Prepared by:
Emmons & Olivier Resources, Inc.
for the Comfort Lake-Forest Lake Watershed District
and Minnesota Pollution Control Agency

Comfort Lake-Forest Lake Watershed District
Six Lakes Total Maximum Daily Load Implementation Plan


June 5, 2009

water | ecology | community

Cover Images
Left Image: *Forest Lake*
Right Image: *Raingarden*

Document Component Specs
Text: Corporate Express • Signature white, 20 lb. text – 30% post-consumer fibers, Green Seal® Certified
Back Cover: Neenah Paper • Esse • Texture, Sapphire • 100 lb. cover • 30% post-consumer fibers, Green Seal® Certified
Wire Binding: Manufactured using recycled high carbon steel

BACKGROUND

The MPCA listed Moody Lake, Bone Lake, School Lake, Shields Lake and Comfort Lake as impaired based on the eutrophication standard (Table 1, Figure 1). Recent water quality monitoring indicates that Little Comfort Lake will likely be listed as impaired for nutrients in the future. While the lake exceeded impairment thresholds, it lacked sufficient data to be listed by the MPCA in 2008. However, the lake's current WQ database (2006-2008) provides sufficient data for anticipated listing in 2010.

The drainage through this system of lakes flows from Moody Lake to Bone Lake to School Lake to Little Comfort Lake to Comfort Lake. Shields Lake flows into the un-impaired (for eutrophication) Forest Lake which flows to Comfort Lake. Thus, the Comfort Lake watershed includes the watershed of each of the other lakes as well as drainage flow from the City of Forest Lake and the City of Wyoming. Forest Lake is impaired for mercury (Hg) and a TMDL has been completed to address that impairment. Forest Lake is also listed as impaired for PCBs.

Figure 1 displays arrows indicating the general drainage direction of the major lakes and displays the drainage region boundaries encompassing the land areas that drain to the major lakes. The only shallow lake in this group is Shields Lake.

Table 1. Impaired Waters Listing

Lake name:	**Moody Lake**	**Bone Lake**	**School Lake**	**Shields Lake**	**Comfort Lake**
DNR ID#:	13-0023-00	82-0054-00	13-0057-00	82-0162-00	13-0053-00
Hydrologic Unit Code:	07030005	07030005	07030005	07030005	07030005
Pollutant or stressor:	Nutrient/ Eutrophication Biological Indicators	Nutrient/ Eutrophication Biological Indicators	Nutrient/ Eutrophication Biological Indicators	Nutrient/ Eutrophication Biological Indicators	Nutrient/ Eutrophication Biological Indicators
Impairment:	Aquatic recreation	Aquatic recreation	Aquatic recreation	Aquatic recreation	Aquatic recreation
Year first listed:	2008	2004	2008	2006	2002
Target start/completion (reflects the priority ranking):	2008/2009	2008/2009	2008/2009	2008/2009	2008/2009
CALM category:	5C: Impaired by one pollutant and no TMDL study plan is approved by EPA	5B: Impaired by multiple pollutants and at least one TMDL study plan is approved by EPA	5C: Impaired by one pollutant and no TMDL study plan is approved by EPA	5C: Impaired by one pollutant and no TMDL study plan is approved by EPA	5B: Impaired by multiple pollutants and at least one TMDL study plan is approved by EPA

