

# DRAFT Lake Magda and Meadow Lake Nutrient TMDL Five Year Review



Prepared for:  
**Shingle Creek**  
Watershed Management Commission

3235 Fernbrook Lane  
Plymouth, MN 55447  
[shinglecreek.org](http://shinglecreek.org)



**Prepared by:**

**WENCK Associates, Inc.**  
7500 Olson Memorial  
Highway  
Phone: 763-4252-6800  
Fax: 952-831-1268  
[www.wenck.com](http://www.wenck.com)

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# Executive Summary

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This report is a review of progress toward meeting the load reductions identified in the Lake Magda (Wenck 2010a) and Meadow Lake (Wenck 2010c) Nutrient TMDLs. It includes an assessment of recent data and information that have been collected on these lakes as well as actions that have been implemented to reduce nutrient loads since the TMDL was completed in 2010. Finally, this report describes the actions planned for the next 5 years of the implementation plan and sets forth how progress toward the TMDL will be measured.

Lake Magda, located in the City of Brooklyn Park, was placed on the 2002 State of Minnesota's 303(d) list of impaired waters. Meadow Lake, which is located in the City of New Hope, was also placed on the 303(d) list in 2002. The original TMDL studies determined that phosphorus load reductions of 69% (Lake Magda) and 82% (Meadow Lake) would be necessary to ensure both lakes meet or exceed state water quality standards for nutrients.

The Implementation Plans for Lake Magda (Wenck 2010b) and Meadow Lake (Wenck 2010d) identified priority actions and strategies for the first five years of implementation. Some of these were discrete actions or projects, and for the most part those have been completed or are in planning. Other actions such as implementing internal load reduction projects have not yet been completed.

Monitoring of lake water quality on Lake Magda and Meadow Lake has been intermittent over the past 20 years, primarily through the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP). While management actions have reduced nutrient loading to both lakes, no statistically significant trends of improvement have been observed yet, and the lakes consistently exceed state standards.

A significant amount of data and information has been collected on both lakes since the completion of the TMDL, including: in-lake water quality monitoring, vegetation surveys, fish surveys, and sediment core collection for internal load analysis. These data were used to update the watershed and lake response models used in the original TMDL study to prepare updated TMDL allocations and load reduction targets for each lake. The updated models suggest that phosphorus load reductions of 54% and 83% are still needed for Lake Magda and Meadow Lake, respectively, for these lakes to meet state water quality standards. To meet these reductions, both lakes will need to focus on reducing nutrient loading from watershed and internal sources.

Priorities for the next five years will be:

- ▲ Continue to reduce watershed load to both lakes by adding new BMPs, enhancing existing treatment BMPs and by increasing infiltration of runoff.
- ▲ Reduce internal load in Meadow Lake through water level drawdown and sediment treatment and fish and aquatic vegetation management.
- ▲ Develop and implement balanced short- and long-term aquatic vegetation and fish management plans for both lakes.

# 1.0 TMDL Overview

## 1.1 BACKGROUND

Lake Magda and Meadow Lake are located in the Cities of Brooklyn Park and New Hope, respectively (Figure 1-1). Both lakes are considered shallow lakes and have maximum depths less than 10 feet. Lake Magda drains to Eagle Creek, a tributary to Shingle Creek, via a channel that flows north along Highway 169. Meadow Lake discharges to Bass Creek, also a tributary to Shingle Creek, via a 21-inch storm sewer on the northwest corner of the lake. The entire drainage area of Lake Magda (43 acres) and Meadow Lake (88 acres) are located in the Cities of Brooklyn Park and New Hope, respectively, and consist of fully developed urban and suburban land.

