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Schmidt, Pomerleau and Bass Lakes Nutrient TMDL Five Year Review

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Table of Contents

Table of Contents (Cont.)

FIGURES

APPENDICES

Executive Summary

This report is a review of progress toward meeting the load reductions identified in the Schmidt, Pomerleau and Bass Lakes Nutrient TMDL (Wenck 2009a). 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 2009. 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.

Three basins in the Bass Chain of Lakes – Pomerleau, Schmidt, and Bass – were formally designated Impaired Waters for excess nutrients in 2002. A TMDL and Implementation Plan were approved in 2009. The TMDL determined that phosphorus load reductions of 67% (Pomerleau), 9% (Schmidt), and 34% (Bass) would be necessary to ensure the lakes met or exceeded state water quality standards for nutrients.

The Implementation Plan (Wenck 2009b) 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.

Annual monitoring of lake water quality on Pomerleau, Schmidt and Bass Lakes has been conducted intermittently over the past 20 years, primarily through the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP). While management actions have reduced nutrient loading to all three lakes, no trend of improvement has been observed yet in Pomerleau and Bass Lakes, which still consistently exceed state standards. Schmidt Lake, in contrast, has improved water quality over the past 10 years and now consistently meets state water quality standards. Schmidt Lake was removed from the State's Impaired Waters List in 2014.

A significant amount of data and information has been collected on all three lakes since the completion of the TMDL, including: in-lake water quality monitoring, stream and tributary 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 74% and 33% are still needed for Pomerleau and Bass, 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. No reductions are required for Schmidt Lake at this time since the lake currently meets State water quality standards.

Priorities for the next five years will be:

- Reduce internal load released by sediments in Bass and Pomerleau Lakes.
- Develop and implement balanced short- and long-term aquatic vegetation management plans. These plans will define goals, success indicators, and costs and the feasibility of achieving the desired goals.
- Complete subwatershed assessments in high-loading areas and undertake targeted treatment and infiltration BMPs.
- Continue to reduce watershed load by adding treatment and infiltration BMPs as opportunities arise.
- Expand and enhance public education and outreach within the drainage area.

1.0 TMDL Overview

1.1 BACKGROUND

Schmidt, Pomerleau, and Bass Lakes are located in the City of Plymouth (Figure 1-1). Schmidt and Bass Lakes are considered shallow lakes, and Pomerleau is classified as a deep lake. Pomerleau Lake discharges through Upper Bass Creek into Bass Lake. Schmidt Lake outlets through the City of Plymouth storm sewer system to Bass Lake. Bass Lake outlets to Bass Creek on the eastern shore of the lake.

The watershed is predominantly single family residential in the City of Plymouth, with a small portion in Maple Grove. The area around Pomerleau Lake and the upper Bass Lake lakeshed has recently undergone extensive land use conversion from golf course/ agricultural/ large lot residential to higher density residential.

Table 1-1. Lake characteristics.

Parameter	Bass Lake	Pomerleau Lake	Schmidt Lake
Surface Area (ac)	175	30	37
Average (Maximum) Depth (ft)	10.1 (31)	10.9 (26)	5.5 (27)
Volume (ac-ft)	1,760	329	202
Residence Time (years)	0.47	0.73	0.50
Littoral Area (ac)	143 (82%)	19.8 (66%)	34 (92%)
Watershed Size (ac)	3,183	266	232

The Schmidt, Pomerleau and Bass Lakes Nutrient Total Maximum Daily Load (TMDL) addressed nutrient impairments in these three lakes. The TMDL and associated Implementation Plan were approved in 2009 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 Pomerleau, Schmidt and Bass Lakes TMDL.

			Existing TP Load [lbs/yr]	Allowable TP Load [lbs/yr]	Estimated Load Reduction	
					lbs/yr	Percent
Pomerleau	Wasteload	Watershed MS4	174	52	122	70%
	Load	Atmospheric	7	7	0	0%
		Internal	29	9	20	69%
		TOTAL LOAD	210	68	142	67%
Schmidt	Wasteload	Watershed MS4	103	93	10	10%
	Load	Atmospheric	9	9	0	0%
		Internal	12	11	1	9%
		TOTAL LOAD	124	113	11	9%
Bass	Wasteload	Watershed MS4	1,279	826	453	35%
		Upstream Lakes	116	78	38	33%
	Load	Atmospheric	46	46	0	0%
		Internal	2	2	0	0%
		TOTAL LOAD	1,443	952	491	34%

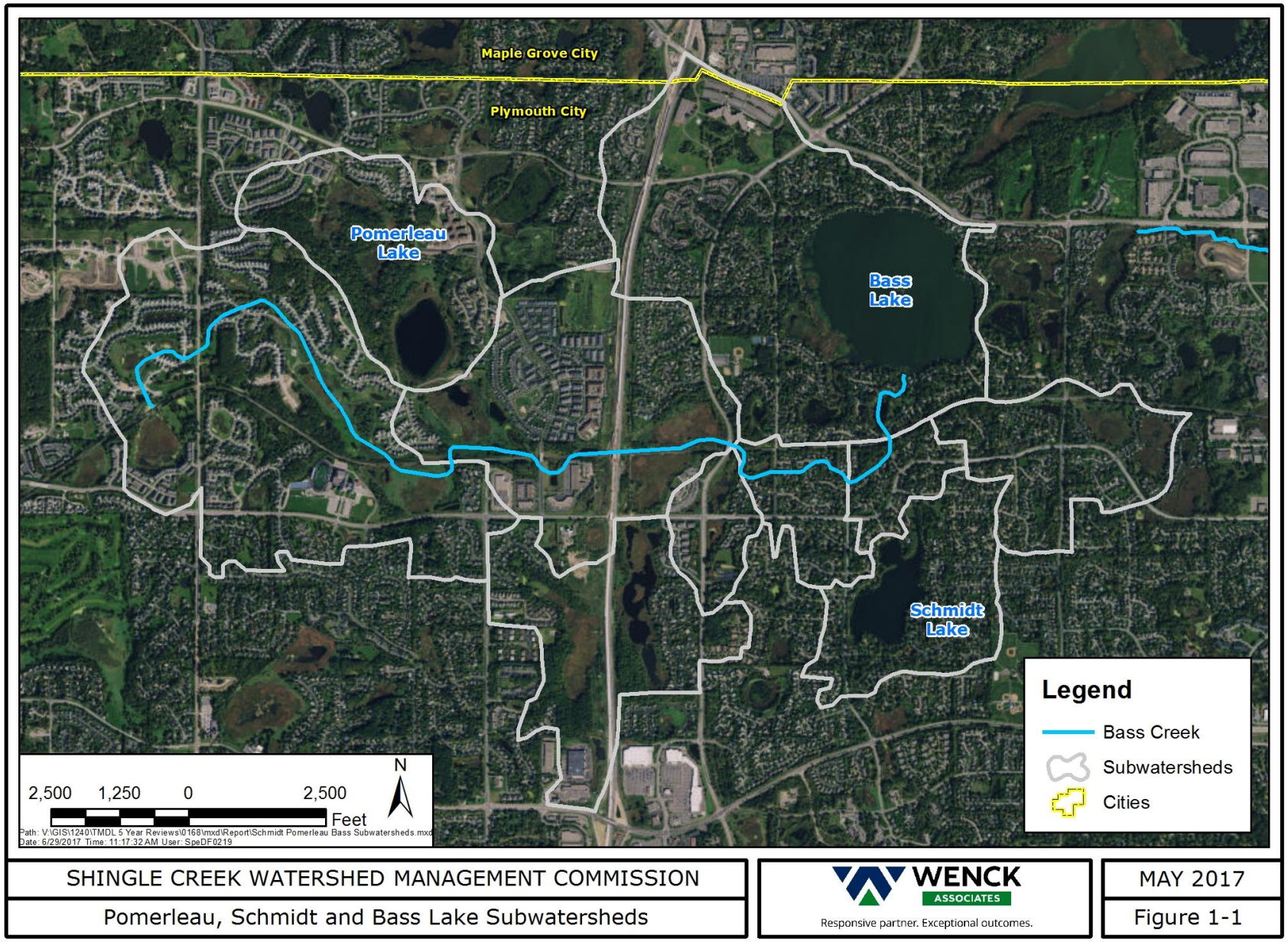

Figure 1-1. Bass, Schmidt and Pomerleau Lake watershed and subwatersheds.

