Medicine Lake, the second largest lake in Hennepin County, is considered one of the most important recreational water bodies in the county. The lake has multiple public accesses, and is intensively used during both summer and winter months. Fishing, boating, swimming, water-skiing and aesthetic viewing are some of the major recreational uses made of the lake. In addition, Three Rivers Park District’s (TRPD) French Regional Park and Regional Trail and the City of Plymouth’s East and West Medicine Lake Parks, and East Medicine Lake Regional Trail are all located along the lakeshore. The Metropolitan Council considers Medicine Lake a “Top Priority Lake” because of its multiple recreational uses and public access.

In 2004, Medicine Lake was placed on Minnesota’s list of “impaired waters.” The Minnesota Pollution Control Agency (MPCA) determined that the Lake had excessive levels nutrients that reduced water transparency, increased the incidence of algal blooms and the growth of nuisance vegetation such as curly leaf pondweed. Medicine Lake’s listing as an impaired water requires that the MPCA complete a study to determine a Total Maximum Daily Load (TMDL). A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

What is TMDL?
TMDL is “Total Maximum Daily Load,” the standard for how much of a pollutant a lake or river can absorb before water quality is degraded. Virtually every water body in the U.S. is being or has been evaluated for pollutant levels. When evaluations determine that water quality is poor because of a specific pollutant, the water body is placed on the impaired waters list. A TMDL study is then required to be conducted under the federal clean water act of 1972. The study sets a threshold for that pollutant and identifies how the daily “load” for that pollutant needs to be reduced to meet the water quality standards. The threshold must include a margin of safety to ensure that water quality is met, must account for seasonal variation in water quality, and must allow for reasonable future growth.

Medicine Lake and most of its watershed are located within the City of Plymouth. The remaining portion of Medicine Lake’s watershed area lies in City of Medicine Lake and portions of Golden Valley, New Hope, Minnetonka and Medina. The Lake is surrounded by a mix of private lakeshore lots and parkland. The lake has a surface area of 902 acres, a maximum depth of 49 feet, and an
estimated mean depth of 17.5 feet. Medicine Lake and its watershed, covering 11,613 acres is considered fully developed. Before it enters Medicine Lake, stormwater runoff typically flows through some form of wet detention; approximately 86 percent of the Medicine Lake watershed is covered with wet detention facilities.

**The problem . . .**
Over the last 100 years the land around Medicine Lake and throughout the Lake watershed changed from the native landscape to agriculture and low density development and finally to urban density homes, businesses and roads. As the land was covered by an increasing amount of pavement and rooftops, storm water runoff did not soak into the ground but instead ran over the ground and directly into the Lake. Thus, a much greater amount of water flowed over the land surface and ultimately into the Lake. The increased water volume also carried a higher load of pollutants than pre-development runoff.

Today, the increased water volume and higher pollutant levels, combined with sources of phosphorus internal to the Lake, result in periods of poor lake water quality. Runoff from the watershed enters the lake from creeks, storm sewer outfalls, and culverts at various points along the lakeshore. Medicine Lake currently exceeds the state's criteria for nutrients as measured by total phosphorus, chlorophyll-a and Secchi disc transparency.

**The solution . . .**
Without additional action to reduce phosphorus levels, Medicine Lake will continue to be affected by water quality problems associated with an urbanized lake watershed. In order to improve water quality, maintain water transparency, and reduce algal blooms and curlyleaf pondweed the Lake's phosphorus levels must be reduced. The MPCA is partnering with Bassett Creek Watershed Management Commission (BCWMC), Three Rivers Park District (TRPD), and a consultant team to complete a TMDL study and Implementation Plan for Medicine Lake.

**The TMDL study and restoration plan will identify:**
- the amount of phosphorus that must be removed or managed from sources in the Lake and coming from the watershed
- the best techniques for managing or removing phosphorus
- who is responsible for managing or removing phosphorus, and how much is to be managed or removed

**The TMDL Process**
In order to achieve water quality standards, Medicine Lake needs to reach a phosphorus measurement of approximately 40 micrograms per liter. Recent measurements show that phosphorus is
consistently much higher (25-60%) than the 40 micrograms/liter target.