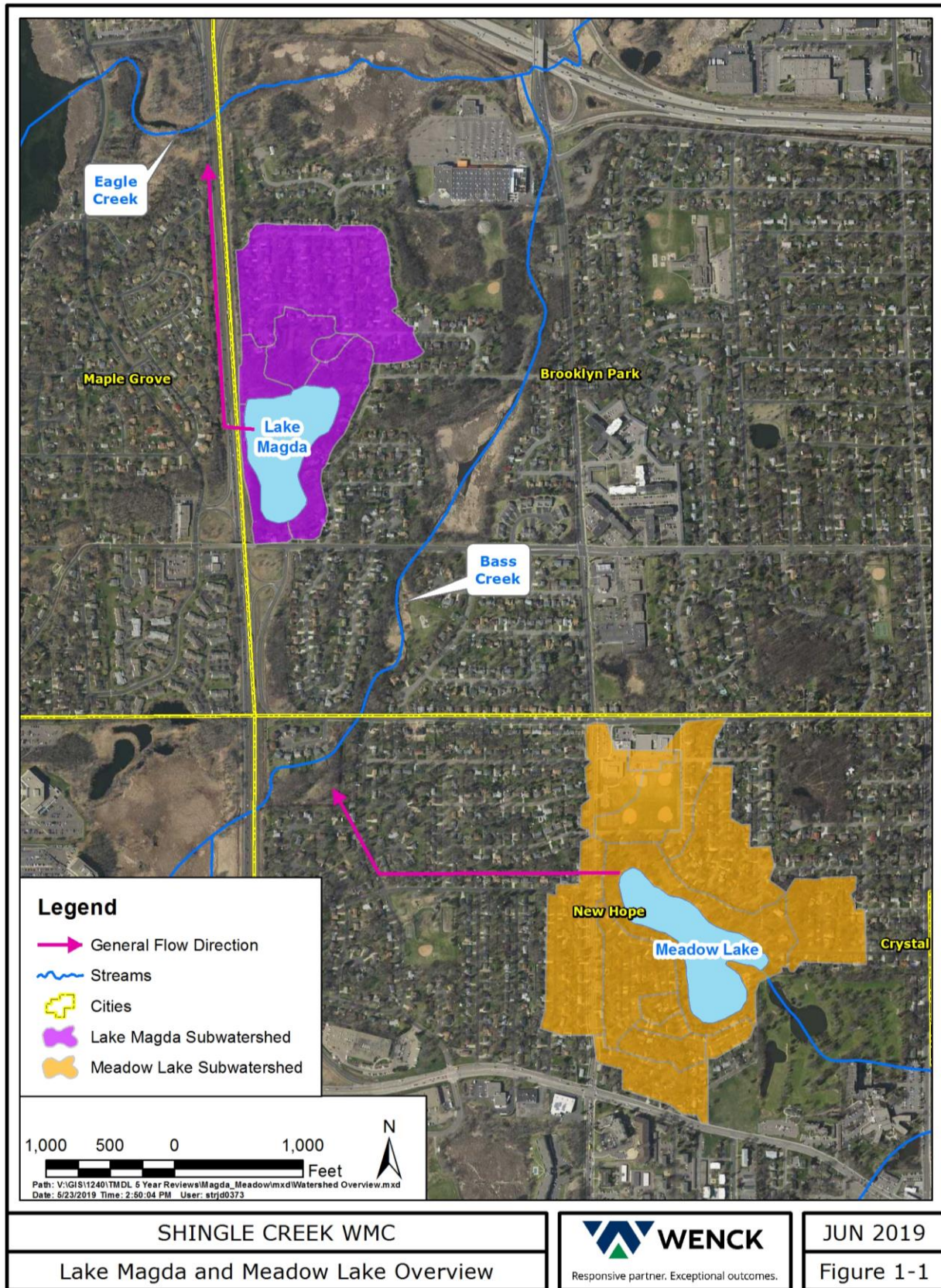
**Table 1-1. Lake characteristics.**

Parameter	Magda Lake	Meadow Lake
Surface Area (ac)	11	12
Average (Maximum) Depth (ft)	3.6 (7)	1.9 (4)
Volume (ac-ft)	40	23
Residence Time (years)	0.9	0.1
Littoral Area (ac)	40 (100%)	23 (100%)
Watershed Size (ac)	43	88

The Lake Magda (Wenck 2010a) and Meadow Lake (Wenck 2010c) Nutrient Total Maximum Daily Load (TMDL) reports addressed nutrient impairments in these lakes. The TMDLs and associated Implementation Plans were approved in 2010 and implementation actions have been underway since that time. The total phosphorus (TP) load reductions calculated in the TMDL are shown in Table 1-2 for each lake.

**Table 1-2. TP load reductions in the Lake Magda and Meadow Lake TMDLs.**

			Existing TP Load [lbs/yr]	Allowable TP Load [lbs/yr]	Estimated Load Reduction	
					lbs/yr	Percent
Magda	Wasteload	Watershed	82.7	23.6	59.1	71%
	Load	Atmospheric	2.4	2.4	0	0%
		Internal	32.2	10.8	21.4	66%
	TOTAL LOAD			117.3	36.8	80.5
Meadow	Wasteload	Watershed	116.0	19.8	96.2	83%
	Load	Atmospheric	2.4	2.4	0	0%
		Internal	74.7	12.6	62.1	83%
	TOTAL LOAD			193.1	34.8	158.3



**Figure 1-1. Lake Magda and Meadow Lake lakesheds.**

## 1.2 IMPLEMENTATION PLAN

### 1.2.1 Principles

The TMDL Implementation Plans enumerated the principles guiding development and implementation of the load reduction plans. These principles, in no order, included:

1. **Restoring biological integrity** and communities including fish, plants, and zooplankton;
2. **Controlling internal load** and reducing the internal phosphorus loading in the lakes;
3. **Retrofitting BMPs in the Watershed as Opportunities Arise** such as street projects, redevelopment, and add or upsize current BMPs;
4. **Foster stewardship** and providing education and training opportunities to city staff to better understand how their areas of responsibility relate to the protection and water quality in the lakes;
5. **Communicating with the public** and providing general and specialized information for everyone within the community.

### 1.2.2 Approach

The impairments to these lakes developed over time as the watersheds draining to them urbanized. As the watershed developed, native prairie, woods and savanna were cleared, and wetlands were ditched and filled to support farming. Over the past century the farms and remaining undeveloped land were converted to urban and suburban uses, increasing the volume of runoff and the amount of pollutants conveyed to the lakes. As a result of this land use and land cover change, the lakes slowly degraded. Just as this degradation took many years, improvement will take many years through ongoing retrofit of the watershed with BMPs as well as eventual redevelopment of existing land uses with lower-impact development and stormwater treatment.

The Implementation Plan took into account both short-term and long-term projects. The short-term projects that could be accomplished in a 5-20 year timeframe focused on the high-priority areas of the watershed that are the largest contributors to phosphorus loading. The long-term practices aimed to establish policies and practices that lower phosphorus loading through retrofitting of BMPs, redevelopment, or new construction.

