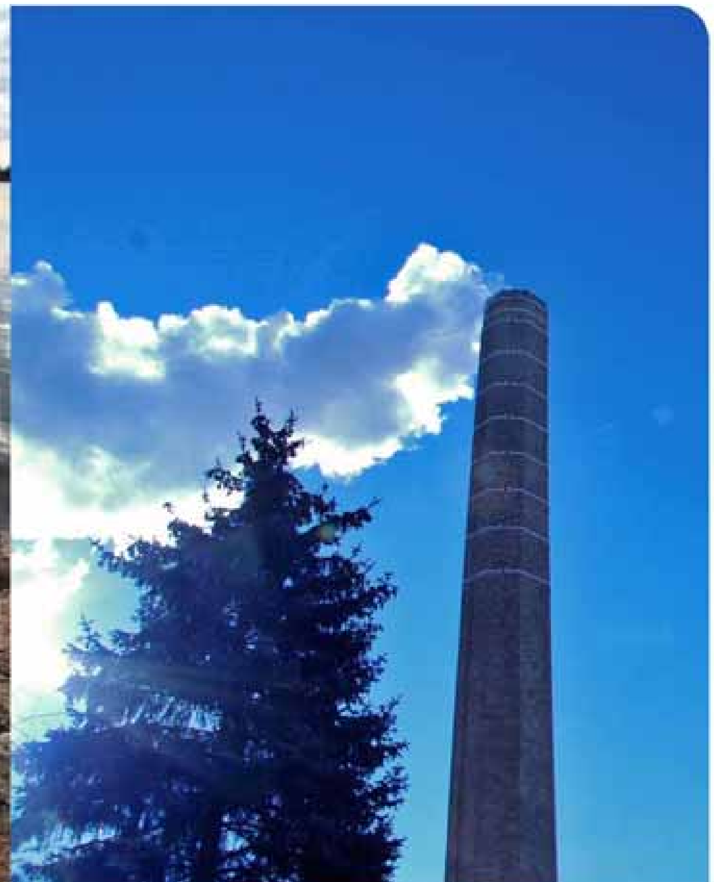

Annual Pollution Report to the Legislature

A summary of Minnesota's air emissions and water discharges

April 2010

Minnesota Pollution Control Agency

Tom Clark, Patricia Engelking and Kari Palmer of the Water Assessment and Reporting Section of the Environmental Analysis and Outcomes Division prepared this report, with assistance from other staff in the Municipal, Industrial, Regional, and the Environmental Analysis and Outcomes divisions.

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An electronic version of this report can be found on the MPCA web site at http://www.pca.state.mn.us/hot/legislature/reports/index.html

This report can be made available in other formats, including Braille, large type, or audiotape upon request.

This report is printed on paper with at least 30 percent post-consumer recycled paper.

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Foreword

The Annual Pollution Report statute requires the Minnesota Pollution Control Agency (MPCA) to estimate the total amounts of air and water pollution emitted in the state during the most recent calendar year for which data are available. The statute further directs the MPCA to estimate the percentage increase or decrease over the previous calendar year, and to estimate the relative contributions of the various sources of these emissions and discharges to the environment.

The Annual Pollution Report, prepared each year since 1996, has evolved to include new kinds of information, such as discharges of toxic air pollutants, greenhouse gas emissions, and emerging issues of concern as these kinds of data have become available. Observations of some advantages and limitations of this kind of report are presented below to add context for interested parties.

Also, a 2009 state law directed the MPCA to compare measured fine-particle concentrations (also known as $PM_{2.5}$) to the range of possible updates to national standards recommended by the federal Clean Air Scientific Advisory Committee prior to adoption of the 2006 standards. This information is included as Appendix A to this report, to fulfill the requirements in Minnesota Session Laws 2009, Chapter 37, Article 1, Subdivision 3.

Advantages of the inventory approach

- The Annual Pollution Report is the only MPCA report that specifically asks for an accounting of emissions and discharges. Such inventories are inherently important, as understanding emission amounts and sources is fundamental in protecting the environment and human health.
- The report attempts to track trends year to year, which is valuable if data are reliable.
- The report covers both air and water pollutants in one document, instead of separate reports, reminding readers of the potential for cross-media impacts.
- The report shows relative contributions of various pollution sources to the total.

Minn. Statutes 116.011 Annual 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 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 calendar year 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 previous calendar year; and
(2) in a manner which will demonstrate the magnitude of the various sources of water and air pollution.
HIST: 1995 c 247 art 1 s 36; 2001 c 187 s 3

Challenges of the inventory report approach

- There is currently no reliable way to quantify the volumes of water pollutants released by nonpoint sources in the form of polluted runoff, such as city streets, construction sites and farm fields. This is a major gap in inventorying pollutants discharged. However, local watershed managers reporting to statewide data management systems like eLINK have enabled better estimates of pollutant loads from nonpoint sources. Reasonable estimates of

Challenges cont.

benefits from soil loss and phosphorus reductions from implementation of best management practices (BMPs) may now be made statewide and are discussed in this report.

- Aggregating data into total volumes lacks the important context of relative risk. Pollutants emitted in smaller volumes can have a greater impact than some emitted in tremendously larger volumes. Volume figures are not able to indicate whether such emissions and discharges are acceptable or unacceptable from a risk assessment perspective.

- The most current pollutant emissions and discharge data are usually at least two years behind real time, sometimes more, depending on the type of pollutants. Air emission estimates are frequently revised as industrial output models and factors used to estimate emissions are refined. Year-to-year comparisons are not always reliable, as emissions methodologies are still evolving.

Outlook

Several important national, regional and state actions affecting pollutant emissions and discharges now and in the future were enacted recently and are worth mentioning:

- **Consolidated Emissions Inventory**: A combination of federal and state funding in 2009 allowed the MPCA to begin development of a new air emissions inventory system called the Consolidated Emissions Data Repository. The new system will consolidate the air toxics, criteria pollutant, and greenhouse gas inventories into a single database. It will also feature web-based electronic reporting for facilities. The electronic reporting feature along with other system improvements will reduce the inventory completion time, improve data quality, and reduce the burden on reporting facilities and agency staff. The new inventory is scheduled to be completed in the fall of 2011.

- **Clean Air Interstate Rule:** The United States Environmental Protection Agency (EPA) adopted its Clean Air Interstate Rule (CAIR) in 2005, setting up a cap-and-trade system for 28 states to lower emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) from electric power plants. These emissions contribute to non-attainment of the ambient air quality standards for ozone and fine particulate matter. CAIR was subject to significant legal challenge. The D.C. Circuit Court of Appeals found several flaws in the rule, and directed EPA to craft a new rule. As one of the challenges concerned whether Minnesota's emissions were significant enough to merit inclusion in the CAIR region, EPA determined that CAIR should not apply in Minnesota. EPA is expected to propose a replacement rule in spring 2010, which will likely be based on new and more stringent ozone and fine particulate matter standards. This replacement rule should also contain a decision about Minnesota's impact, and whether Minnesota will covered by the replacement rule.

- **Updated Lead Standard**: The EPA continually re-evaluates standards for criteria pollutants. While Minnesota is currently in attainment with all national standards, this status can change as standards change. For example, in 2008, the EPA significantly strengthened the lead standard from 1.5 $\mu g/m^3$ to 0.15 $\mu g/m^3$. As a result, Minnesota may not meet the new standard near a lead recycling facility in Dakota County. The new standard also affected reported lead emission values. To show compliance with the new standard, lead monitors need to be added near facilities that emit 0.5 tons or more of lead per year. As a result, many facilities that emit lead re-evaluated their estimated lead emissions using refined emission estimates and stack testing. In many cases, the refined analysis resulted in much lower estimated lead emissions, particularly from coal-fired electric utilities.

- **Visibility State Implementation Plan:** At the end of 2009, the MPCA submitted to EPA Minnesota's Regional Haze State Implementation Plan. EPA will now review the plan to ensure that it complies with the federal regional haze rule. The goal of the regional haze program is to restore natural visibility conditions in the Boundary Water Canoe Area Wilderness and Voyageurs National Park by 2064. The submitted state implementation plan contains goals for visibility improvement by 2018. Visibility is improved by reducing NO_X and SO_2, which are precursor emissions that form haze-causing fine particulates. Minnesota's State Implementation Plan includes emission limits on several power plants and a goal of a 30 percent reduction in emissions from the six-county northeastern Minnesota area by 2018.

- **2008 Greenhouse Gas Legislation:** In 2008, the state legislature enacted several laws related to greenhouse gas control that affect the MPCA. The legislation requires the MPCA and the Minnesota Department of Commerce to report on progress on greenhouse gas reduction goals set in 2007 statutes and to annually propose legislation needed to meet the goals. The progress reports can be found at the following web link:

  http://www.pca.state.mn.us/climatechange/publications.html

- **Transportation Initiatives:** The MPCA has little direct control over transportation sources. However, several programs are underway to decrease diesel emissions.

  - The MPCA received $1.7 million through the American Recovery and Reinvestment Act of 2009 for clean diesel grants and awarded 68 grants to public and private entities. The projects are underway and include emission reduction devices; idle reduction devices on long-haul trucks; engine replacements; and generator engines for refrigerated trailers.

  - MPCA used federal Congestion Mitigation and Air Quality (CMAQ) funding to install emission reduction devices in public diesel fleets in the Twin Cities seven-county metropolitan area. Approximately 300 vehicles were retrofit by the end of 2009 including fire trucks in Minneapolis and St. Paul.

  - The MPCA has been working over the last three years with small trucking businesses and independent truckers and has provided low interest loans to help them purchase idle reduction equipment such as Auxiliary Power Units (APUs). APUs reduce diesel fuel use and result in lower carbon dioxide, nitrogen oxides, particulate matter and air toxics emissions.

  - The MPCA continues to be a major partner of Clean Air Minnesota and its school bus retrofit program called Project Green Fleet. The project completed over 1,700 tailpipe retrofits of diesel school buses by the end of 2009. These retrofits reduce particulate matter, carbon dioxide and air toxic contributions to the atmosphere, and reduce school children's direct exposure to pollutants inside the bus.

- **Clean Water, Land and Legacy Amendment:** At the state level, the Clean Water Legacy Act (CWLA) of 2006 provided one-time funding to the MPCA to conduct accelerated testing of Minnesota's surface water and groundwater and to develop TMDL plans to clean up those waters that do not meet water quality standards.

  In November 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment to the state constitution. The Amendment increases the sales tax rate by three-eighths of one percent on taxable sales, starting July 1, 2009, continuing through 2034. Of those funds, approximately 33 percent will be dedicated to a Clean Water Fund to protect, enhance, and restore water quality in lakes, rivers, streams, and groundwater, with at least five percent of the fund targeted to protect drinking water sources. Total funding appropriated by the legislature for the FY2010-2011 biennium is approximated $150.8 million, going to seven state agencies.

> Of this total, the legislature provided the MPCA with $51.16 million specifically for monitoring and assessment, TMDL development, protection and restoration activities and for groundwater assessment and drinking water protection. These resources will allow the MPCA to continue the accelerated assessment and TMDL development efforts from previous CWLA one-time funding and to more fully integrate MPCA water resource management and protection efforts in cooperation with local governments and stakeholders.

The MPCA has significantly expanded and improved public access to environmental data available electronically through its Environmental Data Access Initiative. Water quality data and air quality concentration and emission data from all over the state are now easily available at this link: http://www.pca.state.mn.us/data/eda/index.cfm

As this system continues to grow and evolve, the MPCA will evaluate new reporting formats for presenting annual pollution data. The agency welcomes suggestions from interested parties for upgrading the current reporting process to better meet the purpose envisioned in the statute.

Introduction and Summary

The Minnesota Pollution Control Agency (MPCA) is required to submit to the Legislature an annual report of the volume of pollution emitted or discharged to the state's air and water resources. The basis of the MPCA's 2009 Annual Pollution Report is the 2008 MPCA Greenhouse Gas Inventory, the 2005 and 2008 Minnesota Criteria Pollutant Emission Inventories, the 2005 Air Toxics Emission Inventory and the 2008 Water Quality National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Reports.

Annual emission and discharge estimates are one important component of tracking progress on air and water pollution, and for tracking performance and relative contributions of pollution sources. The MPCA also regularly prepares reports on the physical, chemical and biological conditions measured in the environment, and on pollutants of special concern to human health and the environment. These reports and others are available on the Internet and are referenced throughout this document for readers who would like additional context and information.

About Emission Inventories

Completing air pollutant emission inventories is a time-intensive process. For example, to develop the point source part of the Criteria Pollutant Emission Inventory for the year 2008, facilities with MPCA permits had until April 1, 2009 to submit their 2008 emissions estimates to the MPCA. Agency staff then compiled these emission estimates into a draft Criteria Pollutant Emission Inventory, which was sent back to the facilities for review in October 2009. Facilities completed their review by November, 2009. MPCA staff then reviewed the changes and completed the inventory for 2008 in January 2010.

The Minnesota Air Toxics Emission Inventory and the area and mobile source components of the Criteria Pollutant Emission Inventory are completed once every three years to coincide with the three-year cycle of the EPA’s National Emission Inventory. MPCA staff develops emissions estimates for the Air Toxics Emission Inventory based upon the completed Criteria Pollutant Emission Inventory, the assistance of permittees, and available information from other state and federal agencies.

Air Emissions

In this report, the MPCA reports on emissions of major air pollutants including carbon dioxide (the principal greenhouse gas), criteria air pollutants (pollutants with national ambient air quality standards), and air toxics.

The MPCA prepares a greenhouse gas inventory each year. The statewide emissions were calculated using a variety of fuel-use data sources. The most recent emissions inventory completed for carbon dioxide is from 2008. This is a preliminary estimate that may change as better information becomes available.

The MPCA reports data from its own Minnesota Criteria Pollutant Emission Inventory. The major air pollutants summarized in this report include particulate matter, ammonia, sulfur dioxide, nitrogen oxides, volatile organic compounds, carbon monoxide and lead. These are known as the criteria pollutants established in the federal Clean Air Act. Emissions of criteria pollutants from large facilities are estimated every year with data from 2008 currently available. However, emissions from smaller sources are estimated every three years with 2005 estimates the most recent available.