1.2 IMPLEMENTATION PLAN

1.2.1 Principles

The TMDL Implementation Plan enumerated the principles guiding development and implementation of the load reduction plan. 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 existing BMPs** and taking advantage of highway and redevelopment projects to add or upsize BMPs;
4. **Require pollutant load reduction and volume management for new development** according to Commission rules and standards as well as Low Impact Design principles;
5. **Fostering 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;
6. **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, the native prairie and savanna was cleared and wetlands 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 Pomerleau, Schmidt and Bass were identified in the form of BMP strategies. Following are the BMP strategies that were highest priority during the first five years of the TMDL. Their 2017 status is shown in *italics*. More detail on completed strategies is discussed later in this report.

Priorities for all lakes

- Evaluate adequacy of existing rules, standards, and ordinances for runoff water quality treatment and volume management and revise if necessary. *The rules and standards were modified in the watershed Management Plan, incasing the volume management standard and expanding their application to smaller projects under 5 acres.*

- Add BMPs as opportunities arise to decrease runoff from the watershed and increase stormwater treatment. *Various projects have been completed – see Table 2-1 below.*
- Monitor and maintain existing stormwater ponds and other BMPs to sustain removal effectiveness. *Ongoing through City program.*
- Increase infiltration and abstraction in the watershed. *Various projects have been completed – see Table 2-1 below.*
- Increase frequency of street sweeping in sensitive areas. *City of Plymouth currently implements street sweeping program throughout all three lake subwatersheds – see Table 2-1 below.*
- Conduct or update aquatic plant surveys and prepare management plans. *Aquatic vegetation surveys were completed for Schmidt and Bass Lakes in 2014. Vegetation surveys for Pomerleau Lake will be completed by the Commission in 2017.*
- Encourage shoreline restoration to improve runoff filtration. Several *shoreline restoration projects have been completed in Schmidt and Bass Lakes – see Table 2-1 below.*
- Measure actual internal load. *Sediment cores were collected and analyzed for phosphorus release in Bass and Schmidt Lake in 2010 and in Pomerleau Lake in 2013. Results of these analyses are presented in Section 3.1.3.*
- Monitor water quality in the lakes on an ongoing basis.
  - *Pomerleau Lake water quality monitoring was conducted by Three Rivers Park District in 2010, 2011, and 2013 and through the Citizen Assisted Lake Monitoring Program (CAMP) in 2014. The Commission will be monitoring water quality in 2017 as part of its Intensive Lake Monitoring Program.*
  - *Schmidt Lake water quality monitoring was conducted by Three Rivers Park District in 2010-2011; through CAMP in 2011, 2015; and by the Commission in 2014; and by the Schmidt Lake Improvement Association in 2012-2016.*
  - *Bass Lake water quality monitoring was conducted by Three Rivers Park District in 2010-2011; through CAMP in 2010-2016; and by the Commission in 2014*

Priorities for Pomerleau Lake

- Focus on reducing external loads
  - Protect high-value wetlands in the lakeshed and minimize the potential for phosphorus export. *The Plymouth is LGU for administering the Wetland Conservation Act within the city. Functions and values of the wetlands have been assessed, and the City's Wetland Management Ordinance establishes zoning standards and buffer widths based on management class.*
  - Maximize stormwater loading controls on new development, encouraging low impact development. *A significant portion of the lakeshed has recently been, or is currently being re-developed from agriculture, golf course, and large-lot residential to low-medium density suburban development. All recent and future re-development in the lakeshed has or will be done according to Commission stormwater management rules.*
  - Retrofit engineering controls where possible.
- Conduct an aquatic plant survey and prepare an aquatic plant management plan. *Aquatic plant surveys will be performed by the Commission during the summer of 2017 as part of its Intensive Lake Monitoring Program.*
- Conduct zooplankton and phytoplankton surveys. *Not yet completed.*
- Conduct an updated fish survey. *The most recent MnDNR fish survey was conducted in 1994, however the City of Plymouth conducted a fish survey in 2012 (Blue Water Science, 2012a). Results of this survey are discussed in Section 3.1.4.*
- Internal load management. *Not yet completed.*

- Partner with DNR to manage the fish community to promote pisciverous fish. *Not yet completed.*
- Evaluate a possible aeration system identified by the DNR in the Pomerleau Lake management plan. *Not yet completed.*

Priorities for Schmidt Lake

- Update the aquatic plant survey and refine the aquatic plant management plan – focusing on invasive species control. *The Schmidt Lake Improvement Association have routinely conducted vegetation surveys and curly-leaf pondweed and Eurasian watermilfoil treatments annually for the past 15 years.*
- Conduct zooplankton and phytoplankton surveys. *Not yet completed.*
- Conduct an updated fish survey. *The most recent MnDNR fish survey was conducted in 1990, however the City of Plymouth conducted a fish survey in 2011 (Blue Water Science, 2011). Results of this survey are discussed in Section 3.1.5.*
- Consider rough fish removal if recommended by the fish survey. *This has not been completed based on results of the 2011 survey.*
- Reduce external loads where possible
  - Small reductions would make a difference. *Several projects have been completed in the lakeshed (see Table 2-1).*
  - Increase infiltration and filtration in the lakeshed. *See Table 2-1.*
  - Encourage property owners to plant a native shoreline buffer. *Several shoreline restoration projects have been completed in Schmidt Lake.*

Priorities for Bass Lake

- Focus on reducing external loads
  - Retrofit engineering controls where possible. *The City has evaluated a number of potential pond retrofit projects. A stream restoration project to reduce erosion and sedimentation upstream of Bass Lake will be completed in 2021.*
  - Protect high-value wetlands and consider restoration of degraded wetlands. *The Plymouth is LGU for administering the Wetland Conservation Act within the city. Functions and values of the wetlands have been assessed, and the City's Wetland Management Ordinance establishes zoning standards and buffer widths based on management class.*
- Conduct zooplankton and phytoplankton surveys. *Not yet completed.*
- Conduct an updated fish survey. *The most recent MnDNR fish survey was conducted in 1991, however the City of Plymouth conducted a fish survey in 2012 (Blue Water Science, 2012b). Results of this survey are discussed in Section 3.1.5.*
- Consider rough fish removal. *This has not been completed based on results of the 2012 survey.*
- Partner with DNR to restore piscivorous and panfish balance. *Not yet completed.*
- Update the aquatic plant survey and aquatic plant management plan. *Not yet 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. 2017 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 Bass and Schmidt, Pomerleau will be surveyed in 2017.*
    - Sediment chemistry. *Completed for all three lakes.*
    - Zooplankton sampling and other biological assessments. *Not yet completed.*

1.3.2 Stakeholder Actions

The regulated stakeholders responsible for meeting the TMDL are the cities draining to the lake chain, Hennepin County, and MnDOT. 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 2017 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*
    - New and enhanced stormwater ponding
    - Infiltration basins and devices
    - In-line or off-line treatment manufactured devices
    - Rain gardens and biofiltration
  - Shoreline Management and Restoration. *See Table 2-1*
  - Street Sweeping. *See Table 2-1*
- Internal Load Reduction

- Implement internal load reduction projects. *Not yet completed. Sediment cores have been collected for all three lakes. Results of these analyses are presented in Section 3.1.3.*

- Biologic Integrity Management
  - Aquatic vegetation surveys and management plans*. An aquatic vegetation management plan has been developed for Schmidt Lake and the Schmidt Lake Improvement Association routinely monitors and conducts herbicide treatments. Pomerleau and Bass Lakes have not developed vegetation management plans, however Bass Lake routinely conducts curly-leaf pondweed herbicide treatments.*
  - Rough Fish Management. *Not yet completed. The City has conducted fish surveys on all three lakes. Results of these surveys are discussed in Section 3.1.5.*
- Tracking and Reporting
  - Integration of BMPs into stakeholders' SWPPs. *Completed on an ongoing basis.*

2.0 Progress Review

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 Pomerleau, Schmidt and Bass Lake TMDL, and some are general actions across the watershed that will also benefit these lakes.