### 1.2.3 Priorities

Implementation priorities for Lake Magda and Meadow Lake were identified in the form of BMP strategies. The following BMP strategies were of highest priority during the first five years of the TMDL. Their 2019 status is shown in *italics*. More detail on completed strategies is discussed later in this report.

#### Priorities for Lake Magda

- ▲ Reduce external load
  - ▲ Retrofit BMPs to add stormwater treatment in the watershed. *Two projects have been completed, see Table 2-1 below*
  - ▲ Increase infiltration in watershed. *Not completed*
  - ▲ Shoreline management and restoration. *No information is available regarding restorations completed.*
  - ▲ Street Sweeping. *The City routinely conducts sweeping in the Lake Magda watershed, see Table 2-1 below*

- ▲ Aquatic plant survey and management plan. *Plant surveys conducted by Commission in 2017. Management plan not completed.*
- ▲ Fish Population Management. *Fish assessment conducted by Commission in 2017. Strategies to manage the fish community have not been developed or completed.*

#### Priorities for Meadow Lake

- ▲ Reduce external load
  - ▲ Retrofit BMPs to add stormwater treatment in the watershed. *Several projects have been completed in watershed, see Table 2-1 below*
  - ▲ Increase infiltration in watershed. *Several projects have been completed in watershed, see Table 2-1 below*
  - ▲ Shoreline management and restoration. *Several projects have been completed by homeowners directly around the lake, see Table 2-1 below*
  - ▲ Street Sweeping. *The City routinely conducts sweeping in the Meadow Lake watershed, see Table 2-1 below*
- ▲ Reduce Internal load through water level drawdown and alum treatment. *Not completed.*
- ▲ Biologic integrity management
  - ▲ Perform aquatic plant surveys, develop management plan, and chemical treatments as necessary. *Plant surveys were conducted by the Commission in 2016. Management plan has not been developed and no chemical treatments have been done.*
  - ▲ Fish Population Management. *Fish assessment conducted by Commission in 2017. Strategies to manage the fish community have not been developed or completed.*

### **1.3 TMDL IMPLEMENTATION PLAN ACTIONS**

#### **1.3.1 Commission Actions**

The Commission agreed to take the lead on general coordination, education, and ongoing monitoring. This information has been incorporated into the Commission's annual Water Quality Reports. Taking the lead, the SCWMC has conducted and will continue to facilitate the following activities. 2019 status is shown in *italics*:

- ▲ General Coordination. *All ongoing activities.*
  - Coordinate water resource policy and the following general activities:
    - Provide advice and assistance to member cities on their implementation activities
    - Research and disseminate information on changing BMP technology and practices
    - Collect annual implementation activity data
    - Recommend activities such as vegetation and/or fishery management, partnering with the DNR
    - Periodically update the Commission's Capital Implement Program (CIP)
    - Maintain the watershed SWMM and P8 models
    - Conduct public hearings on proposed projects
    - Share the cost of qualifying improvement projects
    - Annual monitoring and activities report
    - Establishment of performance standards
- ▲ Education. *All ongoing activities except internal load management feasibility studies.*
  - Public education and outreach
  - Promotion and encouragement of Public Official and Staff education
  - Presentations for lake associations, home ownership associations, block clubs, garden clubs, service organizations, senior associations, advisory commissions, City Councils, and other groups

- Shoreline restoration, rain garden, and other BMP demonstration projects
- Internal load management feasibility studies and recommendations
- ▲ Monitoring
  - Monitor water quality in the lakes. *Completed and ongoing.*
  - Track the effectiveness of activities implemented to reduce nutrient loading in the watershed. *Completed and ongoing.*
  - Provide additional monitoring such as:
    - Aquatic vegetation surveys. *Completed for both lakes.*
    - Sediment chemistry. *Completed for both lakes.*
    - Zooplankton sampling and other biological assessments. *Not completed.*

### 1.3.2 Stakeholder Actions

The regulated stakeholders responsible for meeting the TMDL are the cities draining to the lake chain (Brooklyn Park and New Hope) and Hennepin County. In addition, property owners in the watershed have a role to play in implementing BMPs on their private properties. The stakeholders agreed to consider the following activities in implementing the TMDL. Their 2019 status is shown in italics. More detail on completed strategies is discussed later in this report.

- ▲ External Load Reduction
  - Retrofit BMPs to add stormwater treatment. *See Table 2-1*
    - *Infiltration basins and devices*
    - *In-line or off-line treatment manufactured devices*
    - *Rain gardens and biofiltration*
  - Increase infiltration in the watershed. *See Table 2-1*
  - Shoreline management and restoration. *See Table 2-1*
  - Street Sweeping. *See Table 2-1*
- ▲ Internal Load Reduction
  - Implement internal load reduction project for Meadow Lake. *Not yet completed. Sediment cores have been collected for both lakes. Results of these analyses are presented in Section 3.1.3.*
- ▲ Biologic Integrity Management
  - Aquatic vegetation surveys and management plans. *Aquatic vegetation surveys were performed by the Commission on Lake Magda in 2017 and Meadow Lake in 2016 (see Section 3.1.4). No vegetation management plans have been developed for either lake. Lake Magda and Meadow Lake do not routinely treat or harvest aquatic vegetation.*
  - Fish Management. *Fish assessments were completed by the Commission on both lakes in 2017. Results of these surveys are discussed in Section 3.1.5. Fish management plan and implementation of plan have not been completed.*
- ▲ Tracking and Reporting
  - *Integration of BMPs into stakeholders' SWPPs. Completed on an ongoing basis.*

## 2.0 Progress Review

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### 2.1 TMDL IMPLEMENTATION ACTIONS

#### 2.1.1 Shingle Creek Watershed Management Commission

The Commission has completed a number of actions in implementation of this TMDL. Some of these are specific to the Lake Magda and Meadow Lake TMDLs, and some are general actions across the watershed that will also benefit these lakes.

