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and the Minnesota Pollution Control Agency

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

February 16, 2010

water | ecology | community

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Implementation Plan

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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.

Typical sources of phosphorus include sediment, vegetation, and manures that are washed into lakes with the movement of stormwater. Additional phosphorus above natural levels in soils and vegetation may come from fertilizers applied to the land. Septic systems and wastewater treatment plants can also be a source of phosphorus. In addition, there is some phosphorus that is carried in precipitation.

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 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.

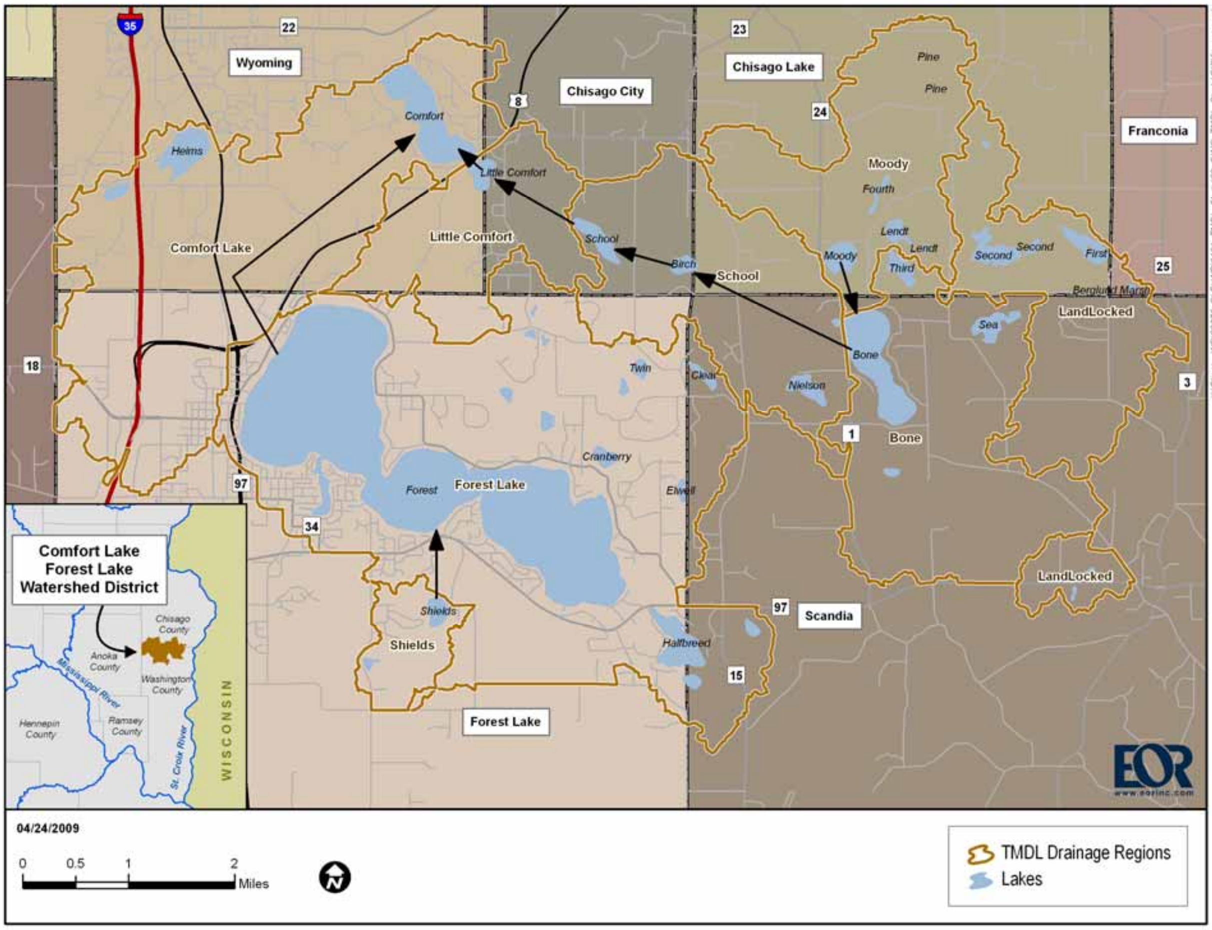


Figure 1. Location Map

The CLFLWD "Six Lakes" TMDL will not only address impairments in the CLFLWD's watershed, but also work to reduce phosphorus loadings to the Sunrise River and ultimately Lake St. Croix. The Lake St. Croix TMDL development is to be based primarily on the report *Nutrient and Suspended-Sediment Concentrations and Loads, and Benthic-Invertebrate Data for Tributaries to the St. Croix River, Wisconsin and Minnesota, 1997–99* (USGS, 2003), which examined the sub-watershed phosphorus and sediment loadings to Lake St. Croix. In this report, the Sunrise River watershed was identified as the largest contributor on the Minnesota side of the basin. The CLFLWD is a sub-watershed within the Sunrise River Watershed, and thus any reductions seen within this TMDL will benefit the lakes in this TMDL, the Sunrise River, and Lake St. Croix.