The Minnesota Air Toxics Emission Inventory estimates emissions of individual air toxics including compounds such as benzene and formaldehyde. There is some overlap between the Minnesota Air Toxics Emission Inventory and the estimates for VOCs and particulate matter because many air toxics are components of these broader categories. The most recent inventory of air toxics emissions is from 2005.

Table 1 lists the total statewide emissions of the major air pollutants from 2004 to 2008. The percent change from 2007 to 2008 is given in the final column. It is possible to look at emission trends between these years; however, it is important not to place undue emphasis on a yearly change since emission estimates fluctuate as a result of changes and improvements in the inventory and other factors such as the economy, meteorology, etc.

Table 1: Minnesota Air Pollution Emission Estimates, 2004-2008*
(thousand tons)

Pollutant	2004	2005	2006	2007	2008	2007-2008 % Change
Carbon dioxide (CO_2)**	127,300	128,100	126,200	126,600	125,600	-0.8%
Particulate matter (PM_{10})***	781	778	776	777	776	0.0%
Sulfur dioxide (SO_2)	163	159	148	138	129	-7.0%
Nitrogen oxides (NO_x)	480	422	409	408	391	-4.2%
Volatile organic compounds (VOCs)	364	349	347	347	345	-0.6%
Carbon monoxide (CO)	1,974	1,771	1,771	1,773	1,771	-0.1%
Total Criteria Pollutants (not including CO_2)	3,762	3,479	3,451	3,443	3,412	-0.9%

*2002 mobile and nonpoint emission estimates were used in the 2004 emission estimates.
2005 mobile and nonpoint emission estimates were used in the 2005-2008 emission estimates.
**Carbon dioxide emissions estimates include net imported electricity.
***PM_{10} emissions represent only primary formation; secondary formation is not included.

The biggest changes in emission estimates between 2007 and 2008 were the 7 percent decrease in sulfur dioxide and the 4 percent decrease in nitrogen oxides. This decrease was mainly due to emissions reductions from electric utilities as a result of Xcel Energy's Metropolitan Emissions Reduction Project (MERP). As part of the project, the Allen S. King coal-fired power plant in Oak Park Heights was renovated with state-of-the-art pollution controls while St. Paul's High Bridge power plant and Minneapolis' Riverside power plants were converted from coal to cleaner-burning natural gas.

As a result of these changes, the Allen S. King plant burned more coal than it did in 2004, but decreased its emissions of SO_2 by over 26,000 tons and its emissions of NO_x by over 11,000 tons. The High Bridge plant completed its conversion to natural gas in February 2008. Its emissions of SO_2 dropped from a high of nearly 4,000 tons in 2004, to just over one ton in 2008 while its emissions of NO_x decreased from over 6,000 tons to under 30 tons in the same time period. In addition, the Riverside plant completed its conversion in 2009. Emission estimates from 2009 are not yet available; however, in 2008, SO_2 emissions had decreased by nearly 2,000 tons and NO_x emissions by over 2,000 tons since 2004 due to a decrease in coal combustion during renovation.

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.

It should also be noted that despite the importance of the secondary formation of particulate matter, estimated air emissions data in this report are only based on direct releases from sources into the atmosphere. Secondary formation occurs when emissions of volatile gases combine and form fine particles downwind of the emission source.

$PM_{2.5}$ and ammonia are not included in Table 1 since estimated values are only available for 2002 and 2005. However, $PM_{2.5}$ emissions are a subset of PM_{10} emissions, so $PM_{2.5}$ mass emissions are included within the PM_{10} estimate. Estimated $PM_{2.5}$ and ammonia emissions are provided in the body of the report.

Lead and mercury are pollutants which can be toxic at very low concentrations. In 2008, 20 tons of lead were estimated to have been emitted in Minnesota and 3,600 pounds of mercury were estimated to have been emitted in 2005.

Water Discharges

Owners or operators of any disposal system or point source are required by Minnesota Statutes, Chapter 115.03(7) to 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). Data in the DMRs are compiled in Effluent Discharge Mass Loading Reports which are generated from DELTA, a compliance tracking system maintained by MPCA data specialists.

The MPCA began using DELTA to generate the reports on which this section is based when inconsistencies in EPA's Compliance Tracking System database were noted, beginning with the 2003 data summary. The agency is now using the DELTA database exclusively for this report. The 2010 Annual Pollution Report will examine the most recent five-year period for which DMR data are available.

The MPCA's water quality program continues to evolve from a predominantly concentration-based, facility-by-facility regulatory approach to one that emphasizes managing total pollution discharges to Minnesota's waters. The current report represents a continuing effort to improve the agency's capacity to accurately perform loading analyses. Due to the multi-year life of permit requirements, however, many of our permits do not yet contain monitoring and reporting requirements that enable efficient, computerized calculations of total annual pollutant loadings. As the agency reissues permits and conducts ongoing review of data, it will continue to build capability in that area and the assessment of pollutant trends over multiple years will become more reliable.

This year's report looks at water discharge data from major municipal and industrial point sources for five commonly measured water pollutants covering the years 2004-2008. Data from 2009 will be incorporated into the 2011 Annual Pollution Report. Adjustments were made to include such data as late reports that may not have been included in the year during which the discharge occurred and parameters added to permit requirements as a result of permit reissuance. The reader may therefore notice some differences in yearly pollutant loads reported in the current report compared with previous editions of the Annual Pollution Report.

In addition to the specific sources of variance highlighted above, a number of additional sources of variation, both up and down, can potentially impact year-by-year comparisons:

- Approximately 10,000 individually reported values have been incorporated into the yearly totals. These reported values are derived from an even larger set of raw data that has been summarized and interpreted by permittees before submission to MPCA, generally in ways that are optimized for concentration-based compliance determination, not environmental assessment.

- The loading calculations incorporate a number of data interpretation decisions that can legitimately be made in a variety of ways.

- Reporting requirements can vary with each permit issuance, resulting in variation in parameters and limit types, unmonitored parameters and unmonitored reporting periods, 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.

This report discusses five common chemical parameters found in wastewater treatment plant effluent including total suspended solids (TSS), biochemical oxygen demand (BOD), total phosphorus (TP), ammonia (NH_3) and nitrate (NO_3). Table 2 shows the water pollution discharge estimate from major point sources by pollutant for 2004-2008. In 2008, the total statewide loading from major dischargers was about three percent lower that the total loading in 2007, suggesting that recent improvements to treatment plant technology and operation continue to have a measurable positive effect on Minnesota's water resources, at least as far as point source discharges are concerned.

Table 2: Minnesota Water Pollution Discharge Estimates from Major Point Sources, 2004-2008 (thousand kilograms)

Pollutant	2004	2005	2006	2007	2008	2007-2008 % Change
Total suspended solids	4,600	5,600	3,700	4,200	3,800	-10%
Biochemical oxygen demand	3,000	2,700	2,100	2,600	2,700	4%
Total phosphorus	920	770	1570	660	680	3%
Ammonia	830	620	490	530	630	19%
Nitrate	3,400	3,600	3,900	4,000	3,800	-5%
Total	12,700	13,200	11,800	12,000	11,600	-3%

The above trends should be viewed in the context of overall climatological events in Minnesota for the years reported. During wet years, more effluent flow is generated and therefore more mass is typically discharged than in dry years. In 2005, annual precipitation totals were below normal over much of the state and by early 2006, concerns about abnormally dry conditions began to surface, especially in northern Minnesota. The drought deepened into late summer 2007, but quickly subsided in response to widespread heavy, even torrential rains that relieved the drought conditions in almost all of Minnesota by the end of the year. In 2008, a return to more normal precipitation patterns was noted, although drier conditions returned in the second half of the year. Each pollutant is discussed in more detail beginning on page 41.

Chapter 1: 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.

Greenhouse gases—Increases in ambient levels of greenhouse gases can lead to global climate change. The principal greenhouse gas emitted is carbon dioxide (CO_2). MPCA tracks CO_2 emissions in Minnesota. The latest emissions estimate is available for 2008. This is a preliminary estimate that may change as better information becomes available. More information is available on climate change and greenhouse gases in the MPCA's 2009 report at the following link:
http://www.pca.state.mn.us/climatechange/publications.html

Criteria pollutants—The 1970 Clean Air Act identified six major air pollutants that were present in high concentrations throughout the United States called "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). Ozone is not directly emitted, so a group of ozone precursors called volatile organic compounds (VOCs) is included instead. Emissions estimates for large facilities are available for 2008. Mobile and nonpoint source emissions are available for 2005.

$PM_{2.5}$ and ammonia (which contributes to $PM_{2.5}$ formation) emissions are estimated every three years with estimates available for 2002 and 2005. The Criteria Pollutant Emissions section also includes a summary of the MPCA's Air Quality Index (AQI) data for 2009.

Air toxics—Many other chemicals are released in smaller amounts than most of the criteria pollutants, but are still 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 organic matter. Minnesota data come from the 2005 Minnesota Air Toxics Emission Inventory.

This report is limited to a summary and discussion of emissions of various air pollutants in Minnesota. However, the MPCA has prepared other reports that discuss air pollution trends and emissions in more detail. Please reference the following reports for more information.

Air Quality in Minnesota: Emerging Trends—2009 Report to the Legislature
http://www.pca.state.mn.us/publications/reports/lr-airqualityreport-2009.html

Annual Air Monitoring Network Plan for the State of Minnesota, 2010
http://www.pca.state.mn.us/air/monitoringnetwork.html

Carbon Dioxide

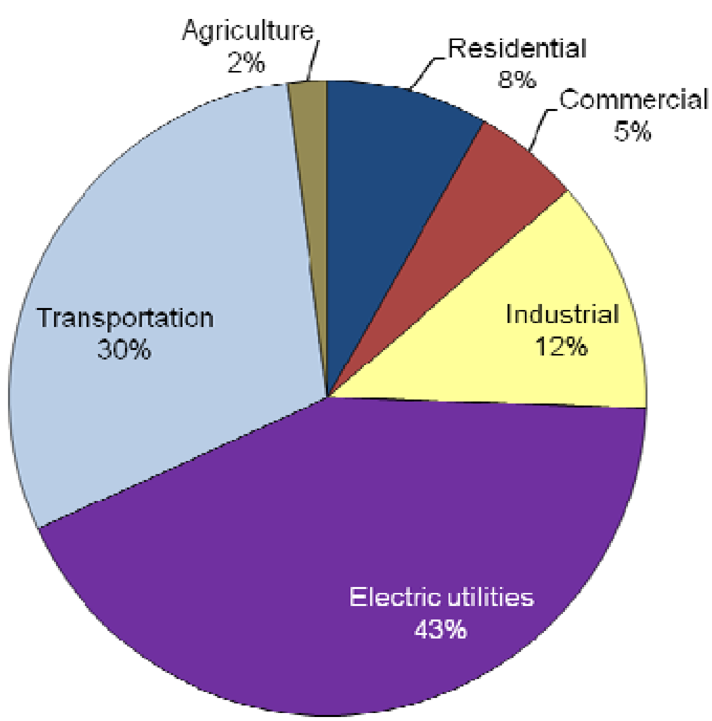
Carbon dioxide (CO_2) is a gas that is principally formed from the combustion of fossil fuels such as oil, gas and coal. It is the most important greenhouse gas contributing to warming of the earth's lower atmosphere. Many greenhouse gases occur naturally, but fossil fuel burning and other human activities are adding gases to the natural mix at an accelerated rate. In 2008, emissions of CO_2 from fossil fuel combustion accounted for about 85 percent of all greenhouse gas emissions from Minnesota.

Emissions data and sources

The most recent estimate for statewide emissions of carbon dioxide in 2008 is 126 million tons. This is a preliminary estimate that may change as better information becomes available. Final estimates for emissions of CO_2 for 2007 and 2008 will be published in the Second Biennial Progress Report to the Legislature on Greenhouse Emissions due in January 2011.

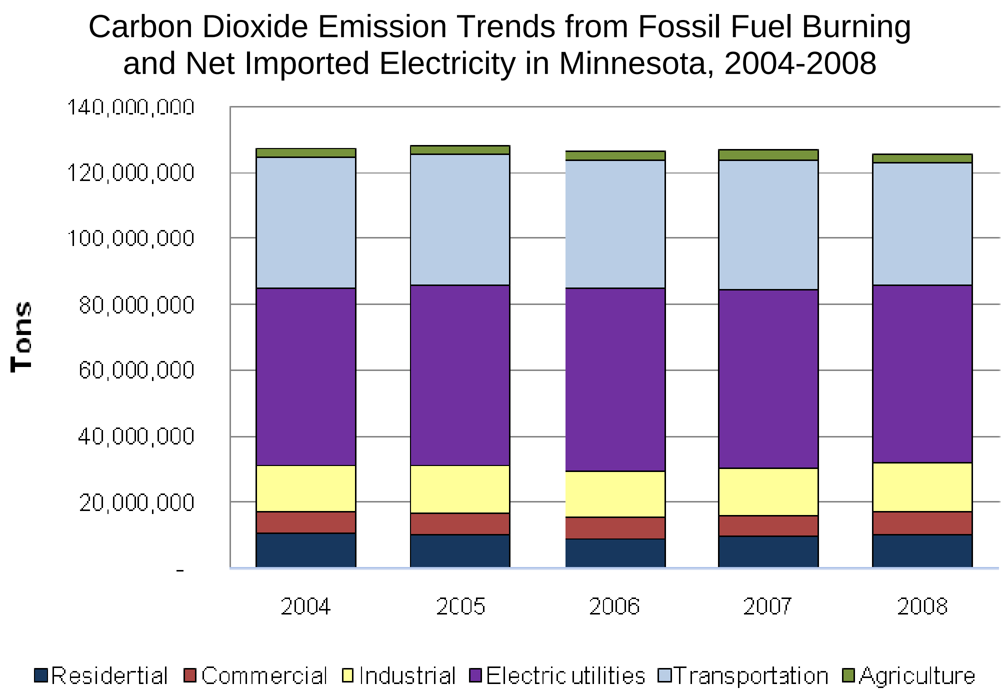
The pie chart below shows the breakdown of carbon dioxide emissions from fossil fuel burning by sector. The majority of the carbon dioxide emissions come from the electric power generation (43 percent) and transportation (30 percent) sectors. The remaining 27 percent of the emissions come from fossil fuel combustion in the industrial, residential, commercial, agricultural and waste sectors. Included in the estimates for emissions from the electric power generation sector are emissions associated with the net import of power from outside of Minnesota to meet domestic electric demand.