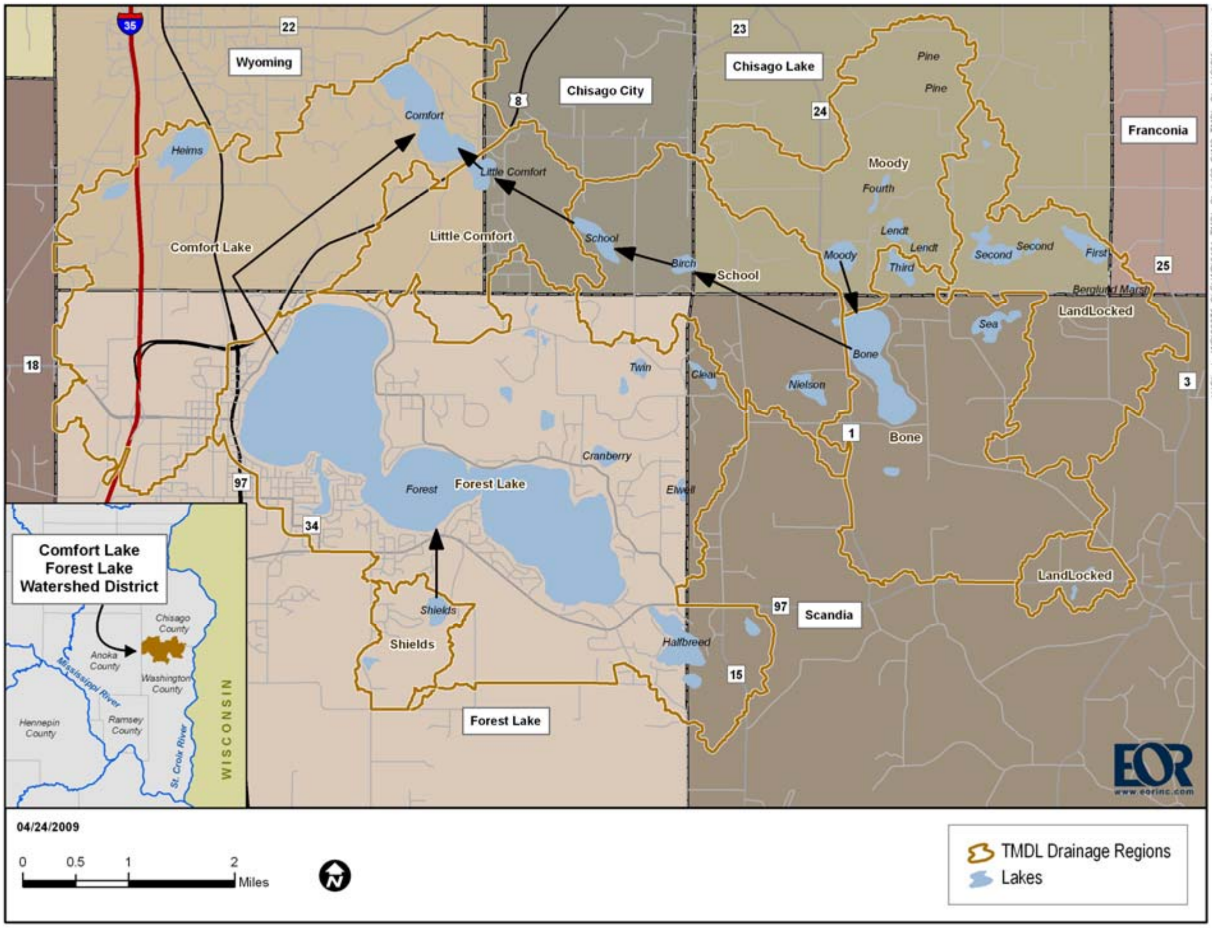


Figure 1. Location Map

TMDL SUMMARY

In the TMDL report, the WLAs and LAs were presented in terms of phosphorus loading per day. The percent reductions were presented only to provide further information. A summary of the TMDLs, WLAs and LAs is provided in Table 2.

Table 2. TMDL TP Allocation Summary

Lake and Standard	TMDL (lbs/day)	WLA (lbs/day)	LA (lbs/day)
Moody Lake: Eutrophication standard (40 µg/L)	0.395	0.003	0.392
Bone Lake: Eutrophication standard (40 µg/L)	1.833	0.014	1.819
School Lake: Eutrophication standard (40 µg/L)	1.238	0.012	1.226
Little Comfort Lake: Eutrophication standard (40 µg/L)	1.58	0.32	1.26
Shields Lake:Eutrophication standard (60 µg/L)	0.534	0.053	0.481
Comfort Lake: Eutrophication standard (40 µg/L)	6.41	3.00	3.41

Moody Lake Allocations

The watershed to Moody Lake does not contain any permitted sources other than potential construction and industrial stormwater permits. In addition, based on expected future land use, no regulated MS4 boundaries are expected to include any of the Moody Lake drainage area (CLFLWD, 2009). Therefore, the only WLA for Moody Lake is for construction and industrial stormwater. An 86% reduction in phosphorus load is required for Moody Lake to meet the TMDL.

Table 3. Moody Lake TP Allocations

Source	WLA (lbs/day)	LA (lbs/day)
Construction (various permits)	0.0015	--
Industrial Stormwater (future permits)	0.0015	--
Non-regulated MS4 portions of City of Scandia, Chisago Lake Township, Internal, Atmospheric, Groundwater	--	0.392

Table 4. TP Reduction Needed to Attain Moody Lake TDML Allocations

Source	Current Modeled Load (lbs/day)	% TP Reduction Needed
Unregulated MS4 portions of Municipalities: Chisago Lake Township	1.17	88%
Unregulated MS4 portions of Municipalities: City of Scandia	0.03	82%
Livestock	0.53	88%
Internal	1.01	88%
Atmospheric and Groundwater	0.02	0%
Upstream Lakes	0.04	0%

Bone Lake Allocations

The watershed to Bone Lake does not contain any permitted sources other than potential construction and industrial stormwater permits. In addition, based on expected future land use, no regulated MS4 boundaries are expected to include any of the Bone Lake drainage area (CLFLWD, 2009). Therefore, the only WLA for Bone Lake is for construction and industrial stormwater. A 70% reduction in internal load is assumed when determining the allocations for Bone Lake. Overall, a 46% reduction in phosphorus load to Bone Lake is required to meet the TMDL.

Table 5. Bone Lake TP Allocations

Source	WLA (lbs/day)	LA (lbs/day)
Construction (various permits)	0.007	--
Industrial Stormwater (future permits)	0.007	--
Unregulated MS4 portions of City of Scandia, Chisago Lake Township, Internal, Atmospheric, Groundwater, Moody Lake outflow	--	1.819

Table 6. TP Reduction Needed to Attain Bone Lake TMDL Allocations

Source	Current Modeled Load (lbs/day)	% TP Reduction Needed
Unregulated MS4 portions of Municipalities: Chisago Lake Township	0.01	45%
Unregulated MS4 portions of Municipalities: City of Scandia	2.06	45%
Livestock	0.21	0%
Internal	0.36	70%
Atmospheric and Groundwater	0.14	0%
Upstream Lakes: Moody	0.59	64%

School Lake Allocations

Birch Lake and its drainage area are included as part of the School Lake watershed and are addressed by the School Lake allocation. It should be noted that the existing phosphorus load contributed to School Lake from Birch Lake exceeds the School Lake TMDL, so an assumption of non-degradation or current water quality was not used for Birch Lake. School Lake cannot attain the water quality goal if Birch Lake remains at the current water quality. A load reduction was included for the discharge from Birch Lake to School Lake in order to meet the load reduction required for School Lake.

The watershed to School Lake (downstream of Bone Lake) contains the permitted sources of The Preserve at Birch Lake large sewage treatment system, and potential construction and industrial stormwater permits. While the City of Forest Lake is located within the watershed to School Lake, the regulated portions of the City of Forest Lake MS4 are not expected to extend into the School Lake watershed. The regulated portions of a future MS4 for the City of Chisago City are expected to extend into the School Lake watershed and a WLA is provided based on the percent of the developable area of the watershed it covers and the modeled watershed load (CLFLWD, 2009). Each permitted source is given a separate WLA. The Preserve at Birch Lake is a large sewage treatment system that discharges to the soil and is therefore given a zero allocation. While the system will certainly discharge phosphorus, it will not discharge phosphorus to a location expected to impact the lake. The allocations assume no reduction in internal load because the School Lake internal load was not identified as a source of concern. Overall, a 51% reduction in phosphorus load to School Lake is required to meet the TMDL.

