Pollution

April 2020

2020 Pollution Report to the Legislature

A summary of Minnesota's air emissions and water discharges

MINNESOTA POLLUTION CONTROL AGENCY

Legislative charge

Minn. Statutes § 116.011 Pollution Report

A goal of the Pollution Control Agency is to reduce the amount of pollution that is emitted in the state. By April 1 of each even-numbered year, the Pollution Control Agency shall report the best estimate of the agency of the total volume of water and air pollution that was emitted in the state in the previous two calendar years for which data are available. The agency shall report its findings for both water and air pollution:

(1) In gross amounts, including the percentage increase or decrease over the previously reported two calendar years; and

(2) In a manner which will demonstrate the magnitude of the various sources of water and air pollution.

History:

1995 c 247 art 1 s 36; 2001 c 187 s 3; 2012 c 272 s 72

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Contributors/acknowledgements

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Executive summary

Every two years, the Minnesota Pollution Control Agency (MPCA) uses the most recent data available to estimate the total amounts of pollution emitted into our air and discharged to our water resources. The MPCA also estimates the percentage increase or decrease over the previous two calendar years, and the relative contributions of the various sources of pollution.

This report also includes information on emissions of toxic air pollutants, greenhouse gas emissions, nonpoint source water pollutants, and emerging contaminants of concern. While it is still not possible to quantify the amounts of all of these pollutants released in the environment, the agency is working to understand the effects of these pollutants on human health and the environment and to develop strategies to reduce their presence in Minnesota's air and water.

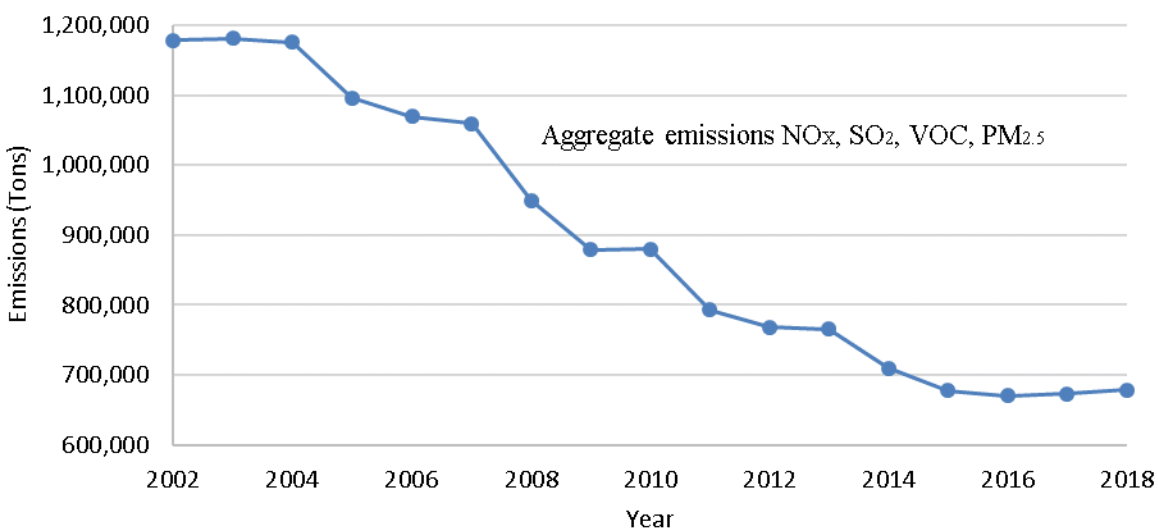
Air emissions

In this report, the MPCA details statewide emissions of pollutants to Minnesota's air, including criteria air pollutants (pollutants with national ambient air quality standards), greenhouse gases, and other air toxics.

Criteria emissions from larger facilities with air permits are available every year; however, emissions from other sources are only available every three years. 2014 is the latest year with statewide emissions data for these sources.

Figure 1 shows estimated total statewide emissions of four major criteria air pollutants from 2002 to 2018. During this time, estimated emissions of these pollutants have decreased by almost 50%. While this report is focused on statewide total emissions, MPCA understands that some air pollutants are emitted disproportionately in areas of concern.

Figure 1. Minnesota statewide emissions trends



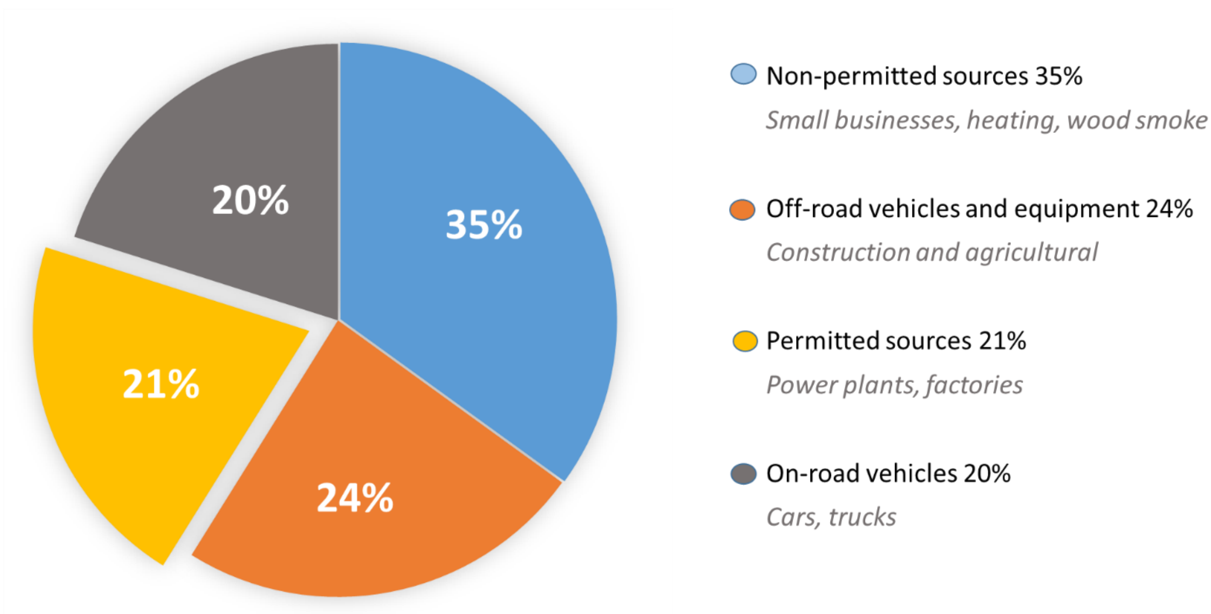
Emissions in 2002, 2005, 2008, 2011 and 2014 were calculated from all sources, including mobile, non-permitted and permitted sources. For in-between years, mobile and non-permitted estimates were held constant; therefore, any changes for those years are solely due to permitted sources. Prior to 2012, $PM_{2.5}$ emissions were calculated every three years. In 2012, MPCA started calculating emissions annually for all permitted sources. It is therefore important not to place undue emphasis on yearly changes. Fire and biogenic emissions are not included in the totals because they vary greatly from year to year.

Since 2002, overall emissions have been decreasing. This is generally due to improvements in pollution control technology, governmental regulations, facilities voluntarily reducing emissions and changes to estimation methodologies. Most criteria emission estimates from permitted sources increased slightly between 2016 and 2018. Changes at utilities and mining companies resulted in increases in all criteria pollutants. Mining production increased significantly in 2017 compared to 2016, when many mines were idled due to low demand, and stayed at about the same production level in 2018. Between 2016 and 2017 emissions for all pollutants in mining increased by about 30%. In 2018, sulfur dioxide emissions from utilities increased; specifically Otter Tail Power Company burned double the amount of coal compared to 2017 and Xcel Energy's Sherburne Generating Plant burned about 30% more coal then in 2017.

In 2018, emissions from manufacturing have also continued to increase across all pollutants. This increase is likely due to continued economic growth and a resulting increase in manufacturing. The most recent finalized statewide emission estimates are from 2014; MPCA expects that 2017 statewide emissions estimates will be available in the summer of 2020.

In 2014, most air pollution came from smaller, widespread sources, including vehicles, small businesses and construction equipment. Figure 2 shows a breakdown of 2014 statewide emissions.

Figure 2. Sources of criteria air pollutant emissions in Minnesota, 2014



Slightly more than a third of Minnesota emissions come from non-permitted sources, such as auto-body shops, gas stations, and home heating and air conditioning systems. Individually, these are small sources, but when combined, contribute significantly to overall emissions. On-road vehicles, such as cars and trucks, make up about 20% of emissions in Minnesota. Off-road vehicles and agricultural and construction equipment contribute 24% of total emissions in Minnesota. Emissions from permitted sources, typically power plants and large industrial factories, make up 21% of total statewide emissions.

Lead, mercury and other air toxics are pollutants that can be toxic at very low concentrations. In 2014, 16 tons of lead were emitted into the air. MPCA is waiting to finalize the 2017 data to update the value. Additionally in 2017, 1518 pounds (draft value) of mercury were emitted in Minnesota. These pollutants have also trended downward, with about a 12% statewide decrease in air emissions of lead from 2011 to 2014 and a 33% decrease in mercury during the period from 2014 to 2017.

In Minnesota, the MPCA estimates greenhouse gases (GHGs) for electric generation, transportation, agriculture, and the industrial, residential, commercial, and waste sectors. The most recent emission inventory for GHGs was completed in 2016. Since 2005, Minnesota's total greenhouse gas emissions have declined by about 12% and are currently not on track to meet the goals of the Next Generation Energy Act of 2007 (NGEA) (Minn. Stat. § 216H.02). NGEA called for a GHG reduction goal of 15% below 2005 emissions by 2015, and longer-term goals for 2025 (30% below 2005 emissions) and 2050 (80% below 2005 emissions). Recently, Executive Order 19-37 was signed to establish a Climate Change Subcabinet and the Governor's Advisory Council on Climate Change. These two groups will provide input to the Governor on how to get on track to achieve the Next Generation Energy Act goals.

Air toxics are estimated every three years, with the latest statewide estimates available from 2014. Air toxics from permitted sources are complete for 2017 and will be discussed elsewhere in the report. Statewide emissions from 2017 are expected to be available later this year.

There may be differences in the total emission figures for a given year discussed in this report versus past MPCA emission reports because data may be updated in MPCA's emission inventory due to corrections or changes in methodology. Detailed and updated air emissions data can be found at https://www.pca.state.mn.us/2018-pollution-report.

Future emissions of pollution to Minnesota's air may be influenced by a number of factors, including:

- **Future installation of NO_x controls**. Although emissions from taconite facilities increased due to improved measurement methods and production increases from 2016 to 2018, emissions are expected to decrease with future installation of NO_x controls required by federal rules.
- **Continued decreases in on-road mobile emissions**. In September 2019, Governor Walz directed the MPCA to begin the rulemaking process to adopt low-emission vehicle and zero-emission vehicle standards. The rulemaking, called Clean Cars Minnesota, aims to ensure that Minnesotans continue to have access to the cleanest vehicles available and to increase the availability of electric vehicles. The MPCA has been taking public input and plans to publish the proposed rules in 2020.
- **Decreasing emissions from electric utilities.** Emissions from utilities should continue to decrease due to increases in renewable energy sources such as wind and solar; increases in energy efficiency; and power plant modernization, which includes retirement of less efficient, older coal plants and increased use of natural gas. MPCA is also in the initial stages of developing a strategy for complying with U. S. Environmental Protection Agency (EPA)'s Affordable Clean Energy Rule (ACE). ACE requires states to evaluate coal-fired power plants for efficiency improvements.

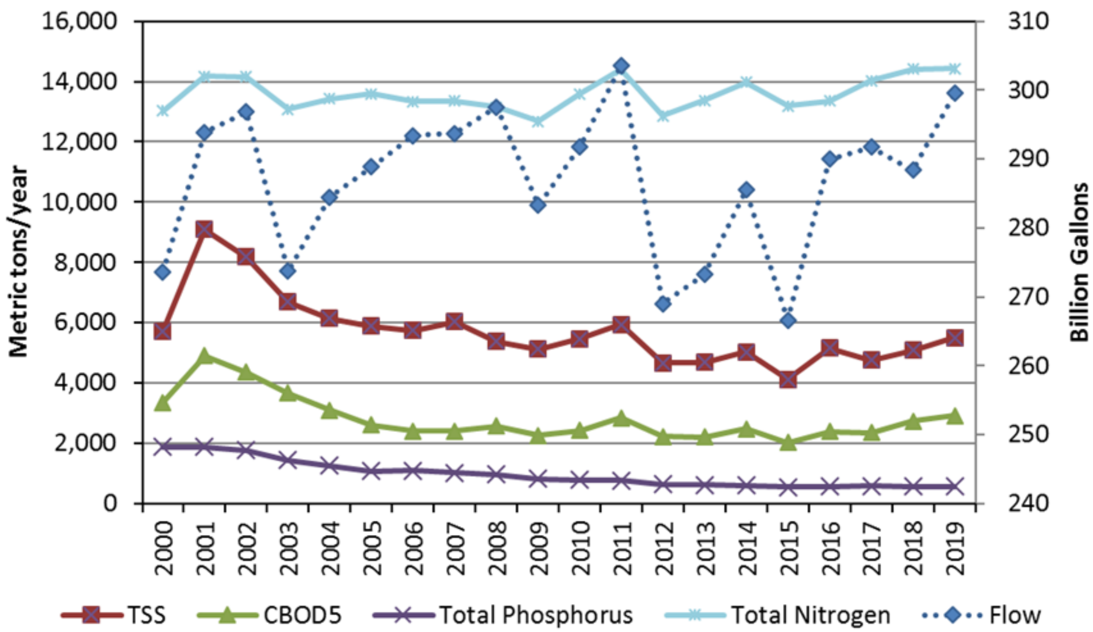
Water discharges

In this report, the MPCA provides estimates of discharges to surface water from point sources of pollution—primarily municipal and industrial wastewater treatment facilities. The report also describes agency efforts to reduce nonpoint sources of pollution and progress in watershed monitoring and assessment. A final section highlights ongoing efforts in the state to monitor and address contaminants of emerging concern in Minnesota's waters.

Pollutant loads from wastewater treatment facilities are calculated by combining effluent flow data with reported pollutant concentrations or estimated pollutant concentrations where facility-specific data are not available. Estimated concentrations used to calculate pollutant loads are based on categorical assumptions that account for waste stream and facility-type characteristics. Concentration estimates are based on effluent data from similar waste streams and facility types when available, and in some cases estimates are based on best professional judgment. Pollutant loads calculated from measured wastewater flows and observed concentrations are considered to be highly reliable while less confidence is warranted for pollutant loads derived from estimated concentrations.

The chart below shows pollutant effluent flow and loading trends for four measures of wastewater pollution from 2000-2019. The four pollutants are total suspended solids (TSS), carbonaceous biochemical oxygen demand ($CBOD_5$), total phosphorus and total nitrogen. Effluent flow is reported in billion gallons per year. Pollutant loads for TSS, $CBOD_5$, total phosphorus and total nitrogen are reported in metric tons per year.

Figure 3. Pollutant loading trends from Minnesota wastewater treatment facilities, 2000-2019



Overall, effluent flows tend to fluctuate based on precipitation. The overall health of the economy also affects the amount of industrial production, which in turn affects industrial effluent flows and the amount of industrial effluent treated at municipal wastewater treatment facilities. Regulatory policies implemented over the past 15 years have promoted the reduction of total phosphorus discharged by wastewater treatment facilities, which has led to significant improvements in water quality. Total phosphorus is the primary pollutant associated with excess algal growth in Minnesota's lakes and streams.

With the exception of total nitrogen levels, which have increased in wastewater discharges, facilities have also decreased the following:

- Total suspended solids, which include sediment and other particles that cloud the water.
- Carbonaceous biochemical oxygen demand, which is a measurement of the potential to deplete levels of dissolved oxygen needed by fish and other aquatic life.

Facilities throughout Minnesota have made significant investments in technology, equipment and training that have led to these improvements.

Wastewater treatment facilities have also significantly reduced direct discharges of mercury to Minnesota's waters. Mercury is a toxic element that accumulates in fish tissue and presents a risk to fish eating populations. Mercury reduction in wastewater is a result of successful source reduction programs at entities like dental offices and installation of treatment technologies at wastewater treatment plants for mercury removal, where necessary. On average, the data show a 36% reduction in mercury loads from a 4.02 kilogram per year baseline in 2005/2006. Direct discharges of mercury in wastewater are very small compared to atmospheric sources of pollution.

Minnesota has made significant progress in cleaning up point sources of water pollution. Nonpoint sources of pollution from rainfall or snowmelt moving over or through the ground, carrying natural or human-made pollutants into lakes, streams or wetlands now pose the greater challenge for prevention and cleanup. Many of nonpoint sources of pollution that affect Minnesota's surface and groundwater resources are the result of choices that people make every day such as lawn care practices, farming practices, watercraft operation and waste disposal. The daily decisions that homeowners, developers, farmers and businesses make regarding land uses are crucial to protecting water resources from the effects of nonpoint source pollution.

Point sources have the greatest potential to impact the environment during periods of low precipitation and stream flow. Nonpoint sources, including runoff from agricultural fields, feedlots, urban areas, and on-site sewage treatment (septic) systems, are most significant during periods of high precipitation and stream flow. Further pollutant reductions are needed from both point sources and nonpoint sources to achieve goals in set in federal and state law for protecting human health and the environment.