Sources of Carbon Dioxide Emissions from Fossil Fuel Burning and Net Imported Electricity in Minnesota, 2008



Trends

Carbon dioxide emissions from fossil fuel burning in Minnesota have remained relatively flat since 2004.



References/web links

For more information on climate change and CO_2 emissions, see the MPCA's 2009 report to the legislature at the following link:

http://www.pca.state.mn.us/climatechange/publications.html

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 Minnesota Pollution Control Agency (MPCA). The report quantifies emissions of the following regulated pollutants:

- particulate matter less than 10 microns in diameter (PM_{10})
- sulfur dioxide (SO_2)
- nitrogen oxides (NO_x)
- volatile organic compounds (VOCs)
- carbon monoxide (CO)
- lead (Pb)

The emission inventory is used to track the estimated pollutant emissions of each facility and to determine the type and quantity of pollutants being emitted into the atmosphere. Ozone is a criteria pollutant that is not directly emitted, so a group of ozone precursors called volatile organic compounds (VOCs) is included instead. The data are then used to calculate an annual emission fee for each facility. Starting in 2002, MPCA also began estimating $PM_{2.5}$ and ammonia emissions every three years. Estimates are currently available for $PM_{2.5}$ and ammonia for 2002 and 2005.

The Minnesota Criteria Pollutant Emission Inventory estimates emissions from permitted facilities every year in order to fulfill the Minnesota rule. In addition, every three years, the MPCA estimates emissions from two other principal source categories: nonpoint sources and mobile sources. Overall, the Minnesota Criteria Pollution Emission Inventory includes emissions from three principal source categories.

1. **Point 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. **Nonpoint sources**: Typically stationary sources, but generally smaller sources of emissions than point sources. Examples include dry cleaners, gasoline service stations and residential wood combustion. Nonpoint sources may also include a diffuse stationary source, such as wildfires or agricultural tilling. 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 non-road sources. On-road vehicles include vehicles operated on highways, streets and roads. Non-road sources are off-road vehicles and portable equipment powered by internal combustion engines. Lawn and garden equipment, construction equipment, aircraft and locomotives are examples of non-road sources.

The Minnesota Criteria Pollutant Emission Inventory is complete for point sources through 2008. Emission estimates are available for nonpoint and mobile sources for 2005. When 2008 summary data are given, they include nonpoint and mobile data from 2005 and point source data from 2008. This report presents trend data for point sources from 2004-2008.

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.

In addition, despite the importance of secondary formation for some pollutants (e.g., $PM_{2.5}$), estimated air emissions data in this report are based on direct releases from sources into the atmosphere. Secondary formation of pollutants is not included in the estimates because there is currently no reliable way to estimate their quantity. However, models to predict secondary formation of particles are under development.

Find more information on the Minnesota Criteria Pollutant Emission Inventory:
http://www.pca.state.mn.us/air/criteria-emissioninventory.html

See the MPCA Environmental Data Access web site to download MPCA emission estimates for criteria pollutants and air toxics including county level emissions for 2005:
http://www.pca.state.mn.us/data/edaAir/emissions.cfm

Find more information on criteria air pollutants in the following EPA web site:
http://www.epa.gov/air/urbanair/index.html

See the EPA's AIR*Data* web site to download EPA criteria pollutant emission estimates:
http://www.epa.gov/air/data/index.html

Air Quality Index (AQI)

The Air Quality Index (AQI) was developed by the EPA to provide a simple, uniform way to report daily air quality conditions.

In Minnesota, four criteria pollutants are used to calculate the AQI: ground-level ozone, sulfur dioxide, carbon monoxide and fine particles ($PM_{2.5}$). High AQI days in Minnesota are usually the result of elevated levels of ozone or $PM_{2.5}$. The AQI is currently calculated for the Brainerd area, Detroit Lakes, Duluth area, Ely, Grand Portage, Marshall, Rochester, St. Cloud, and the Twin Cities. Not all pollutants are monitored at each location.

The AQI translates each pollutant measurement to a common index, set at 100 to reflect when health effects might be expected in sensitive populations. The pollutant with the highest index value is used to determine the overall AQI. The table below shows the different AQI categories along with the corresponding index range.

AQI Color Legend

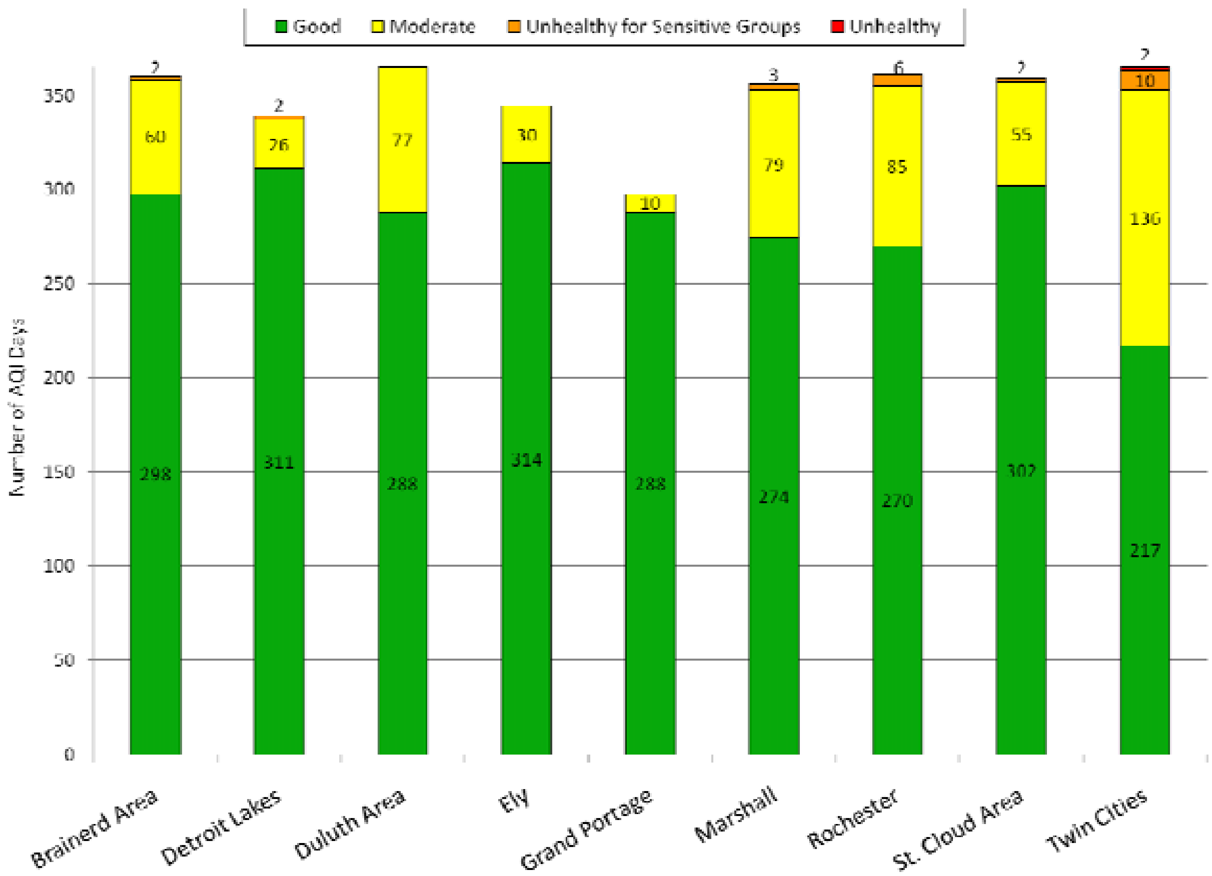
Beginning in May 2008, the pollutant concentration breakpoints for the AQI categories (i.e. Good, Moderate, Unhealthy for Sensitive Groups, etc.) were adjusted to reflect revisions to the National Ambient Air Quality Standards (NAAQS) for ozone and fine particles. As a result of these changes, $PM_{2.5}$ concentrations which were previously associated with an AQI of 90 and ozone concentrations previously associated with an AQI of 79 are now equal to an AQI of 101, the threshold for issuing an air pollution health alert.

The chart on the next page displays the number of Good, Moderate, Unhealthy for Sensitive Groups, and Unhealthy days for all monitored regions in 2009. The EPA may report slightly different AQI summary totals for Minnesota because the MPCA and EPA use different methods to calculate the AQI. The MPCA AQI summary totals will show a higher number of Moderate and Unhealthy for Sensitive Group days than EPA summary totals due to the calculation method for the $PM_{2.5}$ AQI.

Yearly variations in weather patterns can affect air quality. This was particularly evident in 2009, as cooler summer temperatures kept ozone concentrations well within the good and moderate AQI range. Overall, air quality continued to improve in 2009, as evidenced by an increase in the percentage of good AQI days and a corresponding decrease in the percentage of moderate days from 2008. However, while most reporting regions experienced an equivalent number of Unhealthy for Sensitive Group days from 2008 to 2009, the number of Unhealthy for Sensitive Group days doubled in the Twin Cities. Additionally, the Twin Cities experienced two Unhealthy days in 2009.

All of the Unhealthy for Sensitive Groups and Unhealthy AQI days in the Twin Cities were the result of elevated $PM_{2.5}$ concentrations. The Twin Cities AQI monitoring network measures hourly $PM_{2.5}$ concentrations at six locations including: St. Paul, Minneapolis (Phillips, Wenonah School), Apple Valley, Blaine, and St. Michael. Across these sites the number of Unhealthy for Sensitive Group days ranged from four to eight AQI days. The site at Apple Valley was the only monitoring site to experience Unhealthy AQI days. While fine particle concentrations tend to rise and fall uniformly across broad geographic regions, local meteorological conditions, geographical features, and emissions activities will impact the peak pollutant concentrations at each monitor.

2009 Air Quality Index Days by Category and Reporting Region



References/web links

For more information on the AQI, see the following web sites:

http://aqi.pca.state.mn.us/hourly/

http://www.epa.gov/airnow/

http://www.epa.gov/airnow/aqibroch/

Particulate Matter

Particulate matter 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. Some particles are seen as soot or smoke while others are so small they can only be detected with an electron microscope.

EPA currently has National Ambient Air Quality Standards (NAAQS) for particulate matter in two size classes, $PM_{2.5}$ and PM_{10}. $PM_{2.5}$, also known as fine particulate matter, includes particles with diameters less than or equal to 2.5 microns. PM_{10}, which is also known as inhalable particulate matter, includes particulate matter smaller than or equal to 10 microns. $PM_{2.5}$ and PM_{10} are associated with numerous adverse health effects, which are briefly described in the following sections. Health researchers have identified adverse health effects from a range of different sizes of particulate matter. Over time, federal particulate matter regulations have shifted to focus on smaller-sized particles.

Particulate matter also causes adverse impacts to the environment. 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. This can result in the depletion of nutrients in the soil, damage to sensitive forests and farm crops, and diversity changes in ecosystems. Particulate matter also causes soiling and erosion damage to materials and buildings. Finally, different types of particulate matter, for example black carbon (soot) and sulfate particles, play a role in climate change by altering cloud formation and precipitation and depending on the type of particle and location, contributing to global warming or cooling.

$PM_{2.5}$

Fine particles are an aerosol including solid particles and liquid droplets in the air that vary in size, composition and origin. Fine particles contain sulfate, nitrate, ammonium, elemental carbon, organic carbon-containing chemicals, minerals, trace elements and water.

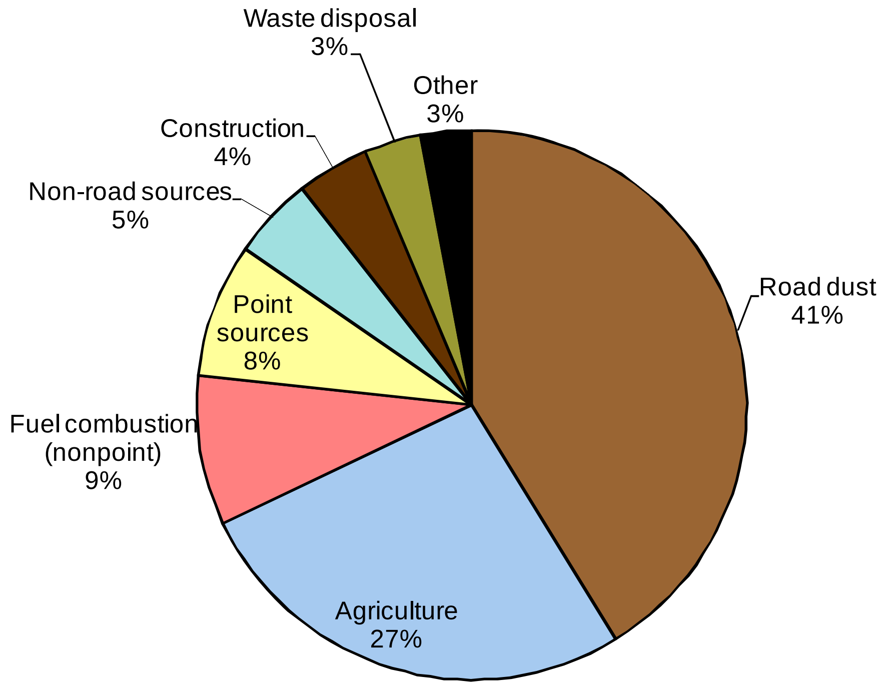
Studies have shown that ambient $PM_{2.5}$ concentrations are linked with increased hospital admissions and deaths from cardiovascular and respiratory problems. Elevated $PM_{2.5}$ concentrations are also associated with a number of adverse effects including heart attacks; atherosclerosis; acute and chronic bronchitis; asthma attacks; respiratory symptoms; and reduced lung function growth and increased respiratory illness in children.