Table 7. School Lake TP Allocations

Source	WLA (lbs/day)	LA (lbs/day)
Construction (various permits)	0.0045	--
Industrial Stormwater (future permits)	0.0045	--
City of Chisago City MS4: future permit	0.003	--
The Preserve at Birch Lake: MN0050474	0.000	--
Unregulated MS4 portions of City of Scandia, Chisago City, and City of Wyoming, Chisago Lake Township, Internal, Atmospheric, Groundwater, Bone Lake outflow	--	1.226

Table 8. TP Reduction Needed to Attain School Lake TMDL Allocations

Source	Current Modeled Load (lbs/day)	% TP Reduction Needed
City of Chisago City MS4	0.016	83%
Unregulated MS4 portions of City of Chisago City	0.33	75%
Unregulated MS4 portions of Municipalities: City of Forest Lake	0.10	74%
Unregulated MS4 portions of Municipalities: Chisago Lake Township	0.04	75%
Livestock	0.29	76%
Internal	0.13	0%
Atmospheric and Groundwater	0.03	0%
Upstream Lakes: Bone and Birch	1.61	45%

Little Comfort Lake Allocations

The watershed to Little Comfort Lake (downstream of School Lake) contains the permitted sources of the City of Forest Lake MS4, the Liberty Ponds large sewage treatment system, potential construction and industrial stormwater permits, and the future permitted MS4s of the City of Chisago City, and the City of Wyoming. Each are given a separate WLA. The Liberty Ponds sewage treatment system discharges to the soil and is therefore given an allocation of zero. While the system will certainly discharge phosphorus, the discharge is to the soil and the phosphorus does not reach the lake. The WLA for each of the current and future regulated MS4 communities is calculated based on the percent of the developable area of the watershed it covers and the modeled watershed load (CLFLWD, 2009). A 70% reduction in internal load is assumed for Little Comfort Lake in the determination of load allocations. Overall, a 54% reduction in phosphorus load to Little Comfort Lake is required to meet the TMDL. The attainment of TMDL water quality for School Lake provides 78% of the phosphorus load reduction required to meet the TMDL.

Table 9. Little Comfort Lake TP Allocations

Source	WLA (lbs/day)	LA (lbs/day)
Construction (various permits)	0.005	--
Industrial Stormwater (future permits)	0.005	--
City of Forest Lake MS4: MS400262	0.01	--
City of Chisago City MS4: future permit	0.15	--
City of Wyoming MS4: future permit	0.15	--
Liberty Ponds: MN0067466	0.00	--
Unregulated MS4 portions of City of Forest Lake, City of Chisago City, City of Wyoming, Internal, Atmospheric, Groundwater, School Lake outflow	--	1.26

Table 10. TP Reduction Needed to Attain Little Comfort Lake TMDL Allocations

Source	Current Modeled Load (lbs/day)	% TP Reduction Needed
City of Forest Lake MS4	0.02	33%
City of Chisago City MS4	0.20	24%
City of Wyoming MS4	0.24	36%
Unregulated MS4 portions of City of Forest Lake	0.07	30%
Unregulated MS4 portions of City of Chisago City	0.26	29%
Unregulated MS4 portions of City of Wyoming	0.26	29%
Livestock	0.06	0%
Internal	0.15	70%
Atmospheric and Groundwater	0.02	0%
Upstream Lakes: School Lake	2.16	67%

Shields Lake Allocations

The watershed to Shields Lake contains the permitted sources of the City of Forest Lake MS4 and potential future construction and industrial stormwater permits. While the City of Forest Lake covers the entire watershed to Shields Lake, the regulated portions of the City of Forest Lake MS4 are not estimated to extend into the Shields Lake watershed (CLFLWD, 2009). Each permitted source is given a separate WLA. The internal load reduction and the watershed load reduction must both be 83% in order to meet the TMDL.

Table 11. Shields Lake TP Allocations

Source	WLA (lbs/day)	LA (lbs/day)
Construction (various permits)	0.002	--
Industrial Stormwater (future permits)	0.002	--
City of Forest Lake MS4: MS400262	0.049	--
Unregulated MS4 portions of City of Forest Lake, Internal, Atmospheric, Groundwater: no permit	--	0.481

Table 12. TP Reduction Needed to Attain Shields Lake TMDL Allocations

Source	Current Modeled Load (lbs/day)	% TP Reduction Needed
City of Forest Lake MS4	0.30	83%
Unregulated MS4 portions of City of Forest Lake	0.21	83%
Livestock	0.003	0%
Internal	2.50	83%
Atmospheric and Groundwater	0.02	0%
Upstream Lakes: none	0.00	0%

Comfort Lake Allocations

The watershed to Comfort Lake (including the Forest Lake watershed but downstream of Little Comfort Lake) contains the permitted sources of the City of Forest Lake MS4, future City of Wyoming MS4, future City of Chisago City MS4, and potential construction and industrial stormwater permits. Each are given a separate WLA. The WLA for the City of Forest Lake MS4 and the future MS4s are calculated based on the percent of the developable area of the watershed it covers and the modeled watershed load plus any WLA for drainage from Forest Lake itself (CLFLWD, 2009).