- As will be discussed later in this document, the Commission sponsors ongoing citizen volunteer water quality monitoring on the three lakes, and has undertaken water quality, sediment core, and aquatic vegetation monitoring through its Intensive Lake Monitoring Program.
- Since the TMDL and Implementation Plan were completed, the Commission has updated its watershed management plan and development rules to be even more stringent. The development and redevelopment 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. The Pomerleau, Schmidt and Bass Lake subwatersheds contain numerous commercial and industrial parcels smaller than five acres. As these develop or redevelop, they will now be required to implement load-reduction Best Management Practices (BMPs)

2.1.2 Stakeholder Actions

The cities draining to the lake chain (primarily the City of Plymouth), Hennepin County, and MnDOT have implemented load reduction BMPs to improve water quality. The BMPs that have been implemented since 2005 are listed in Table 2-1 along with each BMP's estimated phosphorus load reduction. This table does not include actions completed by individual property owners or by any lake associations.

The Pomerleau Lake watershed has seen a shift in land use from agriculture to residential development over the past 20 years. It is estimated that approximately 50% of the Pomerleau Lake watershed has developed under current stormwater management rules. Since 2005, there have been five major residential development projects in the watershed which have resulted in construction of approximately 14 stormwater BMPs (Table 2-1). Model results suggest these BMPs collectively treat approximately 74 pounds of TP per year. However, the residential developments have created more impervious area throughout watershed which has resulted in higher watershed runoff rates (i.e. curve numbers) and flow volumes to Pomerleau Lake. Thus, even though BMPs are currently in-place to treat the newer residential areas, average annual TP loading from the watershed have not changed significantly since the original TMDL study.

Similar to Pomerleau Lake, the Bass Lake watershed – especially the western portions - have experienced significant shifts in land use from agriculture to residential development over the past 20 years. Since 2005, there have been 32 development/re-development projects and 41 stormwater BMPs constructed in the Bass Lake watershed. Model results suggest these BMPs treat approximately 950 pounds of TP per year, however increased impervious area from these developments has resulted in higher runoff rates, higher flow

volumes, and slightly higher annual TP loads to Bass Lake compared to the original TMDL study.

Table 2-1: BMPs implemented since 2005 and estimated phosphorus load reductions.

Lake	City	BMP Type	BMP Description	TP Load Reduction (lbs/yr)
Pomerleau	Plymouth	Residential Development Stormwater BMPs	Approximately 7 water quality ponds, 6 rain gardens, and 1 filtration constructed since 2005 to treat stormwater from 5 major residential development projects	NA[1]
		Street Sweeping (~3.5 road miles)	Sweeping occurs 3 times per year (April, June, and August) using a vacuum assisted street sweeper	10.4
			Subtotal	**10.4**
Schmidt	Plymouth	Inlet Protections	City has installed 51 catch basin inserts throughout watershed since 2005	NA[2]
		Shoreline Restorations	Several shoreline restoration projects implemented since 2005	NA[2]
		Raingardens	City has installed 3 curb-cut raingardens throughout watershed in conjunction with street reconstruction projects	6.2
		Street Sweeping (~4.0 road miles)	Sweeping occurs 3 times per year (April, June, and August) using a vacuum assisted street sweeper	11.9
			Subtotal	**18.1**
Bass	Plymouth	Residential Development Stormwater BMPs	Approximately 38 water quality ponds, 2 iron-enhanced sand filters, and 1 underground chamber constructed since 2005 to treat stormwater from 32 development/re-development projects	NA[1]
		Shoreline Restorations	7 Shoreline restoration projects implemented since 2005	NA[2]
		Street Sweeping (~44.5 road miles)	Sweeping occurs 3 times per year (April, June, and August) using a vacuum assisted street sweeper	132.2
			Subtotal	**132.2**

Notes:

NA[1] No net reduction is attributed to the residential development in these subwatersheds. Land use conversion from agriculture to residential in these subwatersheds has generally resulted in no change or slightly higher watershed TP loads due to higher runoff rates and runoff volumes

NA[2] Not enough information available to estimate potential TP reductions for these projects

3.0 Modeling and TMDL Allocation Updates for Pomerleau, Schmidt and Bass Lakes

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 Pomerleau, Schmidt and Bass Lakes since the completion of the TMDL study. Monitoring activities have included stream flow and water quality (Bass Lake), collection and analysis of intact sediment cores (all three lakes), vegetation surveys (Bass, Schmidt), fish surveys (all three lakes), and in-lake water quality monitoring (all three lakes). These monitoring activities have resulted in a better understanding and more robust dataset than the information available during the TMDL study. Each of these activities is described below in more detail.

3.1.2 Stream Monitoring

Precipitation, water level, flow and water quality was monitored by Three Rivers Park District on behalf of the City of Plymouth at three different sites (BL1, BL2, and BL3) (Figure 3-1) in 2010-2012 and 2014-2015 (link to report). The three monitoring sites are located on tributaries that discharge directly to Bass Lake. The subwatershed draining to BL3 covers approximately 65% (1,850 acres) of the Bass Lake watershed and it is therefore significantly larger than the subwatersheds draining to the BL1 and BL2 monitoring sites.

Flow monitoring results indicate annual flow volumes ranging from approximately 2,000-4,000 acre feet per year and runoff depths ranging from 10-20 inches per year across the entire Bass Lake watershed. By comparison, the P8 watershed model used to develop the 2009 TMDL for Bass Lake also estimated watershed runoff volumes ranging from 2,000-4,000 acre feet per year and runoff depths ranging from 10-20 inches across the watershed.

Water quality monitoring parameters included total phosphorus (TP), soluble reactive phosphorus (SRP), total nitrogen (TN), and total suspended solids (TSS). Results indicate average annual watershed TP concentrations at the smaller tributary sites, BL1 and BL2, range from 150-275 µg/L. Average annual TP at the BL3 tributary station was 155 µg/L in 2015 which was the only year that this station was monitored. The P8 model used in the original TMDL study predicted an average annual TP concentration of 153 µg/L for the entire watershed draining to Bass Lake. Thus, the Bass Lake TMDL study provided relatively accurate estimates of the watershed runoff volumes and TP concentrations monitored by Three Rivers Park District in 2010-2012 and 2014-2015.