Emissions data and sources

$PM_{2.5}$ concentrations in the air are the result of many manmade and natural sources of emissions. $PM_{2.5}$ can be directly emitted to the air in the form of small particles. Examples of these “directly” emitted $PM_{2.5}$ particles include the smallest particles created from mechanical, grinding or abrasion processes, blowing dust and the soot from combustion processes such as diesel engines and wood burning. MPCA estimates these types of emissions in the direct $PM_{2.5}$ emission inventory.

The MPCA estimate for statewide primary emissions of $PM_{2.5}$ in 2005 is 166,000 tons. This includes the $PM_{2.5}$ directly emitted from sources included in the MPCA emission inventory; however, it does not include secondarily formed or natural sources of $PM_{2.5}$, which can comprise at least half of the $PM_{2.5}$ found in the air.

Sources of Direct $PM_{2.5}$ Emissions in Minnesota, 2005*



*Does not include secondarily formed or natural sources

More than 40 percent of the estimated mass of primary, manmade $PM_{2.5}$ emissions comes from fugitive dust from unpaved and paved roads. A quarter of the emissions come from suspended soils released from agricultural tilling. Almost 10 percent come from industrial, commercial and residential fuel combustion. The remainder comes from a variety of large facilities such as electric utilities and the paper and mining industries; combustion of fuels in non-road sources; construction and waste disposal. Although this inventory suggests that most of the estimated $PM_{2.5}$ emissions are related to the soils found in the earth's crust, such as from agricultural tilling and road dust, in reality, only a small fraction of the $PM_{2.5}$ concentrations measured in typical air result from these "crustal" emission sources. Much of Minnesota's $PM_{2.5}$ air pollution results from secondary sources in Minnesota and other states that release "precursor" gases such as sulfur dioxide, nitrogen oxides, ammonia, or carbon-containing chemicals to the atmosphere. Depending on the weather conditions, these precursor gases will undergo chemical reactions in the air to form "secondary" $PM_{2.5}$.

At least half of the ambient fine particles measured in the Twin Cities and Rochester, and a proportionally larger fraction of the ambient $PM_{2.5}$ measured in rural areas, were found to result from $PM_{2.5}$ "precursor" gases. The following table describes the sources associated with the most common fine particle components, and whether they are the result of direct emissions or secondary formation.

Table 3: Major Sources of $PM_{2.5}$ Components

Component	Major Sources	Present in the air because…
Sulfate (SO_4)	Coal combustion	Secondary
Nitrate (NO_3)	Coal combustion, mobile sources and gas heating	Secondary
Ammonia (NH_4)	Agriculture	Secondary
Elemental Carbon	Mobile sources and biomass burning	Primary
Organic Carbon	Biogenic emissions (i.e. natural decay), mobile sources, and biomass burning	Primary and Secondary
Crustal material	Fugitive dust	Primary
Metals	Combustion and fugitive dust	Primary

Trends

Statewide $PM_{2.5}$ emissions are estimated every three years. $PM_{2.5}$ emissions were estimated for the first time in 2002 and 2005 estimates are now available. Total estimated $PM_{2.5}$ emissions were 169,000 tons in 2002 and 166,000 tons in 2005. Estimating $PM_{2.5}$ emissions is challenging and the methodology is expected to improve over time. Given the uncertainty in the emission estimates, and the ongoing improvements in the estimation methods, it is difficult to interpret whether there has been a decrease in actual emissions**.**

References/web links

For more information on $PM_{2.5}$, see the following web sites:

http://www.epa.gov/oar/particlepollution/

http://www.epa.gov/airtrends/pm.html

PM_{10}

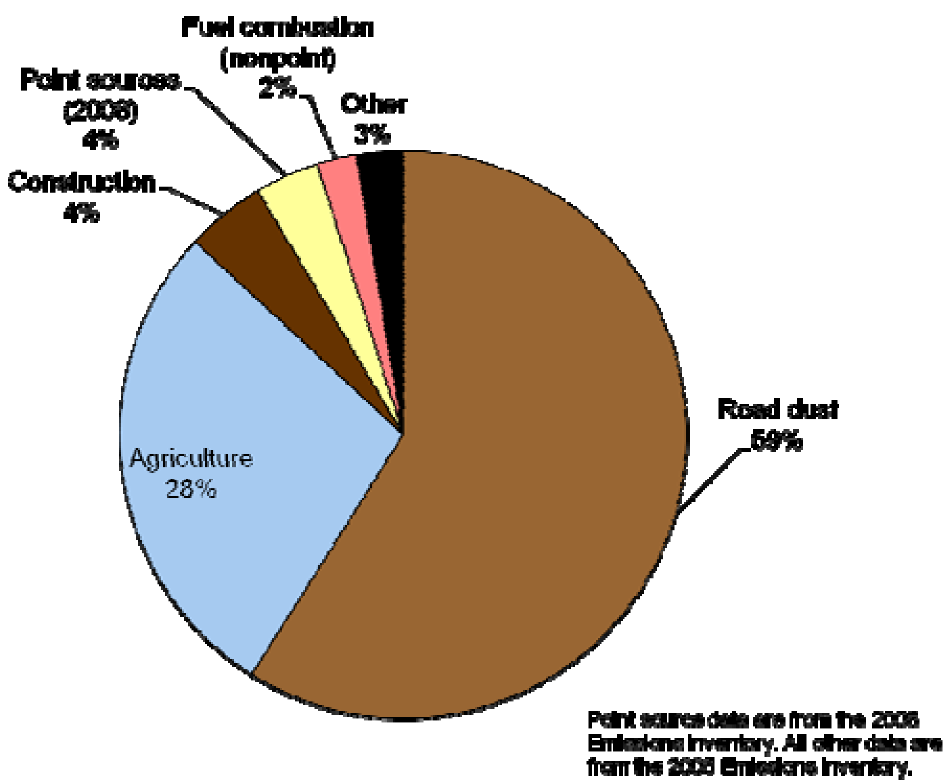
PM_{10} includes all particles with aerodynamic diameters less than 10 microns. $PM_{2.5}$ is a subset of $PM_{2.5}$ emissions. Roughly half of the mass of Minnesota's ambient PM_{10} particles are of particles within the $PM_{2.5}$ size and so the direct and secondary formation and the health effects discussed for $PM_{2.5}$ have relevance for PM_{10}. However, ambient PM_{10} include a much higher fraction of crustal materials. PM_{10} has been linked to cardiovascular and respiratory health effects, but the studies of PM_{10} indicate a weaker association with cardiovascular health effects than for $PM_{2.5}$.

PM_{10} particles are generally emitted from sources such as vehicles traveling on unpaved roads, agricultural tilling, materials handling, and crushing and grinding operations, and windblown dust. The larger of these particles can settle rapidly from the atmosphere within hours, and their spatial impact is typically more limited (compared to $PM_{2.5}$) because they tend to settle out of the air downwind from where they were emitted.

Emissions data and sources

The MPCA estimate for statewide primary emissions of PM_{10} in 2008 is 776,000 tons. This includes the PM_{10} primarily emitted from sources included in the MPCA emission inventory; however, it does not include secondarily formed PM_{10}.

Sources of Direct PM_{10} Emissions in Minnesota, 2005 and 2008



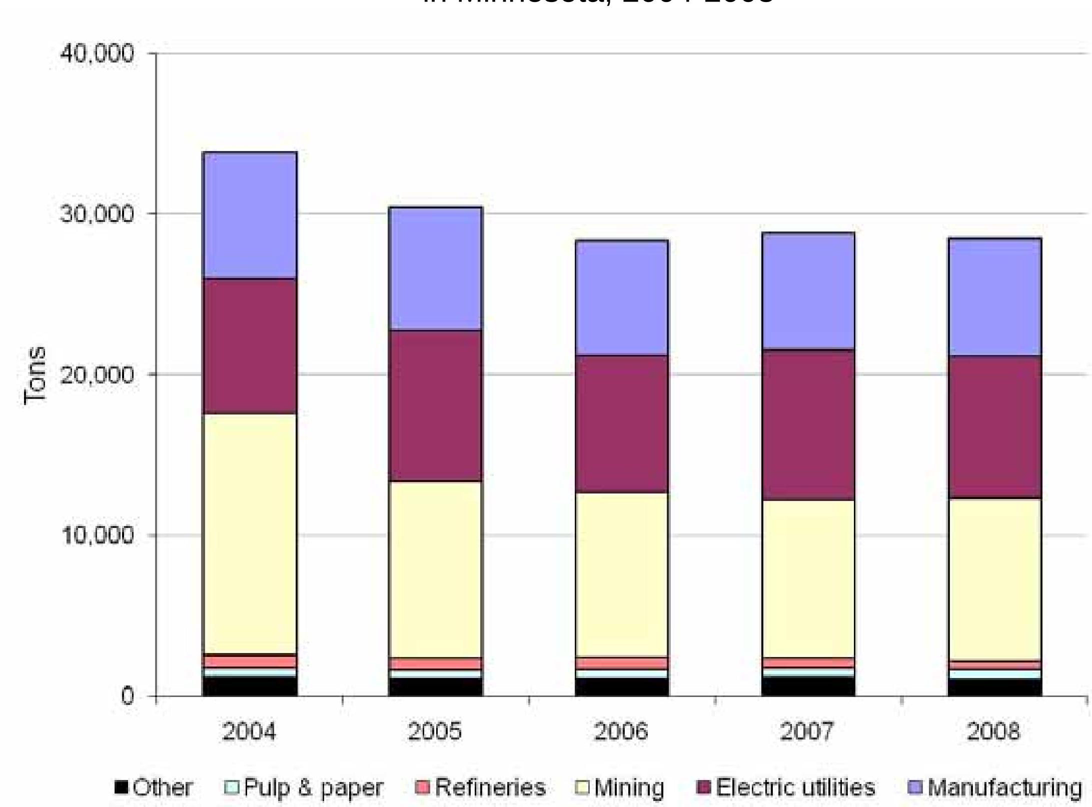
Almost 60 percent of the mass of direct primary PM_{10} emissions come from fugitive dust from unpaved and paved roads. Over a quarter of emissions come from agricultural tilling. Four percent is emitted from construction. The remainder comes from a variety of large facilities such as electric utilities and the paper and mining industries and fuel combustion.

PM_{10} particles formed secondarily in the atmosphere from chemical reactions involving gaseous pollutants such as nitrogen oxides, sulfur oxides, some volatile organic compounds and ammonia are not accounted for in these pie charts and graphs.

Trends

In 2008, point sources contributed 4 percent to the total state PM_{10} emissions. PM_{10} emissions have decreased since 2004. In 2005, there was a decrease in emissions estimates from the mining sector due to methodology and emission factor changes including new stack test factors. There was little change in sectors between 2007 and 2008 with only slight decreases in most categories.

PM10 Point Source Emission Trends by Sector
in Minnesota, 2004-2008



References/web links

For more information on PM_{10}, see the following web site:

http://www.epa.gov/oar/particlepollution

Ammonia

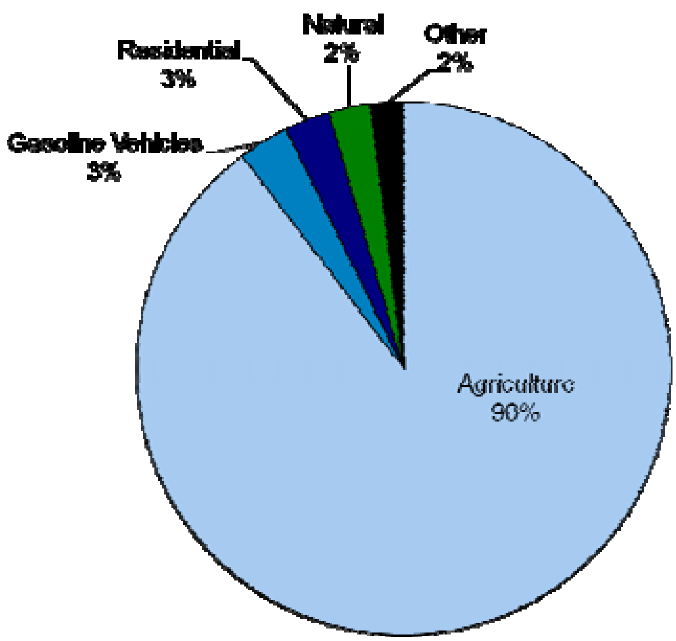
Ammonia is a colorless gas with a distinctive odor. The main source of ammonia gas in the air is livestock waste and fertilizer application. It can be smelled at a concentration near 50 ppm, but human health effects are not expected at that level. Exposure to high concentrations of ammonia may irritate the skin, eyes, throat and lungs and cause coughing and burns.

The MPCA tracks emissions of ammonia because it is a major component of fine particles ($PM_{2.5}$). Ammonia combines with sulfur dioxide and nitrogen oxides to form ammonium sulfate and ammonium nitrate particles. These particles make up half of fine particle mass in urban areas in Minnesota and at least three-quarters of fine particle mass in rural areas.

Emissions data and sources

The MPCA estimate for statewide emissions of ammonia in 2005 is 180,000 tons. The majority of ammonia emissions were from agricultural production, primarily livestock waste and fertilizer application.

Sources of Ammonia Emissions in Minnesota, 2005



Trends

Statewide ammonia emissions are estimated every three years. Ammonia emissions were included in the emissions inventory for the first time in 2002 when total Minnesota ammonia emissions were estimated at 179,000 tons. In 2005, Minnesota ammonia emissions were estimated at 180,000 tons. This slight increase is likely within the error of the emissions estimating process and there was essentially no change in ammonia emissions between 2002 and 2005.