The St. Croix Basin Team, which is made of individuals from federal, state, and local governments in Minnesota and Wisconsin as well as local organizations, has established an agreement to reduce phosphorus and sediment loadings to Lake St. Croix by 20%.

Therefore any work done within the St. Croix River basin to reduce phosphorus, like this TMDL, will aid in achieving the 20% reduction goal. This TMDL will reduce the amount of TP coming out of the watershed from 1418 lb/yr to 1262 lb/yr or an 11% reduction.

In addition, a number of potential stream impairments have been identified for the streams connecting the lakes within the Comfort Lake-Forest Lake Watershed District. The potential impairment listings include three sites for turbidity and six sites for dissolved oxygen and E. coli. It is not immediately apparent whether or not the lake impairments are the cause of any of these potential stream impairments. Investigation on these potential stream impairments may be completed through the Sunrise River TMDL.

TMDL SUMMARY

The TMDL for each lake was apportioned between the waste load allocation (WLA) and the load allocation (LA). The WLA includes loads from sites currently covered by an NPDES permit: the City of Forest Lake MS4, two large sewage treatment systems, and construction and industrial stormwater sites. The WLA also includes sites expected to be covered by an NPDES permit in the future: City of Scandia MS4, City of Wyoming MS4, and City of Chisago City MS4. The LA includes loads from stormwater runoff that originate in unregulated MS4 communities (Chisago Lake Township), unregulated MS4 portions of permitted MS4 or future permitted MS4 communities (City of Scandia, City of Chisago City, City of Wyoming and City of Forest Lake) livestock loading, internal loading, and atmospheric deposition.

The watershed load (including regulated MS4, future regulated MS4 and unregulated or non-MS4 areas) was divided between the WLA and LA according to the amount of upland area estimated in each category. The upland area was selected to represent the developable area in the watershed; it includes the total watershed area with the lake and wetland area subtracted out. Total area was not used due to the high amount of surface water in some of the watersheds.

MS4 wasteload was allocated based on the portion of the lake's developable watershed area contained within the estimated regulated portions of the MS4. The boundaries of the regulated portion of the MS4s were estimated by excluding the portions of MS4 communities that are not technically covered under NPDES permits (i.e., areas that are either agricultural or otherwise not projected to be served by stormwater conveyances, such as open space, park and recreation, and rural residential). The portion of each municipality that is not estimated to be within the regulated boundaries of an MS4 is provided with a LA determined based on the developable watershed area. To calculate TMDL allocations, upstream impaired lakes were assumed to have outflow meeting the phosphorus standard because each of these lake impairments is also addressed through the TMDL.

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 and MPCA, 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 and MPCA, 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 and MPCA, 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	0.005	60%
Unregulated MS4 portions of City of Chisago City	0.14	77%
Unregulated MS4 portions of Municipalities: City of Forest Lake	0.06	76%
Unregulated MS4 portions of Municipalities: Chisago Lake Township	0.10	74%
Unregulated MS4 portions of Municipalities: City of Scandia	0.18	74%
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 and MPCA, 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 and MPCA, 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 and MPCA, 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 and MPCA, 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 13. 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 14. 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.