3.1.1 Sediment Core Analysis

Intact sediment cores were collected by the Commission on Bass and Schmidt Lakes in 2010, and Pomerleau Lake in 2013. These cores were delivered to the University of Wisconsin - Stout where they were analyzed for sediment phosphorus release under anoxic conditions. Lab results indicate sediment phosphorus release rates were 14.5, 9.3, and 11.8 $mg/m^2/day$ for Bass, Schmidt, and Pomerleau Lakes, respectively. These rates are considered high and exceed the 75^{th} percentile of lakes in Minnesota with measured

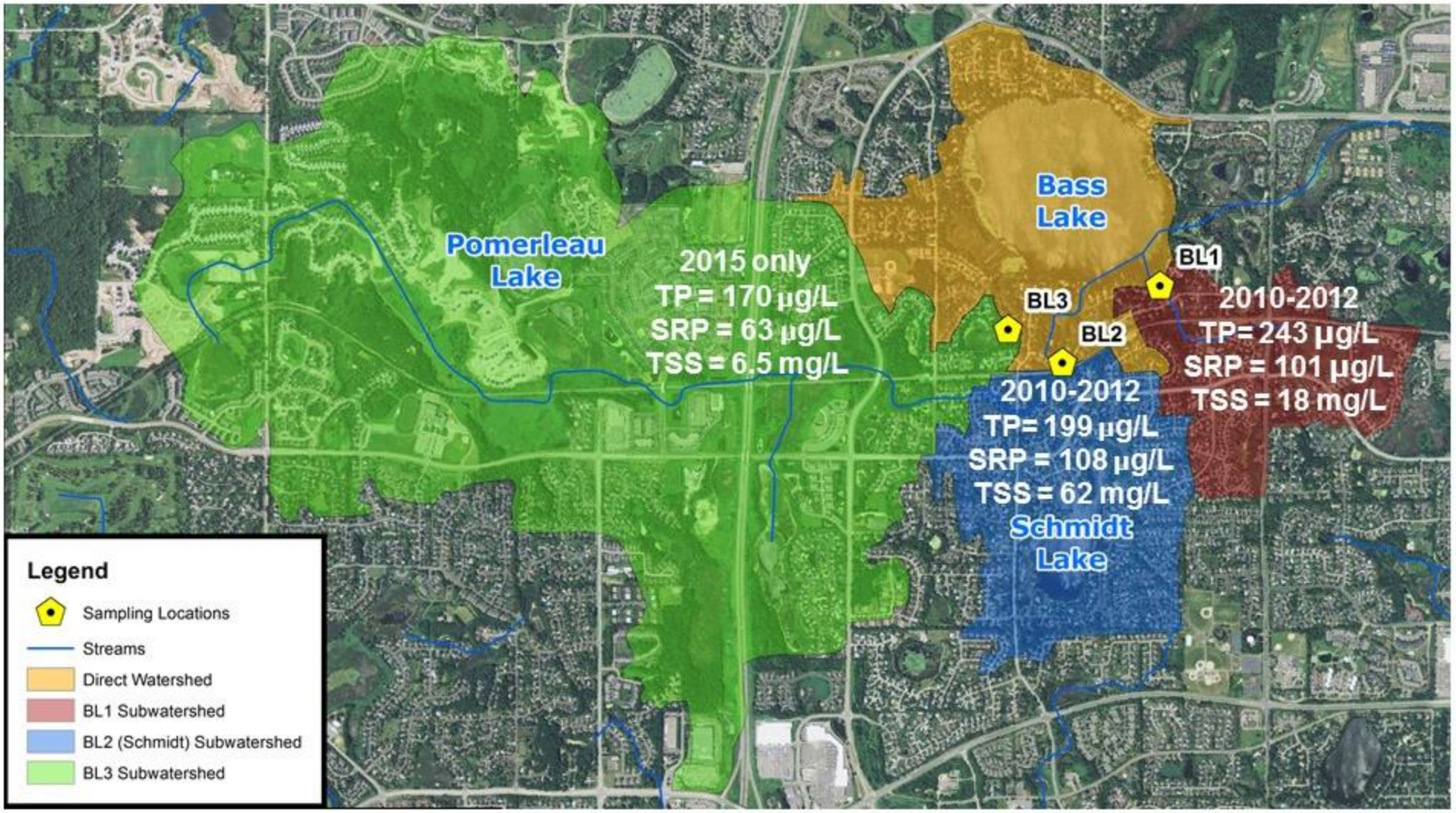

Figure 3-1. Stream monitoring locations in the Bass Lake subwatershed.

phosphorus release rates. These rates were combined with an anoxic factor calculation (Nurnberg 2004) to provide an updated estimate of each lake's average annual internal load. The updated internal load estimates are significantly higher than the internal loads estimated for the original TMDL study (see Tables 3-1 through 3-3 in Section 3.2). The original TMDL study used literature values to assign sediment release rates to each lake to 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 in these lakes.

3.1.2 Vegetation Surveys

Vegetation surveys were performed by the Commission in 2014 on Bass and Schmidt as part of the Intensive Lake Monitoring Program. No vegetation surveys have been performed on Pomerleau Lake to date, however early and late season vegetation surveys are scheduled for 2017 as part of the Commission's Intensive Lake Monitoring Program. The 2014 vegetation surveys for Bass Lake showed relatively good species diversity (8-9 species observed), however plant abundance was low (22%-24% coverage) and limited to the small bays/lagoons and water depths less than 8 feet. Low plant abundance is likely due to poor water quality conditions - primarily water clarity - which are currently not meeting state water quality standards. Curly-leaf pondweed (CLP) was observed at 21% of the sites during the June 2014 survey for Bass Lake. CLP is a non-native plant species that can out-compete native plant species and disrupt lake ecosystems by changing the dynamics of internal phosphorus loading. The Bass Lake Association has conducted targeted herbicide treatments for CLP over the past 10-15 years.

The 2014 vegetation surveys for Schmidt Lake showed relatively good species diversity (8-9 species observed) and plant abundance (83%-85% coverage). CLP was observed at only 15% of the sites during the June 2014 survey for Schmidt Lake. The Schmidt Lake Improvement Association has routinely conducted targeted herbicide treatments for CLP and Eurasian watermilfoil (EWM) for the past 15 years. The Schmidt Lake Improvement Association has also performed semi-regular vegetation surveys dating back to 2004 (link to report). These surveys show that CLP and EWM abundance throughout the lake has decreased since the mid-2000s.

3.1.3 Fish Surveys

Fish surveys were conducted on all three lakes in 2011-2012 by Blue Water Science on behalf of the City of Plymouth. Results of these surveys suggest the Bass and Schmidt Lake fish communities were relatively healthy and had low numbers of rough fish species such as common carp and black bullhead. Prior to these surveys, the most recent fish assessments for Bass and Schmidt Lakes were MnDNR fish surveys completed in 1991 and 1990, respectively. Comparing the 2011-2012 surveys to the early 1990s surveys suggest the fish communities in these lakes have not changed significantly. Management recommendations for these lakes were to conduct routine fish surveys every 3-4 years to ensure these lakes maintain a healthy fish community.

Results of the 2012 fish survey conducted on Pomerleau Lake showed low species diversity (only four species sampled) and the fish community was dominated by black bullheads and black crappies. Comparing these results to the most recent MnDNR survey conducted in 1994 suggest a shift in the fish community in Pomerleau has occurred since the early 1990's. In 1994, the black bullhead population was low, the fish community was dominated by green sunfish, and the lake had a relatively high number of small largemouth bass.

Neither green sunfish or largemouth were observed during the 2012 survey. The 1994-2012 shift is likely the result of partial winterkills which happen periodically in Pomerleau Lake. Management recommendations for the lake included monitoring DO levels during the winter months to determine if aerators are needed, black bullhead harvesting for 2-3 years, and follow-up fish surveys to evaluate the fish community.

3.1.4 In-lake Water Quality Monitoring

Annual monitoring of lake water quality on Schmidt, Pomerleau and Bass has been conducted periodically over the past 10 years. Much of the data was collected through the Metropolitan Council Environmental Services (MCES), Citizen Assisted Monitoring Program (CAMP), City of Plymouth, Three Rivers Park District, and the Schmidt Lake Improvement Association. The Commission monitored water quality on Bass and Schmidt Lake in 2014 through its Intensive Lake Monitoring Program and will be monitoring Pomerleau through this program in 2017. Results of the 2014 monitoring on Bass and Schmidt Lake are presented in the Commission Annual Water Quality Report (link to report). Average annual total phosphorus (TP), chlorophyll-a (chl-a), and Secchi depth for the past 25 years is summarized in Appendix A. In general, TP concentrations in Pomerleau Lake do not show any trends while concentrations in Bass Lake have increased since the late 1990s. Average annual TP concentrations for both lakes have failed to meet state standards every year over the past 10 years.