References/web links

For more information on how ammonia affects fine particle formation see the section on $PM_{2.5}$.

Sulfur Dioxide

Sulfur dioxide (SO_2) belongs to the family of sulfur oxide gases. Sulfur oxide gases are formed when fuel containing sulfur (mainly coal and oil) is burned and during gasoline production and metal smelting.

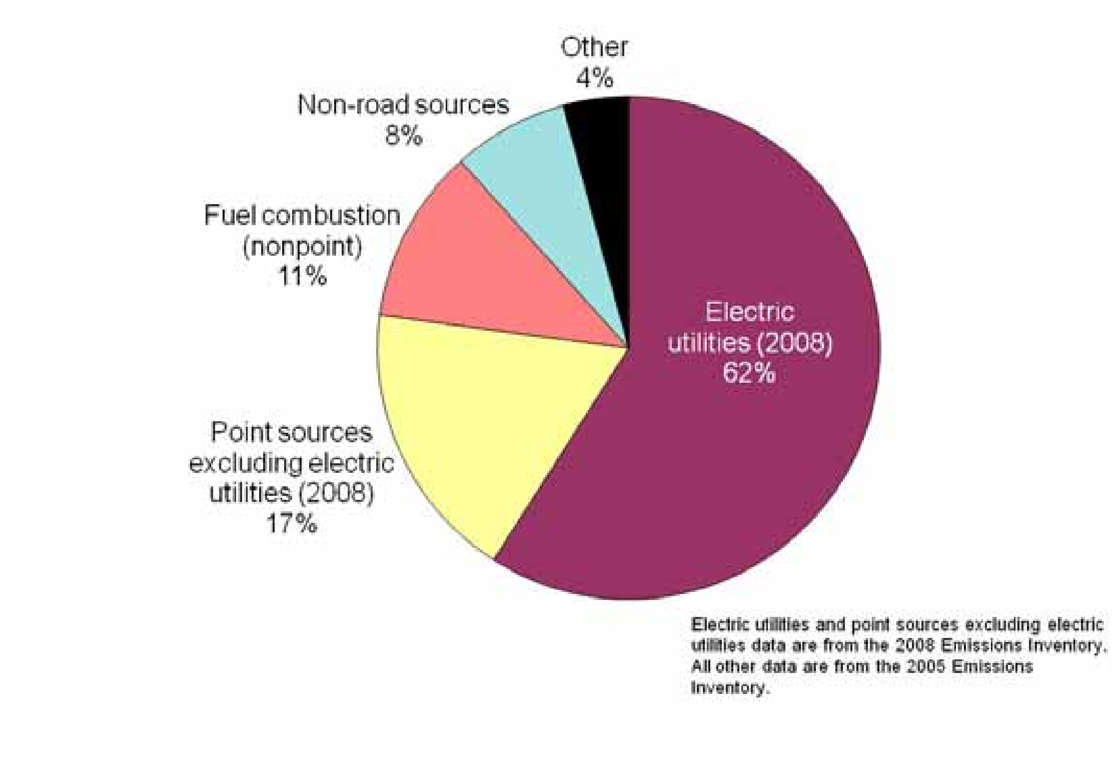
Current scientific evidence links short term exposures to SO_2 with adverse respiratory effects including bronchoconstriction and increased asthma symptoms. Studies show a connection between exposure to SO_2 and increased visits to emergency departments and hospital admissions for respiratory illness. Children, asthmatics and the elderly may be particularly sensitive. SO_2 also reacts with other chemicals in the air to form tiny sulfate particles. It is difficult to distinguish between health effects due to SO_2 exposure and those due to fine particulate exposure.

SO_2 also causes significant environmental damage. SO_2 reacts with other substances in the air to form acids, which fall to earth as rain, fog, snow, or dry particles. Acid rain damages forests and crops, changes the makeup of soil, and makes lakes and streams acidic and unsuitable for fish. Continued exposure changes the number and variety of plants and animals in an ecosystem. In addition, SO_2 accelerates the decay of buildings and monuments and is a major cause of reduced visibility due to haze in Minnesota.

Emissions data and sources

The MPCA estimate for statewide emissions of SO_2 in 2008 is 129,000 tons. The figure below shows sources of 2005 and 2008 SO_2 emissions.

Sources of Sulfur Dioxide Emissions in Minnesota, 2005 and 2008



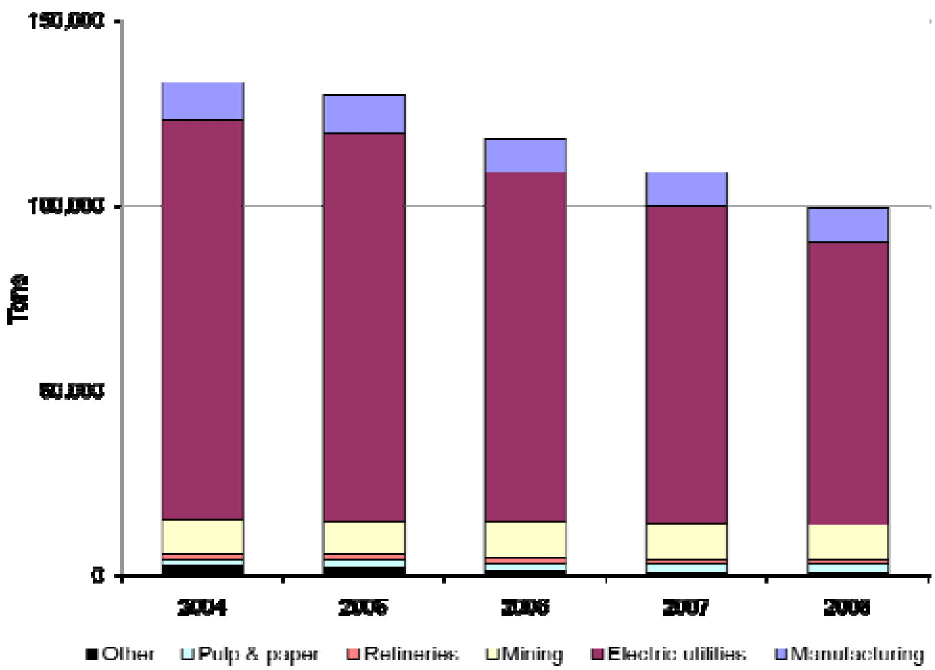
The majority (62 percent) of SO_2 emissions come from coal-burning electric utilities. Seventeen percent comes from industrial point sources while 11 percent are the result of smaller industrial burning of coal, distillate oil and prescribed burning. Non-road agricultural, railroad and construction equipment burning distillate oil make up the bulk of remaining SO_2 emissions.

Trends

Point sources contribute 79 percent to the total state SO_2 emissions with coal-burning electric utilities the greatest emitters. Emissions from point sources have been decreasing since 2004 due mainly to reductions in emissions from electric utilities resulting from Xcel Energy's Metropolitan Emissions Reduction Project (MERP). As a result of the project, the Allen S. King coal-fired power plant in Oak Park Heights was renovated with state-of-the-art pollution controls while St. Paul's High Bridge power plant and Minneapolis' Riverside power plants were converted from coal to cleaner-burning natural gas.

As a result of these changes, The Allen S. King plant burned more coal than it did in 2004, but decreased its emissions of SO_2 by over 26,000 tons. The High Bridge plant completed its conversion to natural gas in February 2008. Its emissions of SO_2 dropped from a high of nearly 4,000 tons in 2004, to just over one ton in 2008. In addition, the Riverside plant completed its conversion in 2009. Emission estimates for 2009 are not yet available; however, in 2008, SO_2 emissions had decreased by nearly 2,000 tons since 2004 due to a decrease in coal combustion during renovation.

Sulfur Dioxide Point Source Emission Trends
By Sector in Minnesota, 2004-2008



References/web links

For more information on sulfur dioxide, see the following web sites:

http://www.epa.gov/air/sulfurdioxide/

http://www.epa.gov/air/airtrends/sulfur.html

Nitrogen Oxides

Nitrogen oxides (NO_x) is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. The two primary constituents are 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 is reported because NO and NO_2 continuously cycle between the two species. NO_x form when fuel is burned at high temperatures.

Current scientific evidence links short-term NO_2 exposures with adverse respiratory effects including increased asthma symptoms, more difficulty controlling asthma, and an increase in respiratory illnesses and symptoms. Studies also show a connection between exposure to NO_2 and increased visits to emergency departments and hospital admissions for respiratory illnesses, particularly for children, the elderly, and asthmatics.

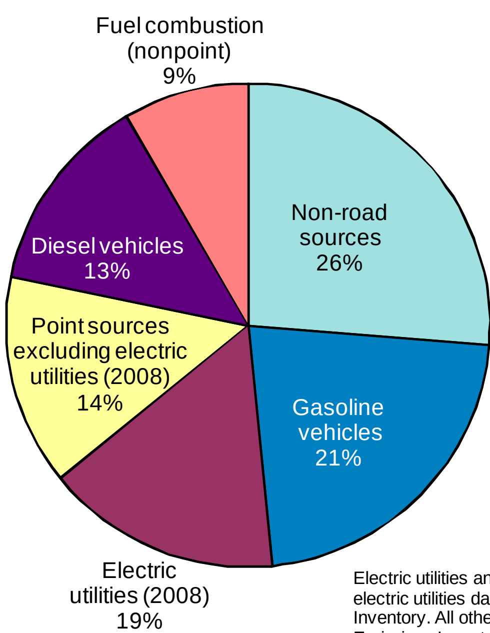
NO_x are a major precursor both to ozone and to fine particulate matter ($PM_{2.5}$). As discussed in the ozone and $PM_{2.5}$ sections of this report, exposure to these pollutants is associated with serious adverse health effects.

High NO_x concentrations also have environmental impacts. Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland and aquatic systems. This can result in changes in species number and composition such as the reduction of fish and shellfish populations. Nitrate particles and nitrogen dioxide also increase visibility impairment as they block the transmission of light and reduce visibility in areas such as the Boundary Waters Canoe Area Wilderness and Voyagers National Park and urban areas such as Minneapolis and St. Paul. In addition, nitrous oxide (N_2O), another component of NO_x, is a greenhouse gas that contributes to global climate change.

Emissions data and sources

The MPCA estimate for statewide emissions of NO_x in 2008 is 391,000 tons. The figure below shows sources of 2005 and 2008 NO_x emissions.

Sources of Nitrogen Oxide Emissions in Minnesota, 2005 and 2008



Electric utilities and point sources excluding electric utilities data are from the 2008 Emissions Inventory. All other data are from the 2005 Emissions Inventory.

More than a quarter of NO_x emissions come from non-road sources such as railroads and agricultural, construction and recreational equipment. Another 21 percent comes from on-road gasoline vehicles. Electric utilities contribute 19 percent of NO_x emissions. Combustion from other large point sources emits 14 percent while diesel vehicles emit an additional 13 percent. Fuel combustion from smaller sources contributes most of the remainder of NO_x emissions in Minnesota.

Trends

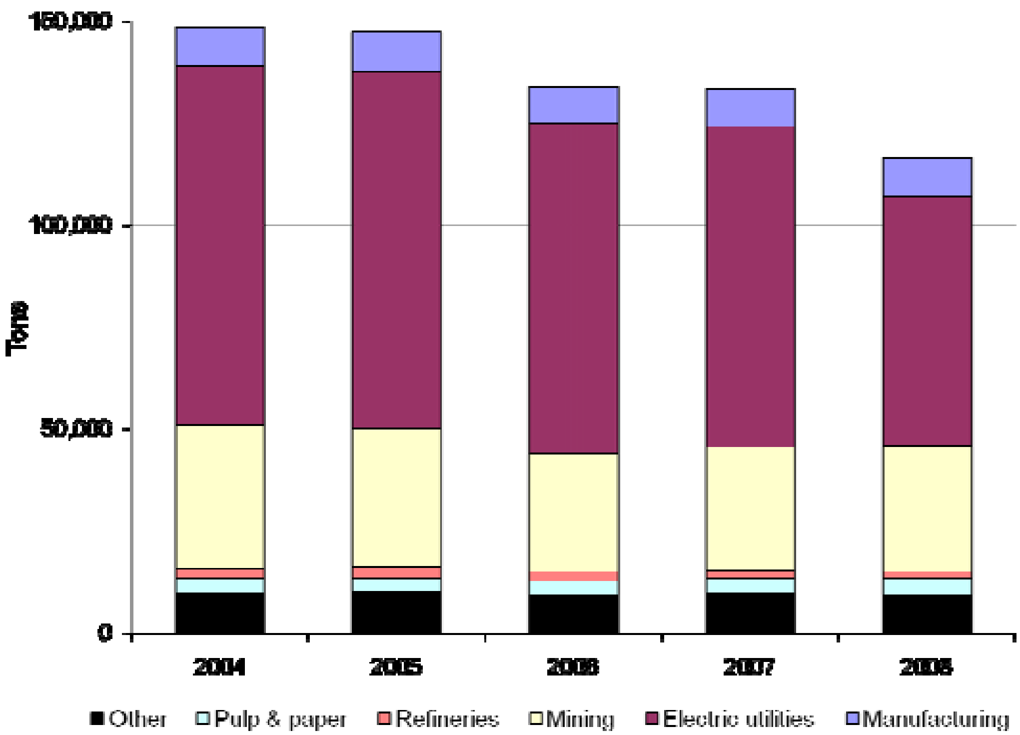
Point sources contribute 33 percent of the NO_x emissions in Minnesota. There was a pronounced decrease in NO_x emissions in 2006 and 2008 due to emission estimate reductions in the mining and electric utilities sectors.

The biggest decrease was in the electric utility sector due to Xcel Energy's Metropolitan Emissions Reduction Project (MERP). As a result of the project, the Allen S. King coal-fired power plant in Oak Park Heights was renovated with state-of-the-art pollution controls while St. Paul's High Bridge power plant and Minneapolis' Riverside power plants were converted from coal to cleaner-burning natural gas.