Table 15. Summary of TP Reduction Needed by Source for each Lake

Source	Lake											
	Moody		Bone		School		Little Comfort		Shields		Comfort	
	Current Modeled Load (lbs/day)	% TP Reduction Needed	Current Modeled Load (lbs/day)	% TP Reduction Needed	Current Modeled Load (lbs/day)	% TP Reduction Needed	Current Modeled Load (lbs/day)	% TP Reduction Needed	Current Modeled Load (lbs/day)	% TP Reduction Needed	Current Modeled Load (lbs/day)	% TP Reduction Needed
MS4 portions of Municipalities:												
City of Chisago City MS4	na	na	na	na	na	na	0.2	24%	na	na	0.06	0%
City of Forest Lake MS4	na	na	na	na	0.005	60%	0.02	33%	0.3	83%	1.35	0%
City of Wyoming MS4	na	na	na	na	na	na	0.24	36%	na	na	1.55	0%
Unregulated MS4 portions of Municipalities:												
City of Chisago City	na	na	na	na	0.14	77%	0.26	29%	na	na	0.02	0%
Chisago Lake Township	1.17	88%	0.01	45%	0.10	74%	na	na	na	na	na	na
City of Forest Lake	na	na	na	na	0.06	76%	0.07	30%	0.21	83%	0.55	0%
City of Scandia	0.03	82%	2.06	45%	0.18	74%	na	na	na	na	0.01	0%
City of Wyoming	na	na	na	na	na	na	0.26	29%	na	na	0.86	0%
Other sources:												
Livestock	0.53	88%	0.21	0%	0.29	76%	0.06	0%	0.003	0%	0.01	0%
Internal	1.01	88%	0.36	70%	0.13	0%	0.15	70%	2.5	83%	0.37	0%
Atmospheric and Groundwater	0.02	0%	0.14	0%	0.03	0%	0.02	0%	0.02	0%	0.13	0%
Upstream Lakes	0.04	0%	0.59	64%	1.61	45%	2.16	67%	na	na	1.86	21%

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) and in the CLFLWD Watershed Management Plan (CLFLWD, 2008) 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 [and redevelopments]) 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)

Maintenance practices themselves are a necessary component of the operation of BMPs and, as such, do not provide additional reduction. However, larger projects providing additional reduction could be conducted in conjunction with maintenance activities when equipment is already onsite.

Projects will not be limited solely to the above BMPs. Other BMPs such as stormwater harvesting for irrigation or reuse, filtration and biofiltration practices, underground practices as well as any other BMPs which would provide phosphorus storage and reduction will be considered when planning and implementing Best Management Practices.

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) and incorporated into the Capital Improvement Plan in the *Comfort Lake-Forest Lake Watershed District Watershed Management Plan* (CLFLWD, 2008). 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 assuming all projects are found to be feasible. 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. Planning-level cost estimates for the projects are provided in Table 17.

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 for a load reduction of about 107 lb/yr.

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 for an estimated load reduction of about 257 lb/yr (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 about 99 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 for a load reduction of about 138 lb/yr.

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) for a load reduction of about 92 lb/yr.

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 for a load reduction of about 131 lb/yr.

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.

Clean Water Partnership Project: Little Comfort Lake Watershed Load Assessment

Past monitoring, and the load allocation modeling effort, revealed increased phosphorus loading between the outlet of Bone Lake and the inlet of Little Comfort Lake. As part of the assessment project two continuous flow monitoring sites are set-up between Bone Lake and the Comfort Lake inlet (one on July Avenue and one on Manning Avenue) for the collection of grab samples throughout the year at these two sites plus the Little Comfort Lake inlet in order to determine phosphorus and suspended sediment loads. The main outcome of the assessment project is to pinpoint the area(s) of highest loading between the Bone Lake outlet and Little Comfort Lake inlet in order to better site potential projects to achieve the best load reduction in order to meet water quality standards.

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 for a load reduction of about 42 lb/yr.

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) for a load reduction of about 39 lb/yr.

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) for a load reduction of about 200 lb/yr.

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) for a load reduction of about 9 lb/yr.

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. The project is estimated to cost $500,000 (CLFLWD, 2007) for a load reduction of about 53 lb/yr.

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 for an estimated load reduction of 15 lb/yr.

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. These methods are options that may be most appropriate after some years of adaptive management, or if other identified methods are found not to be feasible. 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. The Comfort Lake-Forest Lake Watershed District Rules apply throughout the entire watershed and are supported by enforcement and inspection procedures. In addition, 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 support and 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.

Mn/DOT and county roads in the watershed are currently not under permit coverage. No WLA is therefore assigned to them. If, in the future, the U.S. Census Bureau Urban Area extends into the watershed and these roads come under permit coverage, WLA will be shifted from the municipality or township in which the roads occur. In the case of a load transfer, the WLA will be converted to a load per unit area (e.g. lbs/acre) and the resulting WLA for the roads will be based on their areal proportion. This would result in no change in the overall WLA for the lakes.

Soil & Water Conservation District, Natural Resources Conservation Service Programs

The Washington Conservation District and the Chisago Soil and Water Conservation District administer several state and federal funding programs that are available to landowners to implement a variety of agricultural and urban best management practices. The Washington Conservation District currently runs a technical assistance and cost share program for implementation of water quality BMPs (funded by Washington County and the state) and collaborates with the Comfort-Lake Forest Lake Watershed District.

The Washington Conservation District and the Chisago Soil and Water Conservation District can also provide technical assistance to landowners. The Natural Resources Conservation Service also provides technical assistance and runs a variety of cost-share programs.