Although there is no completely reliable way to quantify volumes of pollutants released by nonpoint sources, the Board of Water and Soil Resources (BWSR) estimates pollution reductions from projects that receive Clean Water Funds. From 2000 to 2019, more than 11,556 best management and conservation practices have been installed with Clean Water Funds, resulting in a reduction of about 189,279 pounds of phosphorus and 176,791 tons of sediment across the state. Minnesota agencies released the fifth Clean Water Fund Performance Report in February 2020, which documents how Clean Water Funds are being spent and how much progress has been made. The MPCA also publishes a Healthier Watersheds: Tracking the Actions Taken webpage to track reductions in both point and nonpoint water pollution.

Future discharges of point source pollution to Minnesota's waters will be influenced by a number of factors, including the following:

- **Wastewater treatment infrastructure**—Minnesota's wastewater systems are aging. Significant investments are needed to replace failing infrastructure and upgrade treatment facilities to meet more restrictive standards and expand systems to accommodate growth. Both rural and metro facilities face serious challenges to make these improvements to their infrastructure.
- **River eutrophication standards**—Adopted in 2015, these standards are designed to protect aquatic life from the negative impacts of excess algae in rivers and streams. More restrictive discharge limits associated with these standards have the potential to further reduce pollutants from wastewater facilities.
- **Nutrient Reduction Strategy—**Multiple state and federal agencies developed the Minnesota Nutrient Reduction Strategy in 2014 to address excess levels of nutrients—primarily phosphorus and nitrogen—in Minnesota's waters. Reduction goals for phosphorus and nitrogen outlined in the strategy are designed to protect both Minnesota waters and downstream waters, including Lake Winnipeg, the Great Lakes and the Gulf of Mexico. Nitrate loads leaving Minnesota via the Mississippi River contribute to the oxygen-depleted "dead zone" in the Gulf of Mexico. A 2013 study on Nitrogen in Minnesota Surface Waters indicated that more than 70% of nitrate is coming from cropland, with the rest coming from sources such as wastewater treatment plants, septic and urban runoff, forests and the atmosphere.

- **Clean Water Fund investment—**Clean Water Fund dollars resulting from passage of the Clean Water, Land and Legacy Amendment will continue to accelerate the implementation of practices to improve and protect Minnesota's water resources. However, Clean Water Funds available for implementation are not sufficient to meet the demand from local governments and landowners.

Air pollutant emissions overview

Thousands of chemicals are emitted into the air. Many of these are air pollutants that can directly or indirectly affect human health, reduce visibility, cause property damage and harm the environment. For these reasons, the MPCA attempts to reduce the amount of pollutants released into the air. In order to understand the sources of air pollution and to track the success of reduction strategies, the MPCA estimates the emissions of certain air pollutants released in Minnesota.

The Minnesota Emission Inventory estimates emissions from permitted facilities every year in order to fulfill Minnesota rules. In addition, federal rules require the MPCA to estimate emissions every three years from three other principal source categories: non-permitted sources, mobile sources, and fire sources. Biogenic sources include emissions from natural sources such as soils and vegetation. This report only includes manmade sources. Overall, the Minnesota Emission Inventory includes emissions from four principal source categories.

1. *Permitted sources:* Typically large, stationary sources with relatively high emissions, such as electric power plants and refineries. A "major" source emits a threshold amount (or more) of at least one criteria pollutant, and must be inventoried and reported.
2. *Non-permitted sources:* Typically stationary sources, but generally smaller sources of emissions than point sources. Examples include dry cleaners, gasoline service stations and residential wood combustion. These sources do not individually produce sufficient emissions to qualify as point sources. For example, a single gas station typically will not qualify as a point source, but collectively the emissions from many gas stations may be significant.
3. *Mobile sources:* Mobile sources are broken up into two categories: *on-road* vehicles and *off-road* sources. *On-road vehicles* include vehicles operated on highways, streets and roads. *Off-road* sources include off-road vehicles and portable equipment powered by internal combustion engines. Lawn and garden equipment, construction equipment, aircraft and locomotives are examples of off-road sources.
4. *Fires:* Fire emissions are produced by inadvertent or intentional agricultural burning, prescribed burning or forest wild fires.

Criteria pollutants—The 1970 Clean Air Act identified six major air pollutants that were present in high concentrations throughout the United States known as "criteria pollutants." These air pollutants are particulate matter ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), nitrogen oxides (NO_x), ozone (O_3), carbon monoxide (CO) and lead (Pb). The Minnesota Criteria Pollutant Emission Inventory estimates emissions of five criteria pollutants (PM_{10}, SO_2, NO_x, CO and Pb) as well as a group of ozone precursors called volatile organic compounds (VOCs). Emissions estimates for large facilities are available for 2018. 2014 emissions estimates are available for non-permitted, mobile and fire sources. Statewide 2017 emissions should be available sometime in the summer of 2020.

$PM_{2.5}$ and ammonia (which is tracked because it contributes to $PM_{2.5}$ formation) yearly emission calculations for permitted facilities started in 2012, while non-permitted, mobile, and fire are still calculated on a three-year cycle, with latest estimates available for 2014, with 2017 emissions expected later this year. Fire emissions depend on many factors including type of fire, ecosystem conditions, and weather. As a result, fire emissions vary greatly from year to year. Similarly, biogenic emissions are widespread and contribute to background air pollution concentrations. They are impacted by vegetation, temperature and solar radiation. Biogenic emission estimates are not included in this report.

Greenhouse gases—Increases in ambient levels of greenhouse gases can lead to global climate change. The MPCA tracks and reports emissions for six greenhouse gases (carbon dioxide (CO_2), nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) in terms of CO_2 equivalents (CO_2e). CO_2e compares the warming potential of different gases to the impact of CO_2. Emission estimates for 2016 are included in this report. Federal and state rules require MPCA to estimate GHG emissions from permitted sources each year. Starting in 2011, small permitted sources began reporting GHG emissions. In 2012, all permitted point sources began submitting GHG emissions to the MPCA.

Air toxics – Many other air pollutants are released in smaller amounts than most of the criteria pollutants, but may still be toxic. The EPA refers to chemicals that can cause serious health and environmental hazards as hazardous air pollutants or air toxics. Air toxics include chemicals such as benzene, formaldehyde, acrolein, mercury and polycyclic aromatic hydrocarbons (PAHs). Air toxic emissions from all sources are estimated every three years. Minnesota data comes from the 2014 Minnesota Air Toxics Emission Inventory. 2017 data is expected to be available later in the year.

With each new inventory, improvements are made in terms of pollutants covered, source categories included, and the accuracy of emission estimates. Therefore, changes in the way emissions are calculated may affect trends, even if there was no real increase or decrease in emissions.

The reader may note differences in the total emission figures for a given year discussed in this report, versus previous emission reports the MPCA has published, because data may be updated in past emission inventories due to corrections or changes in methodology.

This report shares summarized statewide emissions of air pollutants. A detailed breakdown of 2014 air emissions is available online on the MPCA website. When 2017 data become available, the MPCA website and emission inventory workbooks will be updated accordingly. MPCA has developed multiple workbooks containing permitted source, statewide and county-level emissions. The applications contain permitted source data going back to 2006 and statewide data starting in 2008. The workbooks are a way for MPCA to share data in an automated, interactive and user-friendly format.

For more information, see the following websites:

https://www.pca.state.mn.us/air/air-emissions

https://www.pca.state.mn.us/air/statewide-and-county-air-emissions

https://www.pca.state.mn.us/air/point-source-air-emissions-data

Criteria air pollutant emissions

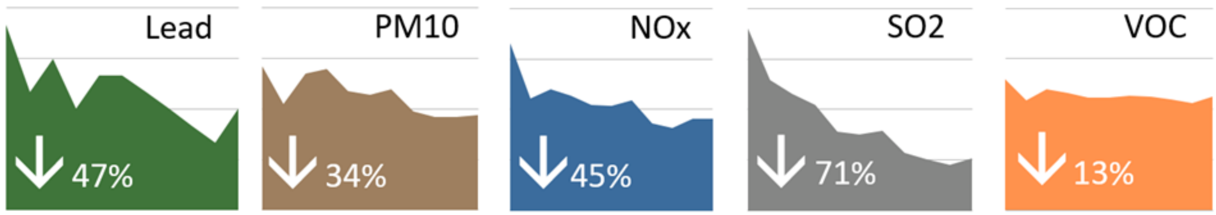
Minnesota's Emission Inventory Rule requires all facilities in Minnesota that have an air emissions permit to submit an annual emission inventory report to the MPCA. The report quantifies emissions of the following regulated pollutants:

- *Particulate matter less than 10 microns in diameter (PM_{10})* is a broad class of chemically and physically diverse substances that exist as discrete particles (liquid droplets or solids) over a wide range of sizes. EPA currently has National Ambient Air Quality Standards for particulate matter in two size classes, $PM_{2.5}$ and PM_{10}. $PM_{2.5}$ and PM_{10} are associated with numerous adverse health effects. Fine particles are the major cause of reduced visibility in parts of the United States. In addition, when particles containing nitrogen and sulfur deposit onto land or waters, they may affect nutrient balances and acidity. Finally, different types of particulate matter, for example black carbon (soot) and sulfate particles, play a role in climate change.

- *Sulfur dioxide (SO_2)* belongs to the family of sulfur oxide gases and forms when fuel-containing sulfur (mainly coal and oil) is burned and during gasoline production and metal smelting. Short-term exposures to SO_2 is linked with adverse respiratory effects. SO_2 also reacts with other chemicals in the air to form tiny sulfate particles and acids that fall to earth as rain, fog, snow, or dry particles. Acid rain damages the environment, accelerates the decay of buildings and monuments and is a major component of haze.
- *Nitrogen oxides (NO_x)* are made up of two primary constituents: nitric oxide (NO) and nitrogen dioxide (NO_2). NO is a colorless, odorless gas that is readily oxidized in the atmosphere to NO_2. NO_2 exists as a brown gas that gives photochemical smog its reddish-brown color. NO_x forms when fuel is burned at high temperatures. NO_2 exposure is linked with adverse respiratory effects. It is also a major precursor both to ozone and to fine particulate matter ($PM_{2.5}$). Deposition of nitrogen can lead to many environmental problems including fertilization and acidification of terrestrial, wetland and aquatic systems, which can result in changes in species number and composition such as reduction of fish populations, increased visibility impairments and others. Nitrous oxide (N_2O), another component of NO_x, is a greenhouse gas.
- *Volatile organic compounds (VOCs)* are compounds containing the elements carbon and hydrogen that exist in the atmosphere primarily as gases because of their low vapor pressure. VOCs are defined in federal rules as chemicals that participate in forming ozone. Many VOCs are also air toxics and can have harmful effects on human health and the environment.
- *Carbon monoxide (CO)* is a colorless and odorless toxic gas formed when carbon in fuels is not burned completely. A major source of CO is motor vehicle exhaust. Exposure to elevated CO levels is associated with impaired visual perception and work capacity among others, and can lead to death. At concentrations commonly found in the ambient air, CO does not appear to have adverse effects on plants, wildlife or materials. However, CO is oxidized to form carbon dioxide (CO_2), a major greenhouse gas and it contributes to the formation of ground-level ozone.
- *Lead (Pb)* is a naturally occurring element. Major sources of lead emissions were motor vehicles and industrial sources. Since lead in gasoline was phased out, air emissions and ambient air concentrations have decreased dramatically. Currently, metals processing (lead and other metals smelters) and aircraft using leaded fuel are the primary sources of lead emissions. There are no known safe levels of lead in the body. Chronic exposure or exposure to higher levels can result in multiple effects, including damage of the kidneys and nervous system in both children and adults. Elevated lead levels are also detrimental to animals and to the environment.

The Minnesota Criteria Pollutant Emission Inventory is complete for permitted sources through 2018. Figure 4 shows emission trends for permitted sources since 2008. These emissions have decreased significantly over the past decade largely due to governmental regulations and industry efforts to reduce emissions. As mentioned elsewhere in this report, emissions of nitrogen oxides and sulfur dioxide have decreased significantly in the past decade due to facilities switching from coal to natural gas and installing new pollution controls on their units.

Figure 4. Minnesota permitted source emissions 2008-2018



There has been a reduction in all criteria pollutant emissions from 2008 to 2018 (the most recent years with emission estimates from all sources). Figure 5 shows the statewide total in emissions from nitrogen oxide, sulfur dioxide, volatile organic compounds and particulate matter. Emissions from all source types (mobile, non-permitted and permitted sources) have decreased by about a quarter since 2008.

Figure 5. Criteria air pollutant statewide emission trends

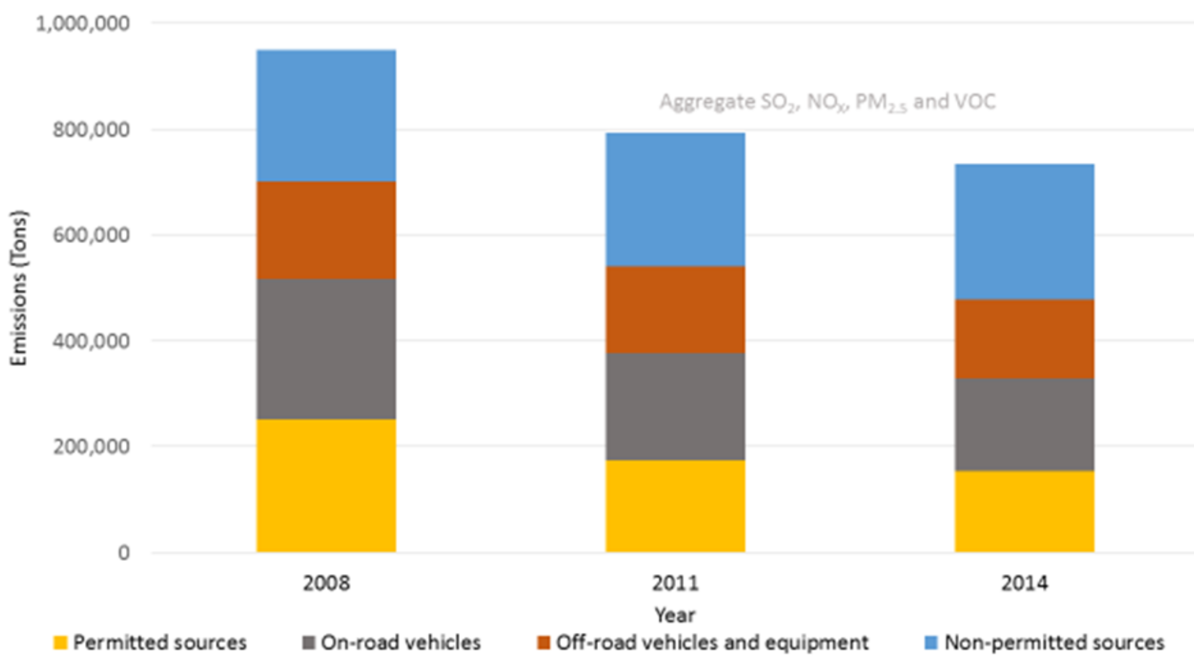


Table 1 shows statewide emissions for major criteria air pollutants and percent changes from 2016 to 2018. It is important to note that estimated air emissions data in this report are only based on direct releases from sources into the atmosphere. Secondary formation of particulate matters and other pollutants is not covered in this report, despite the importance of those pollutants to human health and the environment. Emissions increased slightly for all pollutants other than PM_{10} from 2016 to 2018.

Table 1. Minnesota air pollution emission estimates 2016 to 2018 (tons)

Pollutant	2016	2017	2018	2016-2018 % Change
Particulate matter (PM_{10})**	472,112	471,503	471,666	-0.1
Sulfur dioxide (SO_2)	33,032	30,247	33,757	2.2
Nitrogen oxides (NOx)	248,931	255,197	255,352	2.8
Volatile organic compounds (VOCs)	248,054	247,445	248,561	0.2
Particulate matter ($PM_{2.5}$)**	139,910	140,106	140,413	0.4
Lead (Pb)	15	14	16	6.7

* 2014 mobile and nonpoint emissions estimated were used in the 2016 to 2018 emissions estimates. The only changes are from point sources.

** PM_{10} and $PM_{2.5}$ emissions represent only direct emissions; secondary formation is not included.

Air toxics

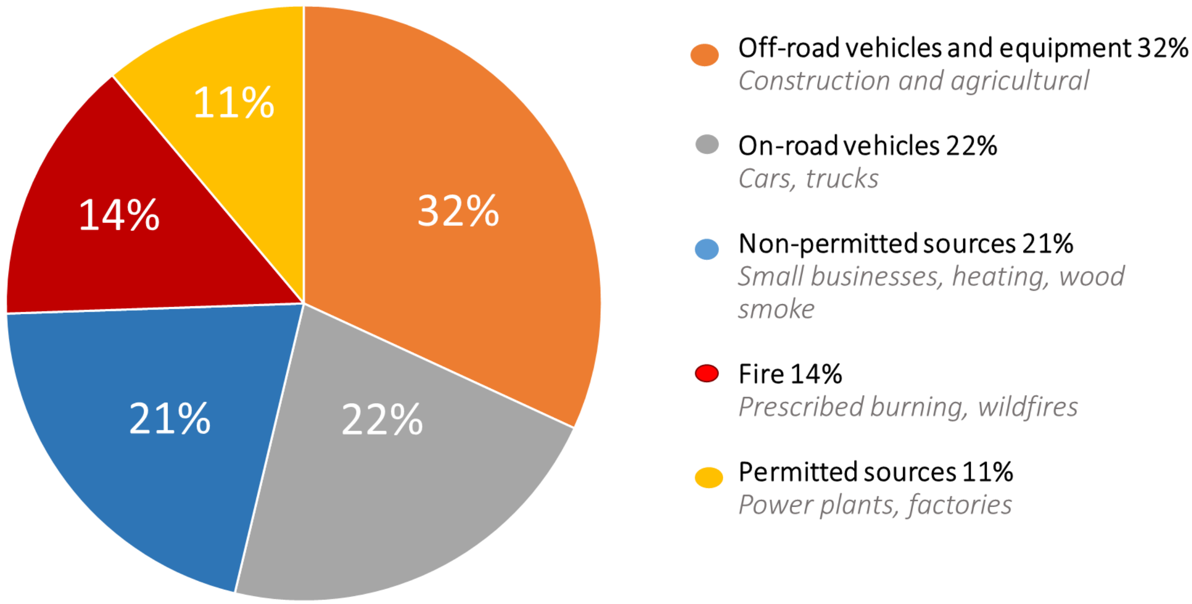
The EPA defines air toxics as pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects.

