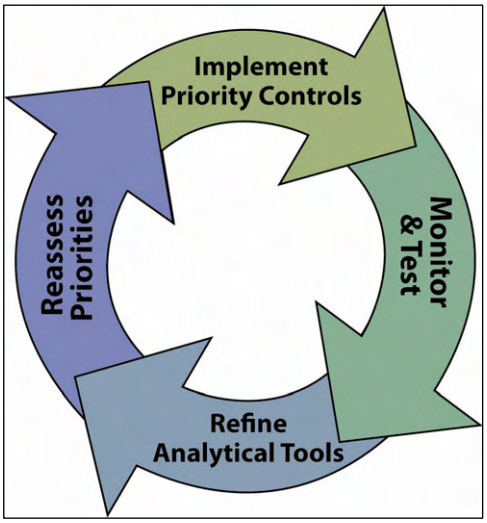
Implementation Activity	Phosphorus Load Reduction [High – Med – Low]	Cost Estimate (2009 $)	Timeframe	Participants
WASTELOAD ALLOCATION (PERMITTED) REDUCTION ACTIVITIES				
Columbia Heights Boat Ramp Improvements	Med	$75,000 - $130,000	2012 - 2015	Columbia Heights, RCWD
Silverwood Park Improvements	Med	$300,000	2007-2012	TRPD
Silver Lake Beach Park Improvements	Med	$70,980	completed	Columbia Heights, RCWD
Shoreland Buffers and Restoration	Med - High	$40,000 – $120,000	2010 - 2020	Columbia Heights, St. Anthony, TRPD, RCWD, DNR
Apache Redevelopment	High	$300,000 – $600,000	2010 - 2020	St. Anthony, RCWD
Columbia Heights Road Reconstruction Rain Gardens	Med	$40,000 - $100,000	2010 - 2020	Columbia Heights, RCWD
Road Reconstruction of Stinson Ave Retrofits	Med	$40,000 - $100,000	2010 - 2020	St. Anthony, RCWD
Neighborhood Small Scale Water Quality Retrofits	Med - High	$50,000 - $300,000	2010 - 2020	RCWD, Cities
Existing P-free fertilizer laws	High	--	2010 - 2020	Cities
Education Program	Low	--	2010 - 2020	RCWD, MS4s
RCWD Rules	Med	--	2010 - 2020	RCWD
LOAD ALLOCATION (NON-PERMITTED) REDUCTION ACTIVITIES				
Fisheries Management	Med	$50,000 – $100,000	2010 - 2015	RCWD, DNR, TRPD
Aquatic Macrophyte Management	Med	$20,000 - $120,000	2010 - 2015	RCWD, DNR, RCD,TRPD, Ramsey Co.
Chemical Treatment	High	$8,000 - $10,000	2011	RCWD, DNR, TRPD, BWSR, MPCA

5. ADAPTIVE MANAGEMENT APPROACH

The stakeholders have stressed the need to follow an adaptive management approach for improvements in Silver Lake. Under this approach, the implementation plan includes many watershed and in-lake actions that will be measured quantitatively for load reduction success. After the result is measured, changes in the strategy will be taken to adjust and move forward. Failures are corrected and successful efforts are repeated elsewhere. This will rely on a well-defined monitoring program (see Chapter 5.2).

Actions are occurring at a very rapid pace within the RCWD and communities. The RCWD has been a leader in the metro area in developing effective watershed-based programs. It also has a long history of data collection and an active monitoring program. With these qualifications, it makes sense for the RCWD to assume a key role as coordinator in documenting the progress that is made as implementation proceeds. This role is described further in Chapter 3.1. The RCWD will convene an implementation work group periodically to review the status of the lake and evaluate progress made towards achieving phosphorus load reductions.

The implementation actions outlined in this management plan are intended to improve the water quality in Silver Lake. However, at this stage of plan development it is not known to what extent the recommended implementation activities will be pursued nor the magnitude and scope to which the recommended activities will be realized. Since the cumulative effect on water quality therefore is also unknown, an ongoing assessment process will be implemented to evaluate the impact (effectiveness) of implementation activities on lake water quality and then tailor future implementation actions. This on-going assessment and resultant changes to the implementation approach is referred to as adaptive management and is illustrated in the circular flow path in Figure 3.



As management practices are being implemented in the watershed and within the lake, water quality will be monitored to evaluate the impact that the implementation actions have on overall water quality in the lake. If water quality is improving, this suggests that the current approach is working and the same course will be followed. If water quality is not improving, this suggests that the approach being taken is not sufficient, or is targeted to the wrong sources. In this case, the approach will be evaluated and adjusted so that tangible water quality improvements can be realized.

Figure 3. Adaptive Management Process

(Adapted from Nicholas Institute for Environmental Policy Solutions, 2007)

5.1 Permit Requirements

NPDES stormwater permits must be consistent with WLAs. The current NPDES MS4 General Permit requires permittees to review the adequacy of their Stormwater Pollution Prevention

Program (SWPPP) to meet any applicable[1] United States Environmental Protection Agency (US EPA) approved WLA. The permit does not have a reporting requirement and does not provide guidance to permittees on how to evaluate the adequacy of their SWPPP. The permit expires June 1, 2011.

The MPCA anticipates having an approved reissued permit by January of 2012. The revised permit, currently in draft form, requires permittees to

1. meet any applicable WLA and demonstrate continuing progress toward meeting those WLAs; and
2. submit a Commissioner-approved reporting form for applicable WLAs. The form requires the permittee to
    a. list BMPs they have implemented and are applying toward applicable WLAs;
    b. list general implementation activities that can be applied toward applicable WLAs; and
    c. describe an adaptive management strategy, including approximate timelines, for meeting applicable WLAs.