Water quality in Schmidt Lake, on the other hand, has improved since the TMDL study. Over the past 10 years, Schmidt Lake has met state water quality standards for TP in 9 of 9 years monitored, Chl-a in 7 of 9 years monitored, and Secchi depth in 10 of 10 years monitored. In 2014, the MPCA's Impairment Assessment Team reviewed the recent monitoring data for Schmidt Lake and determined the lake is currently meeting state water quality standards and recommended that Schmidt lake should be removed from the State's 303(d) list of impaired waters. The 2014 and 2016 303(d) lists show the lake's status as delisted, although neither of the lists have received final EPA approval.

3.2 MODELING AND TMDL UPDATES

The original TMDL study 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 for each lake. As discussed in sections 2.1 and 3.1, several BMPs have been implemented and a significant amount of data has been collected for each lake since the completion of the original TMDL study. 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, and calibrated 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 Pomerleau Lake Updated Targets

The original TMDL models used 1999 as a base year for estimating the existing nutrient loading and TMDL allocations for Pomerleau Lake. The original TMDL model called for watershed and internal TP load reduction goals of approximately 122 lbs/year and 20 lbs/year, respectively (Table 1-1). Recent in-lake monitoring, watershed monitoring, and sediment core collection and analysis have greatly improved our understanding of the current condition TP budget Pomerleau Lake. The updated lake response model suggests watershed loading will need to be reduced by approximately 96 lbs/year and internal loading by 130 lbs/year in order for Pomerleau Lake to meet state water quality standards (Table 3-1). Figure 3-2 shows how our understanding of the existing and allowable TP loads in Pomerleau Lake have changed since the original TMDL study.

Table 3-1. Updated existing and allowable TP loads for the Pomerleau Lake.

			Existing TP Load [lbs/yr]	Allowable TP Load [lbs/yr]	Estimated Load Reduction	
					lbs/yr	Percent
Pomerleau	Wasteload	Watershed MS4	156	60	96	62%
	Load	Atmospheric	7	7	0	0%
		Internal	142	12	130	92%
		TOTAL LOAD	305	79	226	74%

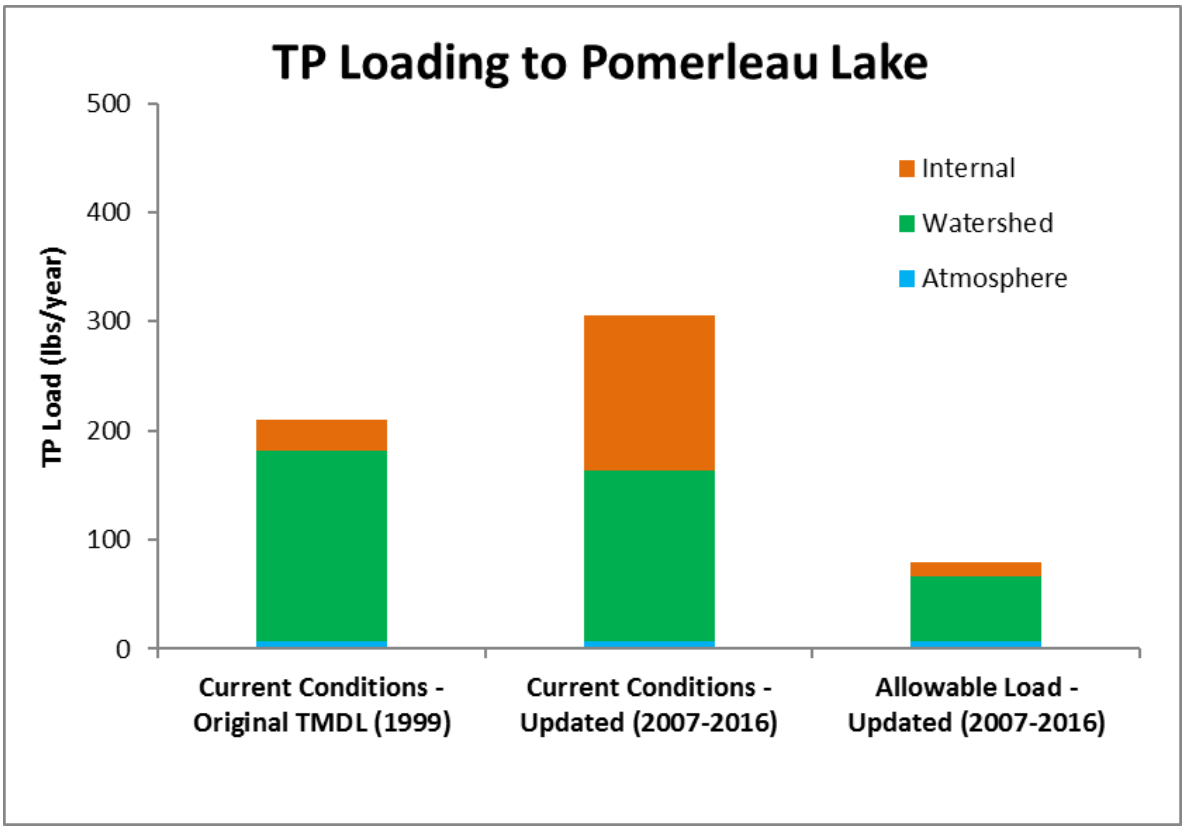

Figure 3-2. Current conditions and updated allowable load targets for Pomerleau Lake.

3.2.2 Schmidt Lake Updated Targets

The original TMDL model used 2001 as a base year for estimating existing nutrient loads and setting the TMDL allocations for Schmidt Lake. This model called for watershed and internal TP load reduction goals of approximately 10 lbs/year and 1 lb/year, respectively (Table 1-1). BMPs completed since 2001 would be considered for computing load reduction toward the TMDL. Since 2005, it is estimated that BMPs implemented in the watershed and lake have led to an annual TP reduction of approximately 18 pounds per year (Table 2-1). Recent monitoring data shows Schmidt Lake is currently meeting state water quality standards and the lake was removed from the impaired waters list in 2016. Thus, the original TMDL load reduction targets for Schmidt Lake have been achieved and no other reductions are required at this time (See Table 3-2 and Figure 3-3).

Table 3-2. Updated existing and allowable TP loads for the Schmidt Lake.

			Existing TP Load [lbs/yr]	Allowable TP Load [lbs/yr]	Estimated Load Reduction	
					lbs/yr	Percent
Schmidt	Wasteload	Watershed MS4	124	124	0	0%
	Load	Atmospheric	9	9	0	0%
		Internal	87	87	0	0%
		TOTAL LOAD	220	220	0	0%