- ▲ The Commission sponsors ongoing citizen volunteer water quality monitoring on both lakes, and has undertaken water quality monitoring, sediment core collection and analysis, and aquatic vegetation surveys through its Intensive Lake Monitoring Program.
- ▲ Since the TMDL and Implementation Plans were completed, the Commission has updated its development rules to be more stringent. The water quality and infiltration requirements now apply to non-single family residential parcels down to one-half acre in size. The previous threshold was five acres. As these develop or redevelop, they are now required to implement load-reduction Best Management Practices (BMPs).

#### 2.1.2 Stakeholder Actions

The cities draining to each lake have implemented load reduction BMPs to improve water quality. The BMPs that have been implemented since the base year for the TMDL modeling for Lake Magda (2000) and Meadow Lake (1999) are listed in Table 2-1 and shown in maps in Appendix B. Table 2-1 also includes each BMP's estimated phosphorus load reduction. This table may not reflect all actions completed by individual property owners or the lake associations.

**Table 2-1. BMPs implemented since 2000 (Magda Lake) and 1999 (Meadow Lake) and estimated TP load reductions.**

Lake	City	BMP Type	BMP Description	TP Load Reduction (lbs/yr)
<b>Lake Magda</b>	Brooklyn Park	Sump Manhole with Baffle <sup>2</sup> (S31247)	The sump installed in S31247 is a 48inch with a flow dissipater.	1
		Sump Manhole <sup>2</sup> (S31255)	The sump installed is assumed to be a 24-inch diameter manhole with a depth of 4-feet.	<1
		Street Sweeping <sup>4</sup> (~2.1 road miles)	Sweeping occurs approximately 2 times per year in the spring and fall. Street sweeping also assumes 30% of the canopy reaches the road.	4
	<b>Lake Magda Subtotal</b>			<b>5</b>
<b>Meadow Lake</b>	New Hope	Grit Chamber <sup>2,3</sup> (ML-4-1) (GC-123)	Grit Chambers were installed in 2008 during street reconstruction project. The as-built drawing lists a 7' diameter 5' for chamber 1 and 5' diameter for chamber 2.	8
		Grit Chamber <sup>2,3</sup> (ML-3-1) (GC-120)	Grit Chambers were installed in 2008 during street reconstruction project. The as-built drawing lists a 7' diameter 5' for chamber 1 and 5' diameter for chamber 2.	4
		Grit Chamber <sup>2,3</sup> (ML-1-1) (GC-103)	Grit Chambers were installed in 2008 during street reconstruction project. The as-built drawing lists a 8' diameter 6' for chamber 1 and 5' diameter for chamber 2.	4
		Grit Chamber <sup>2,3</sup> (ML-5-1) (GC-124)	Grit Chambers were installed in 2008 during street reconstruction project. The as-built drawing lists a 7' diameter 5' for chamber 1 and 5' diameter for chamber 2.	4
		Sump Manhole <sup>2</sup> (ML-6-1)	Assumed a diameter of 2-feet and a depth of 3-feet (as depicted on as-built profile)	1
		Meadow Lake Elementary	The reduction calculation uses the simple method outlined in the MPCA stormwater manual.	2
		E Meadow Lake Lane Rain Garden	The reduction calculation uses the simple method outlined in the MPCA stormwater manual.	1
		Street Sweeping <sup>4</sup> (~5 road miles)	Sweeping occurs between April – October once per month. Street sweeping also assumes 30% of the canopy reaches the road.	18
		Shoreline Restorations	Several shoreline plantings and restoration projects have been implemented by individual property owners	NA <sup>1</sup>
	<b>Meadow Lake Subtotal</b>			<b>42</b>

<sup>1</sup> Not enough information available to estimate potential TP reductions for these projects

<sup>2</sup> Sump manholes are compared to the P8 outputs for TSS particle size and associated TP content. The particle sizes assumed to accumulate in the sumps and grit chambers are coarse to fine sands (1mm – 250µm).

<sup>3</sup> Grit chambers contain two chambers. Both chambers have the ability to collect sediment up to the invert elevation of the pipe. Grit chambers also assume that settling only includes coarse to fine sands, similarly to sump manholes.

<sup>4</sup> Street sweeping TP load reductions estimated using UMN Street Sweeping Calculator

## 3.0 Modeling and TMDL Allocation Updates

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### 3.1 DATA COLLECTED SINCE TMDL STUDY

#### 3.1.1 Overview

A significant amount of watershed and in-lake data and information have been collected for Lake Magda and Meadow Lake since the completion of the TMDL studies. Monitoring activities have included in-lake water quality monitoring (both lakes), collection and analysis of intact sediment cores, vegetation surveys and fish surveys. These monitoring activities have resulted in a better understanding and more robust dataset than the information available during the TMDL studies. Each of these activities is described below in more detail.