The Minnesota Air Toxics Emission Inventory estimates emissions of air toxics from all sources every three years. The majority of pollutants with MPCA emission estimates are part of EPA's hazardous air pollutant group. The most recent completed inventory for Minnesota is 2014; the agency expects to have 2017 data completed by summer of 2020. 2017 air toxics from permitted sources are complete. The inventory includes four principal source categories: permitted, non-permitted, mobile and fire sources.

MPCA staff compiled the emissions estimates for permitted and the majority of non-permitted sources in the 2014 inventory. Emissions for wildfires and prescribed burning were obtained from EPA. The results for aircraft (including ground support equipment), locomotives and commercial marine vessels were also estimated by EPA. For all off-road equipment and on-road vehicles, MPCA used estimates from EPA's national inventory.

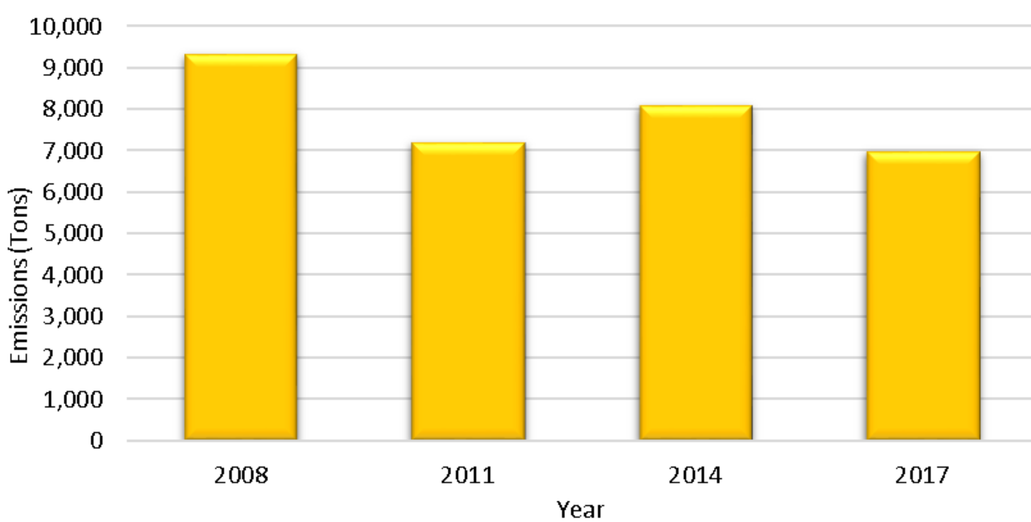
The following chart summarizes 2014 statewide emissions from directly emitted air toxics pollutants. It does not include secondarily formed pollutants. Non-permitted sources include very small stationary sources such as auto body shops and dry cleaners. These account for 21% of emissions. Mobile sources, including both on-road vehicles such as cars and trucks and off-road equipment such as recreational vehicles and agriculture equipment, account for more than 50% of total emissions. Large permitted facilities contributed 11% and fires accounted for 14% of the total. Biogenic emissions are not included in the breakdown because they depend on many environmental factors such as weather, background and ecosystem conditions that are largely uncontrolled by human activity.

Figure 6. Sources of air toxics emissions in Minnesota, 2014



The chart below shows total air toxics emissions for permitted sources. Since 2008, emissions have been on a general downward trend. Emissions decreased further from 2014 to 2017.

Figure 7. Air toxics from permitted sources 2008 – 2017

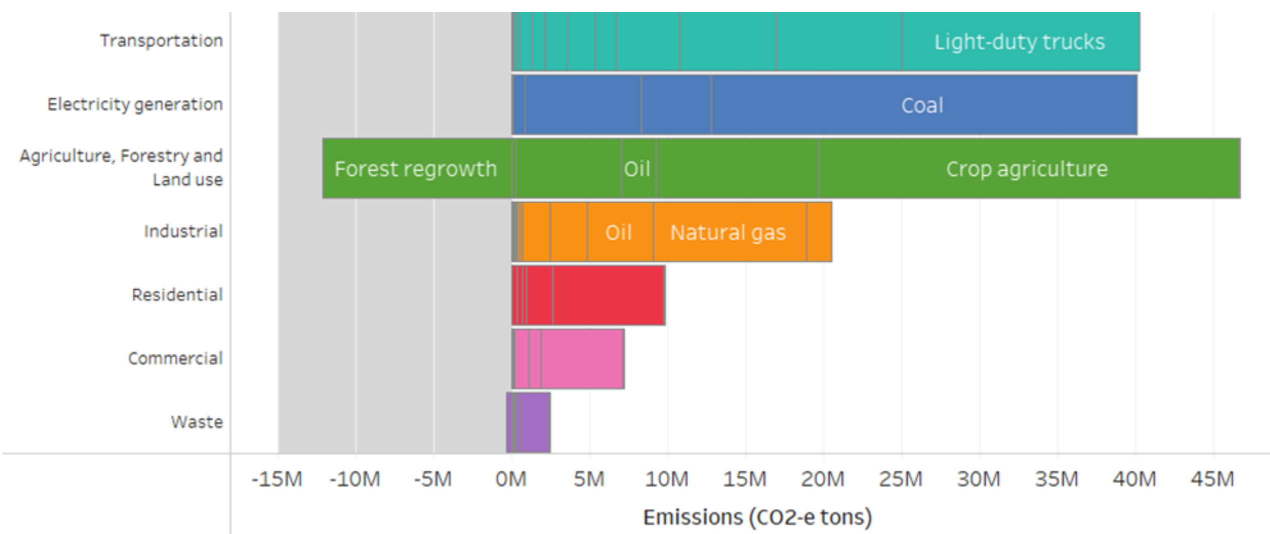


For more details about 2014 and 2017 permitted sources air toxics emissions, please visit the online application. This application will be updated with 2017 data once finalized emissions become available. MPCA developed multiple workbooks containing permitted sources, statewide and county level emissions. End users have hands-on access to emissions data, which they can view and use in an interactive format. Web applications contain statewide data going back to 2008.

Greenhouse gases

Greenhouse gases (GHGs) warm the atmosphere and surface of the planet, leading to alterations in the earth's climate. Many greenhouse gases occur naturally, but burning fossil fuels and other human activities are adding these gases to the natural mix at an accelerated rate. In 2016, Minnesota's GHG emissions were estimated to be 154.2 million CO_2e tons. CO_2e compares the global warming potential of emissions of different gases to the impact of the emission of one ton of CO_2. Most of Minnesota's GHG emissions are the result of using fossil fuel energy for electricity generation, transportation, heating, and other uses. Figure 8 shows GHG emissions by economic sector. The largest sources of emissions are from the generation of electricity and transportation. GHG emissions from electricity generation include emissions from electricity generated in other states to meet Minnesota's net electricity demand. More than 70% of the GHG emissions from the transportation sector are from light duty trucks, passenger vehicles and medium to heavy-duty trucks. Other significant sources include aviation and natural gas transmission in pipelines.

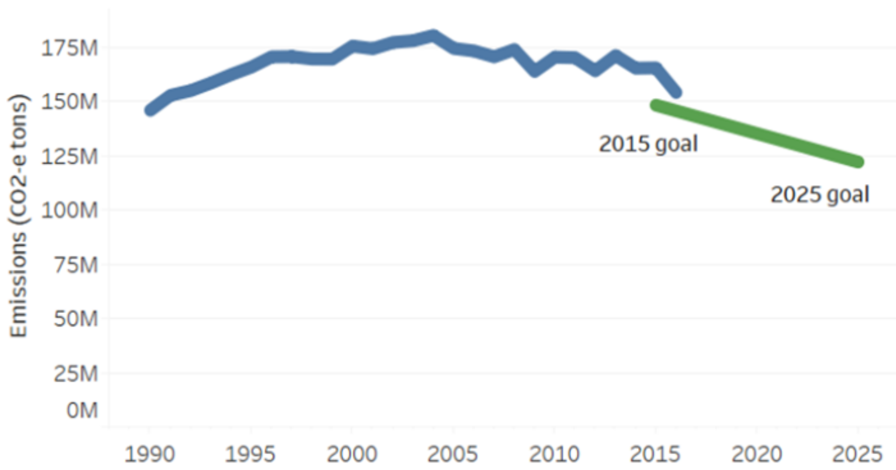
Figure 8. 2016 sector GHG emissions, storage sources, and sector percent of total



Trends in Minnesota's greenhouse gas emissions

Trends in emissions over time help show the effects of policies and other factors that might change emissions. Since 2005, Minnesota's total greenhouse gas emissions have declined by about 12%, and are not on track to meet the NGEA goals (Figure 9). Each economic sector shows a unique trend in emissions. As mentioned earlier, Executive Order 19-37 was signed to provide input to the Governor on how to get on track to achieve the NGEA goals. In addition, MPCA has recently offered grants for voluntary actions to reduce GHG emissions. Grants have included funds for electric vehicles charging stations for small business fleets and funds to reduce emissions of high global warming potential refrigerants. In addition, in February of 2020 MPCA published its plan for the second phase of Volkswagen settlement funding for Minnesota. The second phase of the settlement included funds to build new electric vehicle charging stations (including fast chargers along highways), to replace heavy-duty vehicles and equipment with electric alternatives, and to replace diesel school buses with new electric buses.

Figure 9. Minnesota's GHG emissions 1990-2016 and goals



References/web links

For more information on climate change in Minnesota, greenhouse gas emissions, and initiatives to reduce emissions and adapt to a changing climate, see the following website:

https://www.pca.state.mn.us/air/climate-change-minnesota

Mercury

Exposure to mercury can harm the nervous system, posing the greatest risk to a developing fetus and fish-eating wildlife. For most Minnesotans, eating fish contaminated with unhealthy levels of mercury poses the greatest risk of exposure. While fish are a desired source of protein and other nutrients, citizens are advised to limit their consumption of larger predatory fish. Consult the Minnesota Department of Health (MDH) Fish Consumption Advisory for guidelines to specific lakes and rivers at: https://www.health.state.mn.us/communities/environment/fish/eating/sitespecific.html.

Mercury emissions are transported through the atmosphere and deposited by rain into Minnesota's lakes and rivers. Minnesota's Draft 2020 Impaired Waters List includes 5,774 water quality impairments in 3,416 different bodies of water. Of the waters tested, mercury is the cause of 1,653 impairments in 1,245 different lakes and rivers. To achieve necessary reductions of mercury in fish, the MPCA developed a statewide mercury Total Maximum Daily Load (TMDL) study. The TMDL establishes a goal of a 93% reduction in mercury from all human sources including emissions originating from outside of Minnesota. The MPCA is working to meet the 93% reduction in the state by following the mercury TMDL implementation plan, developed by stakeholders in 2009. To accomplish the reductions specified in the TMDL, the MPCA proposed and later adopted rules regarding mercury reduction plans in Minn. R. 7007.0502. These rules established mercury emissions reductions for certain sources of mercury air emissions to bring both public and privately owned facilities into line with the statewide mercury TMDL reduction goals. In order to evaluate the progress of reducing mercury in our waters, mercury emissions inventories are developed and tracked, and the subsequent response in fish tissue is documented.

All lakes and rivers within Minnesota will benefit from the reduced mercury emissions that will be achieved by accomplishing the goals of the statewide TMDL implementation plan. The TMDL demonstrated that mercury deposition was essentially uniform throughout the state and that deposition represented 99% of the mercury source to lakes and rivers in the state. Despite the uniform deposition of mercury, about 25% of Minnesota surface waters may not meet the water quality standard after the mercury emissions goal is achieved, because these waters are more efficient at concentrating mercury into fish. Scientists understand some of the factors that cause this enhanced mercury accumulation, but not well enough to know the relative importance of each factor and what actions could reduce the enhanced mercury accumulation. The MPCA's scientific research into the unusually high mercury concentrations in fish in some Minnesota rivers was funded by the Legislative-Citizen Commission on Minnesota Resources (LCCMR) in 2014 and continued through June 2017 (https://www.lccmr.leg.mn/projects/2014-index.html#201403j). MPCA staff and collaborating academic scientists are continuing to analyze the large acquired dataset.

Sector activities and reductions

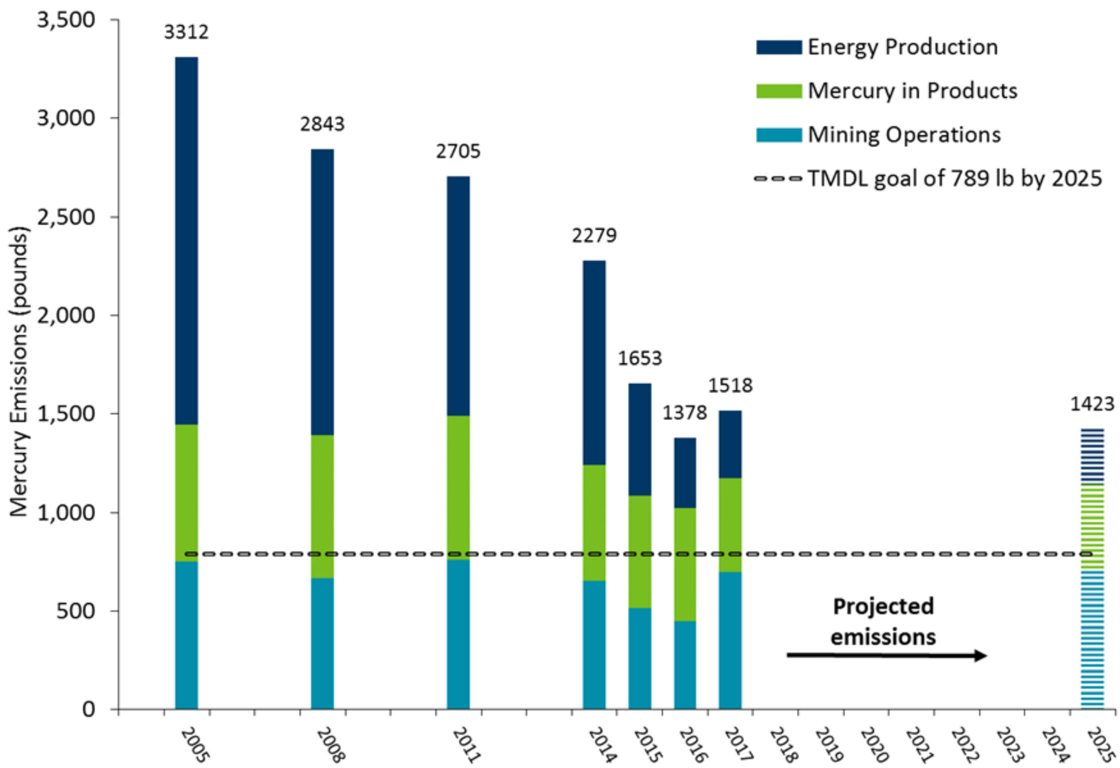
A number of efforts are in place to reduce mercury emissions. The state's power utilities achieved reductions ahead of schedule achieving the goals of the Minnesota Mercury Emissions Reduction Act of 2006 and the mercury TMDL. The 2017 mercury emissions are draft and currently being analyzed, and therefore not included in this report. It is estimated that electric utilities emitted an approximate 169 pounds of mercury in 2017 and are estimated to represent the smallest of the three source categories. This is a remarkable decrease from 1,716 pounds emitted by electric utilities in 2005. The decrease is due to electric utilities installing new emissions controls and switching from coal to natural gas.

Emissions from mercury use in various products also saw a decrease in 2017 as a result of additional research to improve emission estimates from solid waste collection and processing. The previous mass balance study on waste incinerators was updated to include recent years of ash testing data. The addition of this new data allowed the MPCA to improve the emissions factor used and resulted in roughly a 108-pound decrease in mercury emissions from the previous estimate. However, it is too early to determine if this is a downward trend or simply variability between years. The MPCA continues to work to improve the confidence interval of the mercury emissions inventory through partnerships and research.

Conversely, emissions from the taconite mining sector have risen by roughly 270 pounds as a result of an overall production increase across the industry between 2016 and 2018. The taconite mining sector also concluded its research of possible mercury-reduction technologies and submitted mercury reduction plans to the MPCA in December 2018. The MPCA received eight plans and each varied in the amount of mercury reductions proposed. Two facilities submitted plans with proposed reductions meeting the required 72% reduction specified in Minn. R. 7007.0502, two facilities submitted alternative plans with proposed reductions less than the required 72% reduction specified, and four facilities submitted alternative plans with no proposed reductions but further evaluation beginning in mid-2020.