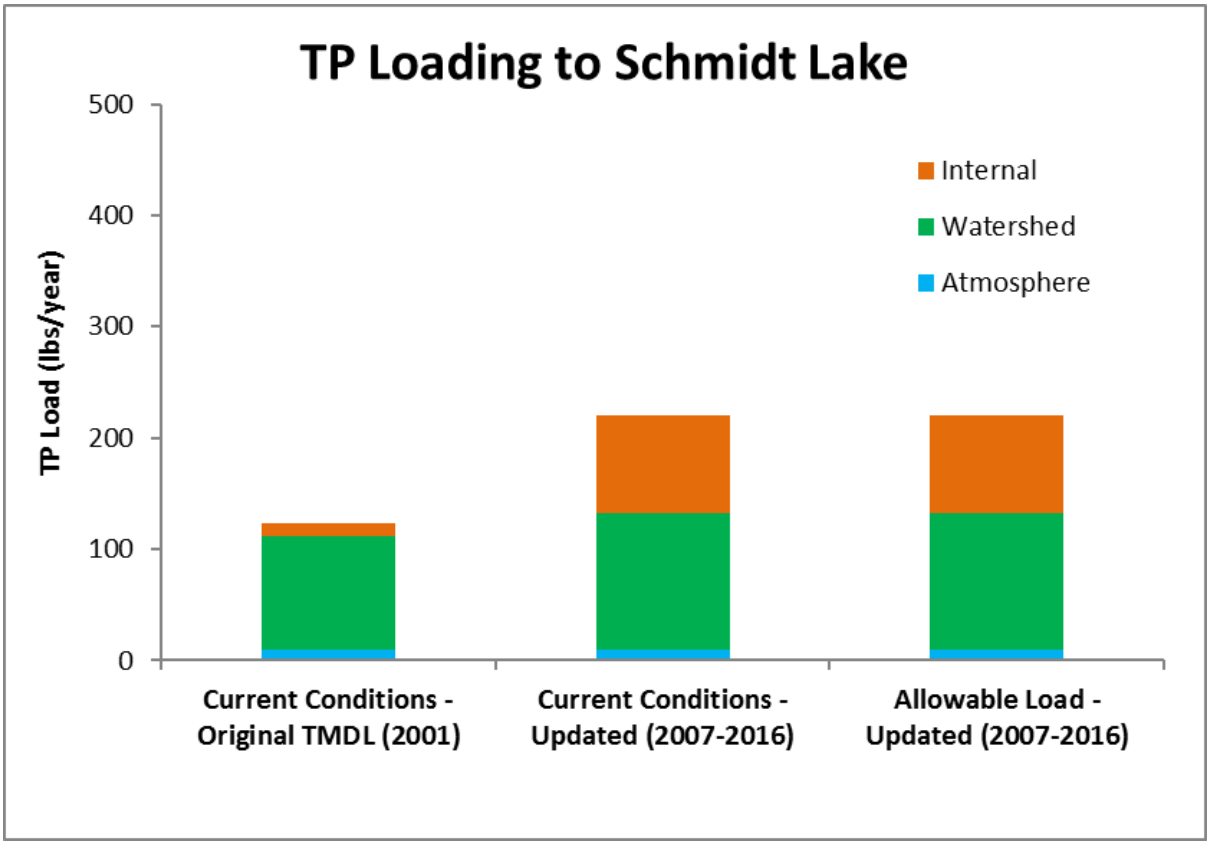

Figure 3-3. Current conditions and updated allowable load targets for Schmidt Lake.

3.2.3 Bass Lake Updated Targets

The original TMDL models used 1999 as a base year for estimating the existing nutrient loading and TMDL allocations for Bass Lake. The original TMDL model called for watershed and internal TP load reduction goals of approximately 1,279 lbs/year and 2 lbs/year, respectively (Table 1-1). Recent in-lake monitoring, stream monitoring, and sediment core collection and analysis have greatly improved our understanding of the current condition TP budget for Bass Lake. The updated lake response model suggests watershed loading will need to be reduced by approximately 215 lbs/year and internal loading by 416 lbs/year in order for Bass Lake to meet state water quality standards (Table 3-3). Figure 3-4 shows how our understanding of the existing and allowable TP loads in Bass Lake have changed since the original TMDL study.

Table 3-3. Updated existing and allowable TP loads for the Bass Lake.

			Existing TP Load [lbs/yr]	Allowable TP Load [lbs/yr]	Estimated Load Reduction	
					lbs/yr	Percent
Bass	Wasteload	Watershed MS4	1,640	1,425	215	16%
		Upstream Lakes	93	53	41	44%
	Load	Atmospheric	42	42	0	0%
		Internal	479	33	446	93%
		TOTAL LOAD	2,254	1,552	701	33%

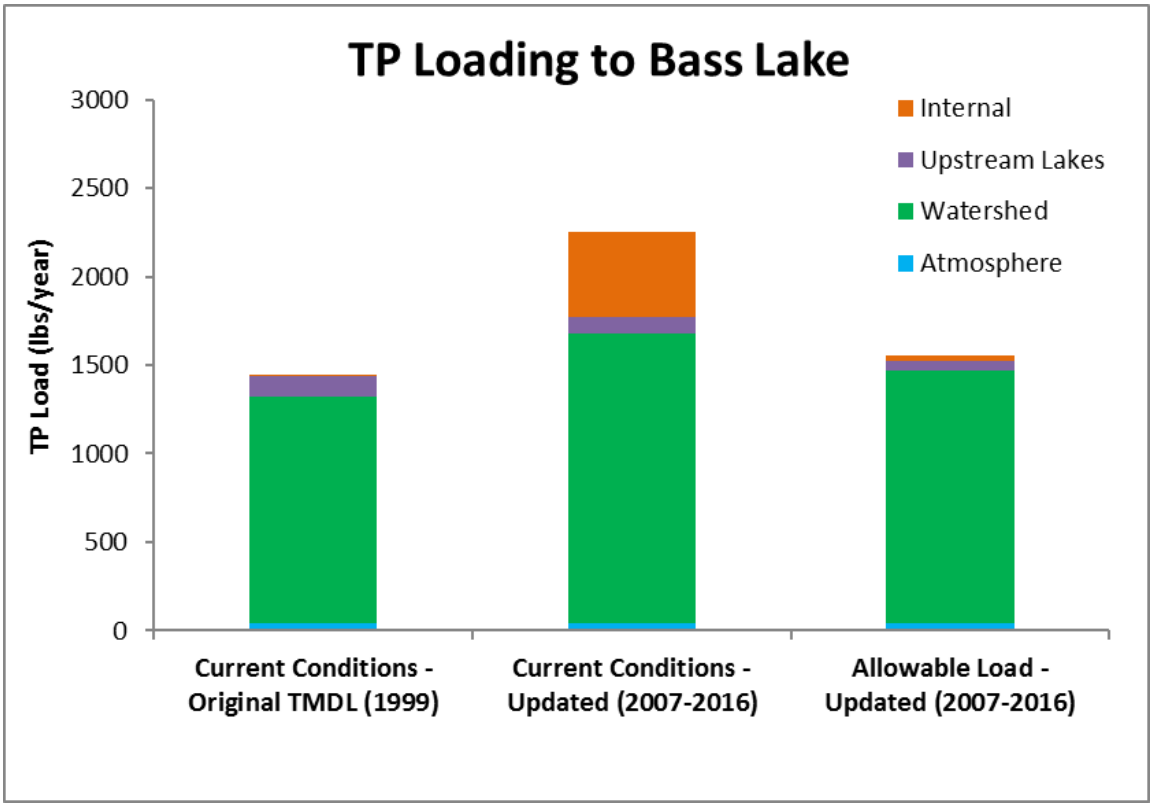

Figure 3-4. Current conditions and updated allowable load targets for Bass Lake.

4.0 Next 5 Year Actions

4.1 PRIORITIES

The City of Plymouth and the Commission's Technical Advisory Committee reviewed and discussed the data and potential future actions. Priorities for Bass and Pomerleau Lakes for the next five years will be:

- Reduce internal load released by sediments.
- Continue to reduce watershed load to the lakes by adding new and enhancing existing treatment BMPs and by increasing infiltration of runoff.
- Complete subwatershed assessments in areas where monitoring data shows higher watershed loading rates.
- Undertake targeted monitoring to better understand sources of watershed load.
- Develop and implement balanced short- and long-term aquatic vegetation and rough fish management plans.

Priorities for Schmidt Lake for the next five years will be:

- Maintain or reduce watershed load to the lake to protect water quality and prevent backsliding.

4.2 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. That more thorough monitoring was completed on Bass and Schmidt Lakes in 2014, with the next assessment expected in 2019. Pomerleau Lake is being assessed in 2017, with a repeat scheduled for 2022. The detailed assessments include aquatic vegetation monitoring.

4.2.1 Subwatershed Assessments

The Commission will work in partnership with Plymouth to complete assessments in priority subwatersheds. These assessments will identify and prioritize opportunities for small-scale BMPs such as boulevard rain gardens and public space bioinfiltration BMPs. One such priority is the subwatershed to the south and east of Bass Lake. Monitoring data collected at the outflow of that subwatershed showed elevated concentrations of phosphorus being discharged into the lake. The Commission will maintain a Cost Share Fund to be used to assist its member cities in implementing identified small BMPs.