The Medicine Lake TMDL process started earlier in 2008 with the completion of the TMDL workplan by the Minnesota Pollution Control Agency. The workplan has the following six tasks:

- Task 1: Past Study and Existing Data Review, Analyses, and Summary
- Task 2: Watershed and In-Lake Modeling
- Task 3: Stakeholder/Public Participation Process
- Task 4: Evaluate Improvement Options/Develop Allocations and Implementation Plan
- Task 5: Develop Monitoring Plan
- Task 6: Write Draft TMDL Report/Final TMDL Assistance/Reporting

Task 1 (Review of past studies and data) is largely complete, and Tasks 2 (modeling) and 3 (stakeholder participation) are now underway.

**Involving Stakeholders in the Decision Making**

Task 3 of the TMDL workplan is involving stakeholders in the decision making process. Completing a TMDL study and implementation plan requires substantial monitoring, data gathering, and modeling of internal (in the lake) and external (in the watershed) flows of nutrients. However, the science cannot tell us what are the most important priorities for selecting among different implementation strategies, nor can science identify whether a selected management practice is feasible. The process must therefore engage stakeholders to provide the value-based decision-making.

The Medicine Lake TMDL Steering Committee was formed to allow stakeholders to guide the value-based decision-making for the final project recommendations. The Steering Committee has completed its first and second meetings with the third meeting scheduled for Thursday, March 12th.

**Who is on the Steering Committee?**

Each local government in the Medicine Lake subwatershed that has an MS4 permit or has funding or regulatory authority over stormwater is being asked to have one technical and one non-technical (elected or appointed official, citizen, or business owner) representative. Other stakeholders who are being asked to participate include homeowners, business representatives, state agencies, environmental advocacy organizations, and the Medicine Lake association (AMLAC).

The Steering Committee will be making decisions that will shape the implementation plan. The Committee’s decision-making jurisdiction does not generally include technical issues.
Committee will, however, be using technical results to decide the best course of action for cleanup efforts to meet the required load reduction determined through the TMDL. Medicine Lake has been much studied over the previous two decades. A history of previous studies is shown below.

**Previous Studies and Plans for Medicine Lake**

<table>
<thead>
<tr>
<th>Plan/Study</th>
<th>Entity Conducting Study</th>
<th>Study Recommendations or Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987 Management Plan</td>
<td>Bassett Creek Watershed Management Commission, Metropolitan Council</td>
<td>Hypolimnetic Aeration, Wetland restoration, Bio-manipulation (fish removal) (EPA funding but not implemented)</td>
</tr>
<tr>
<td>1995-1997 Watershed Study</td>
<td>Bassett Creek WMC, Minnesota Pollution Control Agency, Three Rivers Park District, City of Plymouth</td>
<td>Developed P8 Model for lake watershed, Evaluated pond effectiveness in watershed, Evaluated BMPs - Street sweeping, - Detention ponds, - Runoff diversion, - Sediment traps</td>
</tr>
<tr>
<td>2000 Medicine Lake Watershed and Lake Management Plan</td>
<td>Bassett Creek WMC</td>
<td>Construct alum treatment plants on major inflows, Implementation of non-structural BMPs - P fertilizer ban, - Street sweeping, - Construct vegetated buffers along shoreline, - Control litter and animal waste in watershed</td>
</tr>
<tr>
<td>2004 Medicine Lake Management Plan</td>
<td>City of Plymouth, Other agencies</td>
<td>External source mitigation - Erosion control, streambank stabilization, - Detention pond management, - Plymouth Creek outfall pond, - Street sweeping, - P fertilizer restriction, - Goose management, - Shoreline and pond buffers, - Rain gardens</td>
</tr>
<tr>
<td>2008 TMDL Study</td>
<td>Bassett Creek WMC, Three Rivers Park District, Minnesota Pollution Control Agency</td>
<td>In process . . .</td>
</tr>
</tbody>
</table>