Despite significant reductions from some sectors, the MPCA projects that the state will not meet the plan's 2025 statewide reduction goal. To meet Minnesota's 2025 emissions goal, significant reduction of mercury emissions from the taconite mining sector and further reduction from mercury use in various products will be necessary.

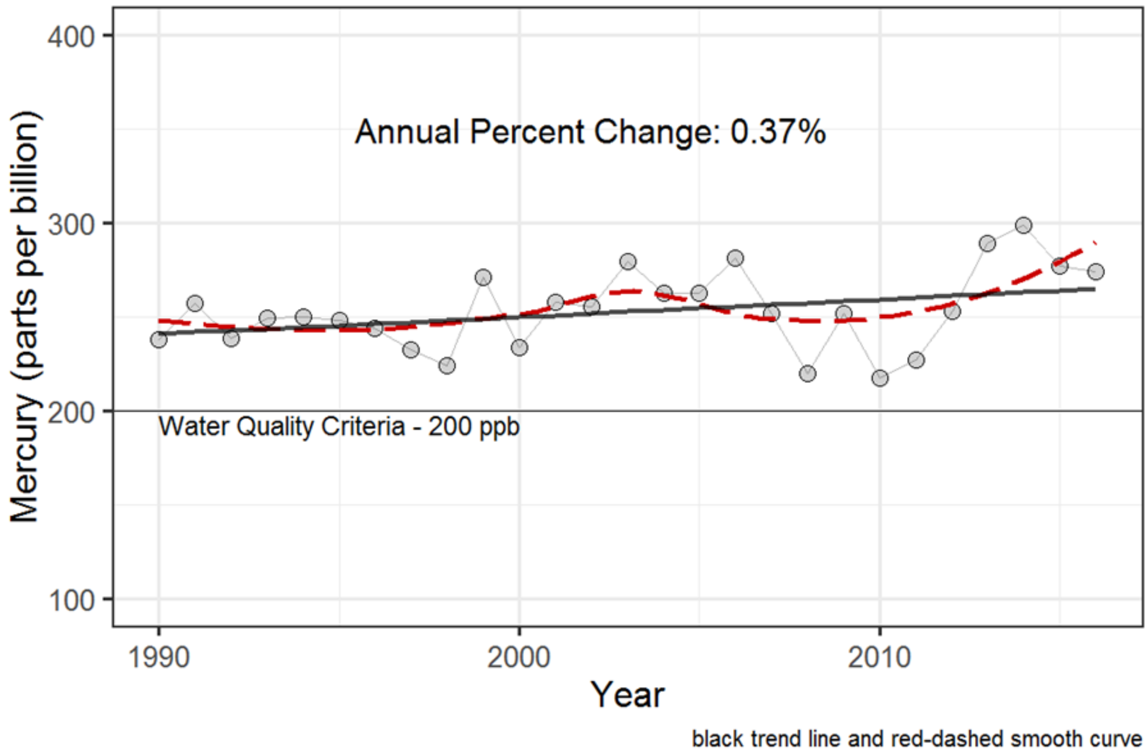
Figure 10. Mercury emission from Minnesota sources: 2005 through 2017



Mercury concentration in Minnesota fish

MPCA scientists use walleye and northern pike collected since 1990 to examine the change in mercury concentrations in lakes over time. The 27-year fish-mercury trend from 1990 to 2016, shown in Figure 11, indicates an increasing average mercury concentration. The concentration increase, 0.37% per year on average, is statistically significant, and has resulted in an increase of about 10% over three decades. Minnesota's water standard for mercury in edible fish tissue – 200 parts per billion (ppb) – is shown for reference on the figure, because it is the threshold above which lakes and streams are impaired and warrant a fish consumption advisory. The standard protects humans for consumption of one meal per week of fish caught in Minnesota. MPCA scientists plan to update the fish mercury trend analysis after an additional five years of data are available. More explanation of the mercury trends in fish is available in the 2020 Clean Water Fund Performance Report.

Figure 11. Trend of mercury in northern pike and walleye from Minnesota lakes: 1990-2016



References/web links

For more information on mercury, see the following websites:

MPCA's mercury reduction plan: https://www.pca.state.mn.us/water/plan-reduce-mercury-releases-2025

UN Environment, Global Mercury Assessment 2018: https://www.unenvironment.org/resources/publication/global-mercury-assessment-2018

Minamata Convention on Mercury: http://mercuryconvention.org/

Water pollutant discharges overview

Minnesota's rivers, streams and lakes provide great natural beauty, and supply the water necessary for recreation, industry, households, agriculture and aquatic life. The goals of the MPCA's water programs are to maintain and improve water quality, ensure water quality meets statewide goals, and to reduce and prevent pollution from all sources. Key work for accomplishing these goals includes regulating point source discharges, controlling nonpoint sources of pollution, and assessing water quality to provide data and information to make sound environmental management decisions.

The federal Clean Water Act requires states to adopt water quality standards to protect the nation's waters. The MPCA has adopted standards to protect the state's abundant and diverse water resources from the impacts of excess nutrient, sediment and organic material as well as toxic pollutants. These standards define how much of a pollutant can be in a surface or groundwater supply while still allowing it to meet its designated uses, such as for drinking water, fishing, swimming, irrigation, aquatic life or industrial purposes. Standards are used to assess the condition of water bodies, develop restoration and protection plans and set discharge limits for regulated entities such as wastewater treatment plants.

In collaboration with state and local partners, the MPCA uses a watershed approach to conduct its monitoring, planning and permitting work to protect and restore waters.

For each pollutant that causes a water to fail to meet state water quality standards, the federal Clean Water Act requires the MPCA to conduct a Total Maximum Daily Load (TMDL) study. A TMDL study identifies both point and nonpoint sources of each pollutant to waters that fails to meet water quality standards. Many of Minnesota's water resources cannot currently meet their designated uses because of pollution from a combination of point and nonpoint sources.

Wastewater discharges

Owners or operators of any disposal system or point source are required by Minnesota law to obtain permits, maintain records and make reports of any discharges to waters of the state. These self-monitoring reports submitted to MPCA are commonly referred to as Discharge Monitoring Reports (DMRs). DMR data are reviewed using compliance tracking data systems maintained by MPCA data specialists.

Consistent with the state's overall watershed approach the MPCA is moving from a facility-by-facility regulatory approach to one that emphasizes managing total pollution loads to Minnesota's watersheds. Due to the five-year permit cycle, however, for select pollutants, some permits have yet to be modified to incorporate the monitoring and reporting requirements necessary to enable efficient, computerized calculations of total annual pollutant loadings. As the MPCA reissues permits and conducts ongoing review of data, it will continue to build capability in this area and the assessment of pollutant trends by watersheds over multiple years will become more reliable.

Overall pollutant loads to receiving waters are based on a combination of effluent flow and pollutant concentrations in the effluent. Effluent flow and pollutant loading estimates for National Pollution Discharge Elimination System (NPDES) permitted facilities such as wastewater treatment plants, exclude once-through non-contact cooling water data from power generation facilities—large volumes of (primarily) river water used for cooling purposes. These once-through non-contact cooling waters are discharged with the addition of heat, and with minor additions of other pollutants. Pollutant loads associated with these discharges were largely present in the waterbodies before the waters were withdrawn for cooling purposes so reporting them as wastewater pollutants would be misleading.

The degree of confidence in each loading estimate can be expressed as the proportion of the load derived from observed values compared to the proportion derived from estimated values. The loading graphs in this report are color coded by 'Observed' and 'Estimated' to serve as a confidence measure for each pollutant load measure.

Prior to 2014, the wastewater sections of the MPCA's Pollution Reports to the Legislature were based on data reported by approximately 99 major wastewater dischargers. These are facilities permitted to discharge at least 1 million gallons of treated wastewater per day and account for approximately 85% of the volume of treated wastewater discharged to waters of the state. Reports now include data from all surface water dischargers, regardless of size. The inclusion of smaller facilities provides a more complete measure of pollutant loads since non-major facilities can collectively impact water quality. Figure 12 shows the distribution of municipal wastewater facilities by size.

Figure 12. Distribution of municipal wastewater facilities by size

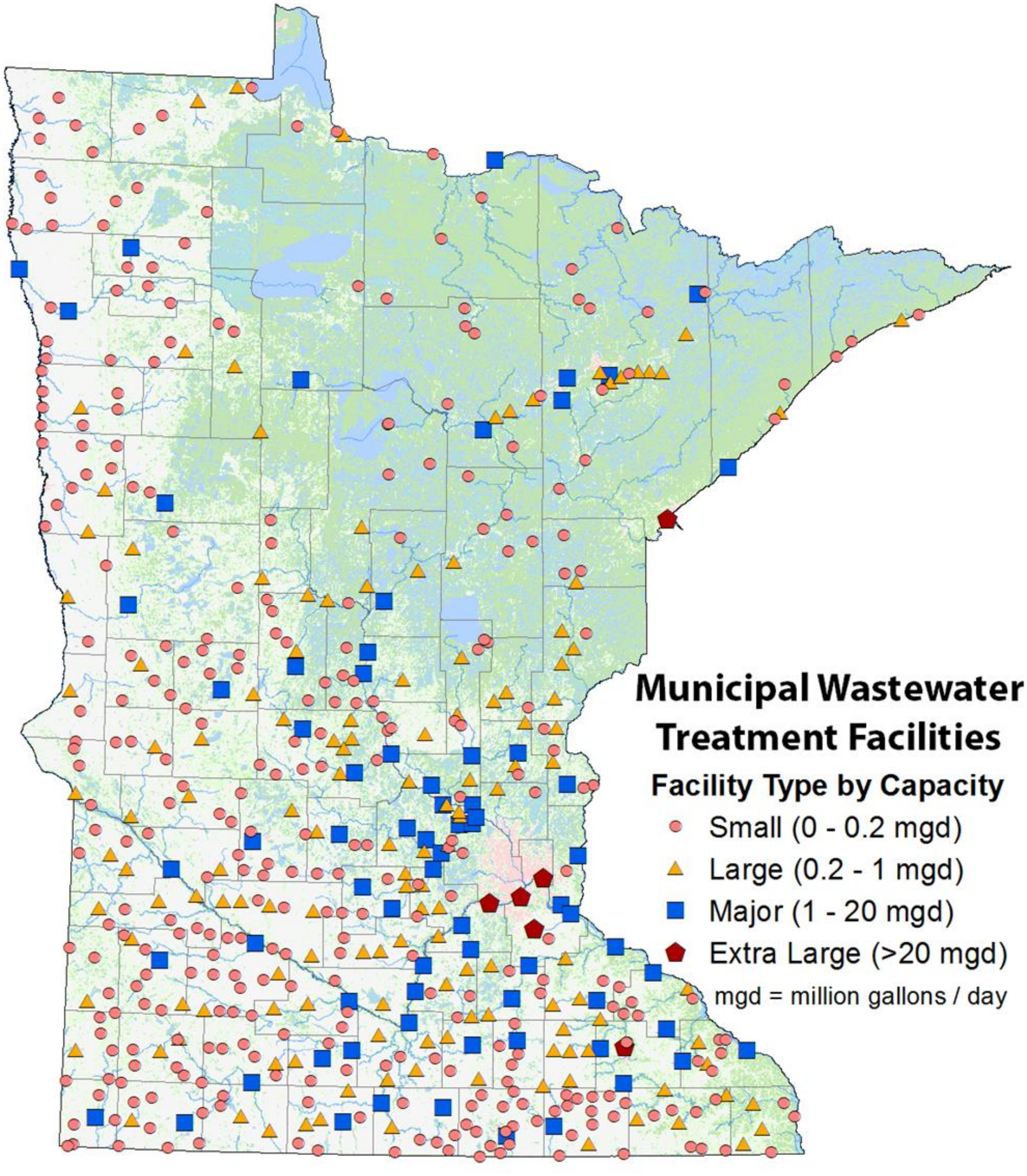
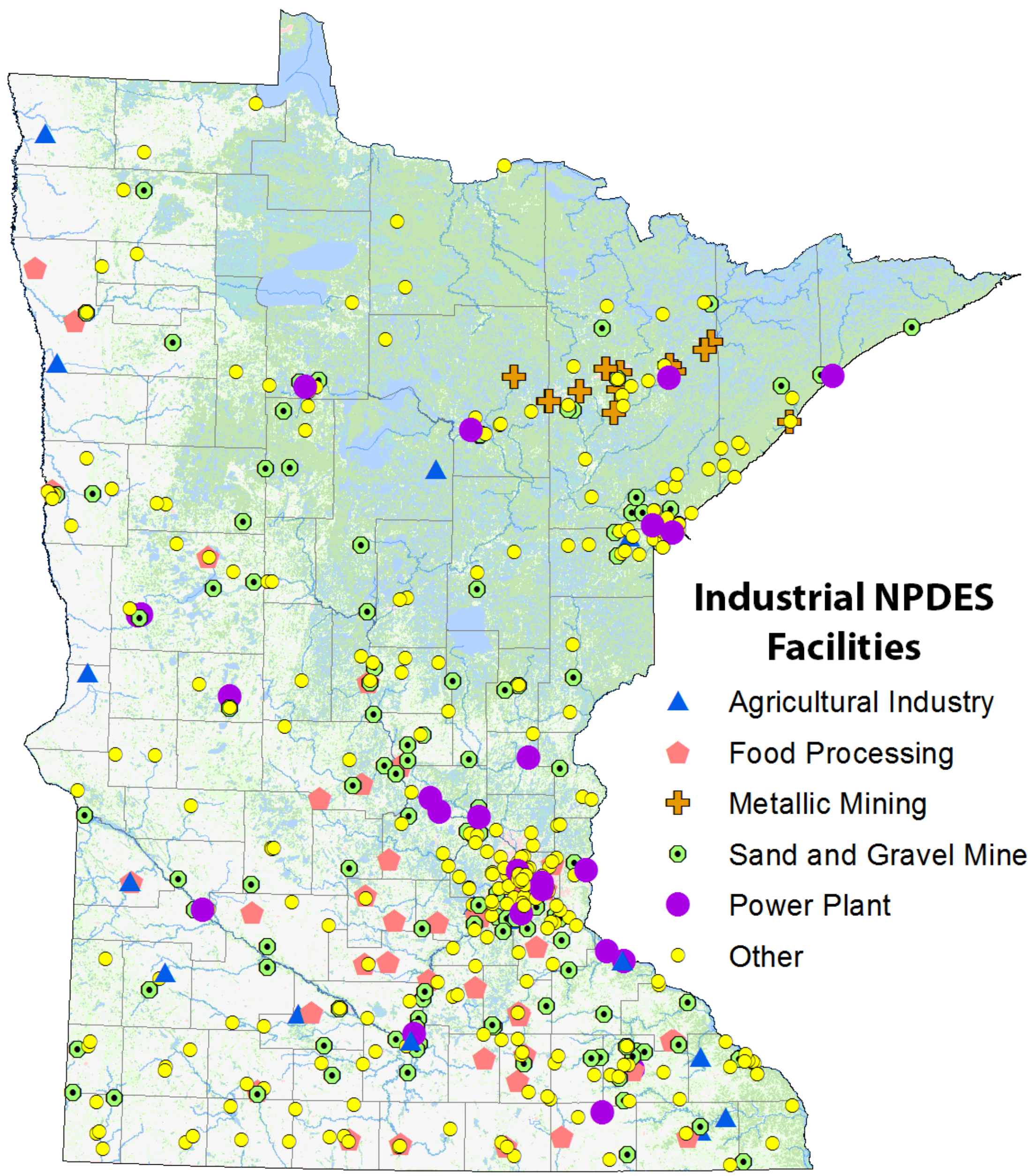


Figure 13 below shows the distribution of industrial discharges by type. Facilities are grouped in the following broad categories: agricultural industry, food processing, metallic mining, sand and gravel mines, power plants and other.

Figure 13. Distribution of industrial wastewater dischargers by type



Five common chemical parameters found in wastewater treatment plant effluent are highlighted in this report: total suspended solids (TSS), carbonaceous biochemical oxygen demand ($CBOD_5$), total phosphorus, total nitrogen and mercury.

