Summary of Total Maximum Daily Load (TMDL) report
Reducing phosphorus to minimize algae

Lake Pepin and upstream Mississippi River

from the Crow River to the St. Croix River

What are the issues?

Algae blooms, some leading to fish kills, once plagued Lake Pepin, a naturally occurring lake on the Mississippi River in southeast Minnesota. The Minnesota Pollution Control Agency (MPCA) placed Lake Pepin on its impaired waters list in 2002 because nutrient levels were too high to meet state water quality standards. The MPCA started a study in 2006 on reducing those nutrient levels. The study now includes the Mississippi River upstream, from the Crow River near Dayton, Minn., to the St. Croix River near Hastings, Minn.

The study references phosphorus reductions in several upstream rivers, which are addressed in separate studies.

Phosphorus, much of it from upstream rivers, causes algae blooms in Lake Pepin, as shown in this August 2014 photo by the Minnesota Department of Natural Resources.

Sediment is also an important issue for Lake Pepin. The Mississippi River carries high loads of sediment - the majority from the Minnesota River upstream - with much of it settling out in Lake Pepin. The sediment levels are so high that the upper part of the lake is already filling in. Some phosphorus attaches to sediment, meaning reductions in sediment could reduce phosphorus and minimize algae blooms. A healthier Lake Pepin means addressing both phosphorus and sediment, and addressing them upstream.

How does the study address the issues?

A Total Maximum Daily Load (TMDL) is a study to determine how much of a pollutant a water body can receive and still meet water quality standards. TMDL studies are part of federal and state efforts to monitor water bodies, identify impaired waters, and plan for their restoration.

In the case of Lake Pepin, the TMDL study addresses the level of phosphorus that Lake Pepin and upstream waters can carry and still meet water quality standards.

The Lake Pepin TMDL study was an immense undertaking, due to the size of the watershed, scope of the project, and science developed for it:

- **Size:** Nearly 50,000 square miles – roughly half of Minnesota plus parts of three neighboring states – drain to Lake Pepin through the Upper Mississippi, St. Croix, and Minnesota rivers. No other TMDL project in Minnesota has covered such a large watershed.
- **Scope:** The TMDL addresses phosphorus impairments in the lake and two sections of the Mississippi River upstream. It proposes reductions in phosphorus from many sources.
- **Science:** The MPCA and its partners developed site-specific standards for Lake Pepin and upstream rivers, developed a computer model to help determine pollutant reductions, and examined the link between phosphorus and sediment.

Pepin: Lake or river?

Lake Pepin has characteristics of both a lake and river. Pepin is one of the widest parts of the Mississippi River, bordered by Minnesota on the west and Wisconsin on the east. It is located about 60 miles downstream of St. Paul, Minn., just south of the confluence of the St. Croix and Minnesota rivers with the Mississippi. The lake is 21 miles long, averages 1.7 miles wide and covers 29,295 acres. It has a maximum depth of 60 feet and an average depth of 18 feet.

How were nutrient reductions determined?

The MPCA initially addressed the sediment levels in the Mississippi River and nutrient levels in Lake Pepin in one TMDL study. The agency and partners developed a computer model that examined both sediment and nutrient levels for the Upper Mississippi River from Lock and Dam No. 1 at St. Paul through Lock and Dam No. 4 below Lake Pepin. The model supported TMDLs for both sediment and nutrient impairments in Pools 2, 3, and 4 of the Upper Mississippi River.

Lake Pepin in southeast Minnesota is popular for many types of recreation.

Based on recommendations in 2008 from the study's Stakeholder Advisory Committee and Science Advisory Panel, the MPCA decided to separate the issues of sediment and nutrients by developing separate TMDLs:

- The TMDL addressing sediment for the South Metro Mississippi from St. Paul through Lake Pepin, which was approved by the U.S. Environmental Protection Agency (EPA) in 2016.
- The TMDL for nutrients for Lake Pepin, now open for public comment in spring 2020.

Because Lake Pepin is unique in many ways, the Science Advisory Panel recommended a site-specific standard, a more customized water quality standard, for the lake. One reason is that Lake Pepin has characteristics of both a lake and a river. The MPCA Citizens Board adopted the standard in 2014.

The MPCA and partners then used the computer model to predict the impact of different scenarios on nutrient levels in the lake. The model showed that nutrient reductions in upstream rivers would be needed for Lake Pepin to meet the standard and to continue to do so as population increases and other changes occur. About two-thirds of the algae in Lake Pepin are produced upstream. Thus, the TMDL includes two upstream sections that must meet Minnesota river eutrophication standards:

- Mississippi River from the Crow River to Upper St. Anthony Falls
- Mississippi River from Upper St. Anthony Falls to the St. Croix River

While Lake Pepin is close to meetings its standard, the Upper Mississippi sections need further reductions to meet their water quality standards, as outlined in the table below.