As a result of these changes, the Allen S. King plant burned more coal than it did in 2004, but decreased its emissions of NO_x by more than 11,000 tons. The High Bridge plant completed its conversion to natural gas in February 2008. Its emissions of NO_x dropped from a high of over 6,000 tons in 2004, to under 30 tons in 2008. In addition, the Riverside plant completed its conversion in 2009. 2009 emission estimates are not yet available; however, in 2008 NO_x emissions had decreased by over 2,000 tons since 2004 due to a decrease in coal combustion during renovation.

Mining emissions have also been lower since 2005. Mining emissions vary annually depending on the demand for taconite pellets. The kilns that bake the pellets burn natural gas, which results in NO_x emissions.

Nitrogen Oxide Point Source Emission Trends
By Sector in Minnesota, 2004-2008



References/web links

For more information on nitrogen oxides, see the following web sites:

http://www.epa.gov/air/nitrogenoxides/

http://www.epa.gov/airtrends/nitrogen.html

Ozone

Ozone is a colorless gas composed of three atoms of oxygen. Naturally occurring ozone in the upper atmosphere helps protect the earth's surface from ultraviolet radiation. However, at elevated concentrations, ground-level ozone can trigger a variety of health problems.

Breathing air containing ozone can reduce lung function and inflame airways, which can increase respiratory symptoms and aggravate asthma or other lung diseases. Ozone exposure also has been associated with increased susceptibility to respiratory infections, medication use, doctor visits, and emergency department visits and hospital admissions for individuals with lung disease. Ozone exposure also increases the risk of premature death from heart or lung disease. Children are at increased risk from ozone because their lungs are still developing and they are more likely to have increased exposure since they are often active outdoors.

Scientific evidence shows that repeated exposure to ground-level ozone also has detrimental effects on plants and ecosystems including interfering with plants' ability to produce and store food, damaging the leaves of trees and other plants, and reducing forest growth and crop yields. Cumulative ozone exposure can lead to reduced tree growth; visibly injured leaves; and increased susceptibility to disease, damage from insects and harsh weather. These effects can have adverse impacts on ecosystems, including loss of species and changes to habitat quality, and water and nutrient cycles.

Emissions data and sources

Emissions of ozone are not reported because ozone is not normally emitted directly into the air. Instead, it is created when "ozone precursors" such as nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in a hot stagnant atmosphere. Since heat and sunlight are needed for ozone to be produced, elevated levels of ozone in Minnesota are normally seen on very hot summer afternoons. Both urban and rural areas may have high levels of ozone since wind carries ozone and its precursors far from the original sources.

Ozone precursors come from a variety of sources. NO_x can form when fuels are burned at high temperatures. The major NO_x sources are combustion processes from highway vehicles and power plants. VOCs are emitted from a variety of sources, including industrial sources, motor vehicles and consumer products. NO_x and VOCs are also emitted by naturally occurring sources such as soil and vegetation. See the nitrogen oxides and volatile organic compounds sections of this report for more information regarding 2008 emissions of ozone precursors.

References/web links

For more information on ozone, see the following web sites:

http://www.epa.gov/air/ozonepollution/index.html

http://www.epa.gov/airtrends/ozone.html

Volatile Organic Compounds

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. Therefore, only gaseous hydrocarbons that are photochemically reactive and participate in the chemical and physical atmospheric reactions that form ozone and other photochemical oxidants are considered VOCs.

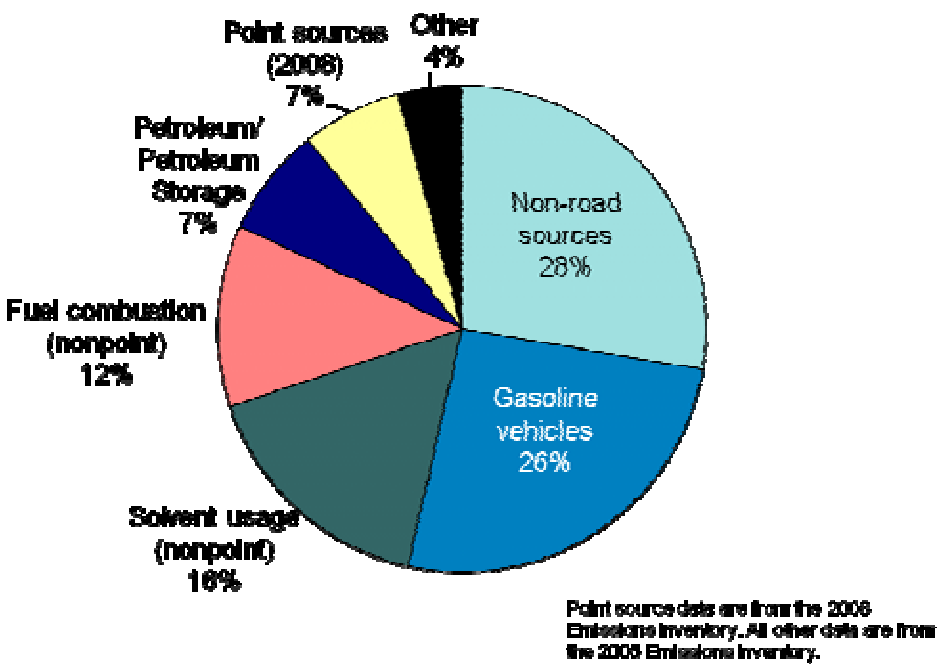
Many VOCs are also air toxics and can have harmful effects on human health and the environment. However, VOCs are regulated as a criteria pollutant because they are precursors to ozone. See the sections on ozone and air toxics for related human health and environmental effects.

Emissions data and sources

The MPCA estimate for statewide emissions of VOCs in 2008 is 345,000 tons.

VOCs are emitted from a variety of sources including industrial facilities, motor vehicles, consumer products, and natural sources such as soils and vegetation. The figure below shows only manmade Minnesota sources of VOCs in 2008.

Sources of Volatile Organic Compound Emissions in Minnesota, 2005 and 2008

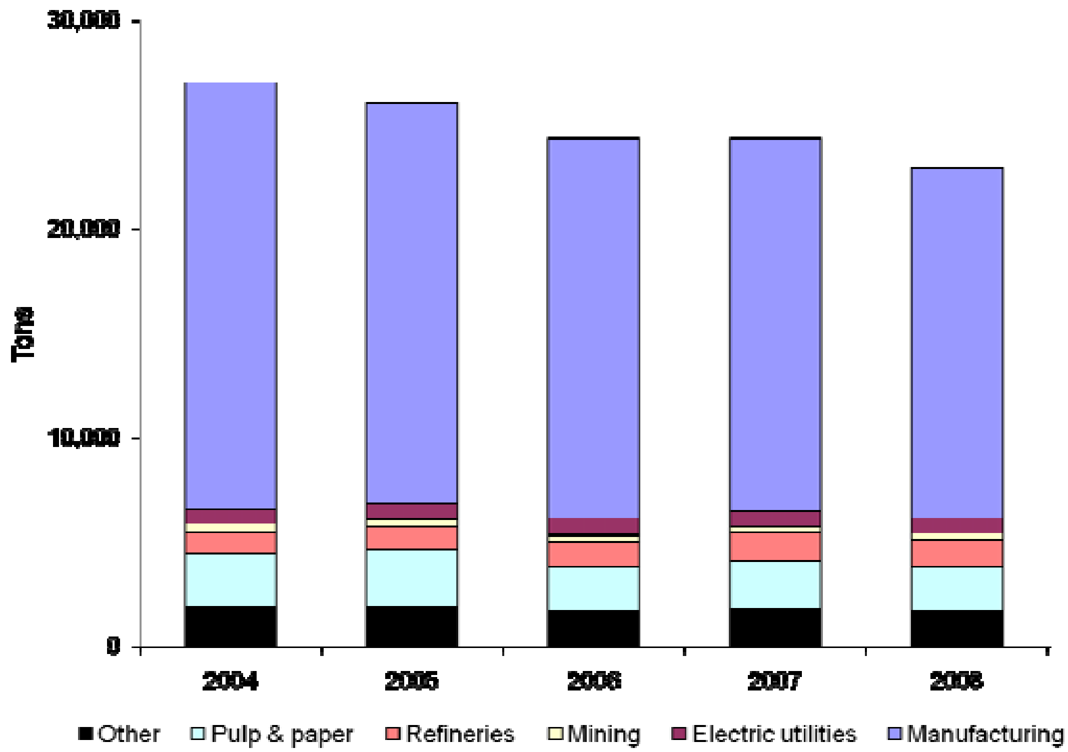


Almost 30 percent of VOC emissions are from non-road sources, in particular recreational vehicles such as snowmobiles, boats, ATVs and motorcycles burning gasoline. Some additional non-road sources of VOCs include agricultural, construction and lawn and garden equipment. On-road gasoline vehicles emit another quarter of VOC emissions. Solvent usage from smaller sources emits 16 percent. Nearly 12 percent of VOC emissions are from residential burning of wood in fireplaces and woodstoves. The storage and transport of gasoline, solvent usage and other emissions from larger facilities make up the bulk of the remaining VOC emissions.

Trends

Point sources contribute 7 percent of the VOC emissions in the state. Emissions have been gradually decreasing since 2004 due mainly to decreases in the manufacturing sector.

Volatile Organic Compound Point Source Emission Trends
By Sector in Minnesota, 2004-2008



References/web links

For more information on volatile organic compounds, see the sections on ozone and air toxics.

Carbon Monoxide

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. Higher levels of CO generally occur in areas with heavy traffic congestion and during the colder months of the year.

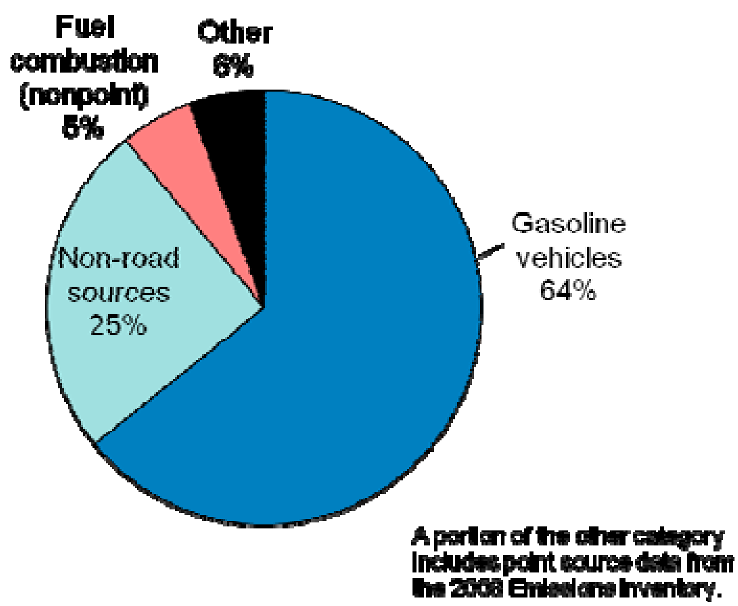
CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease. At higher concentrations it also affects healthy individuals. Exposure to elevated CO levels is associated with impaired visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks. Prolonged exposure to high levels 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 contributor to global climate change. CO also contributes to the formation of ground-level ozone.

Emissions data and sources

The MPCA estimate for statewide emissions of CO in 2008 is 1,771,000 tons. The figure below shows sources of 2008 CO emissions.

Sources of Carbon Monoxide Emissions in Minnesota, 2005 and 2008

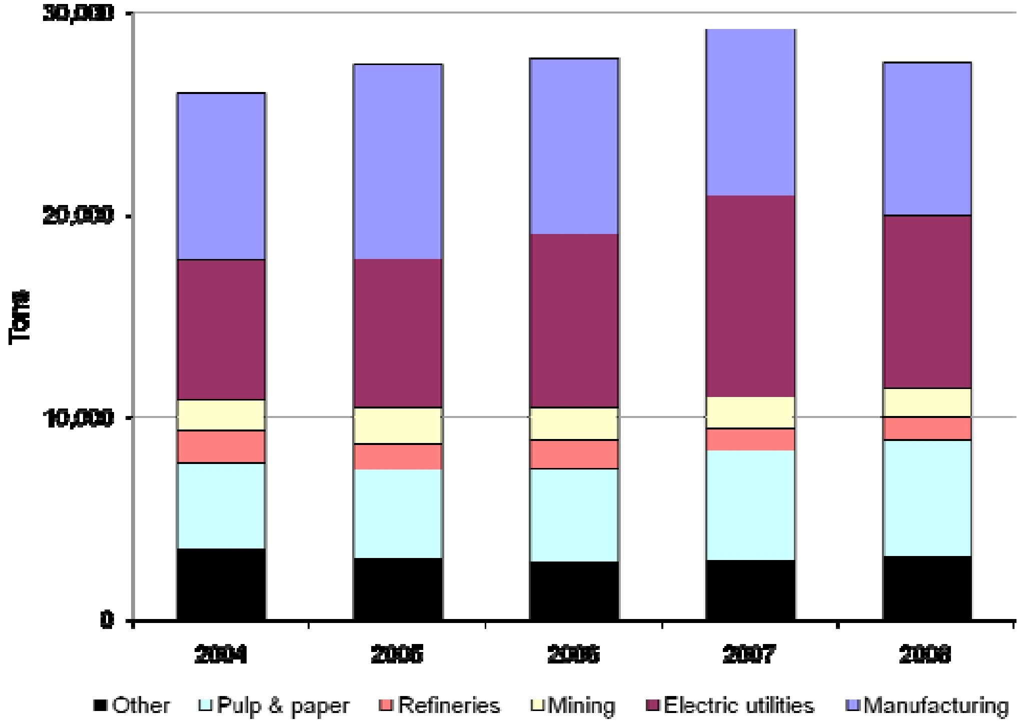


The majority of CO emissions come from the combustion of gasoline in on-road vehicles. A quarter of emissions come from the combustion of fuels in non-road recreational vehicles such as snowmobiles, boats, golf carts, and ATVs as well as lawn and garden equipment. Fuel combustion, particularly residential wood combustion, contributes an additional five percent of CO emissions. A variety of sources, including emissions from fuel combustion and metals processing in large facilities, burning waste, and emissions from diesel vehicles comprise the remaining emissions from CO.