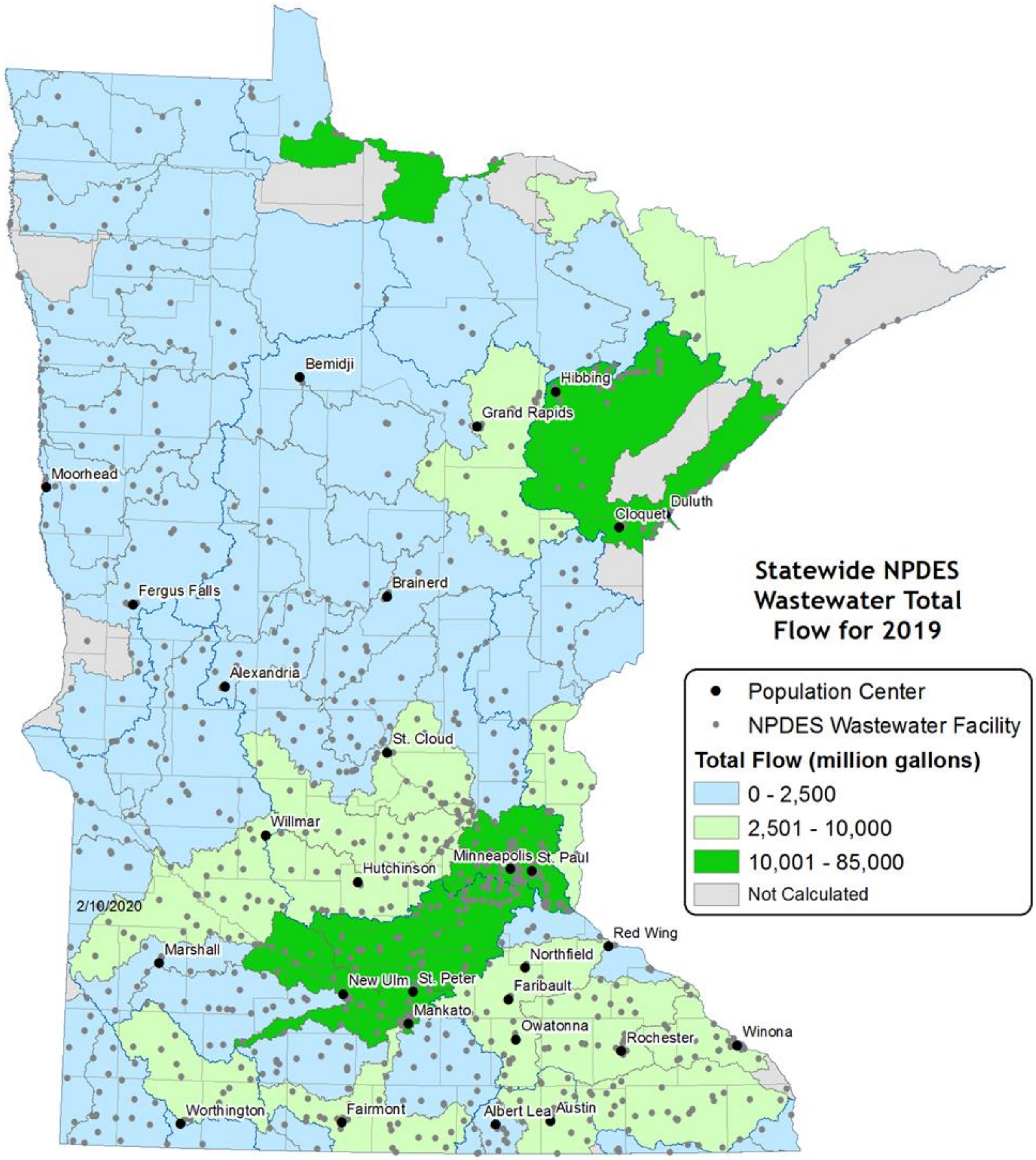
Effluent flow volumes are also included this report. Although flow is not a regulated pollutant, it is a useful gauge of overall facility performance because of the direct relationship between pollutant loading and effluent flow volume. For example, if effluent flow and pollutant loading show proportional annual increases, it is an indication that overall effluent concentrations have remained stable and the loading increase is attributable to the increase in flow. Conversely, if the pollutant load showed consistent annual decreases despite an increase in effluent flow volume, the concentration has likely decreased and the effluent quality has improved.

Table 2 on page 24 summarizes effluent pollutant loading and flow volume estimates for municipal and industrial wastewater treatment facilities in Minnesota from 2000 to 2019.

Flow

Overall, wastewater flow volumes have fluctuated from a baseline of 284 billion gallons per year in 2000/2001 to a peak of 304 billion gallons per year in 2011. Average effluent flow from 2015 through 2019 was 2 billion gallons/year greater than effluent flow during the previous five years. Since the year, 2000 major facilities, facilities with the potential to discharge greater than 1 million gallons per day, have discharged approximately 78% of the total treated wastewater in the state. Municipal wastewater treatment facilities discharged 61% of the total treated wastewater from 2000 through 2004. Since 2005, the proportion of municipal wastewater flow has declined to 59% of the total. Peak wastewater flows of 304 billion gallons/year were reported in 2011. 2012 was a particularly dry year in which the volume of municipal wastewater discharged was lower. However, despite increasing hydrologic trends in subsequent years, changes in wastewater flows remained relatively modest. From 2014 to 2019, surface water discharges reported by the wastewater sector have averaged 287 billion gallons per year, a slight increase from the long-term average.

Figure 14. Minnesota wastewater effluent flow for 2019



Point source pollutant loading trends

Figure 15 shows pollutant effluent flows and loading trends for TSS, CBOD, total phosphorus, total nitrogen and mercury from 2000 – 2019. Pollutant loads are calculated from reported effluent flows and pollutant concentrations. It is notable that the record amounts of precipitation in Minnesota in 2019 have resulted in increased wastewater flows and have contributed to increased wastewater pollutant loads. Mercury trends from wastewater treatment facilities are shown in Figure 23 on page 36. Overall trends include:

TSS loads: Stable—TSS loads increased in 2001 and 2002 but have otherwise remained fairly stable at approximately 5,000 metric tons per year.

$CBOD_5$ loads: Declined—Loads have declined from loads ranging from 3,000 to 4,000 metric tons per year during the 2000 to 2004 period to an average load of 2,400 tons per year since 2005.

Total phosphorus loads: Declined—Total phosphorus loads have decreased significantly from 1,800 metric tons per year during the 2000 to 2002 period to less than 600 metric tons per year since 2014.

Total nitrogen loads: Increased—Total nitrogen loads have increased slightly from 13,500 metric tons per year in 2000/2001 to almost 14,300 metric tons per year in 2018/2019. The long-term average nitrogen effluent load is 13,500 metric tons/year.

Mercury loads: Declined—Significant mercury load reductions have been achieved from 4 kg per year in the 2005 to 2006 time period to 2.35 kg per year in 2018/2019. Mercury loads prior to 2005 are excluded because of changes in the ability to detect mercury in effluent.

Figure 15. Pollutant loading trends from Minnesota wastewater facilities, 2000-2019

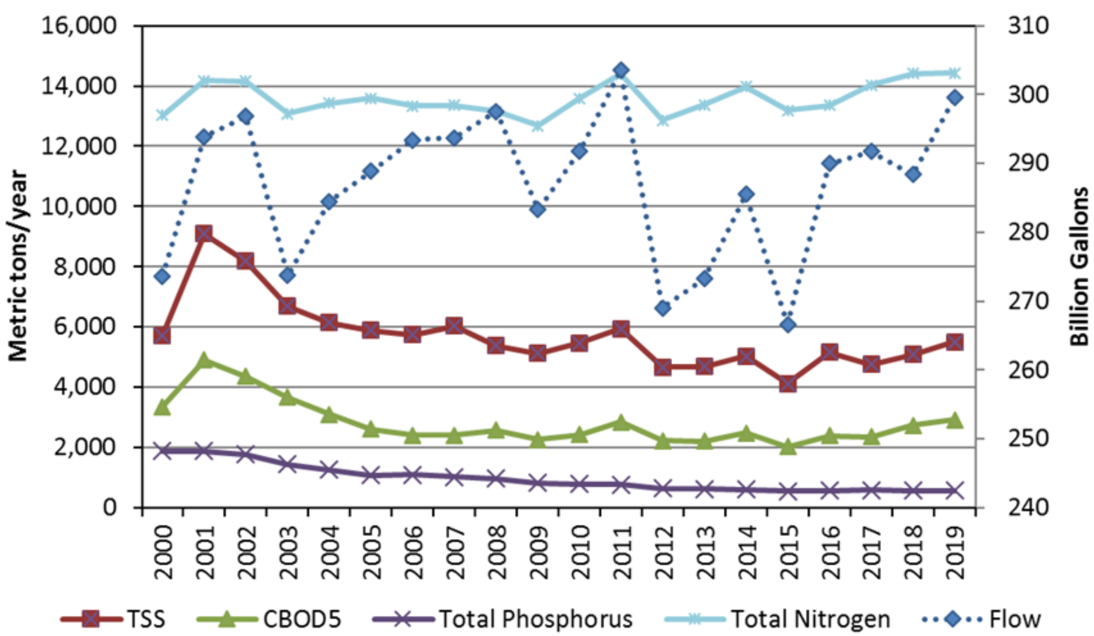


Table 2 shows pollutant effluent flow and loading trends from 2000 through 2019. Effluent flow is reported in billion gallons per year. Pollutant loads for TSS, $CBOD_5$, total phosphorus and total nitrogen are reported in metric tons per year. Pollutant loads for mercury are reported in kilograms per year.

Table 2. Annual total flow and pollutant load

	Flow (MG/year)	TSS (MT/year)	Total phosphorus (MT/year)	$CBOD_5$ (MT/year)[1]	Total nitrogen (MT/year)	Mercury (Kg/year)[2]
2000	273,617	5,688	1,883	3,344	12,978	
2001	293,868	9,055	1,884	4,887	14,115	
2002	296,866	8,142	1,774	4,350	14,109	
2003	273,694	6,651	1,442	3,660	13,031	
2004	284,454	6,110	1,250	3,081	13,369	
2005	288,895	5,865	1,076	2,604	13,546	4.1
2006	293,423	5,718	1,086	2,400	13,293	3.9
2007	293,695	5,992	1,025	2,404	13,306	3.2
2008	297,565	5,336	970	2,570	13,107	2.8
2009	283,277	5,092	821	2,252	12,627	2.6
2010	291,825	5,412	790	2,412	13,495	3.0
2011	303,503	5,909	773	2,832	14,268	3.1
2012	269,036	4,634	637	2,219	12,730	2.0
2013	273,210	4,655	616	2,192	13,230	2.3
2014	285,508	5,001	595	2,452	13,873	2.8
2015	266,655	4,061	543	2,017	13,082	2.3
2016	290,004	5,070	568	2,360	13,240	2.1
2017	291,752	4,709	584	2,340	13,919	2.1
2018	288,404	5,038	569	2,729	14,285	2.1
2019	299,578	5,432	576	2,901	14,301	2.6

[1]Industrial facilities are excluded from $CBOD_5$ load calculations due to lack of data.
[2]Peat mining facilities are excluded from mercury calculations due to unreliability of flow and mercury data.

Table 3 shows flow-weighted mean concentration (FWMC) trends from 2000 through 2019. FWMC is calculated by dividing the annual load by the annual flow and is a measure of the overall performance of wastewater dischargers. All FWMCs are reported in milligrams per liter (mg/L) except for mercury which is reported in nanograms per liter (ng/L). TSS FWMCs have declined from 6.6 mg/L in the years from 2000 to 2004 to 4.4 mg/L from 2014 to 2019. $CBOD_5$ FWMCs have declined from approximately 3.6 mg/L in the 2000 to 2004 period to approximately 2.2 mg/L since 2014. Total phosphorus FWMCs have declined from approximately 1.7 mg/L in the 2000 to 2003 time period to approximately 0.53 mg/L in from 2014 to 2019. Total nitrogen FWMCs have remained stable at 12 mg/L since 2000. Mercury concentrations declined from approximately 3.8 ng/L in 2005 to approximately 2 ng/L since 2015.

Table 3. Annual flow-weighted mean concentration

	TSS (mg/L)	$CBOD_5$ (mg/L)	Total phosphorus (mg/L)	Total nitrogen (mg/L)	Mercury (ng/L)
2000	5.49	3.23	1.82	12.53	
2001	8.14	4.39	1.69	12.69	
2002	7.25	3.87	1.58	12.56	
2003	6.42	3.53	1.39	12.58	
2004	5.67	2.86	1.16	12.42	
2005	5.36	2.38	0.98	12.39	3.78
2006	5.15	2.16	0.98	11.97	3.52
2007	5.39	2.16	0.92	11.97	2.86
2008	4.74	2.28	0.86	11.64	2.52
2009	4.75	2.10	0.77	11.78	2.42
2010	4.90	2.18	0.72	12.22	2.68
2011	5.14	2.47	0.67	12.42	2.74
2012	4.55	2.18	0.63	12.50	1.93
2013	4.50	2.12	0.60	12.79	2.22
2014	4.63	2.27	0.55	12.84	2.61
2015	4.02	2.00	0.54	12.96	2.30
2016	4.62	2.15	0.52	12.06	1.90
2017	4.26	2.12	0.53	12.60	1.92
2018	4.61	2.50	0.52	13.09	1.92
2019	4.79	2.56	0.51	12.61	2.26

Table 4 shows the annual percent change in flow and pollutant loads. 2001 stands out as a year that saw significant increases in the loading of all pollutants, probably as a result of the significant flooding which occurred that year. Excluding 2001, the year-to-year percent change data show the following:

- An average 3% per year decline in annual TSS loads
- An average 3% decline in annual $CBOD_5$ loads
- An average 6% decline in annual total phosphorus loads
- 0% change in annual total nitrogen loads
- An average 2% decline in annual mercury

Table 4. Percent change in annual flow and pollutant loads

	Flow (%)	TSS (%)	$CBOD_5$ (%)	Total phosphorus (%)	Total nitrogen (%)	Mercury (%)
2000						
2001	7%	59%	46%	0%	9%	
2002	1%	-10%	-11%	-6%	0%	
2003	-8%	-18%	-16%	-19%	-8%	
2004	4%	-8%	-16%	-13%	3%	
2005	2%	-4%	-15%	-14%	1%	
2006	2%	-2%	-8%	1%	-2%	-6%
2007	0%	5%	0%	-6%	0%	-19%
2008	1%	-11%	7%	-5%	-1%	-11%
2009	-5%	-5%	-12%	-15%	-4%	-9%
2010	3%	6%	7%	-4%	7%	14%
2011	4%	9%	17%	-2%	6%	6%
2012	-11%	-22%	-22%	-18%	-11%	-37%
2013	2%	0%	-1%	-3%	4%	17%
2014	5%	7%	12%	-3%	5%	23%
2015	-7%	-19%	-18%	-9%	-6%	-17%
2016	9%	25%	17%	5%	1%	-10%
2017	1%	-7%	-1%	3%	5%	1%
2018	-1%	7%	17%	-3%	3%	-1%
2019	4%	8%	6%	1%	0%	22%

Table 5 shows the annual percent change in flow and pollutant loading from a baseline defined as the average of the years 2000 and 2001. Percent change since 2002 from baseline data show:

- An average 1% increase in effluent flows
- An average 26% decrease in TSS loads
- An average 36% decrease in $CBOD_5$ loads
- An average 54% decrease in total phosphorus loads
- An average 1% decrease in total nitrogen loads
- An average 32% reduction in mercury loads (baseline 2005-06 due to change in detection level)

Table 5. Percent change in annual (values) from baseline

	Flow (%)	TSS (%)	Total phosphorus (%)	$CBOD_5$ (%)	Total nitrogen (%)	Mercury* (%)
2000-01 Baseline	283,743 (MG/year)	7,368 (MT/year)	1,883 (Mt/year)	4,115 (MT/year)	13,544 (MT/year)	4.02 (Kg/year)
2002	5%	10%	6%	-6%	4%	
2003	-4%	-10%	-11%	-23%	-4%	
2004	0%	-17%	-25%	-34%	-1%	
2005	2%	-20%	-37%	-43%	0%	3%
2006	3%	-22%	-42%	-42%	-2%	-3%
2007	4%	-19%	-42%	-46%	-2%	-21%
2008	5%	-28%	-38%	-49%	-3%	-29%
2009	0%	-31%	-45%	-56%	-7%	-36%
2010	3%	-27%	-41%	-58%	0%	-26%
2011	7%	-20%	-31%	-59%	5%	-22%
2012	-5%	-37%	-46%	-66%	-6%	-51%
2013	-4%	-37%	-47%	-67%	-2%	-43%
2014	1%	-32%	-40%	-68%	2%	-30%
2015	-6%	-45%	-51%	-71%	-3%	-42%
2016	2%	-31%	-43%	-70%	-2%	-48%
2017	3%	-36%	-43%	-69%	3%	-47%
2018	2%	-32%	-34%	-70%	5%	-48%
2019	6%	-26%	-30%	-69%	6%	-36%

* Mercury baseline is 2005-2006 due to change in detection level.

Variability in the quality and quantity of available effluent data can potentially impact annual comparisons.

- The loading calculations incorporate data interpretation decisions that can legitimately be made in a variety of ways. This typically applies to the classification of waste-stream and facility types for the assignment of categorical concentrations. There are also select facilities that report highly inconsistent values for some parameters and are excluded until the questionable values can be verified.
- Reporting requirements can vary with each permit issuance resulting in variation in parameters, limit types, and reporting periods and making year-by-year comparisons difficult. Additionally, when a facility does not monitor a pollutant in a month that it discharges, the concentration for that month is presumed to be the average annual concentration.
- Wastewater treatment facilities regularly experience variations in influent strength, influent flow and facility performance that may not be fully reflected in the data used to generate this report.