Questions?
Brooke Asleson, Project Manager
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Minnesota Pollution Control Agency
651-757-2205
brooke.asleson@pca.state.mn.us
Medicine Lake TMDL Quarterly Newsletter

Medicine Lake has been identified as an “impaired water” under the provisions of the Clean Water Act. The level of phosphorus in the Lake, coming from stormwater runoff via the Lake’s tributaries and direct overland runoff, and from continual re-release of sediment that has accumulated in the Lake over decades, creates a variety of water quality problems. A number of actions have already been taken to reduce phosphorus levels, but without additional action to reduce phosphorus levels Medicine Lake will continue to be affected by water quality problems associated with an urbanized lake watershed. In order to improve water quality, maintain water transparency, and reduce algal blooms the Lake’s phosphorus levels must be reduced. The MPCA is partnering with Bassett Creek Watershed Management Commission (BCWMC), Three Rivers Park District (TRPD), and a consultant team to complete a TMDL study and Implementation Plan for Medicine Lake.

Water Quality Modeling and Calibration

Over several months, considerable work was put into identifying the target TMDL (the maximum “load” of phosphorus) and setting the stage for making decisions on how to meet the target. The Medicine Lake TMDL process is fortunate to have an extensive data history of phosphorus and water quality levels, both in the Lake and the Lake tributaries. These data allow the project team to get a much more accurate picture of the problem and to calibrate the water quality modeling. Long-term monitoring data shows that the Lake typically has phosphorus water concentrations around 48 μg/L or ppb (parts per billion) (with considerable variation from year to year, due to in-lake phosphorus contributions). Monitoring and modeling also establishes an annual amount of phosphorus coming from the Lake watershed through stormwater of about 4,500 lbs (subject to additional minor refinements of the model). These two measurements provide the baseline from which the project team calculates the necessary phosphorus reduction in order to meet the TMDL.

The TMDL

As previous results had showed, Medicine Lake needs to reduce phosphorus levels to 40 ppb. After accounting for all components of the TMDL equation including a margin of safety, the TMDL for the Lake is balanced to achieve 38 ppb. Using the historic data and calibrated models, the project team identified the total “wasteload” and estimates of the wasteload contribution by watershed and city. The wasteload in Medicine Lake is the phosphorus contribution from surface water runoff in all the Lake’s watersheds. Historic data and modeling results
estimate that the wasteload allocation, the maximum allowed amount of phosphorus coming from stormwater runoff, is 3,280 lbs per year. The amount of phosphorus reduction needed from the current estimated wasteload is therefore about 1,220 lbs per year.

The Medicine Lake Stakeholder Steering Committee
The most difficult decision in the TMDL process is deciding how to meet the phosphorus reduction goal. Two separate decisions are critical to meeting the goal:
1) Allocating the wasteload among the various entities that manage land uses and stormwater systems in the Lake watershed, and;
2) Identifying specific methods (Best Management Practices, or BMPs) that each entity will use to reduce phosphorus to its wasteload allocation level.

In order to make these decisions, the TMDL work plan requires that stakeholders be involved in the decision making process. The Steering Committee has been meeting since October of 2008 to discuss data and recommend courses of action. Since the first project newsletter (February of 2009), the Committee has met three times, during which the Committee reviewed progress on data analysis and water quality modeling and identified criteria for use by the consultant team and the Committee in making decisions.

Setting Decision Criteria
One of the primary elements of the decision making process is for the Committee to identify the criteria by which critical decisions will be made. Setting criteria before actually considering options helps by defining what the Committee finds important or valuable, then engaging in discussion within the framework of those definitions. The Committee set separate criteria for the two primary decisions.