Potential Funding Sources

Potential funding sources for implementation actions to address these TMDLs include, among others:

- CWP Loans for septic replacement or upgrades
- CWP Protection and Restoration Funds
- 319 Implementation
- Clean Water Amendment funds

EDUCATION PROGRAM

The CLFLWD education and outreach program, in partnership with the East Metro Water Resource Education Program (EMWREP), works to educate the public, municipal staff and officials, business owners, the agricultural community and various other target audiences within the watershed about the impacts of storm water discharges on water bodies and the steps that they can take to reduce pollutants in storm water runoff. Presentations to Cities, Townships and County officials, the preparation of newsletters, fact sheets and flyers, and conducting tours of CLFLWD activities are important aspects of the education and outreach program. The CLFLWD also publishes educational articles in the local newspapers in order to educate the public on water resource issues.

PROTECTION OF UNIMPAIRED OR UNASSESSED WATERS

A number of water bodies within the watersheds of the lakes addressed through this TMDL Implementation Plan are unimpaired or unassessed. The protection or restoration of these water bodies will assist in the improvement of water quality in the impaired water bodies addressed by these TMDLs. For example, Forest Lake and Sylvan Lake are unimpaired so any degradation in their water quality will result in a further degradation of downstream water quality in water bodies such as Comfort Lake, the Sunrise River, and the St. Croix River.

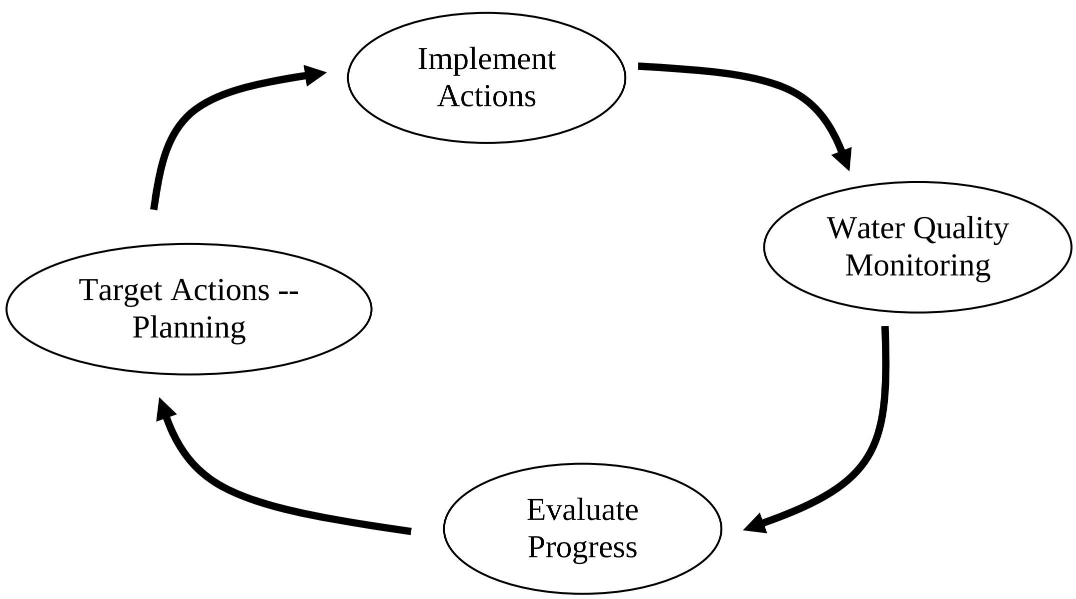
Clean Water Partnership Project: Forest Lake (Subwatershed FL44) Assessment

The water quality of Forest Lake is not impaired. Forest Lake has an 8,160 acre watershed with phosphorus loading to the lake evaluated through a water quality and load allocation modeling effort led by CLFLWD. Subwatershed "FL44" was estimated to contribute 539 pounds total phosphorus per year to Forest Lake, the largest subwatershed load identified. This project includes the evaluation of the impact of a former DNR fish rearing pond on the loading from the large wetland complex in the FL44 subwatershed and an evaluation of feasible options to reduce loads from this subwatershed. The overall project also includes methods to reduce one of the largest estimated loads to the FL44 wetland (156 lbs) from a livestock operation at the northeast end of the FL44 wetland. The CLFLWD is working on the development of a 30-foot buffer along the wetland edge with exclusion fencing to keep cattle out of the wetland and eliminate this livestock-related load.

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.