Forest Lake, a large un-impaired (for nutrients) water, drains into Comfort Lake through the Sunrise River. For Comfort Lake, the allocations for drainage through Forest Lake were calculated as a portion of the outflow load from Forest Lake when the lake is discharging at its current water quality. The outflow load from Forest Lake was allocated based on the equivalent downstream contribution to Comfort Lake. Therefore, the load used to determine allocations was reduced from current water quality to account for the modeled 26% reduction in load expected to occur between the outlet of Forest Lake and Comfort Lake (CLFLWD, 2007). The load was then portioned to WLA and LA based on each municipality's percentage of Forest Lake's developable drainage area estimated to be under WLA or LA land uses in the future (CLFLWD, 2009). This effectively allows loading in the Forest Lake drainage area to remain at existing levels, since Forest Lake itself is not impaired.

Overall, a 5% reduction in total load to Comfort Lake is needed to meet the TMDL. All five of the other impaired lakes eventually drain through Comfort Lake. Therefore, the water quality of Comfort Lake is highly dependent on the quality of upstream lakes. Comfort Lake allocations were made by holding watershed loads to existing levels and assuming some improvement in water quality of Little Comfort Lake, but not the full improvement required by the TMDL. This allocation method provides an additional level of assurance that the TMDL and goal water quality can be met in Comfort Lake.

Table 14. Comfort Lake TP Allocations

Source: Permit Number	WLA (lbs/day)	LA (lbs/day)
Construction (various permits)	0.02	--
Industrial Stormwater (future permits)	0.02	--
City of Forest Lake MS4: MS400262	1.35	--
City of Wyoming MS4: future permit	1.55	
City of Chisago City MS4: future permit	0.06	
Unregulated MS4 portions of City of Forest Lake, City of Chisago City, City of Scandia and City of Wyoming, Internal, Atmospheric, Groundwater, Little Comfort Lake outflow: no permit	--	3.41

Table 15. TP Reduction Needed to Attain Comfort Lake TMDL Allocations

Source	Current Modeled Load into Comfort Lake (lbs/day)	% TP Reduction Needed
City of Forest Lake MS4*	1.35	0%
City of Wyoming MS4	1.55	0%
City of Chisago City MS4*	0.06	0%
Unregulated MS4 portions of City of Forest Lake*	0.55	0%
Unregulated MS4 portions of City of Scandia*	0.01	0%
Unregulated MS4 portions of City of Wyoming	0.86	0%
Unregulated MS4 portions of City of Chisago City*	0.02	0%
Livestock	0.01	0%
Internal	0.37	0%
Atmospheric and Groundwater	0.13	0%
Upstream Lakes: Little Comfort	1.86	21%

* Includes the city's portion of the outflow from Forest Lake. The City of Wyoming does not include any area draining to Forest Lake.

APPROACH TO LAKE RESTORATION

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 will depend on the lake's nutrient balance and opportunities for restoration. In a lake that does not have an excessive internal loading problem, like School Lake and Comfort Lake, the focus will be solely on reducing external loads. In a lake that does have high internal loading rates, such as Shields Lake, practices to address internal loading will be central to the lake restoration effort and will be conducted in addition to the control of external loads. Internal load reduction efforts will be needed for Moody, Bone, Little Comfort, and Shields Lakes.

Although controlling the internal load in Shields Lake will be central to restoring the lake, controlling the external loads is essential in the restoration of a shallow lake. A restoration is less likely to be stable when external nutrient loads are still high (Moss et al. 1996).

As a number of the lakes flow into each other (Moody to Bone to School to Little Comfort to Comfort), improvements in the water quality of upstream lakes are taken into account for the water quality of downstream lakes. Therefore the upstream lakes should be higher priority in overall implementation to ensure that downstream lakes can attain goal water quality.

LOAD REDUCTION IMPLEMENTATION ACTIONS

The Comfort Lake-Forest Lake Watershed District and municipalities will work together to implement water quality improvements and lake restoration efforts.

A number of Best Management Practices (BMPs) are identified in the Comfort Lake-Forest Lake Watershed District's (CLFLWD) *Water Quality Modeling Investigation*

(CLFLWD, 2007) that will help to address lake impairments. Recommended BMPs include those to address agricultural, lakeshore and urban areas:

> Agricultural BMPs identified included:
>
> - Conservation tillage to reduce soil and nutrient runoff to lakes.
> - Buffers, vegetated swales, and rock inlets to protect streams and lakes from sediment and nutrients contained in agricultural runoff.
> - Livestock and manure management to reduce animal impacts to streams and nutrient loading to lakes.
>
> Lakeshore BMPs include:
>
> - Lakeshore septic improvements to reduce the number of failing septic systems and reduce nutrient loads.
> - Shoreline restoration to improve shoreline habitat and reduce erosion.
> - The establishment and preservation of native vegetative buffers to promote filtration and shoreline stabilization.
>
> Urban BMPs (including new developments and retrofits for existing developments) include:
>
> - The establishment and preservation of native vegetative buffers to promote filtration in riparian areas.
> - Rain gardens.
> - Permeable pavement and pavers
> - Other low impact development strategies such as green roofs, infiltration basins, and others.
>
> Maintenance practices also provide opportunities for load reduction projects. For example, a city may clean an existing stormwater detention pond during routine maintenance. The [Comfort Lake-Forest Lake Watershed] District, along with the city, has the opportunity to determine the feasibility of increasing the size of the pond to increase the sediment and nutrient removal efficiency. (CLFLWD, 2007)

A number of internal load reduction methods are also recommended in the Comfort Lake-Forest Lake Watershed District's (CLFLWD) *Water Quality Modeling Investigation* (CLFLWD, 2007) to help to address lake impairments where the internal load is a primary source of phosphorus load. Recommended internal load reduction methods include rough fish management, curly leaf pondweed management, alum treatment, and biomanipulation:

> Rough fish such as carp and bullhead are known to cause significant internal loading to lake by their disturbance of lake sediments. Management activities included periodic harvesting of carp in the lake and watershed.
>
> Curly leaf pondweed can add substantial internal loading of phosphorus during July. Control by regular (annual or semiannual) chemical application is an accepted and cost-effective practice. Adaptive management by way of regular

inspection can determine the frequency and dose required to manage curly leaf pondweed. For the purposes of cost estimation, reapplication for curly leaf pondweed management occurs annually but reevaluation after several initial years may indicate that annual reapplication is not cost-effective.