Allocation Criteria
Allocations must:
1. be equitable
2. consider limitations
3. be based on scientific data
4. consider historic actions (look forward and backward)
5. meet the minimum regulatory threshold

Best Management Practice (BMP) Criteria
BMPs should be prioritized:
1. by cost effectiveness
2. by diversity of benefit
3. to emphasize shared implementation
4. to emphasize measureable results

For all the criteria, the Committee identified definitional qualifiers. Under the allocation criteria, for instance, the criterion “be equitable” was qualified by noting that an equitable allocation would consider:
- existing observed phosphorus load from each entity,
- consider the ability of the entity to meet the reduction goal
- all entities that were contributing to the problem

Steering Committee Meetings

<table>
<thead>
<tr>
<th>Meeting Date</th>
<th>Agenda Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 12th</td>
<td>- Review water quality modeling and calibration,</td>
</tr>
<tr>
<td></td>
<td>- Discuss categories of decision criteria</td>
</tr>
<tr>
<td>April 9th</td>
<td>- Review modeling progress,</td>
</tr>
<tr>
<td></td>
<td>- Review critical TMDL decisions,</td>
</tr>
<tr>
<td></td>
<td>- Refine decision criteria,</td>
</tr>
<tr>
<td></td>
<td>- Discuss options for allocating responsibility for phosphorus reductions</td>
</tr>
<tr>
<td>May 14th</td>
<td>- Final loading capacity and reduction</td>
</tr>
<tr>
<td></td>
<td>- Assess allocation method</td>
</tr>
<tr>
<td></td>
<td>- Refine decision criteria for BMPs</td>
</tr>
</tbody>
</table>
These criteria are being used by the project team to make technical and methodological recommendations, and by the Committee to guide value-based decisions. The following tables are from the May 14, 2009, meeting and illustrate two alternative ways to achieve the desired watershed load reduction:

**Reducing Phosphorus Loading - Uniform Loading Rate**

<table>
<thead>
<tr>
<th>Subwatershed</th>
<th>Existing Load to Lake</th>
<th>Uniform Loading</th>
<th>% Reduction from Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TP (lbs)</td>
<td>TP (lbs/acre/yr)</td>
<td>Acres</td>
</tr>
<tr>
<td>East Medicine Lake Park</td>
<td>96</td>
<td>0.81</td>
<td>118</td>
</tr>
<tr>
<td>South Bassett Creek</td>
<td>300</td>
<td>0.57</td>
<td>529</td>
</tr>
<tr>
<td>Middle Bassett Creek</td>
<td>72</td>
<td>0.51</td>
<td>139</td>
</tr>
<tr>
<td>North Bassett Creek</td>
<td>114</td>
<td>0.61</td>
<td>188</td>
</tr>
<tr>
<td>Northeast Medicine Lake</td>
<td>173</td>
<td>0.26</td>
<td>554</td>
</tr>
<tr>
<td>North Medicine Lake</td>
<td>225</td>
<td>0.46</td>
<td>486</td>
</tr>
<tr>
<td>West Medicine Lake</td>
<td>72</td>
<td>0.37</td>
<td>194</td>
</tr>
<tr>
<td>City of Medicine Lake + Direct</td>
<td>202</td>
<td>0.47</td>
<td>425</td>
</tr>
<tr>
<td>Ridgedale Creek</td>
<td>673</td>
<td>0.47</td>
<td>1441</td>
</tr>
<tr>
<td>Plymouth Creek</td>
<td>2152</td>
<td>0.51</td>
<td>4236</td>
</tr>
<tr>
<td>18th Avenue</td>
<td>617</td>
<td>0.31</td>
<td>2019</td>
</tr>
<tr>
<td>Watershed-wide</td>
<td>4696</td>
<td>0.45</td>
<td>10431</td>
</tr>
</tbody>
</table>