#### 3.1.2 In-lake Water Quality Monitoring

Periodic water quality monitoring has been conducted on Lake Magda and Meadow Lake since the original TMDL study. Much of the data was collected through the Metropolitan Council Environmental Services' Citizen Assisted Monitoring Program (CAMP) and the Minnesota Pollution Control Agency's Citizen Lake Monitoring Program. The Commission monitored water quality on Lake Magda in 2017 and Meadow Lake in 2016 through its Intensive Lake Monitoring Program. Results of these monitoring efforts are presented in the Commission's 2016 and 2017 Annual Water Quality Reports ([link to reports](#)). Average annual total phosphorus (TP), chlorophyll-a (chl-a), and Secchi depth for both lakes over the past 20 years is also summarized in Appendix A of this report.

In general, water quality may have improved slightly in Lake Magda and there is no clear water quality trend in Meadow Lake. Total phosphorus and chl-a concentrations for both lakes have exceeded the standard every year that monitoring has taken place. Similarly, water clarity in both lakes is poor as Secchi depth has never met State water quality standards.

#### 3.1.3 Sediment Cores

Intact sediment cores were collected by the Commission on Lake Magda in 2014 and on Meadow Lake in 2009. The sediment cores were analyzed by the University of Wisconsin - Stout for sediment phosphorus release under anaerobic conditions. Lab results indicate that the anaerobic phosphorus release rate for Lake Magda was 2.3 mg/m<sup>2</sup>/day which is relatively low (below 25<sup>th</sup> percentile) compared to Wenck's database of over 100 Minnesota lakes where phosphorus release was measured in the lab. Meadow Lake's lab-measured release rate was 12.4 mg/m<sup>2</sup>/day, which is considered high and exceeds the 75<sup>th</sup> percentile of lakes in Minnesota. These rates were combined with an anoxic factor calculation (Nurnberg 2004) to provide an updated estimate of each lake's average annual internal load (see Section 3.2).

The original TMDL study used literature values and model residual to assign internal loading values to each lake since the lab-measured release rate information was not available at the time of the study. Thus, the updated internal load estimates presented in this report provide a more accurate estimate of internal loading from sediments in these lakes.

### **3.1.4 Vegetation Surveys**

Vegetation surveys were performed by the Commission on Lake Magda in 2017 and on Meadow Lake in 2016 as part of the Intensive Lake Monitoring Program. To the Commission's knowledge, no other systematic vegetation surveys have been performed on Lake Magda and Meadow Lake to date and it is not believed that chemical treatments and/or harvesting are routinely conducted on either lake to manage AIS or other vegetation species. Early and late season vegetation surveys are scheduled again for Lake Magda in 2022 and Meadow Lake in 2021 as part of the Commission's Intensive Lake Monitoring Program.

The 2017 vegetation surveys for Lake Magda showed moderate species diversity (7 species observed) and plant abundance (56-78% coverage). Submerged plant abundance would likely be higher if water clarity was better, particularly later in the season. Since 1999, water clarity has not met state standards during all seven years in which Secchi depth was measured. One of the most commonly observed species of aquatic vegetation was Elodea (Canadian waterweed), which was observed at 11% of sites less during the May 2017 survey and 50% of sites during the July 2017 survey.

Curly-leaf pondweed (CLP) was also abundant (61% coverage) during the May survey. As expected, there was no CLP observed during the July survey since CLP usually dies mid-summer. CLP is an invasive plant species that can out-compete native plant species and disrupt lake ecosystems by changing the dynamics of internal phosphorus loading. Eurasian watermilfoil (EWM), another invasive species, was observed at 11% of stations during the July survey.

The 2016 vegetation surveys for Meadow Lake showed low species diversity (four species observed). Plant abundance was high (100% coverage) during the June 2016 survey and low (19% coverage) during the August 2016 survey. The most common species observed during the June and August surveys were CLP (57%) and Elodea (19%), respectively. Eurasian water milfoil was not observed during either survey.

### **3.1.5 Fish Surveys**

A fisheries assessment was conducted by the Commission on Lake Magda in early August 2017 ([link to report](#)). Three species were observed during the 2017 assessment and the population was dominated by black crappie and black bullhead. The abundance of these species, combined with the lack of other species, is suggestive of a poor and imbalanced fish community. In productive systems, an imbalanced fishery has the potential to reduce phytoplankton grazers (i.e. Daphnia and other zooplankton) to the point where no significant control of the algae occurs and water quality decreases. Thus, it is likely that Lake Magda's current fish community is contributing to poor water quality conditions. Management efforts to restore a more balanced fish community or eradicate fish completely would likely have positive impacts on the lake's water quality and the vegetation community.

A fisheries assessment was also conducted by the Commission on Meadow Lake in early August 2017 ([link to report](#)). Only two species were observed during the 2017 assessment and the population was dominated by fathead minnow. Fathead minnow are very tolerant of winter-kill conditions, however, Meadow Lake is likely not deep enough to support the species year-round. It is likely that fish over winter in the adjacent golf course ponds and/or recolonize the lake from Bass Creek during high water levels. In high densities, fathead minnow can have significant water quality impacts through feeding on zooplankton,

secretion, and sediment resuspension. Thus, it is highly likely that fathead minnows contribute to poor water quality conditions in Meadow Lake and efforts to eradicate the fish would likely have positive impacts on water quality and the vegetation community.