Alum treatment of lake sediments is a commonly accepted, reliable, and cost-effective means to control sediment phosphorus release from anoxic lake sediments. Reapplication would occur in most lakes at ten-year intervals with the exception of Comfort Lake which would occur at five-year intervals.

Biomanipulation includes lake management procedures that alter the food web to favor grazing on algae by zooplankton, or that eliminate fish species that recycle nutrients, helping to shift the lake towards a clear water state. It was identified as a practice to be implemented at Shields Lake – a shallow lake currently in the turbid water state. Biomanipulation is assumed to achieve a 70% reduction in internal loading. (CLFLWD, 2007)

In addition to BMPs and internal load reduction efforts, specific capital projects were identified in the *Water Quality Modeling Investigation* (CLFLWD, 2007). Feasibility studies will be necessary for each of these projects prior to beginning design and construction. In addition, for most lakes, all of these planned projects alone are not estimated to provide the full reduction in phosphorus loads needed to attain the goal water quality, so an adaptive management process will be used to ensure the long-term implementation of successful lake restoration efforts.

The CLFLWD's planned BMPs, internal load reductions, and capital projects are estimated to provide the annual average phosphorus load reduction required for Bone Lake and Comfort Lake to attain the goal water quality. Additional efforts beyond what is planned by CLFLWD will be needed to attain goal water quality in Moody Lake, School Lake, Little Comfort Lake, and Shields Lake (Table 16). The CLFLWD's planned BMPs may be implemented as cooperative projects of CLFLWD and municipalities.

Table 16. Estimated Annual Phosphorus Load Reductions from Proposed Projects and Annual Phosphorus Reduction Goal

Lake	In-Lake Total Phosphorus Concentration Standard (μg/L)	Load Reduction Goal (lbs TP/yr)	Total Estimated Load Reduction From Proposed Projects (lbs TP/yr)	Additional Load Reduction Required to Meet Goal (lbs TP/yr)
Moody	40	879	460	419
Bone	40	560	650	0
School	40	476	74	402
Little Comfort	40	678	280	398
Shields	60	911	660	251
Comfort	40	127	370	0

Moody Lake

Moody Lake was identified as having a high watershed load and a high internal load. Therefore load reduction strategies for Moody Lake will focus on reducing the watershed load from the agricultural areas surrounding the lake and on managing curly-leaf pondweed, fisheries, and other internal loads.

BMPs

Watershed load reduction for Moody Lake will focus on reducing the load from the agricultural areas adjacent to the lake through manure management, livestock management, and implementation of conservation tillage, buffers, and vegetated swales. These reductions will be implemented through interaction of CLFLWD, municipalities, and county and state agencies with landowners interested in voluntary participation in education, cost-share, and targeted project programs. Coordinating and funding the education and cost-share efforts is estimated to cost $3,000 per year (CLFLWD, 2007) with targeted project costs of up to about $50,000.

Internal Load Reductions

Reducing the internal load in Moody Lake will be a requirement before major improvements can be seen. The internal load reduction efforts will include alum treatment, rough fish management, and curly-leaf pondweed management. The estimated cost of these efforts is $90,000 (CLFLWD, 2007).

Capital Projects

The capital project selected to address the largest tributary load to Moody Lake is a wetland restoration located near Lofton Avenue and 250th Street. The project includes restoration of the wetland hydro-period, vegetation and buffer establishment, and cattle exclusion in coordination with the adjoining property owner. Cattle watering and crossing facilities would be included in the project so that current operations can continue. The project would require acquisition of an easement or property of approximately 30 acres. The estimated load reduction for this project is 99.3 pounds at a cost of $770,000 (CLFLWD, 2007). The project could potentially result in wetland banking credits.

Bone Lake

The strongest influences on Bone Lake’s impairment were identified to be a high watershed load and Moody Lake’s input to Bone Lake. Watershed load reduction efforts will focus on reducing the load from cropland and developed areas of the watershed as these were identified as the largest sources. Internal load was identified as an area for improvement with noted rough fish, curly-leaf pondweed, and Eurasian water milfoil populations in the lake. Lakeshore septic systems and livestock are identified as secondary sources of phosphorus to the lake. Reducing the load from these sources will be a secondary focus. The primary load reduction focus for Bone Lake will be the improvement of water quality in Moody Lake through the efforts identified for Moody Lake.

BMPs
Within the Bone Lake watershed, watershed load reduction activities will focus on reducing the load from the cropland and developed areas within the watershed through shoreline restoration, manure management, livestock management, and implementation of conservation tillage, buffers, and vegetated swales. These reductions will be implemented through interaction of CLFLWD, municipalities, and county and state agencies with landowners interested in voluntary participation in education, cost-share, and targeted project programs. Coordinating and funding the education and cost-share efforts is estimated to cost $3,000 per year (CLFLWD, 2007) with targeted project costs of up to about $50,000.

Internal Load Reductions
Internal load reduction efforts for Bone Lake will include alum treatment, rough fish management, and curly-leaf pondweed management. The estimated cost of these efforts is $337,000 (CLFLWD, 2007).

Capital Projects
Three capital projects are planned for Bone Lake, two wetland restorations and one infiltration basin. One wetland restoration is proposed for a 20 acre wetland in subwatershed SBL38 that is suspected to be acting as a source of phosphorus. The restoration would include habitat and plant diversity improvement and installation of water level control structures. The load reduction that may result from this project is unclear since the reason for the increase in load is not known. However, if there were no increase in load through the restored wetland, the resulting load reduction would be 40 lb/yr. The project is estimated to cost $480,000 (CLFLWD, 2007).