**Reducing Phosphorus Loading - Equal Percent Reduction**

<table>
<thead>
<tr>
<th>Subwatershed</th>
<th>Existing Load to Lake</th>
<th>Equal % Reduction</th>
<th>35%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TP (lbs)</td>
<td>TP (lbs/acre/yr)</td>
<td>TP (lbs)</td>
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<tr>
<td>East Medicine Lake Park</td>
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<td>City of Medicine Lake + Direct</td>
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<td>435</td>
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<td>0.51</td>
<td>1390</td>
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<td>18th Avenue</td>
<td>617</td>
<td>0.31</td>
<td>399</td>
</tr>
<tr>
<td>Watershed-wide</td>
<td>4696</td>
<td>0.45</td>
<td>3033</td>
</tr>
</tbody>
</table>

**Committee Decisions**

The Committee has first discussed the allocation decision. Each entity in the watershed that must acquire a permit for stormwater discharge (Municipal Separate Storm Sewer System, or MS4) must get a wasteload allocation. In the Medicine Lake watershed this includes the following entities:

- Plymouth
- Golden Valley
- New Hope
- Crystal
- Medicine Lake
- Minnetonka
- Medina
- Hennepin County
- Minnesota Department of Transportation
The allocations can be:

- By individual MS4, were each entity is assigned its own responsibility for meeting a wasteload target, which is then attached to and enforced under its stormwater permit. The individual allocation is the default – if the Committee does not select another method, the MPCA will make individual allocations.
- By categories, if the individual wasteload assignments are too difficult to make due to data uncertainties, individual MS4s are grouped by category. For the categorical allocation to work, the MS4s must have a formal means of working together on water quality issues. In Medicine Lake, the Basset Creek Watershed Management Commission could play this role.
- By a combination of categories and individual MS4s, provided there is a clear rationale for allocating in a hybrid manner. Mn/DOT has requested to have its own individual allocation separate from the larger categorical class of the cities and Hennepin County.

The Committee has evaluated these options against the decision criteria, and has expressed preference for a hybrid allocation. The Basset Creek Watershed Management Commission must first agree to serve as coordinator for the categorical allocation.

**Next Steps**

The Committee will discuss the range of implementation scenarios in order to meet the wasteload allocation at the next meeting. Prior to that meeting additional technical data will also be provided by the project team, including an assessment of how different types of BMPs perform under the watershed model to sufficiently reduce phosphorus.

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Background
Medicine Lake is an “impaired water” under the provisions of the Clean Water Act. Phosphorus enters the Lake from stormwater runoff via the Lake’s tributaries and direct overland runoff and enters from continual re-release of sediment that has accumulated in the Lake over decades creates a variety of water quality problems. Over the last decade, cities within the Lake watershed and other organizations have taken a number of actions to reduce phosphorus levels. The Medicine Lake TMDL project has determined, however, that without additional action to reduce phosphorus levels Medicine Lake’s water quality problems will continue indefinitely. In order to improve water quality, maintain water transparency, and reduce algal blooms the Lake’s phosphorus levels must be reduced. The MPCA is partnering with Bassett Creek Watershed Management Commission (BCWMC), Three Rivers Park District (TRPD), and a consultant team to complete a TMDL study and Implementation Plan for Medicine Lake.

Water Quality Modeling and Calibration
Much of the work of the TMDL project has been to create a computer model that estimates how much phosphorus needs to be removed from each watershed’s stormwater runoff and Lake tributaries in order to meet water quality goals. The consultant team and stakeholders put a considerable amount of work into identifying the target TMDL (the maximum “load” of phosphorus), setting baseline phosphorus inputs for each watershed that flows into Medicine Lake, and estimating the potential impact of different phosphorus reduction strategies. Unlike many other impaired waters, a rich data set on phosphorus and water quality was already in place for Medicine Lake and some of its watersheds. Because of the rich data set, the project team and technical stakeholders spent much time calibrating the model to the measured data, and evaluating this project’s modeling results for the entire Lake watershed against previous modeling for a few select watersheds.

The modeling and calibration process was complicated by several factors, including trying to reconcile older modeling software with the current Windows-based version of the software. As a result of these complications, the final modeling results needed several iterations before being finalized. The resulting model, however, is likely to be a much better representation of what is going on in the Lake watershed than would have occurred without
Medicine Lake TMDL Quarterly Newsletter

the previous work. A more accurate model will allow for less guesswork in choosing successful implementation strategies.