## 3.2 MODELING AND TMDL UPDATES

The original TMDL studies used P8 to estimate watershed phosphorus loads to each lake, literature rates to estimate internal load, and BATHTUB lake response models to estimate phosphorus budgets and assign TMDL allocations. As discussed in sections 2.1 and 3.1, BMPs have been implemented and a significant amount of data has been collected for each lake since the completion of the original TMDL studies. These data have greatly improved our knowledge and understanding of each lake and their watershed and in-lake phosphorus sources.

Current conditions and allowable TP loads developed during the original TMDL study were set using monitored data and the P8 watershed and lake response model results from the late 1990s and early 2000s. For the purposes of this report, these models were updated, adjusted using the more recent 10-year data and information discussed in Section 3.1. The updated lake response models were then used to develop TP reduction targets for each lake to meet in-lake water quality standards. The updated models, existing TP budgets, and allowable TP targets for each lake are presented below.

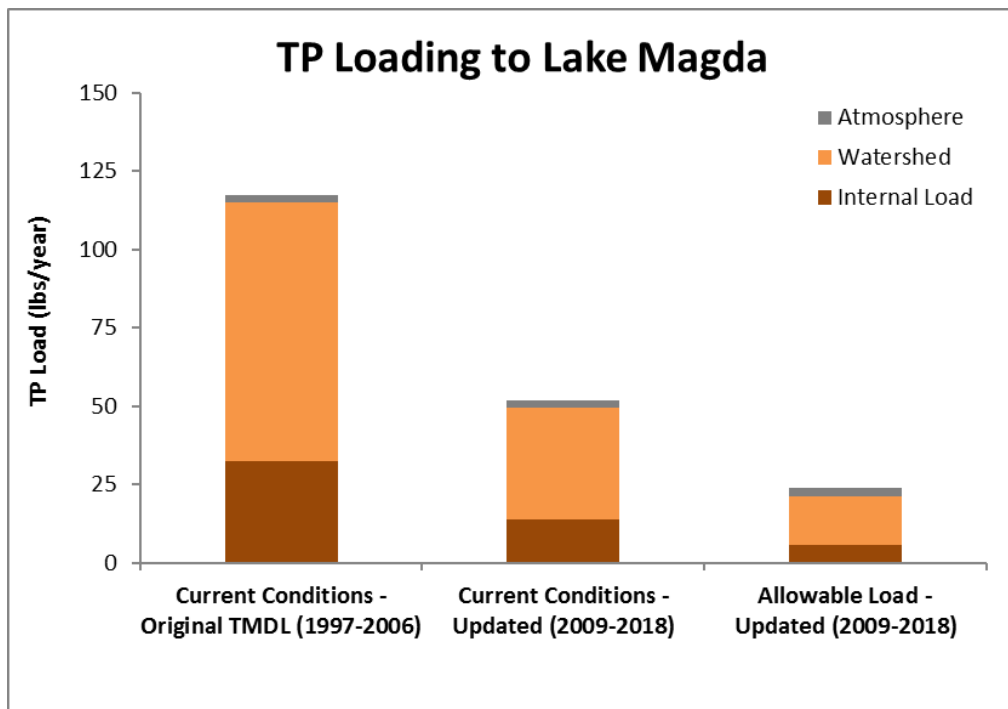
### 3.2.1 Lake Magda Updated Targets

The original TMDL model for Lake Magda used 2000 as a base year for estimating the existing nutrient loading and TMDL allocations. The original TMDL model called for watershed and internal TP load reduction goals of approximately 59 lbs/year and 21 lbs/year, respectively (Table 1-1).

The updated lake response model for Lake Magda suggests watershed loading will need to be reduced by approximately 20 lbs/year and internal load by 8 lbs/year. It should be pointed out that these load reduction requirements are significantly lower than the original TMDL study due to improved TP concentrations in Magda Lake. Average annual TP concentration for Lake Magda at the time of the original TMDL study (model years 1999, 2000, 2003, and 2006) was 140 µg/L. Average annual in-lake TP concentrations over the most recent ten year period (model years 2009, 2012, and 2017) is 101 µg/L. Table 3-1 summarizes existing TP loads from each major source and their required reduction based on the updated models. Figure 3-1 shows how our understanding of the existing and allowable TP loads in Meadow Lake have changed since the original TMDL study.

**Table 3-1. Updated existing and allowable TP loads for Lake Magda.**

			Existing TP Load [lbs/yr]	Allowable TP Load [lbs/yr]	Estimated Load Reduction	
					lbs/yr	Percent
Lake Magda	Wasteload	Watershed MS4	35.7	15.5	20.2	57%
	Load	Atmospheric	2.6	2.6	0	0%
		Internal	13.6	5.8	7.8	57%
	TOTAL LOAD			51.9	23.9	28.0