The second wetland project is a redirection of flow through a wetland that takes the discharge from Moody Lake. An increase in total phosphorus load was observed through this wetland in a wet year. To avoid this increase in load a pipe is planned to redirect flows from the wetland. A berm would also be constructed to raise the water level in the wetland and limit outflow from the wetland itself. The project is estimated to result in a 250 lb/yr reduction in total phosphorus loads at a cost of $330,000 (CLFLWD, 2007).

An infiltration basin is proposed for a site along Oakhill Road North. The project is estimated to capture approximately 40% of the runoff volume from the creek at the southeast inlet to Bone Lake to result in a phosphorus load reduction of 120 pounds per year. The infiltration project is estimated to cost $490,000 (CLFLWD, 2007).

School Lake

School Lake is most strongly affected by the upstream load from Birch Lake. The current load to School Lake from Birch Lake is higher than the TMDL for School Lake. Therefore, reducing the phosphorus input to School Lake from Birch Lake will be the primary strategy for meeting the TMDL for School Lake. Reducing the watershed load to School and Birch Lakes from livestock, cropland, and developed areas will be the focus of load reduction strategies. The primary load reduction focus for School Lake will be the improvement of water quality in Birch Lake.

BMPs

Watershed load reduction activities for the Birch and School Lake watersheds will include reductions in the load from the agricultural and developed areas within the watershed through manure management, livestock management, and implementation of conservation tillage, buffers, and vegetated swales. These reductions will be implemented through interaction of CLFLWD, municipalities, and county and state agencies with landowners interested in voluntary participation in education, cost-share, and targeted project programs. Coordinating and funding the education and cost-share efforts is estimated to cost $3,000 per year (CLFLWD, 2007) with targeted project costs of up to about $50,000.

Internal Load Reductions

Internal load reductions do not appear necessary for School Lake. Load reduction efforts will focus on watershed load reductions.

Capital Projects

The capital project identified for School Lake is a wetland restoration in the Birch Lake watershed. The restoration includes construction of a weir to maintain wet soils in the wetland. However, additional investigation is necessary prior to project initiation to determine if this is indeed the source of the increase in phosphorus load. The project is estimated to provide TP load reductions of 130 lb/yr at a cost of $620,000 (CLFLWD, 2007).

Little Comfort Lake

The input from School Lake to Little Comfort Lake is the strongest influence on the water quality of Little Comfort Lake. Upstream water quality improvements will directly benefit Little Comfort Lake. In addition, load reduction efforts will focus on reducing the watershed load from developed and cropland areas and on reducing the internal load to Little Comfort Lake.

BMPs

Within the Little Comfort Lake watershed, watershed load reduction activities will focus on reducing the load from the cropland and developed areas within the watershed through shoreline restoration, manure management, livestock management, and implementation of conservation tillage, buffers, and vegetated swales. These reductions will be implemented through interaction of CLFLWD, municipalities, and county and state agencies with landowners interested in voluntary participation in education, cost-share, and targeted project programs. Coordinating and funding the education and cost-share efforts is estimated to cost $3,000 per year (CLFLWD, 2007) with targeted project costs of up to about $50,000.

Internal Load Reductions

Internal load reduction efforts for Little Comfort will include alum treatment, rough fish management, and curly-leaf pondweed management at an estimated cost of $83,200 (CLFLWD, 2007).

Capital Projects
An increase in load not explained by the outflow concentration from School Lake is observed between School and Little Comfort Lakes. The increase in load has been attributed to sluggish conditions in a portion of the stream connecting the two lakes. Additional investigation is necessary prior to project initiation to determine if this is indeed the source of the increase in phosphorus load. The project is expected to include construction of an outlet for School Lake, removal of a beaver dam downstream and channel restoration. The project is estimated to cost $280,000 (CLFLWD, 2007).

Shields Lake

Shields Lake, as a shallow lake, is influenced by phosphorus concentrations in balance with the biological community. Internal load was identified as a large source of phosphorus to Shields Lake and will be the primary focus of load reduction efforts.

BMPs
Watershed load reduction activities within the Shields Lake watershed will focus on reducing the load from the adjacent lands through shoreline restoration and implementation of buffers and vegetated swales. These reductions will be implemented through interaction of CLFLWD, municipalities, and county and state agencies with landowners interested in voluntary participation in education, cost-share, and targeted project programs. Coordinating and funding the education and cost-share efforts is estimated to cost $3,000 per year (CLFLWD, 2007) with targeted project costs of up to about $50,000.

Internal Load Reductions
Reducing the internal load in Shields Lake will be an important aspect of lake restoration. Internal load reduction efforts will include alum treatment, rough fish management, and curly-leaf pondweed management. In addition, biomanipulation is planned for Shields Lake. Biomanipulation is intended to shift the lake to a clear water state through food web alterations that increase algae consumption and decrease recycling of nutrients within the lake.

Capital Projects
No capital projects are planned for the Shields Lake watershed.

Comfort Lake

Comfort Lake is most strongly influenced by inputs from upstream lakes. All of the other lakes addressed in this plan eventually drain through Comfort Lake. The water quality in Comfort Lake depends primarily on hydrologic inputs. The more discharge the lake receives from upstream lakes, the poorer the water quality of Comfort Lake. Therefore, upstream water quality improvements will directly benefit Comfort Lake and will be a key focus of the load reduction strategy. The load reduction strategy for Comfort Lake will also include reducing the load to the lake from the developed portion of its watershed.

BMPs

Within the Comfort Lake watershed, watershed load reduction activities will focus on reducing the load from the developed areas within the watershed through shoreline restoration and implementation of conservation tillage. These reductions will be implemented through interaction of CLFLWD, municipalities, and county and state agencies with landowners interested in voluntary participation in education, cost-share, and targeted project programs. Coordinating and funding the education and cost-share efforts is estimated to cost $3,000 per year (CLFLWD, 2007) with targeted project costs of up to about $50,000.