Permittees must complete or update the form within 12 months of receiving an approved WLA. The form is submitted with each Annual Report.

The MPCA has developed a fact sheet describing how it will determine progress toward meeting WLAs. Factors considered by the MPCA may include but are not limited to:

- inclusion of additional BMPs or enhancement of existing BMPs since the last Annual Report;
- improvements in water quality of impaired receiving waters; and
- securing funding to implement BMPs.

Although the WLA for this TMDL is categorical, each permittee must submit an Annual Report that lists BMPs to be applied toward the WLA. This may include BMPs implemented by other permittees or entities such as a watershed district. If a permittee is claiming credit for BMPs implemented by another entity, it should explain so on the Commissioner-approved form. It is acceptable for permittees to refer to other documents provided the documents meet the requirements of the MS4 general permit.

5.2 Compliance Schedule

Activities will be implemented to the extent practical during the first permit cycle. Stormwater retrofits will be tied to re-development plans and will focus on opportunities to get the greatest reduction in pollutant loading per unit cost of implementing the BMPs. Selection of BMPs and the BMP strategy may be modified as BMP research and monitoring results become available.

Target loads will be met as soon as the implementation activities or equivalent phosphorus reduction projects are completed. It is expected that the WLA will be met by 2020.

The water quality data will be formally evaluated at 2-year intervals by the RCWD. The evaluation will be brought to the implementation work group for further consideration. These

[1] An applicable WLA is a WLA the permittee has been assigned in a U.S, EPA approved TMDL.

evaluations will categorize the lake as improving or declining, as compared to lake water quality averages presented in the TMDL study. If the lake is improving, the course of action will be to continue the prescribed implementation plan as outlined in this document. The implementation plan prescribed the lake that is declining or not improving will be reevaluated and modified to better meet the needs of the lake.

In addition to water quality evaluation, St. Anthony and Columbia Heights must make significant progress (planning, funding or implementing) toward meeting the WLA. It is anticipated that this will be a requirement of future MS4 permits issued to these cities. Implementation activities will be tracked as part of the MS4 permit process. The implementation work group will evaluate the progress made and recommend changes to the Implementation Plan as needed.

During the development of the Silver Lake TMDL and this Implementation Plan, a number of wasteload allocation implementation activities (i.e. watershed BMPs), including some identified in Table 7, were completed. Implementation activities completed *before* the baseline modeling done in the TMDL are accounted for in the TMDL allocations. The TMDL baseline modeling year is 2007. All implementation activities completed *after* 2007 constitute a change from TMDL modeled conditions.

5.3 Monitoring

Bi-weekly in-lake monitoring will continue to be conducted by Ramsey County during implementation. Monitoring consists of providing nutrient, chlorophyll-a, and Secchi disk sampling and profiles for dissolved oxygen, specific conductance, temperature and pH between May and September. Silver Lake is also monitored by private citizens as part of the Citizen Lake Monitoring Program, which will likely continue into the future. Available water quality data will be evaluated annually or bi-annually by the RCWD to determine the water quality trends occurring in the lake.

Spring and fall aquatic macrophyte surveys should be completed as part of the recommended Aquatic Plant Management Plan. Beyond the Aquatic Plant Management Plan, additional aquatic plant surveys would be beneficial for understanding the role of curly-leaf pondweed in overall lake phosphorus dynamics, as well as for and tracking macrophyte population shifts in the lake.

Monitoring of best management practices (existing and new) and stormwater inlets to Silver Lake would provide additional information on the effectiveness of BMPs in treating runoff and achieving target loads and the WLA. TRPD and the RCWD, along with Ramsey County, are potential partners that could conduct this type of monitoring and data analysis.

6. INFORMATION / EDUCATION

The Rice Creek Watershed District maintains a general education program. This program is intended to inform citizens on the basics of water quality and best management practices. One of the primary educational tools developed by the RCWD is the BlueThumb website. This website

helps citizens design and install raingardens and lakeshore restoration projects. It also encourages and provides information on other "residential BMPs" such as rainbarrels, pervious pavers, and lawn/leaf cleanup.

The RCWD will maintain regular contact with the Silver Lake Association. As requested, RCWD staff will attend lake association meetings and present information associated with the TMDL and Implementation Plan. Through this channel, the RCWD will also encourage applications to their *Water Quality Cost-Share* program, which provides financial assistance for residential BMPs.

7. REFERENCES

Lehman, J.T., Bell D. W. and K. E. McDonald, 2008. Evidence for Reduced River Phosphorus Following Implementation of a Lawn Fertilizer Ordinance. University of Michigan, Ann Arbor

Minnesota Department of Agriculture (MDA), 2007. Effectiveness of the Minnesota Phosphorus Lawn Fertilizer Law. http://www.mda.state.mn.us/news/publications/protecting/waterprotection/07phoslawrptsumm.pdf

Nicholas Institute for Environmental Policy Solutions, 2007. Adaptive Implementation of Water Quality Improvement Plans: Opportunities and Challenges. School of the Environment and Earth Sciences, Duke University.

Vlach, B. and J. Barten, 2007. As Cited in University of Minnesota, 2008. Assessment of Stormwater Best Management Practices. Appendix A, Case Study #9. Assessment of Source Reduction Due to Phosphorus-free Fertilizers. p. 459.