Trends

Point sources contributed fewer than 2 percent of the total Minnesota CO emissions in 2008. The CO values had been gradually increasing since 2004, but dropped in 2008. The increase in 2007 was mainly due to electric utilities as a result of throughput increases for a few utility facilities and increases in the pulp and paper sector. In 2008, the utility emissions returned to 2006 levels, while the pulp and paper sector continued to increase.

Carbon Monoxide Point Source Emission Trends
By Sector in Minnesota, 2004-2008



References/web links

For more information on carbon monoxide, see the following web site:

http://www.epa.gov/air/urbanair/co/

http://www.epa.gov/air/airtrends/carbon.html

http://www.health.state.mn.us/divs/eh/indoorair/co/index.html

Lead

Lead is a metal found naturally in the environment as well as in manufactured products. In the past, the 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.

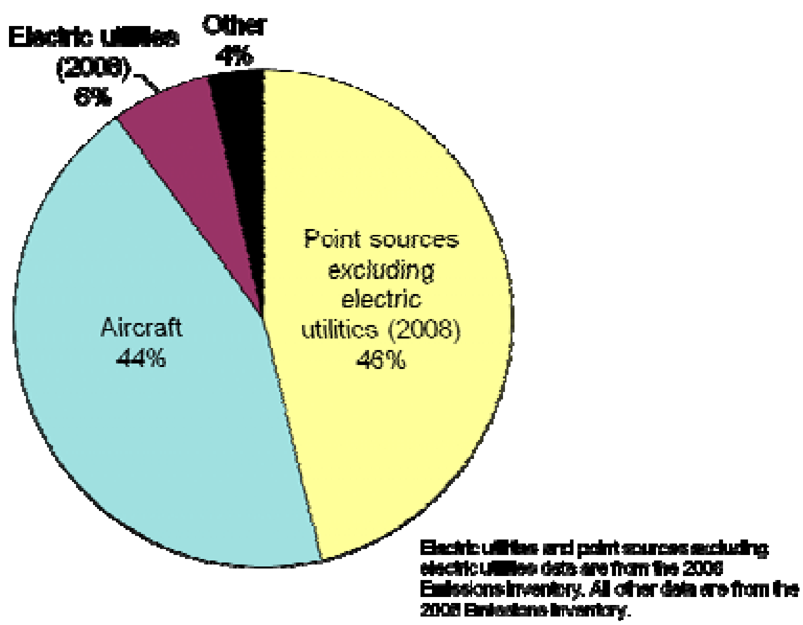
Scientific evidence about the health effects of lead has expanded significantly in the last 30 years. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory and behavior. There is no known safe level of lead in the body.

Elevated lead levels are also detrimental to animals and to the environment. Ecosystems near sources of lead show many adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in animals.

Emissions data and sources

The MPCA estimate for statewide emissions of lead in 2008 is 20 tons. The total mass of lead emitted is much less than the other criteria pollutants. However, it takes only a small amount of lead to cause serious and permanent health problems. Therefore, even relatively low lead emissions are a concern. The figure below shows sources of 2008 lead emissions.

Sources of Lead Emissions in Minnesota, 2005 and 2008

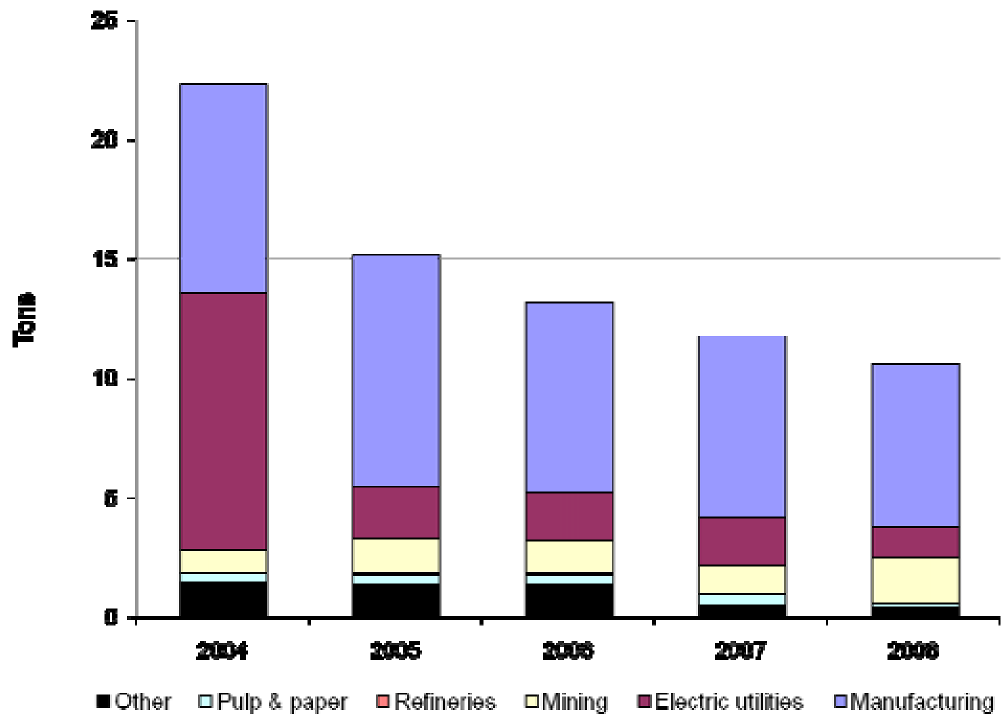


Point sources excluding electric utilities contribute 46 percent of Minnesota's lead emissions. These point sources include metal processing, and some combustion of waste and coal. General aviation aircraft emit 44 percent of lead emissions from burning leaded fuel. Coal-burning power plants add an additional 6 percent of lead to the environment while other small sources contribute the final 4 percent.

Trends

Point sources contribute 52 percent of the state's lead emissions. In Minnesota, the estimated lead emissions from point sources went down dramatically between 2004 and 2008, mainly due to decreases in electric utilities. In 2008, the EPA revised the lead standard to make it 10 times stricter than in the past. To show compliance with the new standard, lead monitors need to be added near facilities that emit 0.5 tons or more of lead per year. As a result, many facilities that emit lead re-evaluated their estimated lead emissions back to 2005 using refined emission estimates and stack testing. In many cases, the refined analysis resulted in much lower estimated lead emissions, particularly from coal-fired electric utilities.

Lead Point Source Emission Trends By Sector in Minnesota, 2004-2008



References/web links

For more information on lead, see the following web sites:

http://www.epa.gov/air/lead/index.html

http://www.epa.gov/air/airtrends/lead.html

http://www.pca.state.mn.us/air/lead.html

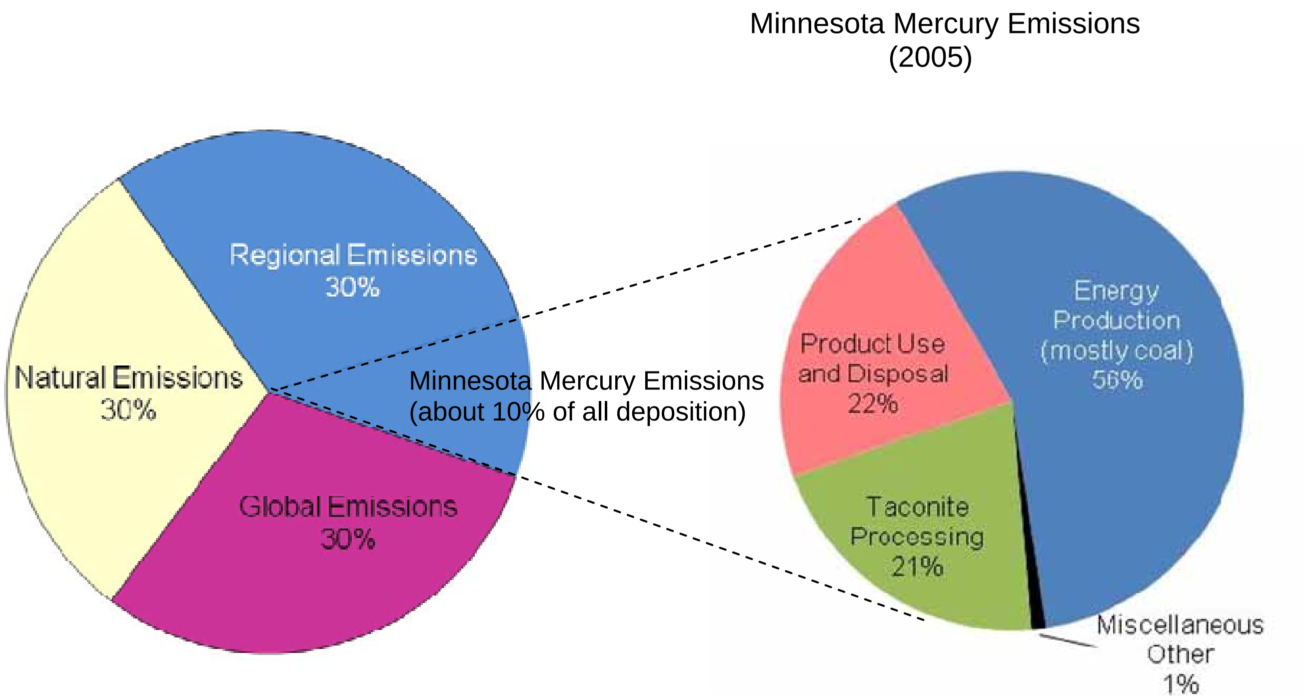
http://www.health.state.mn.us/divs/eh/lead/index.html

Mercury

Mercury is a neurotoxin, a substance that damages the central nervous system of people and other animals. For most Minnesotans, eating fish contaminated with too much mercury poses the greatest risk for exposure. While fish provide a healthy source of protein and consumption is generally encouraged, citizens are advised to restrict their consumption of larger fish from Minnesota lakes, rivers and streams.

The vast majority of mercury in Minnesota's environment comes from air pollution. Minnesota's land and water are contaminated by mercury when it falls in rain and snow or from "dry deposition." Because mercury vapor can be transported long distances by the atmosphere, most of the mercury in Minnesota originates outside of the state and most of Minnesota's emissions are deposited in other states and countries. Some mercury in the atmosphere is due to releases from natural sources such as volcanoes.

Sources of Atmospheric Mercury Deposition to Minnesota



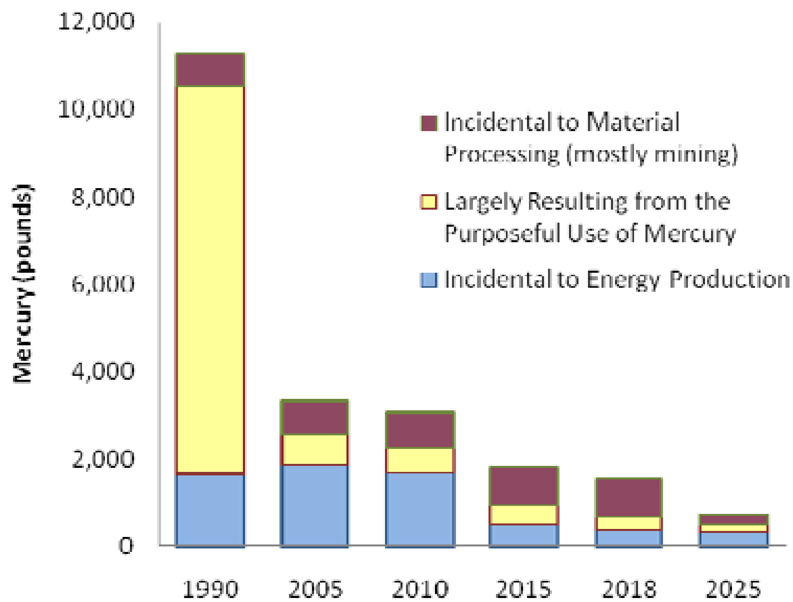
MPCA scientists calculate that for larger fish, such as walleye and northern pike, to be safely eaten more often, mercury pollution sources worldwide will need to reduce their emissions to the atmosphere by about 93 percent from 1990 levels. Accordingly, Minnesota has established a goal of reducing emissions from sources within the state from current levels of about 3,300 pounds per year to below 800 pounds by 2025. The MPCA is in the process of implementing strategies recommended by stakeholders to meet this ambitious goal.

Mercury emitted to the atmosphere due to human activities is divided by the MPCA into three categories: (1) emissions resulting from energy production, mostly coal-burning power plants, (2) emissions due to taconite processing, and (3) emissions due to the use and disposal of mercury in products.

Mercury emissions in Minnesota declined significantly from 1990 to 2005 mostly due to the discontinued use of mercury in products and mandated controls on waste incinerators. Reducing mercury to below 800 lb/year by 2025 will require reductions from all sources in the state. This includes additional product-related decreases as well as 75 to 85 percent reductions from taconite processing and the coal-fired electric generation sector. The Mercury Reduction Act of 2006 requires the state's three largest power plants to reduce emissions by 90 percent by 2014. Similar reductions are in progress or planned at most of the state's remaining facilities.

More information on strategies for meeting these targets can be found on the MPCA web site at http://www.pca.state.mn.us/air/mercury-reductionplan.html

Projected Minnesota Mercury Emissions, 2005-2025
(based on stakeholder recommended strategies)



Mercury concentrations in Minnesota fish

A recent analysis of a 25-year record of mercury in northern pike and walleye from Minnesota lakes has found a recent unexpected rise. After declining by 37 percent from 1982 to 1992, mercury concentrations in these fish started to increase in the mid-1990s. During the last decade of the analysis, 1996-2006, the average mercury concentrations increased 15 percent. This is surprising because during this same period, emissions in Minnesota and the United States declined sharply. MPCA scientists believe that the most likely cause of this increase is either increased global mercury emissions by sources outside of the United States, or factors associated with global climate change, or both. More details about this trend reversal can be found in the third web link below. This increase underscores the need to reduce global mercury emissions and address climate change.