The TMDL

Long-term monitoring data shows that the Lake typically has phosphorus water concentrations around 48 μg/L or ppb (parts per billion) (with considerable variation from year to year, due to in-lake phosphorus contributions). The final modeling establishes an annual amount of phosphorus coming from the Lake watershed through stormwater and other tributary sources of 4,484 lbs. These two measurements (existing concentration and annual input of phosphorus) provide the baseline from which the project team calculates the necessary phosphorus reduction in order to meet the TMDL.

As noted in earlier draft results, after accounting for a margin of safety Medicine Lake needs to reduce phosphorus levels to 38 ppb in order to meet the TMDL standards. The project team identified the total “wasteload” and estimates of the wasteload contribution by watershed and city. The wasteload in Medicine Lake is the phosphorus contribution from surface water runoff in the Lake’s watersheds. The maximum amount of phosphorus that can come from stormwater runoff and still meet the target of 38 ppb is 3,235 lbs per year. The amount of phosphorus reduction needed from the estimated total wasteload is 1,249 lbs per year.

The Medicine Lake Stakeholder Steering Committee

The Stakeholder Steering Committee is responsible for directing the qualitative or value-driven decisions. The Committee spent a great deal of time reviewing the modeling results and ascertaining how to use the results in setting the stage for implementation plan decisions. Two decisions are critical to meeting the phosphorus reduction goal:

1) Allocation - the wasteload, as calculated in the model, needs to be divided among the various entities that manage land uses and stormwater systems in the Lake watershed, and;

2) Prioritizing implementation actions - Identifying specific methods (Best Management Practices, or BMPs) that each entity will use to reduce phosphorus to its wasteload allocation level.

Allocation

The allocation decision has two primary components:

1) Whether to make an allocation to each of the eight MS4 local governments (governments needing a Municipal Separate Stormwater Sewer System permit for discharging stormwater into surface waters); or, to make a “categorical” allocation to all the MS4s (other than the Minnesota Department of Transportation and Hennepin County) to be administered/coordinated by the Basset Creek Watershed Management Commission (BCWMC)?

Allocation Criteria

Allocations must:

1. be equitable
2. consider limitations
3. be based on scientific data
4. consider historic actions (look forward and backward)
2) For individual allocations, what method should be used to allocate the target wasteload among the eight MS4s?

In previous meetings the Committee expressed a preference for using the categorical allocation, provided BCWMC agreed to take on a management role for implementation efforts along with proactive efforts by the cities. If the BCWMC agrees to the management role, the importance of allocating the wasteload among the MS4s is greatly reduced.

Best Management Practices
The choice of BMPs is also to be guided by the Committee’s criteria. BMP options will be described in the TMDL implementation plan. The TMDL water quality model was used to identify the potential benefit of several distinct implementation portfolios. The modeling revealed that the TMDL could not be reached by relying only on one or two types of BMPs, but that a number of both watershed and in-lake BMPs would need to be used. The proposed West Medicine Lake Pond will have a substantial positive impact on the wasteload, but only comprises about 40% of the solution. Additional ponding can reduce the wasteload further, but not nearly enough to achieve the TMDL. In addition, in order to meet water quality goal it is assumed in the TMDL that the internal load will be addressed through lake management activities. More distributed BMPs, in the watershed such as increasing the number of rain gardens, disconnecting and limiting impervious surfaces, and more aggressive use of on-site stormwater controls can also achieve a large reduction in the wasteload. Each of these has different capital costs and maintenance costs that also need to be considered. The Committee’s decision criteria will be used to guide the creation of the portfolio of implementation tools.

Next Steps
The draft TMDL and implementation plan will be presented to the Committee at their final meeting on October 22nd. The following week, October 29th, the draft plan will be offered to the general public for comment.

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