Total suspended solids

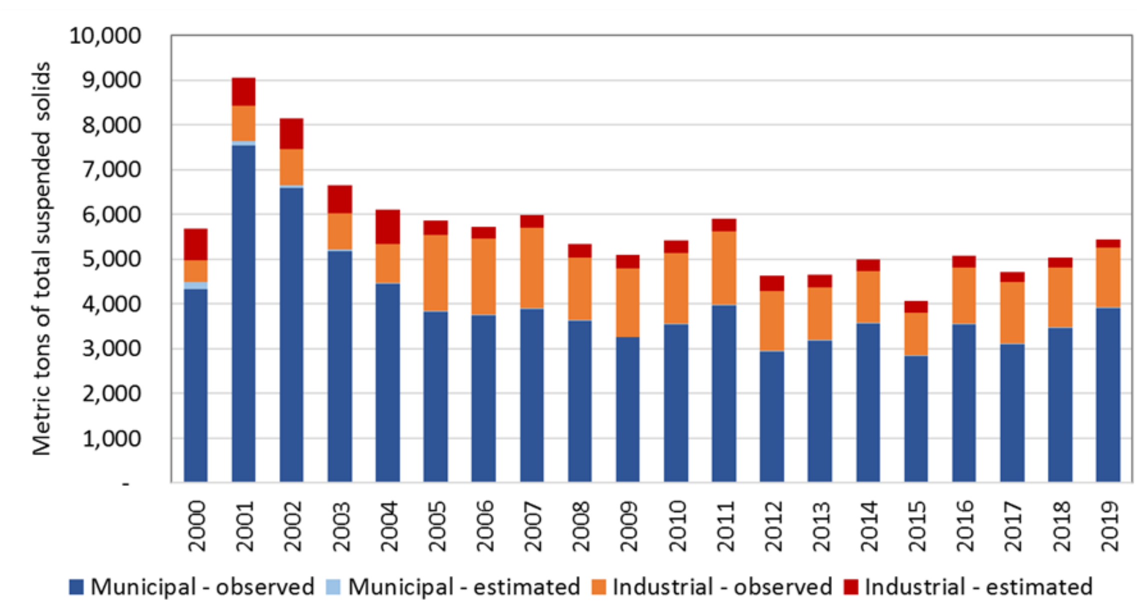
Total suspended solids (TSS) is a measure of the material suspended in water or wastewater. TSS causes interference with light penetration, buildup of sediment, potential degradation of aquatic habitat and harm to aquatic life. Suspended solids also carry nutrients that cause algal blooms that are harmful to fish and other aquatic organisms.

The TSS load for 2019 was 5,432 metric tons, an 11% increase from the 2017-18 average. On average, the data show an annual 26% reduction in TSS loads from a 7,368 metric ton per year baseline in 2000/2001.

Wastewater TSS data are considered reliable, with 96% of loads resulting from observed data points. On average, 69% of wastewater TSS loads are discharged by major facilities although the proportion of TSS loads discharged by major facilities has declined from an average of 79% from 2000 through 2003 to an average of 70% from 2004 through 2019. On average, municipal wastewater dischargers accounted for 81% of wastewater TSS loads from 2000 through 2003 while their proportion of wastewater TSS loading declined to an average of 68% from 2004 through 2019. Overall, wastewater TSS loads have declined from an average of 7,381 metric tons per year in the 2000 through 2003 period to an average of 5,252 metric tons per year from 2007 through 2019.

TSS is one of the most frequently monitored pollutants in wastewater. Most facilities contain technology based effluent limits that are established based on the type of wastewater treatment used at a given facility (e.g., a pond system or a mechanical facility).In most cases the technology based TSS limits are more restrictive than the state TSS water quality standards. As a result, most facilities are discharging below a concentration level of concern, future wastewater TSS reductions are not generally necessary and long-term average TSS wastewater loading has remained relatively stable during the past decade. Nonetheless, advanced treatment required to meet other effluent limits for pollutants such as phosphorus and mercury may result in further TSS reductions since those pollutants tend to be components of or are attached to suspended solids.

Figure 16. Annual wastewater loading values for total suspended solids (TSS)



Carbonaceous biochemical oxygen demand

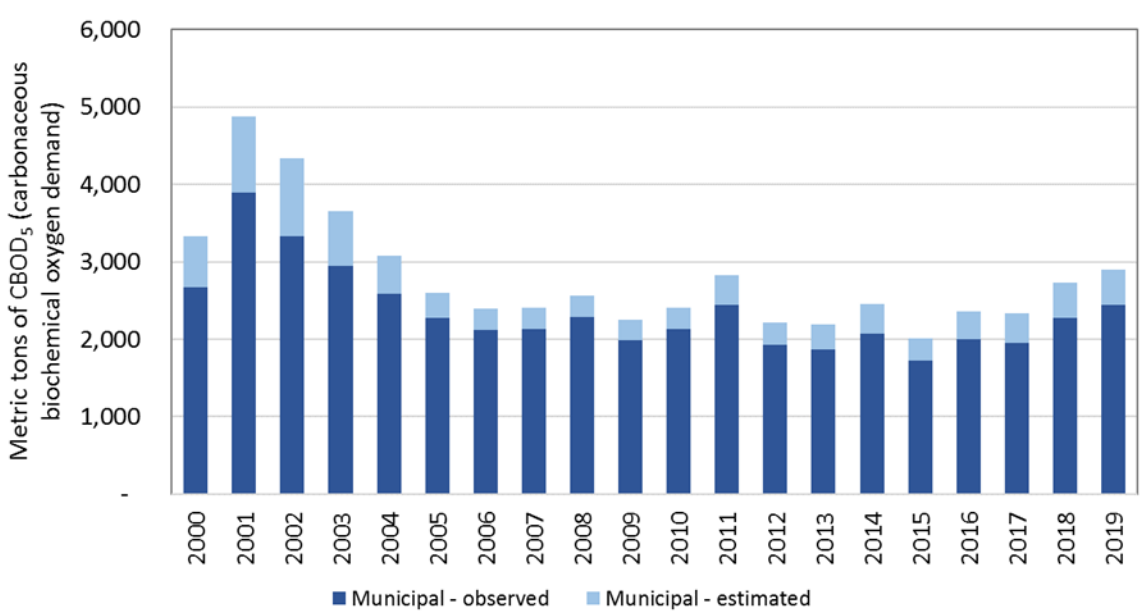
When organic wastes are introduced into water, they require oxygen to break down. High concentrations of organic materials characterize untreated domestic wastes and many industrial wastes. The amount of oxygen required for decomposition of organic wastes by microorganisms is known as the biochemical oxygen demand (BOD), while carbonaceous biochemical oxygen demand ($CBOD_5$) is the amount of oxygen required for microorganisms to decompose carbonaceous waste materials. Both BOD and $CBOD_5$ are indicators of the quality of wastewater effluent and the effectiveness of treatment. Discharges of high levels of BOD or $CBOD_5$ deplete the oxygen available for aquatic life as oxygen is consumed by bacteria during the decomposition of organic material. Depletion of oxygen deteriorates water quality and impacts aquatic life, including fish and other organisms.

Municipal wastewater treatment facility effluent limitations and reporting requirements are expressed as $CBOD_5$. Industrial dischargers most frequently report BOD which reflects the industry-specific requirements within Federal Regulations. For purposes of this report, $CBOD_5$ was used for load calculations because it provides a more complete data set for municipal loading calculations. Industrial facilities are not included in this calculation because there are too few observations to confidently estimate categorical concentrations. The complete BOD/CBOD load could be significantly higher than the currently reported values because industrial flow accounts for nearly half of the flow within the state.

The total municipal $CBOD_5$ load for 2019 was 2,901 metric tons, a 14% increase from the 2017-2018 average. On average, the data show an annual 36% reduction in CBOD loads from a 4,115 metric ton per year baseline in 2000/2001.

Municipal wastewater $CBOD_5$ data are considered reliable, with 82% of values resulting from observed data points. On average, 85% of wastewater $CBOD_5$ loads are discharged by major facilities although the proportion of $CBOD_5$ loads discharged by major facilities has declined from an average of 89% from 2000 through 2003 to an average of 83% from 2004 through 2019. Overall, wastewater $CBOD_5$ loads have declined from an average of 4,060 metric tons per year in the 2000 through 2003 period to an average of 2,437 metric tons per year from 2007 through 2019.

Figure 17. Annual loading values for municipal wastewater $CBOD_5$



Minnesota Nutrient Reduction Strategy (phosphorus and nitrogen)

Minnesota's 2014 Nutrient Reduction Strategy identifies relative nutrient (phosphorous and nitrogen) source contributions to surface waters. The strategy also establishes nutrient reduction goals for both point and non-point sources (Table 6). In aggregate, wastewater sources have achieved the desired phosphorus reductions and work to meet local water quality goals is in progress. Permit nitrogen monitoring frequency requirements have increased as first step towards improving overall understanding of the nitrogen concentrations and loads discharged by Minnesota wastewater facilities. Wastewater nitrogen reductions specified for the Mississippi and Lake Winnipeg drainages have not yet been achieved. The International Red River Board is in the process of adopting nutrient objectives for the Red River in 2020.

Table 6. Timeline and reduction goals

Major Basin	Pollutant	2010 – 2025	2025 - 2040
Mississippi River (Includes the Cedar, Des Moines and Missouri Rivers)	Phosphorus	Achieve 45% reduction goal	Work on remaining reduction needs to meet water quality standards
	Nitrogen	Achieve 20% reduction from baseline	Achieve 45% reduction from baseline
Lake Winnipeg [a] (Red River only)	Phosphorus	Achieve 10% reduction goal	Achieve any additional needed reductions identified through international joint efforts with Canada and in-state water quality standards
	Nitrogen	Achieve 13% reduction goal	
Lake Superior	Phosphorus	Maintain goals, no net increase	
	Nitrogen	Maintain protection	

[a] Timeline and reduction goals to be revised upon completion of the Red River/Lake Winnipeg strategy.

Total phosphorus

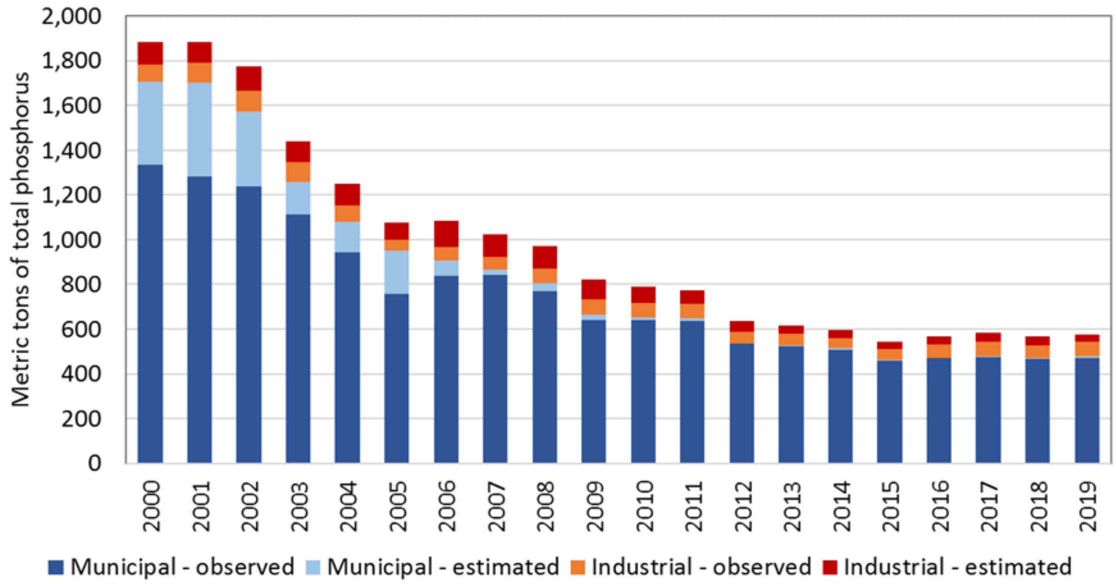
Total phosphorus is the primary pollutant associated with increased algae growth in Minnesota's lakes and streams. Excess phosphorus from human activities causes algae blooms and reduced water transparency, making water unsuitable for swimming and other activities. Phosphorus is released from both point and nonpoint sources of pollution.

Controlling phosphorus is an important part of protecting Minnesota's water resources. Considerable reductions in phosphorus from wastewater treatment facilities have been achieved since the MPCA Citizens Board adopted a strategy for addressing phosphorus in National Pollutant Discharge Elimination System (NPDES) permits in 2000. Phosphorus loads were reduced by 56% from 2000-09 and have decreased a further 34% since 2009. Overall, these efforts have resulted in a steady decline of phosphorus pollution (see chart on next page).

The 2019 total phosphorus load for the state was 576 metric tons, which is no change from the 2017-18 average of 576 metric tons. A 69% reduction in total phosphorus loads has been accomplished from a 1,883 metric ton per year baseline in 2000/2001.

Total phosphorus wastewater data are considered reliable, with 93% of loads resulting from observed data points. On average, 75% of wastewater total phosphorus loads are discharged by major facilities although the proportion discharged by major facilities has declined from an average of 87% from 2000 through 2003 to an average of 79% from 2004 through 2019. Municipal wastewater dischargers accounted for 89% of total phosphorus loads from 2000 through 2003 with their proportion of the loading declining to an average of 84% from 2004 through 2019. Overall, wastewater total phosphorus loads have declined from an average of 1,745 metric tons per year in the 2000 through 2003 period to an average of 1,082 metric tons per year from 2004 through 2008 and further to an average load of 625 metric tons per year from 2010 through 2019.

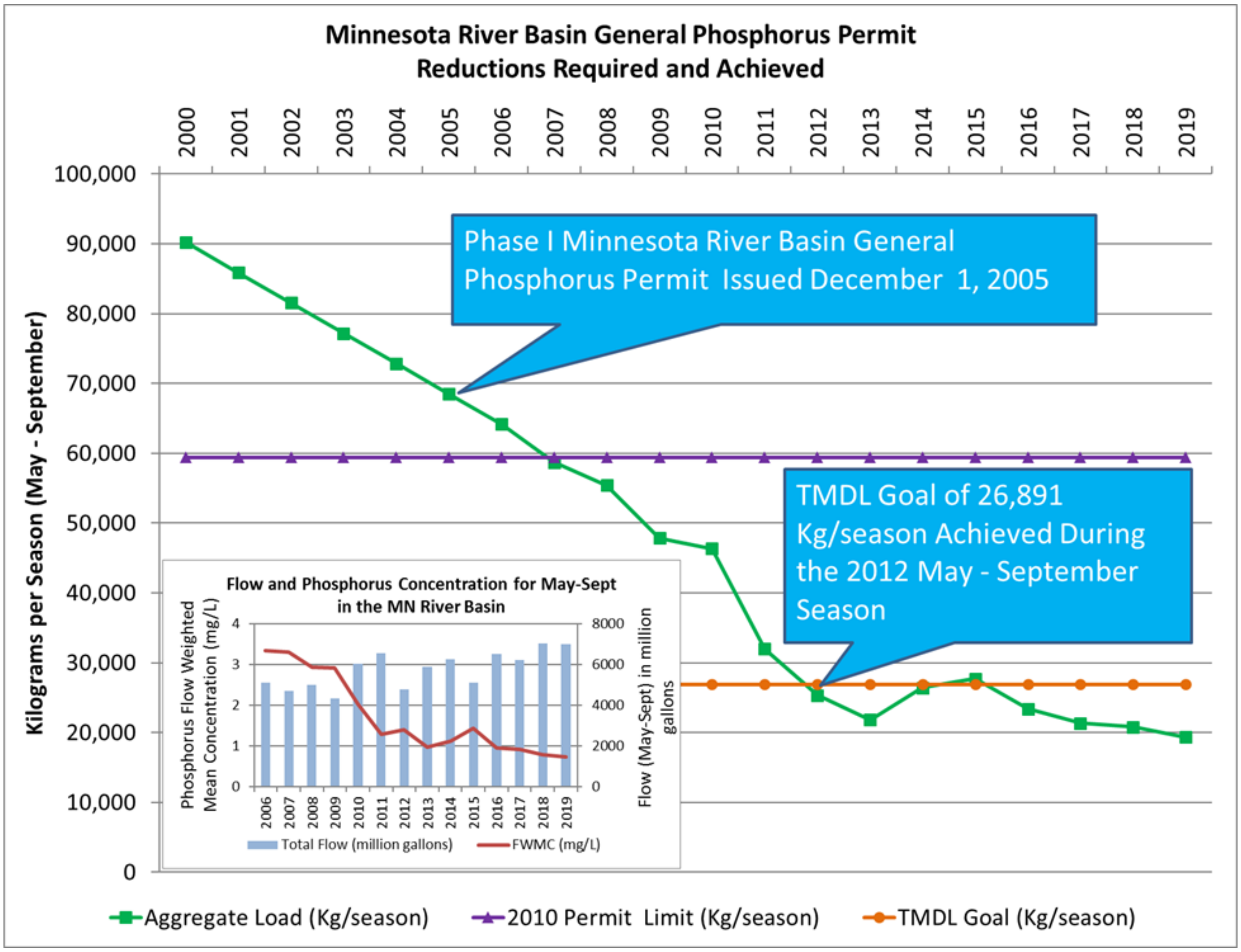
Figure 18. Annual total phosphorus loads from wastewater treatment facilities



Minnesota River Basin phosphorus reductions

Reductions in phosphorus loading to the Minnesota River have also occurred as a result of Minnesota River Basin General Phosphorus Permit, which was issued on December 1, 2005. The permit was developed as part of the Lower Minnesota River Dissolved Oxygen TMDL that was completed to address a dissolved oxygen impairment in the Lower Minnesota River. The permit required the 40 largest continuously discharging wastewater treatment facilities within the Minnesota River Basin to meet a five-month (May-Sep) mass phosphorus limit. The permit required incremental reductions over time. The TMDL's phosphorous reduction goal was met in 2012 (see Figure 19).