Mississippi River water quality Crow River to Upper St. Anthony Falls	**Standard to meet**	**Average level 2006-2014**
Total phosphorus	100 micrograms per liter	113.9 micrograms per liter
Chlorophyll-a n(green pigment in algae)	18 micrograms per liter	28.1 micrograms per liter
Mississippi River water quality Upper St. Anthony Falls to the St. Croix River	**Standard to meet**	**Average level 2004-2010**
Total phosphorus	125 micrograms per liter	182.3 micrograms per liter
Chlorophyll-a (green pigment in algae)	35 micrograms per liter	37.5 micrograms per liter
Lake Pepin water quality	**Standard to meet**	**Average level 2009-2018**
Total phosphorus	100 micrograms per liter	134 micrograms per liter
Chlorophyll-a (green pigment in algae)	28 micrograms per liter	27 micrograms per liter

What reductions are needed to meet standards?

While Lake Pepin is the focus of this TMDL, the work needs to happen upstream. Both point and non-point sources – regulated and unregulated sources – need to reduce the phosphorus they send downstream. If upstream watersheds meet their phosphorus and sediment goals, then local rivers will be healthier and so will Lake Pepin at the end of the system.

Flow is a big factor for the lake:

- During high flows, when runoff is high, sediment is the concern. Several other studies address the sediment issues, including the South Metro Mississippi TMDL and Minnesota River TMDL.

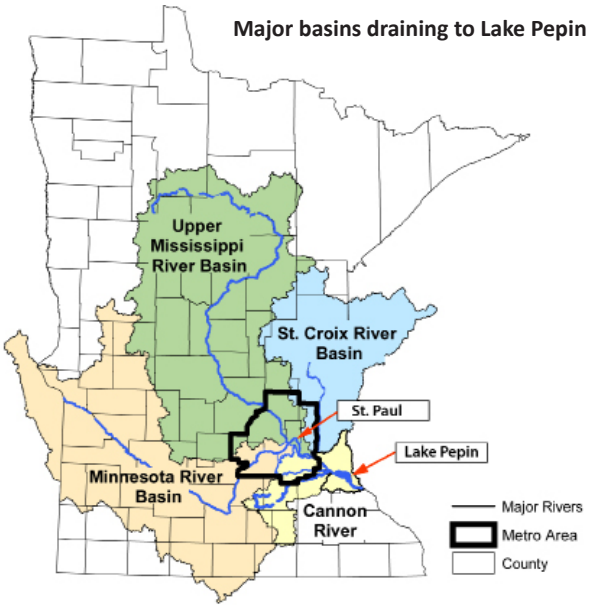
- During low flows, wastewater discharges are more of a concern because they make up more of the flow and their phosphorus has potential to grow algae. The Lake Pepin TMDL and several upstream studies regulate these discharges through permits for wastewater and municipal stormwater. The majority of the cities and industries in the Lake Pepin watershed have done their part in reducing total phosphorus loads over the past 20 years.

The model used to simulate pollutant reductions recommended the following phosphorus reductions on an average yearly basis:

- 70% reduction from wastewater treatment facilities (goal nearly achieved as of 2020)
- 50% reduction from non-point sources in the Minnesota River and Cannon River
- 50% reduction in resuspension of phosphorus from bottom sediment of the Mississippi River from St. Paul to Hastings
- 20% reduction from non-point sources in the Mississippi River at Lock & Dam 1, St. Croix River and other tributaries

These reductions would protect aquatic recreational uses for Lake Pepin and the downstream pools and should be applicable over the range of high and low water flows.

Major basins draining to Lake Pepin



What do these reductions mean for regulated and non-regulated parties?

Water quality data and modeling confirm that both point and non-point source reductions - regulated and non-regulated - are required to meet the water quality standards. Due to the variability in weather and stream flows, the entire load reduction needed across all years could not be borne by either point or non-point sources alone.

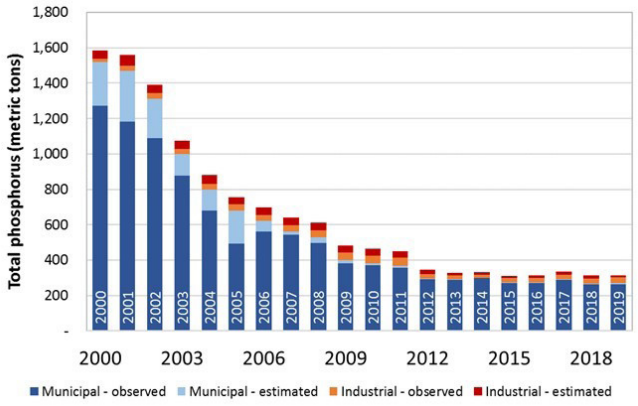
Regulated sources

For regulated parties, mainly wastewater and stormwater systems that need a state permit, reducing algae in Lake Pepin means reducing phosphorus in their discharges to the environment.