**Figure 3-1. Current conditions and updated allowable load targets for Lake Magda.**

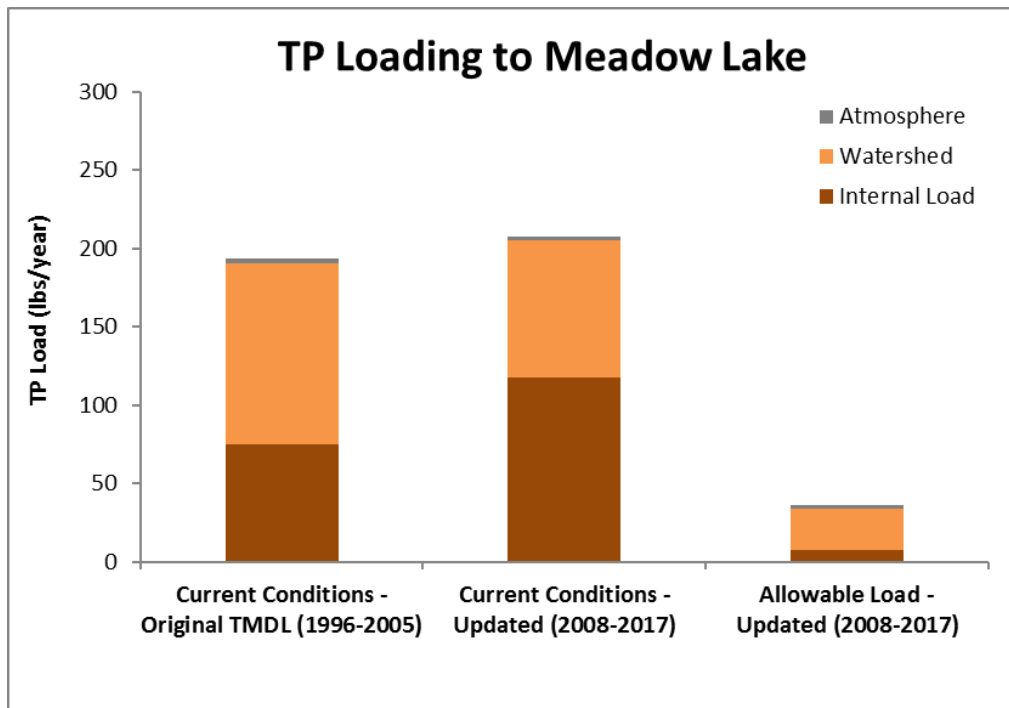
### 3.2.2 Meadow Lake Updated Targets

The original TMDL model for Meadow Lake used 1999 as a base year for estimating the existing nutrient loading and TMDL allocations. The original TMDL model called for watershed and internal TP load reduction goals of approximately 96 lbs/year and 62 lbs/year, respectively (Table 1-1).

The updated lake response model for Meadow Lake suggests watershed loading will need to be reduced by approximately 62 lbs/year and internal load by 110 lbs/year. The updated load reduction requirements are similar to the original TMDL study since TP concentrations have remained relatively consistent in Meadow Lake over the past 20 years. Average annual TP concentration for Meadow Lake at the time of the original TMDL study (model years 1996, 1999, 2002, and 2005) was 239 µg/L. Average annual in-lake TP concentrations over the most recent ten year period (model years 2008, 2011, 2014, and 2016) is 249 µg/L. Table 3-1 summarizes existing TP loads from each major source and their required reduction based on the updated models. Figure 3-1 shows how our understanding of the existing and allowable TP loads in Meadow Lake have changed since the original TMDL study.

**Table 3-2. Updated existing and allowable TP loads for Meadow Lake.**

			Existing TP Load [lbs/yr]	Allowable TP Load [lbs/yr]	Estimated Load Reduction	
					lbs/yr	Percent
Meadow Lake	Wasteload	Watershed MS4	87.2	25.7	61.5	71%
	Load	Atmospheric	2.8	2.8	0.0	0%
		Internal	117.7	7.7	110.0	93%
	TOTAL LOAD			207.7	36.2	171.5



**Figure 3-2. Current conditions and updated allowable load targets for Meadow Lake.**

## 4.0 Next 5 Year Actions

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### 4.1 COMMISSION IMPLEMENTATION ACTIONS

The Commission will continue to rely on volunteers to conduct water quality monitoring on the lakes through the Citizen Assisted Monitoring Program (CAMP) program, supplemented by surface and water column sampling every five to seven years. More thorough monitoring was completed on Lake Magda in 2017 and Meadow Lake in 2016, with the next assessments expected in 2022 and 2021, respectively. The detailed assessments will also include aquatic vegetation surveys and fish assessments.

#### 4.1.1 Subwatershed Assessments

The Commission will continue to work in partnership with cities throughout the watershed to complete assessments in priority subwatersheds. These assessments identify and prioritize opportunities for small-scale retrofit BMPs such as iron-enhanced sand filters, boulevard rain gardens and public space bioinfiltration BMPs. The Commission will maintain a Cost Share Fund to be used to assist its member cities in implementing identified small BMPs.

#### 4.1.2 Education and Outreach

With the West Metro Water Alliance (WMWA), the Commission will work with the cities of Brooklyn Park and New Hope to provide targeted information messages and outreach opportunities.

#### 4.1.3 Project Financial Assistance

The Commission's Cost Share Policy provides that member cities may submit capital improvement projects to the Commission's Capital Improvement Program (CIP), and the Commission will fund 25% of the cost of watershed load reduction projects and 100% of internal load reduction projects. The Commission has also been successful in obtaining grant funding for projects, and will continue to seek out sources of funding to assist the cities in completing projects. The Commission also operates a Cost Share program for small BMPs that is intended to provide assistance in completing projects identified in the subwatershed assessments described above.

#### 4.1.4 Five Year Evaluation

The Commission will complete another Five Year Review for Lake Magda and Meadow Lake in 2024-2025.