Figure 19. Minnesota River Basin General Phosphorus Permit reductions required and achieved

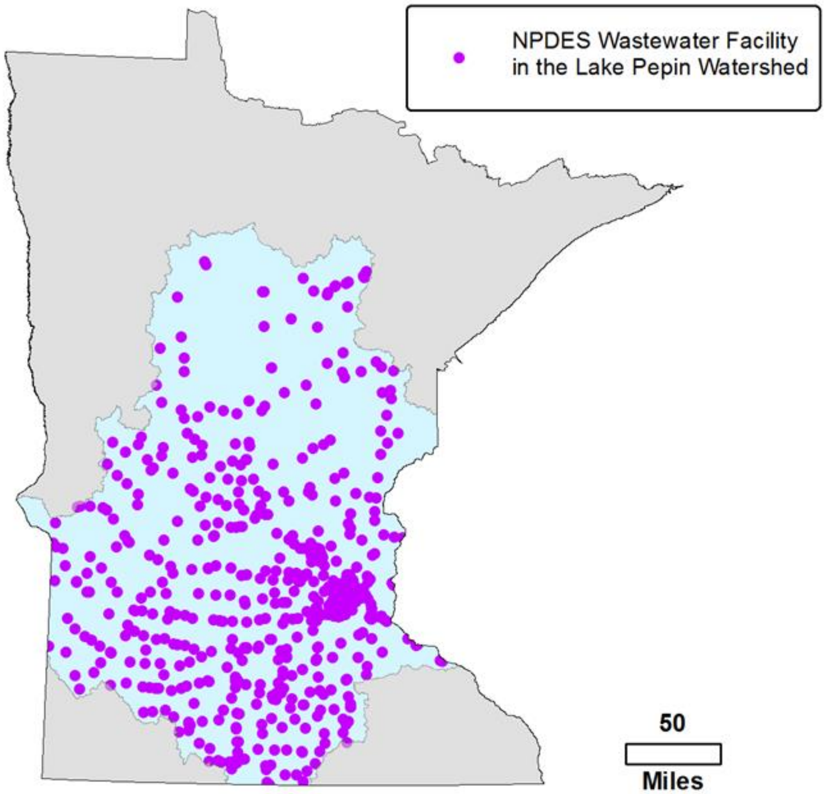


Lake Pepin phosphorus watershed reductions

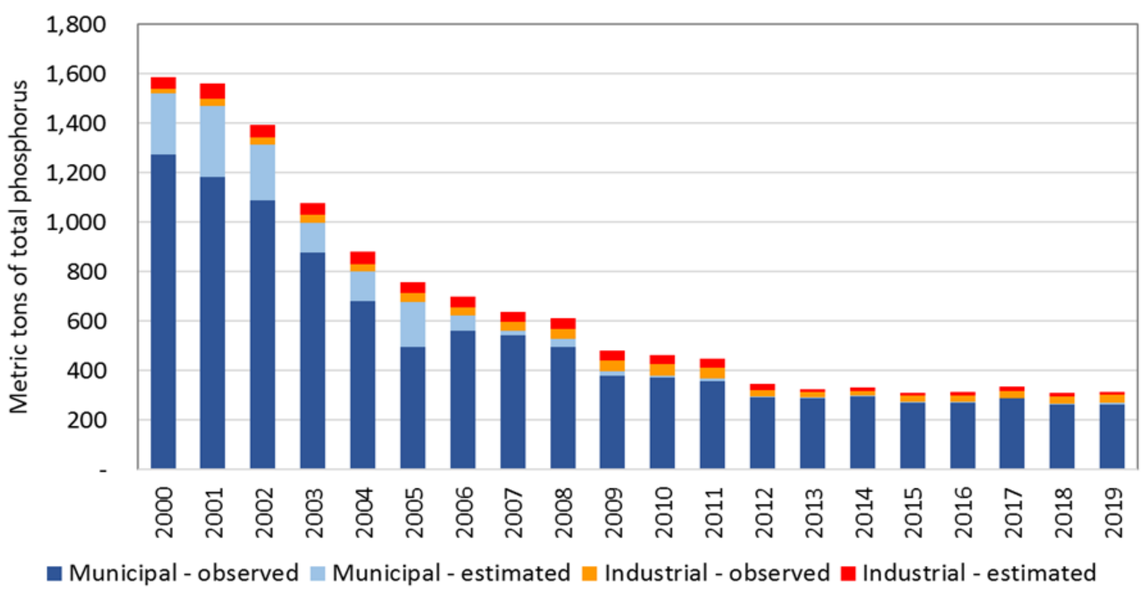
The Lake Pepin watershed covers a significant portion of the state and contains 82% of Minnesota residents. Lake Pepin is impaired due to excess nutrients. A TMDL addressing phosphorus loads to Lake Pepin is expected in 2020. Effluent phosphorus limits designed to address the impairment have been incorporated into permits since 2010.

Phosphorus loads entering the lake have been greatly reduced since the adoption of the lake eutrophication standards in 2008. Increased facility monitoring has also increased the confidence in load values because most municipal loads are now from observed values. Although aggregate total phosphorus loads from Minnesota dischargers have reduced effluent loads below the 600 metric ton per year wastewater point source goal for Lake Pepin, the NPDES permit program's efforts to establish permit limits continues in order to ensure that the load will remain consistent with watershed goals in the future.

Figure 20. Wastewater facilities within the Lake Pepin Watershed and annual wastewater loads



Annual wastewater phosphorus loads in the Lake Pepin Watershed



River eutrophication rule and phosphorus discharge limits

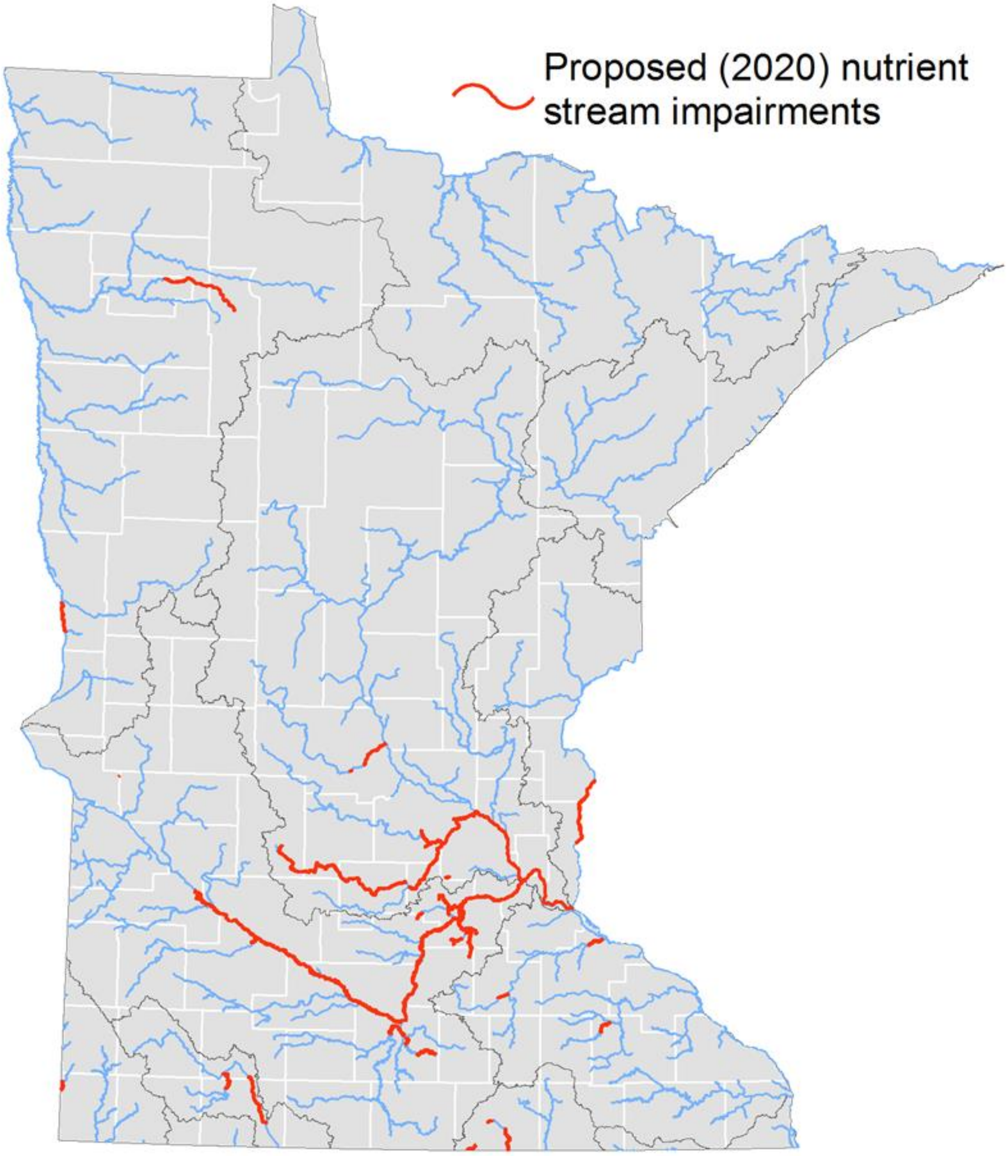
Minnesota's river eutrophication standards (RES) were adopted in 2015 to protect aquatic life from the negative impacts of excess suspended algae in rivers and streams. RES complement the lake eutrophication standards which were approved in 2008.

In addition to effluent phosphorus limits required for facilities whose discharges affect lakes, limits have also been established to meet RES water quality targets. Phosphorus effluent limit reviews are currently complete for many of the 81 major watersheds statewide. However, effluent limits associated with lakes are often sufficiently protective for nutrient impaired rivers. Limit determinations for individual facilities are based on major watershed scale effluent limit analyses that consider all wastewater discharges simultaneously. This holistic watershed approach means that each facility is only required to reduce its fair share of the load.

While limits for many pollutants are based on conditions of the immediate receiving water, eutrophication limits must consider water quality in a number of downstream waters. The MPCA outlines the analysis and calculations used to establish necessary phosphorus effluent limits in a procedure document found at the following link: https://www.pca.state.mn.us/sites/default/files/wq-wwprm2-15.pdf

The majority of nutrient-impaired streams are in the southern part of the state. Three new nutrient-impaired reaches were added to the 2020 proposed impaired waters list making a total of 53 impaired reaches encompassing 814 river miles. The location of these nutrient-impaired reaches is shown in Figure 21.

Figure 21. Streams with nutrient impairments on the 2020 proposed impaired waters list



Total nitrogen

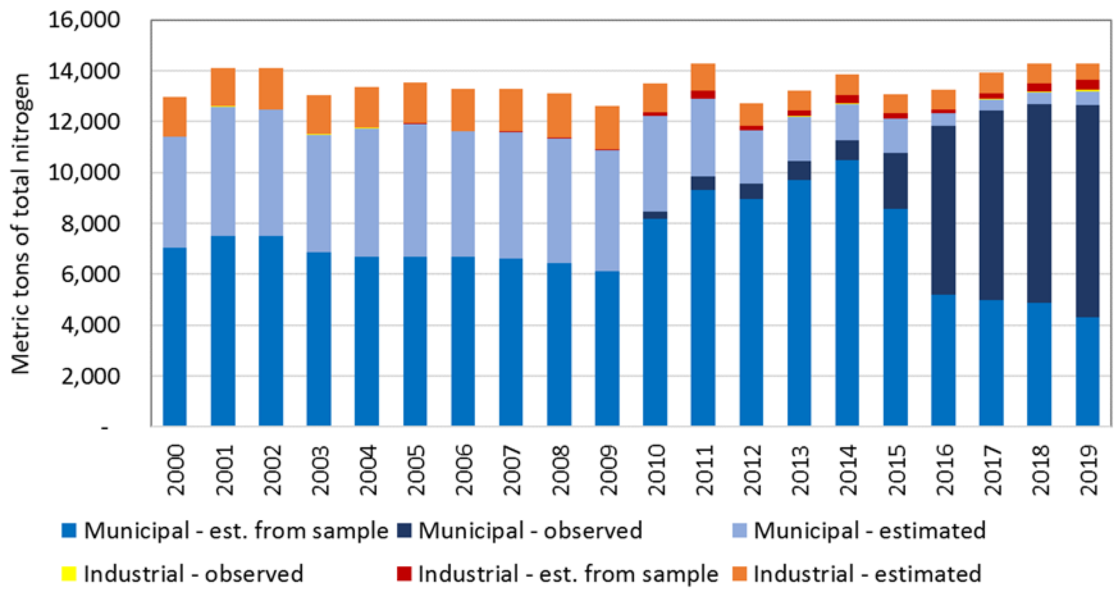
Nitrogen in wastewater generally occurs mostly as either nitrate or ammonia. Nitrogen as ammonia can be toxic to aquatic life and nitrogen in the form of nitrate can be a significant problem in drinking water supplies, and can also be toxic to aquatic life. Traditionally, permits have required more frequent monitoring for ammonia than for nitrate and/or other nitrogen parameters. As a result, it has been difficult to accurately report the total nitrogen (a measure of all forms of nitrogen including nitrate, nitrite, ammonia, and organic nitrogen) loads from point source discharges.

Minnesota's Nutrient Reduction Strategy defines a total nitrogen load reduction goal of 20% from discharges to the Mississippi River and 13% from dischargers to the Red River by 2025. As a first step in reaching this goal, additional monitoring for the necessary nitrogen parameters has been added to permits so that a more accurate calculation of the total nitrogen loading from point source discharges can be established. Once total nitrogen loadings can be accurately defined, initial total nitrogen reductions efforts will be made through source reduction work.

The 2019 wastewater load for total nitrogen was 14,301 metric tons, a 1% increase from the 2017-18 average.

Confidence in the accuracy of wastewater total nitrogen loading estimates is increasing as the proportion of the loading derived from observed effluent data is increasing. In 2019, 57% of wastewater total nitrogen mass loading was derived from reported effluent monitoring data. On average, 89% of wastewater total nitrogen load is estimated to be discharged by major facilities. Municipal wastewater dischargers account for 92% of total nitrogen. 2019 wastewater total nitrogen loads have increased by 6% from the 13,544 metric tons per year from the 2000/2001baseline load.

Figure 22. Total nitrogen loads from wastewater treatment facilities by year



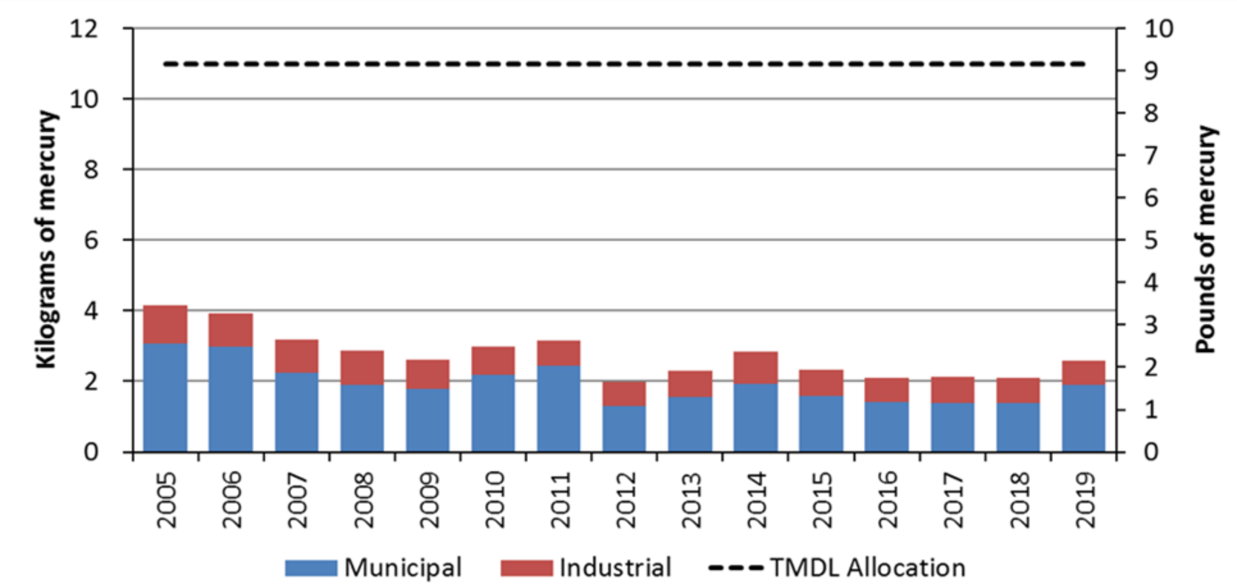
Total mercury

The wastewater mercury load fell below the Statewide Mercury TMDL wasteload allocation in 2003 and has continued to decrease slightly since that time. The wastewater mercury load for 2019 was 2.6 kg, a 22% increase from the 2017-18 average of 2.1 kg. This was the result of the overall increase in effluent flow volumes and increased effluent concentrations discharged by a few individual wastewater treatment facilities. Mercury reduction in wastewater is a result of successful source reduction programs and installation of treatment technologies for mercury removal, when appropriate. On average, the data show a 36% reduction in mercury loads from a 4.05 kilogram per year baseline in 2005/2006.

Total mercury wastewater data are considered moderately reliable with 64% of values resulting from observed data points. Mercury load estimates prior to 2005 are considered unreliable due to the use of analytical methods with limited detection capabilities.

On average, major wastewater dischargers have accounted for 64% of total mercury loads since 2005. Municipal wastewater dischargers are estimated to account for 70% since 2005. Overall, wastewater total mercury loads are estimated to have declined from 4.2 kilograms per year in 2005 to 2.6 kilograms per year in 2019.

Figure 23. Total wastewater mercury loads by year



Nonpoint source pollution

While significant progress has been made to reduce point sources of water pollution more reductions are needed from nonpoint sources of pollutants – natural and human-made pollutants carried by rain or snowmelt into lakes, rivers, wetland and groundwater.