4.2.2 Education and Outreach

With the West Metro Water Alliance (WMWA), the Commission will work with the city of Plymouth to provide targeted information messages and outreach opportunities.

4.2.3 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, with a maximum share of $250,000. 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.

4.2.4 Five Year Evaluation

The Commission will complete another Five Year Review in 2022-2023.

4.3 STAKEHOLDER ACTIONS

4.3.1 Reduce Internal Load

Monitoring and modeling performed subsequent to the TMDLs showed that internal load plays a greater than expected role in limiting water quality in both Bass and Pomerleau Lakes. Both are good candidates for alum treatments to seal the sediments in the deeper parts of the lakes that experience periods of low-oxygen when phosphorus is released into the water column. The City of Plymouth will work with the Commission to evaluate the feasibility of alum treatments and if warranted, undertake them.

4.3.2 Aquatic Vegetation Management

The Bass Lake Association and the Schmidt Lake Improvement Association have been active in managing aquatic invasive vegetation in their lakes for a number of years. Internal load management projects will include a vegetation management plan component to identify options for future management based on changes to the plant communities following improvements in lake water clarity.

4.3.3 Opportunistic Projects

Plymouth, Hennepin County, and MnDOT have been routinely including load reduction and infiltration BMPs into their highway and street reconstruction projects. The City will continue to evaluate potential opportunities to incorporate load and volume reduction BMPs in street, park, and other improvement projects.

4.3.4 Street Sweeping

Plymouth currently conducts targeted street sweeping to help minimize phosphorus and sediment loading to its lakes and wetlands. The City will continue to identify critical areas and sweep streets more frequently as necessary.

4.3.5 Shoreline Buffers and Restoration

Plymouth will continue to urge 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.

5.0 References

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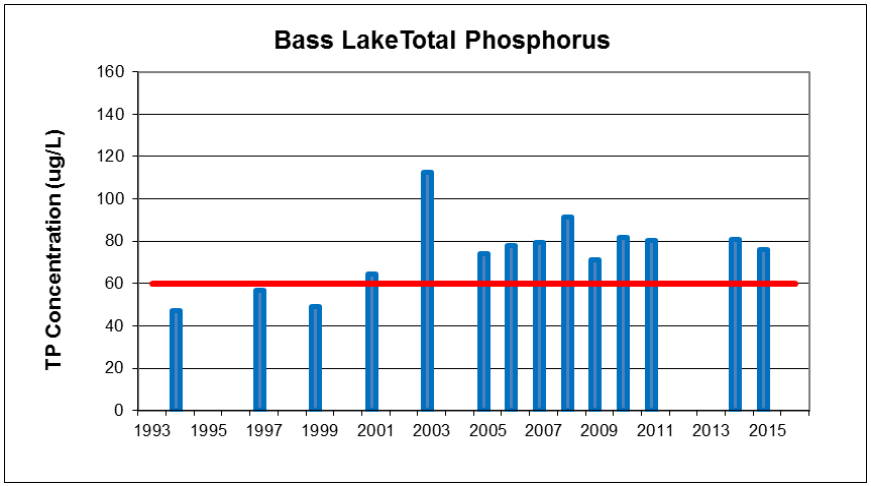
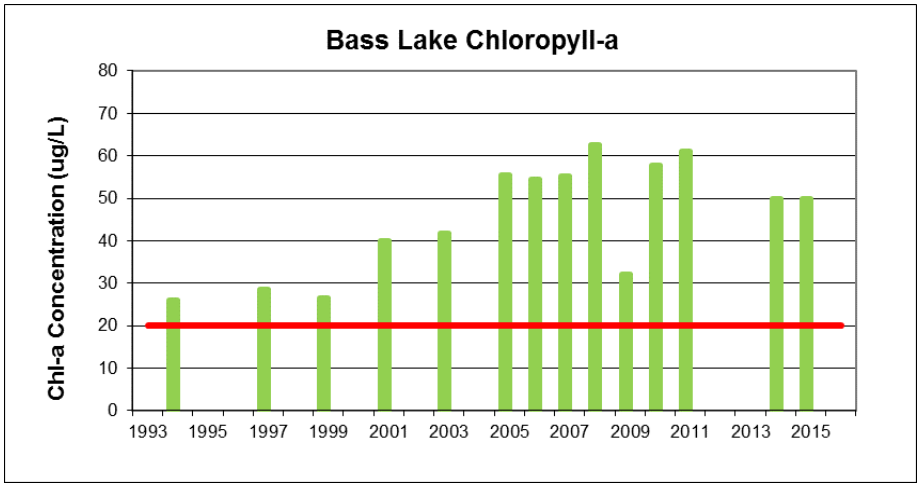
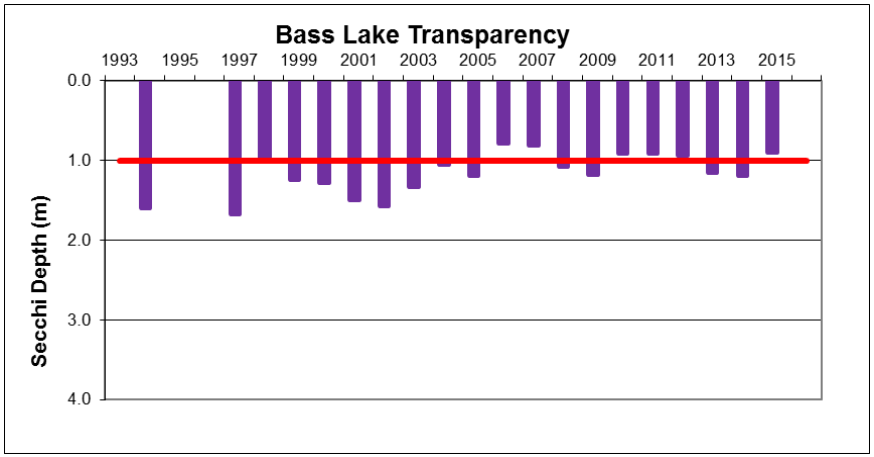
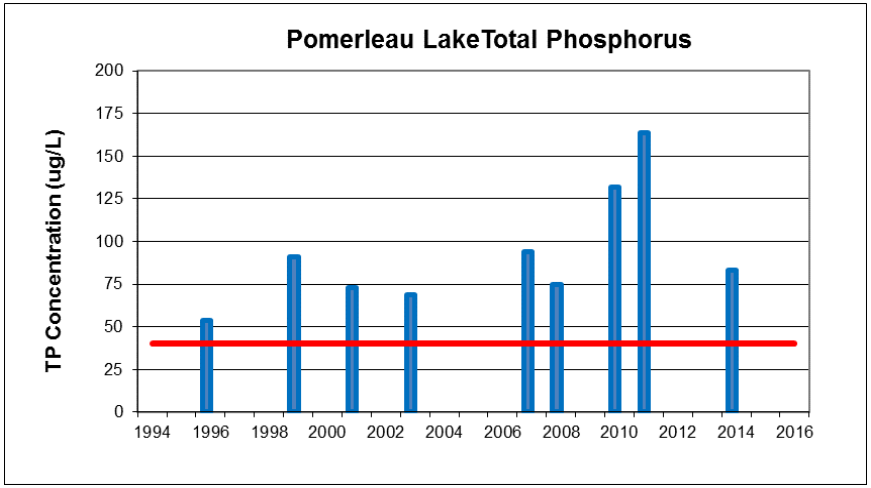
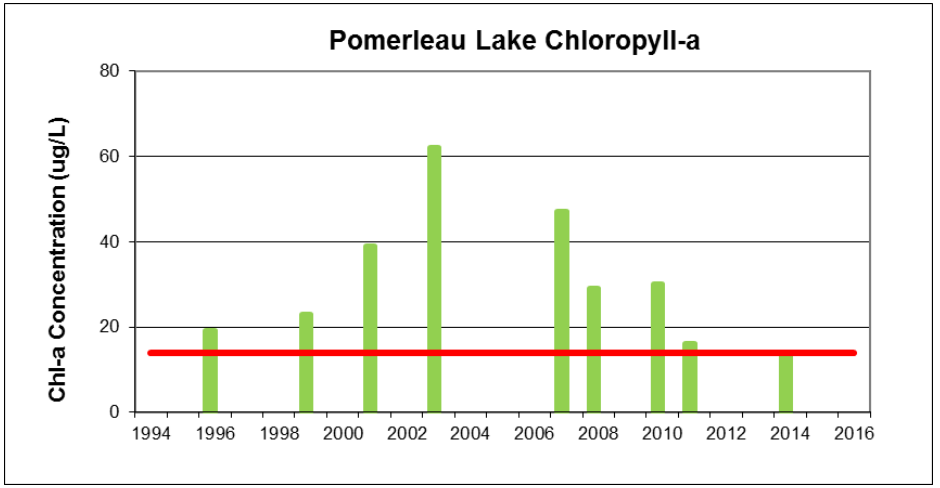