Internal Load Reductions

Internal load reduction strategies do not appear necessary for Comfort Lake although internal load reductions were recommended in *Water Quality Modeling Investigation* (CLFLWD, 2007). More recent lake water quality monitoring data show that water quality tends to exceed the standard in years with low watershed and upstream lake inputs (see Figure 44 and Appendix B). This suggests that the lake's internal load does not need to be reduced in order for Comfort Lake to meet the water quality standard.

Capital Projects

Two wet detention ponds are proposed for the Comfort Lake Watershed. The ponds are planned to capture sediment and associated phosphorus from the developed areas of the City of Forest Lake. The first pond is intended to provide treatment for areas of the City of Forest Lake that developed under lower standards for water quality treatment than are currently in effect. The second pond is an option that could be used to address some water quality treatment for future development. The first pond project is estimated to cost $3,700,000 and provide a phosphorus retention of 265 lb/yr (CLFLWD, 2007). The second pond is estimated to cost $2,200,000 and provide 50 lb/yr phosphorus retention (CLFLWD, 2007). The ponds are currently expected to be located within Bixby Park with the project to be conducted in cooperation with the City of Forest Lake.

Tax-forfeit property located along the Sunrise River in the City of Forest Lake and the City of Wyoming is available to the Comfort Lake – Forest Lake Watershed District for watershed management projects. The planned project includes redirection of some storm event flow from the Sunrise River through a ditch to a future biofiltration feature on the tax-forfeit property in the City of Wyoming. Because of the large flows that can occur from the outlet of Forest Lake and the drainage through the former ditch system, and because of the smaller area of upland available on District owned tax-forfeit property, the system would be designed to capture a portion of the flow through the Sunrise River during storm events, while maintaining adequate flows in the river itself. The biofiltration feature would outlet to the wetland adjacent to the Sunrise River downstream of where flows were redirected. The estimated cost for this project is $610,000. A feasibility study should be conducted to determine the design of the feature and redirected ditch. In addition, coordination will be needed with the owner of the property between the District's tax-forfeit parcels so that the ditch can be directed to District property.

Another potential strategy that was investigated through the TMDL study was that Shallow Pond, a large wetland upstream of Comfort Lake, was acting as a phosphorus source. Monitoring conducted in 2008 upstream and downstream of Shallow Pond did not support this hypothesis. In fact, the data indicate a 45% reduction in TP load through Shallow Pond and an 83% reduction in TSS load (Appendix B). 2008 may represent an atypical hydrologic year, with flows at higher levels in the first half of the sampling period, falling to almost zero flow in the second half. The resultant pollutant loading for this flow pattern could be substantially different than that resulting from a more typical hydrologic situation. In addition the monitoring did not cover spring snow melt conditions which may have a different interaction with Shallow Pond than low flow conditions observed for much of the monitoring season. Despite these distinctions in the flow pattern through Shallow Pond in 2008, past monitoring data also support the conclusion that Shallow Pond is not consistently acting as a source of phosphorus (see section 11.2.2.1 of *Water Quality Modeling Investigation* (CLFLWD, 2007)). The data suggest that alterations to Shallow Pond are not a warranted load reduction strategy.

Identified Alternative or Additional Implementation Actions

In addition to the projects listed for each lake there are other projects or methods available to control phosphorous loads to these six lakes. The *Water Quality Modeling Investigation* (CLFLWD, 2007) identified these two:

Chemical Treatment of Inflows

Chemical treatment of inflows is a method by which a tributary phosphorus load is diverted and treated to reduce phosphorus load by chemical flocculation and settling. Chemical treatment of inflows is operationally intensive and may present permitting obstacles but can be a reasonable solution for areas where inflow concentration is low and other treatment options are not be effective. Lake subwatersheds with aggressive water quality goals and low potential for settling or infiltration (typically high volume and low concentration) are targeted as candidates for chemical treatment of inflows. Alum toxicity would be addressed in final design through jar testing to show effectiveness and prove that toxicity standards would not be exceeded.

Forest Lake Outlet Channel Restoration

The outlet channel from Forest Lake has been identified in past WCD monitoring reports as a source of large sediment and nutrient loading. Furthermore, a past engineering study on the outlet indicates that the channel is in disrepair which results in excessive channel bank erosion and subsequent siltation (TKDA, 2002). A channel restoration project could be undertaken to address these issues. Project components could include vegetative bank stabilization (native plants, etc.) where such measures would suffice and structural bank stabilization (e.g., riprap, concrete, etc.) where necessary to protect the banks and surrounding buildings. Dredging of the channel could also be conducted to remove any deposited sediment similar to past maintenance on the channel (most recently dredged in the mid-late 1990’s). (CLFLWD, 2007)

Construction and Industrial Stormwater Implementation Actions

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, including any applicable additional BMPs required in Appendix A of the Construction General Permit for discharges to impaired waters, or meet local construction stormwater requirements if they are more restrictive than requirements of the State General Permit.

Industrial stormwater activities are also considered in compliance with provisions of the TMDL if they obtain an Industrial Stormwater General Permit or General Sand and Gravel general permit (MNG49) under the NPDES program and properly select, install, and maintain all BMPs required under the permit, or meet local industrial stormwater requirements if they are more restrictive than requirements of the State General Permit.

Load Management or Reduction Programs

Municipal Ordinances and New CLFLWD Rules

The Comfort Lake-Forest Lake Watershed District has developed rules to protect the water quality of the District lakes through stormwater management, erosion control, shoreline buffers and floodplain management. Many of the municipalities also have standards in these areas and it is expected that the Comfort Lake- Forest Lake Watershed District and municipalities will work together to implement water quality standards and programs.