Over the past few years, more regulatory controls for such sources as feedlots, septic systems and stormwater have been implemented, but other sources of nonpoint source pollution are diffuse and can be difficult to assess and manage. Much of the effort to control unregulated nonpoint sources of pollution thus far has consisted of financial incentives to encourage voluntary adoption of best management practices. The section below briefly outlines efforts made possible by the Clean Water Land and Legacy Amendment (CWLAA) and estimates associated pollutant reductions. Also highlighted is a statewide program that provides incentives for farmers to adopt agricultural best management practices to improve water quality and recent progress in watershed monitoring and assessment.

Clean Water Fund

The Minnesota Legislature appropriated $201.4 million for Fiscal Years 2018-2019 and $261.0 M for Fiscal Years 2020-2021 to the Clean Water Fund. Project funds are used for water-quality monitoring and assessment, watershed restoration and protection strategies and drinking water protection activities. Since passage of the CWLAA in 2008all 80 watersheds in Minnesota have benefitted from Clean Water Fund supported activities. Implementation activities comprise the largest portion of spending in watersheds statewide. About 82% of grant and contract awards are for implementation activities.

Minnesota agencies released the most recent *Clean Water Fund Performance Report* in February 2020 to provide a high-level overview of Minnesota's investment to restore and protect the quality of the state's water resources. The report details how spending and progress are occurring across Minnesota. For a link to the report and more information on the Clean Water Fund, see the following link: http://www.legacy.leg.mn/funds/clean-water-fund.

Minnesota Agricultural Water Quality Certification Program

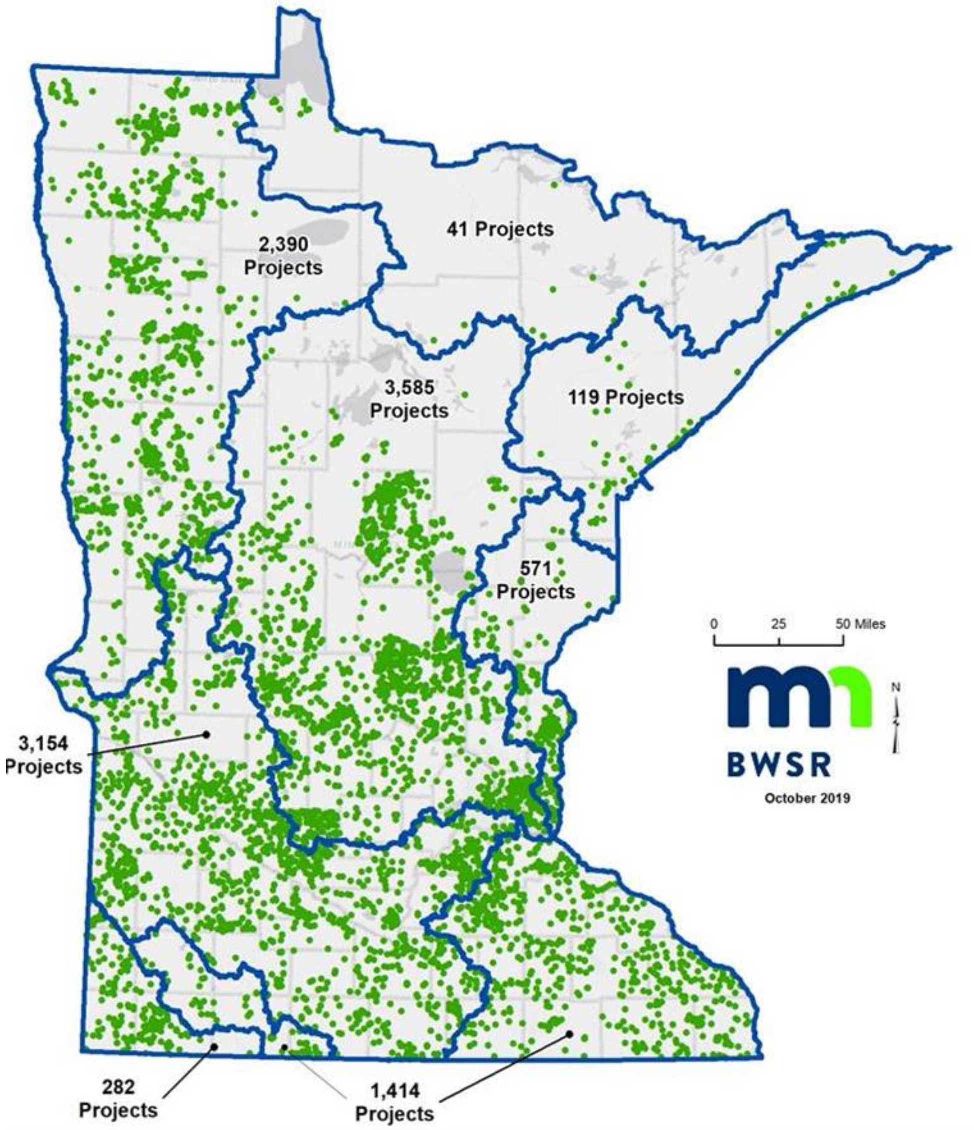
The Minnesota Agricultural Water Quality Certification Program is a statewide voluntary program designed to expedite the on-farm adoption of agricultural conservation practices that protect water quality. The program is a state and federal partnership with the state contribution coming from the Clean Water Fund. In total, this program has certified more than 500,000 acres on almost 800 farms across Minnesota, adding 1,650 new conservation practices to the landscape in approximately three years of statewide operation. Farmers and landowners who implement and maintain approved farm management practices are certified and in turn obtain regulatory certainty for a 10-year period. Regulatory certainty means certified producers are deemed to be in compliance with any new water quality rules or laws during the period of certification. These farmers also receive priority for technical and financial assistance. More information about the Agricultural Water Certification Program can be found at the following link:
http://www.mda.state.mn.us/protecting/waterprotection/awqcprogram.aspx.

Nonpoint Source BMPs Implemented with Clean Water Funding

The Minnesota Board of Water and Soil Resources (BWSR) is the primary state agency responsible for nonpoint source implementation and works in partnership with local governments. Local governments—cities, counties, watershed districts and soil and watershed conservation districts—work directly with individual landowners and communities to implement best management practices that help reduce polluted runoff from agricultural field and city streets.

With funding from the Clean Water Land and Legacy Amendment, the implementation of practices to improve and protect Minnesota’s water resources has accelerated. The map on the next page shows the location of state Clean Water Fund projects and the estimated phosphorus and sediment reductions associated with them. In total, more than 11,556 best management and conservation practices have been installed, resulting in a reduction of about 189,279 pounds of phosphorus and 176,791 tons of sediment across the state from 2010-2019. Figure 23 shows the number and location of Clean Water Fund projects by major basin. While these reductions do not represent all of best management practices implemented on the land in Minnesota, they demonstrate the improvements resulting from Clean Water Fund investment. Although funding has increased, and implementation of practices and projects continues to grow, the total request for projects has remained three times greater than available funds.

Figure 24. Clean Water Fund projects by major basin, 2010-2019



Progress in watershed monitoring and assessment

Clean Water Fund investment is enhancing monitoring of Minnesota's waters and our understanding of the relative contributions of pollutants from various sources and waters.

State and local partners began intensive sampling and assessment of lakes and streams in all the major watersheds in a 10-year cycle, which began in 2008. All major watersheds in Minnesota have now been assessed.

Clean Water Fund investment is improving understanding of the relative contributions of pollutants from various sources and waters. One example is the Minnesota Watershed Pollutant Load Monitoring Network, which measures and compares pollutant load information from Minnesota's rivers and streams and tracks water quality trends. This long-term program utilizes state and federal agencies, universities, and local partners to collect water quality and flow data to calculate pollutant loads. To learn more about Minnesota's Watershed Pollutant Load Monitoring Network, see the following link: https://www.pca.state.mn.us/water/watershed-pollutant-load-monitoring-network

Contaminants of emerging concern and PFAS

The MPCA monitors pharmaceuticals, personal care products, industrial, and other wastewater-associated chemicals in Minnesota's groundwater, lakes, and streams. Although it is not yet possible to quantify the amounts released to the environment because not all of the wastewater dischargers in the state are monitoring these constituents in their effluent, the MPCA's ambient monitoring efforts demonstrate the extent to which these unregulated chemicals are found in Minnesota's surface and groundwater. Most of these chemicals lack established standards or benchmarks for comparing concentrations and characterizing their risk to human health. Concern is growing over the potential health effects of these chemicals for humans and the environment, as well as other unregulated chemicals such as per- and polyfluoroalkyl substances (PFAS). The work summarized here is often accomplished through collaboration with the United States Geologic Survey (USGS), Minnesota Department of Health (MDH), the University of Minnesota, St. Cloud State University, and the University of St. Thomas.

Lake and river studies

Large-scale monitoring of lakes (2012, 2017) and rivers and streams (2010, 2014) shows many pharmaceuticals, personal care products, detergents, and other commercial or industrial chemicals are present in most of Minnesota's surface water. Much of this contamination can be attributed to wastewater treatment plants, subsurface sewage treatment systems, or agricultural land use. However, these contaminants often appear at remote locations without apparent sources. The next large-scale sampling of rivers and streams is planned for 2020.

Groundwater monitoring

The MPCA monitors the state's groundwater annually for the presence of medications, detergents, and other organic chemicals used in industry or found in personal care or household products. The agency tests 40 wells in its ambient groundwater network each year for these types of chemicals. This work has found low levels of a variety of these chemicals in the state's groundwater.

Precipitation study

A 2016 study found antibiotics, anti-corrosives, bisphenol A, DEET, and other chemicals in samples of snow, rain, and air. While the study did not determine the source of these contaminants to the atmosphere, the results suggest that atmospheric transport of these contaminants may partially explain their appearance at remote surface water locations in Minnesota.

Fish studies

A 2014 screening study indicated that chlorinated paraffins (CPs) are present at concentrations of concern in some Minnesota fish. CPs are known to be highly toxic to aquatic invertebrates, which are important food sources in aquatic ecosystems. CPs can also cause tumors in fish and eggshell thinning in ducks. Toxicity to humans is not well studied, but studies in laboratory rats and mice have shown the potential to cause liver, thyroid, and kidney cancer. CPs are widely used in a variety of products, including fire retardants, plastics, sealants, adhesives, and coatings. In 2015, over 350 fish representing a variety of species were collected from 43 waters (13 rivers, 30 lakes) in six of Minnesota's seven ecoregions. Short-, medium- and long-chain CPs were detected in fish fillets from 62% of rivers and 27% of lakes.

Groundwater at wastewater land application sites

In 2016, the MPCA and USGS completed a groundwater contaminant study of large drainfields, municipal rapid infiltration basins and a septage land application site. A total of 34 different contaminants were detected in the shallow groundwater adjacent to these systems, including pharmaceuticals, flame-retardants, corrosion inhibitors, fragrances, and pesticides. No individual contaminant exceeded a concentration of 1 part per billion, nor did they exceed available drinking water guidelines, screening values or standards. However, most of the chemicals lack established standards or benchmarks for comparing concentrations and characterizing their risks.

Stormwater

In 2016, stormwater was tested at nine locations in the Twin Cities Metro Area for a broad suite of pharmaceuticals and other wastewater-associated chemicals. The results of this investigation show that stormwater is an important contributor of these contaminants to surface water, and that it is important to reduce the prevalence of these constituents in stormwater.

Aquatic toxicity profiles

Most of the work done to evaluate risks from contaminants of emerging concern is focused on their potential harm to people, especially through the possibility they may be present in drinking water. However, fish and other aquatic life are exposed continually to contaminants of emerging concern. Characterizing risks to aquatic life from exposure to these chemicals is complex and difficult in the absence of formal standards or other benchmarks. Some have endocrine-active characteristics, mimicking hormones in ways that could adversely affect reproduction, behavior, or physiology in wildlife, aquatic organisms, and possibly humans. Most of these chemicals have not undergone full toxicity evaluations.

The MPCA has begun developing Aquatic Toxicity Profiles (ATPs) to provide an overview of chemical-specific information including chemical properties, occurrence, toxicity, and production volumes. ATPs can help prioritize chemicals for monitoring and follow-up study.

Other special studies

A study of discharges from 25 wastewater facilities in 2009 confirmed that wastewater effluent is a major contributor of pharmaceuticals, alkylphenols, and other chemicals to surface water, highlighting the fact that most wastewater treatment facilities are not designed to remove such chemicals. Focused lake studies from 2008 through 2013 demonstrated the widespread presence of these chemicals in both urban and rural lake water. Biological effect studies, done in conjunction with MPCA's sampling investigations, consistently indicate physiologic and genetic impacts on fish exposed to surface water with low concentrations of these chemicals.
https://www.pca.state.mn.us/water/contaminants-emerging-concern

PFAS

Per- and polyfluoroalkyl substances (PFAS, formerly known as PFCs) are manmade chemicals used to manufacture products that are heat- and stain-resistant and repel water. PFAS used in emulsifier and surfactant applications are found in fabric, carpet and food-paper coatings, coatings for smartphone and computer screens, floor polish, waxes, cosmetics and hair care, dental floss, fire-fighting foam, compostable food ware, adhesives, and certain insecticides. PFAS are persistent in the environment and some are known to bioaccumulate in humans and biota. PFAS have been found in animals and people all over the globe.

In Minnesota, 3M manufactured PFAS started in 1950, including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). PFOS and PFOA were phased out of production by 3M in Minnesota in 2002. PFAS were released into the Mississippi River in effluent from the 3M Cottage Grove wastewater treatment plant. In addition, four sites in Washington County were identified where 3M disposed of PFAS wastes. These are in Oakdale, Woodbury and Cottage Grove, and at the former Washington

County Landfill in Lake Elmo, and have resulted in a 100-square-mile plume of PFAS-contaminated groundwater.

MPCA investigations also detected PFOS at elevated concentrations in fish taken from Pool 2 of the Mississippi River and downstream, as well as in east metro area lakes, including Lake Elmo. In addition, PFOS has also been found in fish from other metro area lakes, most with no known connection to 3M's manufacturing or waste disposal. Mississippi River Pool 2, which receives 3M Cottage Grove effluent, is listed as impaired due to PFOS in fish tissue. Follow-up testing of fish and water has shown an overall decline in Pool 2 PFOS concentrations in fish, with elevated levels remaining in the lowest reach of the pool near the 3M Cottage Grove plant. However, concentrations of PFOS (and other PFAS) in fish and water from Lake Elmo continue to be elevated. The Minnesota Department of Health currently recommends that everyone avoid eating any fish caught in Lake Elmo.

See 2012 report on fish, water, sediment, and invertebrate sampling at http://www.pca.state.mn.us/index.php/view-document.html?gid=19516

In 2018, fish and water were collected from 70 water bodies, statewide. PFOS was detected in fish in 95% of the tested waterways, and at least one PFAS was detected in water samples from every water body. Additional fish, water, and sediment sampling is planned for 2020.

MPCA is coordinating with other permit holders and other states to understand the opportunities to reduce the presence of PFAS in wastewater. MPCA also has plans to investigate PFAS in land-applied biosolids and potential treatment and destruction technologies.

Although PFOS and PFOA have been phased out, there are an estimated 5,000 other PFAS in production. PFAS can enter the environment during manufacture, distribution, use, and disposal of products.

Several findings of elevated PFOS concentrations have been traced to chrome-platers using PFOS-containing products in plating or for chrome mist suppression.

In many cases, PFAS is carried into the environment from facilities that do not manufacture or use significant PFAS compounds – facilities like landfills and municipal wastewater treatment facilities. MPCA is working with permit holders and other states to understand the opportunities to reduce the presence of PFAS in both landfill leachate and wastewater. MPCA has requested $1.4 million from LCCMR to better understand elevated levels of PFAS in waste streams (e.g. wastewater bio-solids, compost contact water, and landfill leachate). Research goals include:

Analyze alternative disposal and treatment options and develop tools for managing PFAS-contaminated waste streams.

Evaluate and characterize PFAS concentrations in land-applied biosolids; leaching from those wastes; and subsequent movement of PFAS into water and food. See link for more information. (https://www.lccmr.leg.mn/proposals/2020/originals/098-b.pdf)

MPCA would like to conduct additional investigation into effluent concentrations and PFAS source identification at wastewater facilities. This effort will build on previous efforts to minimize PFAS at WWTPs, including some sampling done in the 2000s and some work done by individual facilities. MPCA would like to support municipal wastewater facilities in efforts to identify upstream sources and minimize PFAS waste streams.

Most occurrence and toxicity studies have focused on PFOS and PFOA, two PFAS which have been phased out of production. However, our understanding of the toxicity of PFAS is expanding as new toxicity studies on other PFAS are published daily. It is now widely accepted that PFAS as a class are persistent, bioaccumulative, and toxic.

In May 2016, the EPA announced the results of a multi-year review of its health-based guidance for drinking water exposure to PFOS and PFOA, and lowered its health benchmark from 300 nanograms per liter (ng/l) to 70 ng/L. MDH has tightened its health-based guidance for PFOS and PFOA even further, down to 15 ng/L and 35 ng/L respectively. More information on health risks is at this link: http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcshealth.html

These growing concerns have led an international group of PFAS researchers to propose restrictions on production and use of fluorinated chemicals and promote development of non-fluorinated alternatives. The "Madrid Statement" of 230+ signatory scientists is provided at this link: https://ehp.niehs.nih.gov/wp-content/uploads/123/5/ehp.1509934.alt.pdf

A counterpoint from the FluoroCouncil, an American Chemistry Council affiliate representing fluorochemical manufacturers, can be viewed at: https://fluorocouncil.com/PDFs/The-FluoroCouncil-Counterpoint-to-the-Madrid-Statement.pdf