### 4.2 STAKEHOLDER ACTIONS

#### 4.2.1 Opportunistic Projects

Brooklyn Park and New Hope have been routinely including load reduction and infiltration BMPs into their street reconstruction projects. The Cities will continue to evaluate potential opportunities to incorporate load and volume reduction BMPs in street, park, and other improvement projects. Additionally, the Cities, with the help Commission, will continue to explore the possibility of retrofit BMPs such as iron enhanced sand filters, curb-cut raingardens and other regional treatment practices in targeted locations.

#### **4.2.2 Street Sweeping**

Brooklyn Park and New hope currently conduct targeted street sweeping to help minimize phosphorus and sediment loading to its lakes and wetlands. The Cities will continue to identify critical areas and sweep streets more frequently as necessary.

#### **4.2.3 Shoreline Buffers and Restoration**

Brooklyn Park, New Hope and the lake associations will continue to encourage shoreline property owners to install and maintain shoreline buffers and to restore any unstable or eroded shorelines, and will undertake buffer and restoration projects on city-owned lakeshore property where feasible.

#### **4.2.4 Reduce Internal Load**

Monitoring and modeling performed subsequent to the TMDLs showed that internal load reductions will be required in both lakes in order to meet State water quality standards. At this time, Meadow Lake is a good candidate for water level drawdown and chemical treatment (e.g. alum, Phoslock ®, iron filings) to seal the sediments following the drawdown. The City of New Hope will work with the Commission to evaluate the feasibility of the drawdown and sediment treatments and pursue a potential project.

#### **4.2.5 Aquatic Vegetation Management**

Magda Lake and Meadow Lake are not actively managed for fish or aquatic invasive vegetation. The internal load management project described above for Meadow Lake will include fish and vegetation management plans to identify options for future management based on anticipated changes to the fish and plant communities following the drawdown and sediment treatment. Additionally, Lake Magda has demonstrated relatively high CLP coverage and an imbalanced fish community and therefore development of fish and vegetation management plans is recommended.

### **4.3 SUMMARY OF PRIORITIES**

The Cities of Brooklyn Park and New Hope and the Commission's Technical Advisory Committee reviewed and discussed the data and potential future actions. Priorities for Lake Magda and Meadow Lake for the next five years will be:

#### *Priorities for Lake Magda*

- ▲ Reduce watershed loading to Lake Magda
- ▲ Continue to identify and implement BMP(s) in the subwatersheds that discharge to the channel on the north end of lake (see map in Appendix B). Modeling suggests these subwatersheds accounts for approximately 75% of the annual watershed load to the lake. Potential practices for these subwatersheds could include, but are not limited to:
  - Construction of iron enhanced sand filter near the outfall of subwatershed S1247
  - Curb-cut raingardens near/above existing catch basins
  - Additional retrofitting of catch basins with larger sumps, grit chambers, hydrodynamic separators, SAFL Baffels, etc. as opportunities arise
  - Enhanced street sweeping schedule

- ▲ Work with lakeshore owners to implement raingardens, rain barrels, slope stabilizations, shoreline restorations, and other practices throughout the subwatersheds (Magda Direct NW, East, and Highway) draining directly to the lake
- ▲ Develop and implement balanced short- and long-term aquatic vegetation and fish management plan for Lake Magda.

#### Priorities for Meadow Lake

- ▲ Reduce watershed loading to Meadow Lake
  - Partner with the lake association to promote and work with property owners throughout watershed to identify and implement curb-cut raingardens near/above existing catch basins
  - Promote the Metro area Adopt-a- Drain program ([www.adopt-a-drain.org/](http://www.adopt-a-drain.org/).)
  - Continue working with lakeshore owners to implement lakeshore restorations and native plantings
  - Continue enhanced street sweeping program throughout Meadow Lake subwatershed and document effectiveness (e.g. number of sweepings, amount of sediment removed)
  - Collect water quality samples, bathymetric surveys, sediment cores, and assess fish populations on New Hope Golf Course Ponds that are hydrologically connected to the lake to determine if these ponds are a potential source of TP to Meadow lake
- ▲ Reduce internal loading to Meadow Lake
  - Conduct water level drawdown(s) during late fall/winter to expose and consolidate sediment, promote winterkill of existing fish population, reduce CLP seedbank, and promote native vegetation growth
  - Conduct sediment treatment (e.g. aluminum sulfate (alum), Phoslock ®, iron filings) to reduce phosphorus release from the sediment
  - Develop long-term plan to treat, manage, and monitor CLP and fish populations following water level drawdown(s) and sediment treatment

## 5.0 References

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Nürnberg, G. K. 2004. Quantified Hypoxia and Anoxia in Lakes and Reservoirs. The Scientific World Journal, 4: 42-54. [downloads.hindawi.com/journals/tswj/2004/276509.pdf](https://downloads.hindawi.com/journals/tswj/2004/276509.pdf)

Wenck Associates Inc. 2010a. Lake Magda Nutrient TMDL.  
<https://www.pca.state.mn.us/sites/default/files/wq-iw8-20e.pdf>

Wenck Associates Inc. 2010b. Lake Magda Nutrient TMDL Implementation Plan.  
<https://www.pca.state.mn.us/sites/default/files/wq-iw8-20c.pdf>

Wenck Associates Inc. 2010c. Meadow Lake Nutrient TMDL.  
<https://www.pca.state.mn.us/sites/default/files/wq-iw8-18e.pdf>

Wenck Associates Inc. 2010d. Meadow Lake Nutrient TMDL Implementation Plan.  
<https://www.pca.state.mn.us/sites/default/files/wq-iw8-18c.pdf>