INTERIM EVALUATION METRICS

The adaptive management process allows an evaluation of the effectiveness of the implemented actions toward improving the water quality of Moody, Bone, School, Little

Comfort, Shields, and Comfort Lakes over time. However, in the interim as projects are being implemented, additional measures of progress are needed to ensure that targeted actions are being completed. These interim measures include increasing the:

- Volume of runoff treated in stormwater management facilities constructed by local governments
- Number of subwatersheds provided with adequate water quality treatment
- Number of producers and/or hobby farms implementing agricultural BMPs
- Number of manure management plans developed and implemented
- Number of acres of shoreland with adequate buffers
- Number of commercial and residential lots implementing urban BMPs
- Number of lakeshore owners implementing septic system improvements

Every three years, the tracked interim measures in each lake's watershed will be evaluated against the response of the lake. A three year period should allow enough time to begin seeing a response in lake water quality based on completed actions. A trend toward improved water quality (based on in-lake measurements of total phosphorus, secchi depth, and chlorophyll-a) with corresponding implementation actions (based on interim metrics above) will be taken as an indicator that implementation actions are having the intended effect. The planned implementation actions for each lake will be updated and revised as needed based on the evaluation. The regular three year evaluation of implemented actions and lake response will ensure that:

- Progress in implementation is regularly tracked and evaluated
- Alterations to the implementation plan are made based on lake response
- Implementation actions that are not proving effective are not continued

MONITORING

The CLFLWD will continue to monitor all of these lakes in partnership with volunteers and the Metropolitan Council. Details of the CLFLWD monitoring protocol can be found on the CLFLWD website at www.clflwd.org/programs.php, and in the CLFLWD 2007 *Water Monitoring Report*.

Monitoring should occur after implementation activities are initiated in order to evaluate the effectiveness of the BMPs, and should continue throughout the implementation period until water quality standards are attained.

The following parameters should be part of the monitoring plan:

In the deeper lakes, depth profiles of temperature and dissolved oxygen should be taken every two weeks during the growing season at the deepest portion of the lakes.

- Total phosphorus, soluble reactive phosphorus, chlorophyll-a, and transparency should be monitored every two weeks during the growing season.
- Depth profiles of temperature and dissolved oxygen should be taken every two weeks during the growing season at the deepest portion of the lakes.

- After commencement of in-lake curly-leaf pondweed management practices, two macrophyte surveys should be undertaken annually: 1) in the spring, when curly-leaf pondweed is at its peak, and 2) mid-summer, after curly-leaf has died back and native plants and Eurasian watermilfoil are potentially growing. Macrophyte surveys should be conducted every five years in lakes without active management of macrophytes.
- A fish survey should be completed once every five years to obtain data on fish population abundance and size distribution, year class strength as well as to evaluate management activities. Surveys should be conducted following the Manual for Instruction of Lake Survey, Special Publication No. 147 from the Minnesota Department of Natural Resources.

Additionally for Shields Lake:

- Zooplankton monitoring should be undertaken for a full season every five years in Shields Lake. Monitoring should start in early spring (March or April), when large zooplankton peak; zooplankton community dynamics during this period influence the water quality during the remainder of the growing season.
- At least one year of winter nitrate data should be obtained in Shields Lake. Winter nitrate has been shown to be an indicator of plant species richness in shallow lakes and can provide information on nitrogen loading and the potential for aquatic macrophyte restoration (James et al. 2005). This information can help target future management practices aimed at reducing nitrogen loading to the lake.

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 18 provides a summary of the planned timeline for implementation. The timeline may change somewhat from this plan depending on feasibility, partnerships, funding, and other considerations.

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	$940,000		✓	✓		✓	✓	✓	✓			✓		
Bone	$1,717,000	✓	✓	✓	✓		✓	✓	✓			✓	✓	
School	$700,000	✓	✓	✓		✓						✓		
Little Comfort	$443,200	✓	✓	✓	✓	✓	✓	✓	✓			✓		
Shields	$503,000			✓	✓		✓	✓	✓	✓				
Comfort	$6,590,000	✓		✓	✓	✓					✓			✓

Table 18. Summary of Planned Implementation Timeline: Scheduled Project Start Dates

Lake	BMPs				Lake Management				Capital Improvements			
	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	2009 - ongoing	2009 - ongoing		2009 - ongoing	2010	2010	2011			2010		
Bone	2009 - ongoing	2009 - ongoing	2009 - ongoing		2015	2015	2016			2015	2012	
School	2009 - ongoing	2009 - ongoing		2009 - ongoing						2016		
Little Comfort	2009 - ongoing	2009 - ongoing	2009 - ongoing	2009 - ongoing	2016	2016	2017			2015		
Shields		2009 - ongoing	2009 - ongoing		2018	2018	2018	2018				
Comfort		2009 - ongoing	2009 - ongoing	2009 - ongoing					2012 & 2020			2014

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