CLFLWD Cost-Share Program

The Comfort Lake-Forest Lake Watershed District assists landowners with the voluntary implementation of on-lot water quality improvement projects and Best Management Practices (BMPs) through their BMP cost-share incentive program. The program provides targeted funding to projects that provide water quality improvements that are not required by ordinance or rule and address runoff from existing infrastructure or erosion from existing problem areas. This program will help to fund smaller-scale, distributed practices throughout the watershed.

CLFLWD Capital Improvement Plan

The Comfort Lake-Forest Lake Watershed District has developed a Capital Improvement Program guided by the *Water Quality Modeling Investigation* (CLFLWD, 2007) that identifies a number of specific BMPs and capital projects to help to address phosphorus impairments in the District's lakes.

TMDLs

This TMDL study concurrently addresses all of the phosphorus impairments in the Comfort Lake watershed. Each impaired lake upstream of each of the lakes in this TMDL study are addressed through this TMDL, therefore providing reasonable assurance that impacts to downstream lakes from upstream impairments will be addressed.

NPDES MS4 Program

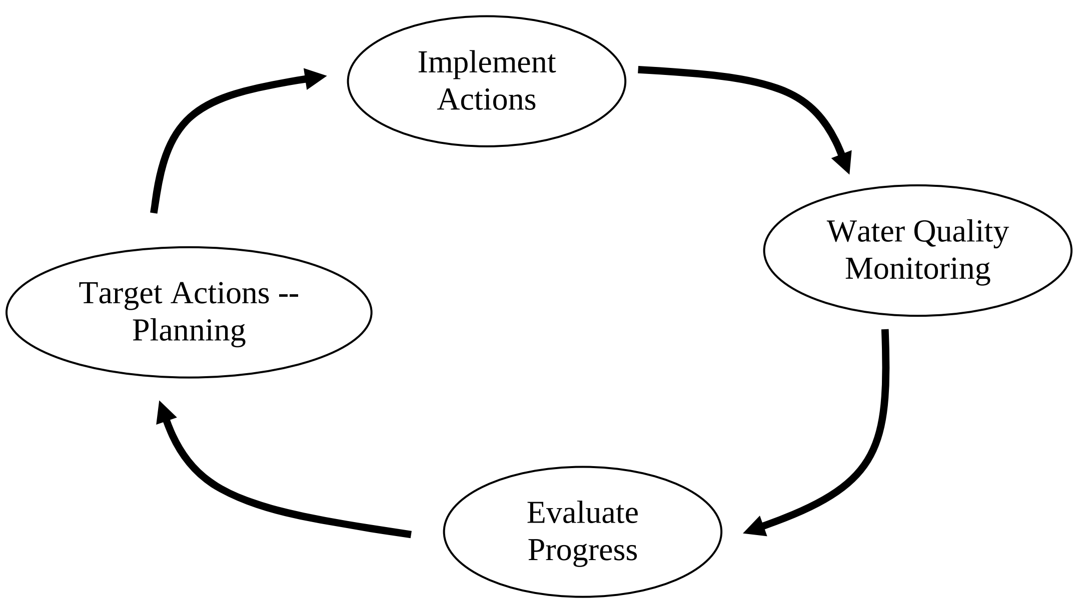
The MS4 permit program is in place only for the City of Forest Lake within the six lakes' watersheds. The majority of municipalities are not currently regulated MS4 communities. However, the City of Wyoming, the City of Chisago City, and the City of Scandia are expected to require an MS4 permit by or before 2020. Each of the current and future MS4 permits are provided with a WLA.

Under the MS4 program, each permitted community must develop a Storm Water Pollution Prevention Program, or SWPPP, that lays out the ways in which the community will actively and effectively manage its stormwater. SWPPPs are required to incorporate the results of any approved TMDLs within their area of jurisdiction, subject to review by the MPCA.

ADAPTIVE MANAGEMENT PROCESS

The implementation actions outlined in this management plan will decrease the total phosphorus loading to the each of the six lakes. However, at this stage specific sites and project types for future nutrient reduction features have been identified for some, but not all, of the load reductions to fully meet the TMDL. In addition, the actual performance of practices may vary after installation from what was estimated. Since the cumulative effect on water quality therefore is also unknown, a continual process must happen that evaluates lake water quality and then tailors the implementation actions to the findings.

As practices are being implemented in the watershed, lake water quality will be monitored to evaluate the impact that the implementation actions have on eutrophication indicators in Moody, Bone, School, Little Comfort, Shields, and Comfort Lakes. 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. This process is referred to as adaptive management.



IMPLEMENTATION PLAN SUMMARY

Table 17 provides a summary of the planned implementation actions specific to each of the six lakes. These implementation actions will be further supported through programs to address future loads and to reduce existing load through cost-share incentives and other efforts.

Table 17. Summary of Planned Implementation Actions

			BMPs				Lake Management				Capital Improvements			
Lake	**Total Initial Capital Costs (2007 dollars)**	**Upstream Lake Improvement**	Livestock/ Manure Management	Conservation Tillage	Shoreline Restoration	Agricultural Buffers, Swales, and Rock Inlets	Rough Fish Management	Curly Leaf Pondweed Management	Alum Treatment	Biomanipulation	Wet Detention Ponds	Wetland Restoration	Infiltration	Water Quality Treatment
Moody	$850,000		✓	✓		✓	✓	✓	✓			✓		
Bone	$1,600,000	✓	✓	✓	✓		✓	✓	✓			✓	✓	
School	$623,800	✓	✓	✓		✓						✓		
Little Comfort	$360,000	✓	✓	✓	✓	✓	✓	✓	✓			✓		
Shields	$380,000			✓	✓		✓	✓	✓	✓				
Comfort	$4,410,000	✓		✓	✓	✓					✓			✓

REFERENCES

Comfort Lake-Forest Lake Watershed District (CLFLWD). 2007. Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capital Improvement Plan. Prepared by Wenck Associates, Inc.