Wastewater: Over the past two decades, most of the cities and industries in the Lake Pepin Basin have done their part to reduce total phosphorus loads. Phosphorus in wastewater from municipal and industrial facilities decreased by 80% from 2000-2019.

The MPCA has assigned a waste load allocation – a percentage of the overall phosphorus reduction needed – to 397 permitted wastewater dischargers, based on their size and treatment type. Many of these facilities are already meeting their targets for local resources and Lake Pepin. However, several facilities in upstream watersheds may need to meet more restrictive phosphorus limits to meet eutrophication standards for their rivers.

Phosphorus reductions in wastewater in the Lake Pepin Basin



Wastewater treatment facilities have reduced phosphorus going to Lake Pepin by 80% since 2000.

Municipal stormwater: For communities with a Municipal Separate Storm Sewer System (MS4), the goal is to reduce phosphorus in their stormwater discharges to rivers upstream of Lake Pepin to 0.35 lb/acre/year. This goal is based on literature review, stakeholder input, and agreement with existing basin-wide TMDLs. This approach does not call for a flat percentage reduction from all MS4 permits. Instead, municipalities may consider work already completed toward reducing phosphorus discharges.

Non-regulated parties

The TMDL calls for big reductions in phosphorus from non-point sources, mainly cropland runoff and fertilizer leaching, but these sources are exempt from regulation and thus the focus will remain on voluntary best management practices (BMPs) that build soil health, reduce runoff and help water quality. For example, cover crops are one practice that helps water quality by keeping soil in place during spring storms. Keeping soil in place prevents sediment – and phosphorus – from draining to lakes and river.

How will the reductions be implemented?

To guide implementation for the Lake Pepin TMDL study, the MPCA is using the Minnesota Nutrient Reduction Strategy (www.pca.state.mn.us/water/nutrient-reduction-strategy), developed to reduce nutrient loads across the state and Minnesota's contribution to the dead zone in the Gulf of Mexico.

The Nutrient Reduction Strategy calls for a 45% reduction in phosphorus in the Mississippi River, compared to a 1980 - 1996 baseline, by 2025. The strategy provides a detailed discussion of phosphorus sources, transport mechanisms, reduction strategies, and example BMP combinations that can attain reduction goals.

The MPCA and other partners have already completed several other TMDLs that address phosphorus and/or sediment in the Lake Pepin watershed, including those for Lake St. Croix, Byllesby Reservoir and the Minnesota River.

Minnesota has made progress in reducing phosphorus and sediment loads to lakes and streams by way of wastewater treatment and soil conservation. Additionally, the buffer initiative and the Conservation Reserve Enhancement (CREP) are expected to improve water quality, but those changes will need many years to take effect and show pollutant reductions.

Much of the work to reduce phosphorus going to the Mississippi River and Lake Pepin needs to be done on agricultural land (non-point sources). Public and private entity solutions will be important, both in terms of creating markets for perennial plants to reduce soil erosion and providing services to support conservation practices. Examples of such work include:

- University of Minnesota's Forever Green program (www.forevergreen.umn.edu)
- General Mills' commitment to use perennial plants in food production
- Land O'Lakes Sustain program (www.landolakessustain.com)

The science shows that work upstream will reduce phosphorus and algae in Lake Pepin and the Upper Mississippi as well as lead to dramatic improvements in several other rivers. Now it's up to cities, landowners, private companies, government programs and other stakeholders to make it happen.

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Study history

- **2002:** State lists Lake Pepin as impaired by nutrients
- **2006-'09:** Extensive stakeholder involvement building model and technical work for TMDL use
- **2008:** State separates phosphorus TMDL from sediment TMDL
- **2009:** Work starts on "custom" water quality standard for lake
- **2014:** MPCA Citizens Board approves standard for lake; river eutrophication standards also adopted by state
- **2016:** Upstream Mississippi River impairments added to study
- **2016:** EPA approves TMDL addressing sediment in South Metro Mississippi
- **2016-'17:** LimnoTech, a private consultant, develops Lake Pepin/Upper Mississippi TMDL document
- **2018-'19:** MPCA and EPA review TMDL document
- **2019:** Informal review and comment period for interested parties
- **2020:** EPA approves TMDL addressing sediment in Minnesota River
- **2020:** Formal public notice period for Lake Pepin/ Upper Mississippi TMDL with comments becoming part of official record
- **Next step:** Respond to comments and submit revised TMDL to EPA for approval

More info

Lake Pepin TMDL study: www.pca.state.mn.us/water/tmdl/lake-pepin-excess-nutrients-tmdl-project

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