Bass LakeTotal Phosphorus
TP Concentration (ug/L)
160
140
120
100
80
60
40
20
0
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015


Bass Lake Chloropyll-a
Chl-a Concentration (ug/L)
80
70
60
50
40
30
20
10
0
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015


Bass Lake Transparency
Secchi Depth (m)
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
0.0
1.0
2.0
3.0
4.0


Pomerleau LakeTotal Phosphorus
TP Concentration (ug/L)
200
175
150
125
100
75
50
25
0
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Pomerleau Lake Chloropyll-a
Chl-a Concentration (ug/L)
80
60
40
20
0
1994
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2000
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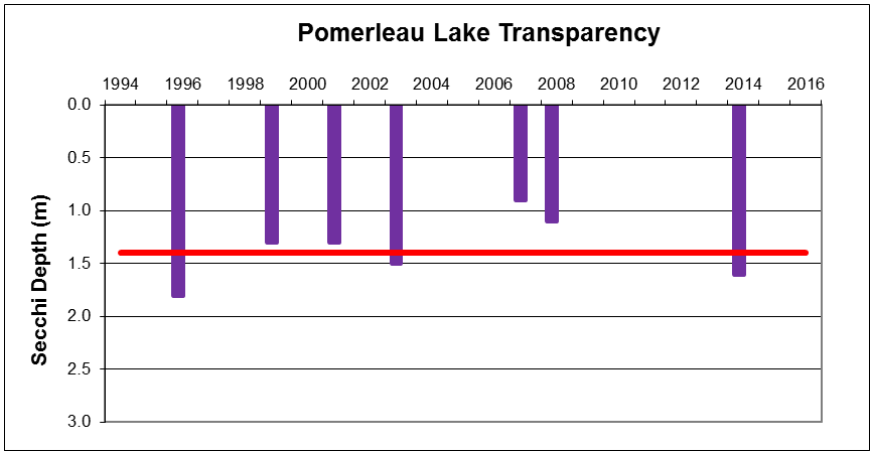
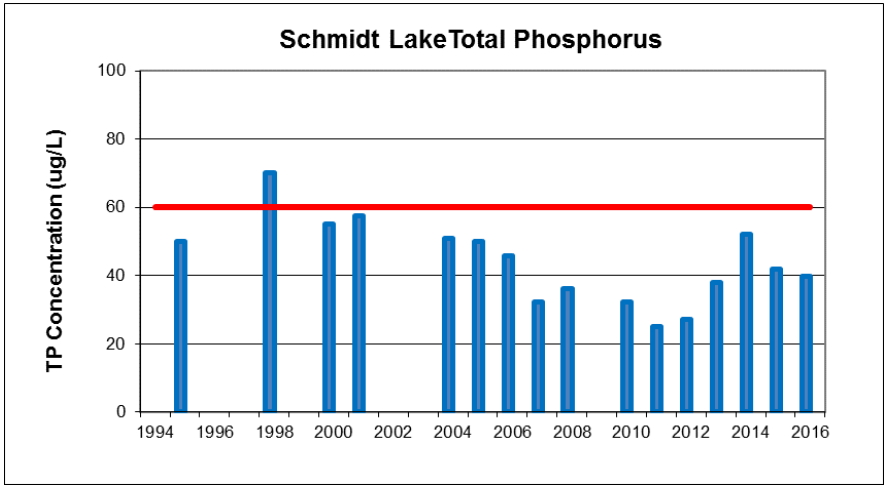
2010
2012
2014
2016


Pomerleau Lake Transparency
Secchi Depth (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016


Schmidt LakeTotal Phosphorus
TP Concentration (ug/L)
0
20
40
60
80
100
1994
1996
1998
2000
2002
2004
2006
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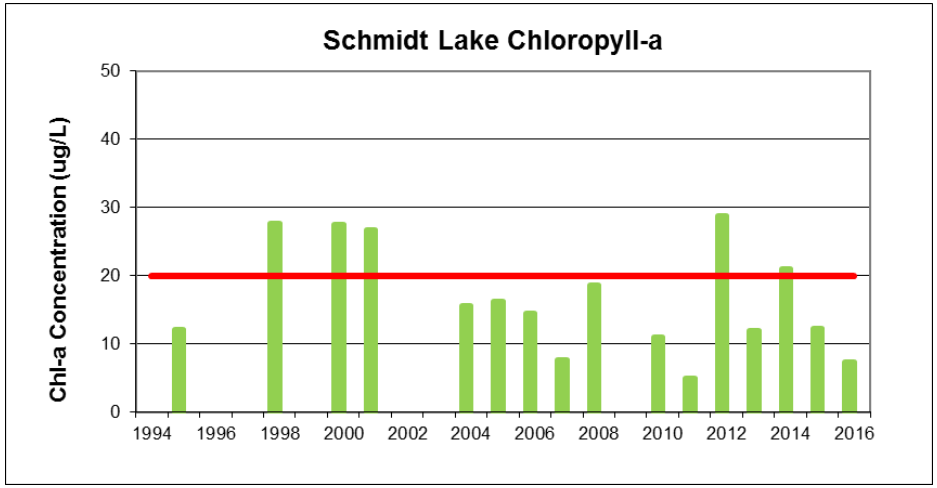
2012
2014
2016


Schmidt Lake Chloropyll-a
Chl-a Concentration (ug/L)
0
10
20
30
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1994
1996
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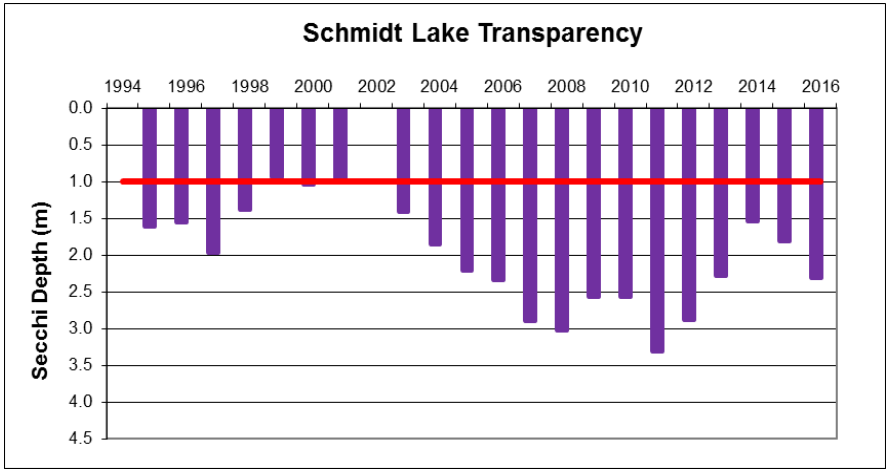
2016


Schmidt Lake Transparency
Secchi Depth (m)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
1994
1996
1998
2000
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2016