References/web links

For more information on mercury, see the following web sites:

http://www.pca.state.mn.us/air/mercury.html

http://www.epa.gov/mercury/

http://pubs.acs.org/doi/abs/10.1021/es8027378

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. Air toxic emission inventories are generally compiled every three years. The most recent completed inventory for Minnesota is for 2005. The inventory includes three principal source categories: point, nonpoint, and mobile sources.

Point Sources: Typically large, stationary sources with relatively high emissions, such as electric power plants and refineries.

Nonpoint Sources: Typically stationary sources, but generally smaller sources of emissions than point sources. Examples include dry cleaners, gasoline service stations and residential wood combustion. Nonpoint sources may also include a diffuse stationary source, such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as point sources. For example, a single gasoline station typically will not qualify as a point source, but collectively the emissions from many gas stations may be significant.

Mobile Sources: Mobile sources are broken up into two categories; on-road vehicles and non-road sources. On-road vehicles include vehicles operated on highways, streets and roads. Non-road sources are off-road vehicles and portable equipment powered by internal combustion engines. Lawn and garden equipment, construction equipment, aircraft and locomotives are examples of non-road sources.

MPCA staff compiled the emissions estimates for point and the majority of nonpoint sources in the 2005 inventory. However, emissions for wildfires and prescribed burning were obtained from EPA. The results for aircraft (including ground support equipment), and locomotives were also estimated by the MPCA. The estimates for commercial marine vessels were estimated from the 2002 emissions, which were prepared by the Central States Regional Air Partnership (CENRAP) using state-specific data. For all non-road equipment and on-road vehicles, MPCA used estimates from EPA's national inventory.

Table 4 provides a summary of air toxics emissions from principal source categories taken from the 2005 Minnesota Air Toxics Emission Inventory. Values in the table reflect all updates since last year's report until February 2010. The table gives total statewide emissions of each chemical, along with the percent from point, nonpoint, on-road, and non-road mobile sources. The inventory includes 167 chemicals: 16 polycyclic aromatic hydrocarbon compounds (PAHs), 13 metal compounds and 138 non-metal compounds.

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	Total (short tons)	Point sources (%)	Nonpoint sources (%)	On-road mobile (%)	Non-road mobile (%)
PAHs					
Acenaphthene	8.7	56	31	4	9
Acenaphthylene	58.2	<1	93	3	3
Anthracene	6.1	7	79	7	7
Benz[a]Anthracene	6.6	<1	96	2	2
Benzo[a]Pyrene	1.9	4	88	3	4
Benzo[b]Fluoranthene	2.2	<1	93	3	3
Benzo[g,h,i,]Perylene	2.9	<1	85	4	10
Benzo[k]Fluoranthene	1.3	<1	89	6	5
Chrysene	4.7	<1	96	1	2
Dibenzo[a,h]Anthracene	0.1	10	88	<1	2
Fluoranthene	8.4	<1	83	5	11
Fluorene	9.6	5	72	8	16
Indeno[1,2,3-c,d]Pyrene	2.0	34	60	2	4
Naphthalene	323.1	5	69	16	9
Phenanthrene	27.7	2	83	4	10
Pyrene	10.4	1	83	6	10
PAHs (non-specified)	5.9	27	73	<1	<1
PAH Total	479.7	5	74	12	8
Metal Compounds					
Antimony	1.2	95	4		<1
Arsenic	7.9	92	2	2	4
Beryllium	0.3	79	12		9
Cadmium	1.1	79	19		2
Chromium	7.7	93	4	3	<1
Chromium VI	1.0	92	2	5	1
Cobalt	2.6	96	3		<1
Copper	8.0	98	2		<1
Lead	27.2	66	1		33
Manganese	46.1	99	<1	<1	<1
Mercury	1.8	81	19	<1	<1
Nickel	18.6	92	6	1	<1
Selenium	3.9	88	12		<1
Metal Total	127.4	89	3	<1	7
Non-Metal Compounds (Excluding PAHs)					
Acetaldehyde	1,854	9	13	46	32
Acetamide	0.0		100		
Acetone	914.0	57	40		3
Acetonitrile	2.5	100	<1		
Acetophenone	0.3	61	39		
Acrolein	246.8	23	34	23	20
Acrylamide	0.3	100			
Acrylic Acid	12.6	100	<1		
Acrylonitrile	4.8	38	62		
Aldehydes	42.5	100			
Allyl Chloride	0.006	89	11		
Aniline	0.00005	100			

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	**Total (short tons)**	**Point sources (%)**	**Nonpoint sources (%)**	**On-road mobile (%)**	**Non-road mobile (%)**
Atrazine	96.8		100		
Benzaldehyde	70.3	2	80		19
Benzene	6,146	2	24	51	23
Benzyl Chloride	2.0	91	9		
Biphenyl	1.6	69	31		
Dichloroethyl Ether (Bis[2-Chloroethyl]Ether)	<1	100			
Bromoform	0.4	98	2		
Methyl Bromide (Bromomethane)	532	1	99		
1,3-Butadiene	807	<1	12	41	46
Butyraldehyde	13.6	6			94
Carbon Disulfide	2.0	71	29		
Carbon Tetrachloride	8.3	99	<1		
Carbonyl Sulfide	6.7	95	5		
Catechol	0.5	100			
Trichlorofluoromethane (CFC-11, R-11)	1.6	43	57		
Trichlorotrifluoromethane (CFC-113, R-113)	95.9	<1	100		
Chlorine	44.5	24	76		
Chloroacetic Acid	0.2	100			
Chlorobenzene	170	<1	100		
Ethyl Chloride	3.2	72	28		
Chloroform	202	3	97		
2-Chloroacetophenone	0.1	98	2		
Cresol/Cresylic Acid (Mixed Isomers)	1.1	100	<1		
m-Cresol	0.0	100			
o-Cresol	2.6	98	2		
p-Cresol	0.6	77	23		
Crotonaldehyde	13.5	1			99
Cumene	21.3	43	57		
Cyanide Compounds	224	<1	2	21	78
2,4-D (2,4-Dichlorophenoxyacetic Acid)	21.7		100		
Dibenzofuran	1.0	16	84		
Ethylene Dibromide (Dibromoethane)	1.0	99	1		
Dibutyl Phthalate	3.6	94	6		
Ethylene Dichloride (1,2-Dichloroethane)	7.1	87	13		
Dichlorvos	0.1	100			
1,4-Dichlorobenzene	195	<1	99		
M-Dichlorobenzene	1.2	1	99		
O-Dichlorobenzene	0.6	28	72		
Dichlorobenzenes	0.1	29	71		
Ethylidene Dichloride (1,1-Dichloroethane)	1.6	45	55		
Cis-1,2-Dichloroethylene	0.2	100			
Cis-1,3-Dichloropropene	0.1	100			
1,3-Dichloropropene	376	<1	100		
Diethyl Sulfate	0.0	100			
Diethanolamine	1.4	34	66		
Dimethyl Phthalate	5.6	99	1		
Dimethyl Sulfate	0.5	98	2		
N,N-Dimethylformamide	21.1	100	<1		
Dimethylaniline(N,N-Dimethylaniline)	0.1	82	18		

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

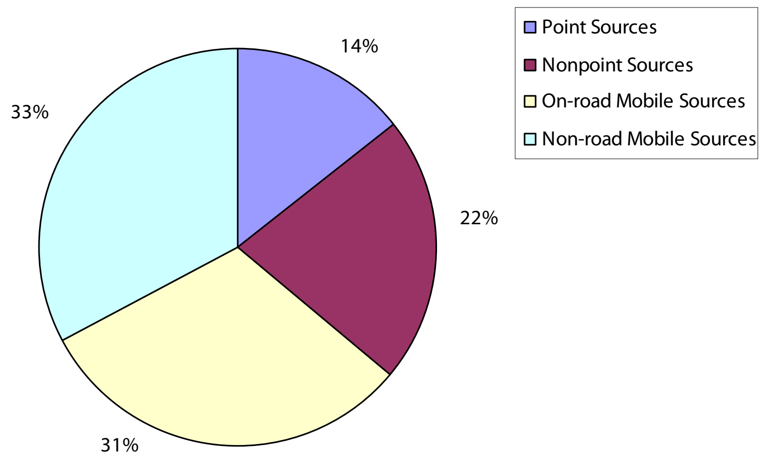
Pollutant Name	Total (short tons)	Point sources (%)	Nonpoint sources (%)	On-road mobile (%)	Non-road mobile (%)
4,6-Dinitro-o-Cresol (Including Salts)	0.0001	100			
2,4-Dinitrophenol	0.01	100			
2,4-Dinitrotoluene	0.1	98	2		
Bis(2-Ethylhexyl)Phthalate (Dehp)	2.7	91	9		
Di-N-Octylphthalate	0.1	100			
p-Dioxane	2.1	52	48		
Epichlorohydrin	0.01	98	2		
1,2-Epoxybutane	0.02	100			
Ethyl Acrylate	0.5	100	<1		
Ethyl Carbamate (Urethane) Chloride (Chloroeth	0.1	100			
Ethylbenzene	2,043	5	6	55	33
Ethylene Glycol	469	14	86		
Ethylene Oxide	15.8	2	98		
Formaldehyde	3,487	14	18	33	35
Glycol Ethers	530	33	67		
Hydrochloric Acid (Hydrogen Chloride Gas)	3,504	88	12		
Hexachlorocyclopentadiene	0.0	69	31		
Hexamethylene Diisocyanate	1.0	100			
Hexane	3,941	38	22	21	20
Hexachloroethane	0.0	100			
Hexachlorobutadiene	0.1	100	<1		
Hexachlorobenzene	0.0	1	99		
Hydrogen Fluoride (Hydrofluoric Acid)	581	94	6		
Hydroquinone	1.6	100			
Isophorone	17.8	85	15		
Maleic Anhydride	0.3	100			
Methyl Ethyl Ketone (2-Butanone)	695	37	63		
Methylhydrazine	1.8	98	2		
Methyl Iodide (Iodomethane)	0.0	100			
Methyl Isobutyl Ketone (Hexone)	177.2	59	41		
Methyl Isocyanate	0.0	100			
Methyl Methacrylate	45	98	2		
Methyl Tert-Butyl Ether	0.8	92	8	<1	
Methanol	2,449	24	76		
4,4'-Methylenediphenyl Diisocyanate (MDI)	4.0	75	25		
Methyl Chloride (Chloromethane)	65.2	9	91		
Methylene Chloride (Dichloromethane)	206.6	30	70		
Nitrobenzene	0.0	99	<1		
4-Nitrophenol	0.2	12	88		
2-Nitropropane	0.01		100		
N-Nitrosodimethylamine	0.004	100			
Parathion	0.1	100			
Polychlorinated Biphenyls (Aroclors)	0.6	<1	100		
Polychlorinated Dibenzodioxins, Total	0.02	98	2	<1	<1
Polychlorinated Dibenzo-P-Dioxins and Furans, Total	0.001	100			
Polychlorinated Dibenzofurans, Total	0.001	78	20	1	<1
Pentachlorophenol	0.3	96	4		
Tetrachloroethylene (Perchloroethylene)	245	38	62		

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	**Total (short tons)**	**Point sources (%)**	**Nonpoint sources (%)**	**On-road mobile (%)**	**Non-road mobile (%)**
Phenol	131	67	33		<1
Phosphine	1.0	58	42		
Phosphorus	2.0	95	4		<1
Phthalic Anhydride	0.1	100			
Polycyclic Organic Matter	25.3	34	66		<1
1,2-Propylenimine (2-Methylaziridine)	0.01	100			
Propionaldehyde	240	2	19	27	51
Propoxur	0.01	100			
Propylene Dichloride (1,2-Dichloropropane)	0.6	71	29		
Propylene Oxide	0.8	97	3		
Quinoline	0.001	100			
Quinone (p-Benzoquinone)	1.0	100			
Styrene	1,135	55	15	21	9
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	0.000002	26	49	17	9
2,3,7,8-Tetrachlorodibenzofuran	0.00002	37	58	3	2
Dioxin and Furans (2,3,7,8-TCDD Equivalents)	0.000002	100	<1		
Methyl Chloroform (1,1,1-Trichloroethane)	989.4	<1	100		<1
1,1,2,2-Tetrachloroethane	3.0	69	31		
Toluene	20,072	3	11	38	47
2,4-Toluene Diisocyanate	1.0	86	14		
o-Toluidine	0.00009	32	68		
Trichloroethylene	145	97	3		
1,2,4-Trichlorobenzene	9.1	100	<1		
1,1,2-Trichloroethane	0.5	100	<1		
2,4,5-Trichlorophenol	0.0001	100			
2,4,6-Trichlorophenol	0.0003	100			
Triethylamine	4.6	26	74		
Trifluralin	6.0		100		
2,2,4-Trimethylpentane	7,699	<1	3	40	57
1,2,4-Trimethylbenzene	73.1	90	10		
1,3,5-Trimethylbenzene	2.0	100			
Trimethylbenzene	8.4	14	86		
Vinylidene Chloride (1,1-Dichloroethylene)	1.1	8	92		
Vinyl Acetate	24.9	97	3		
Vinyl Chloride	3.9	53	47		
m-Xylene	6.9	60	40		
p-Xylene	2.0	100			
Xylenes (Mixed Isomers)	10,554	5	10	41	44
Non-Metal Total	71,903	12	18	30	40
Grand Total	72,510	12	18	30	40

The following chart summarizes air toxics pollutant emissions in Minnesota from 2005. On-road and non-road mobile sources account for 64 percent of the emissions. Nonpoint sources contributed 22 percent of total emissions and point sources contributed 14 percent of emissions.

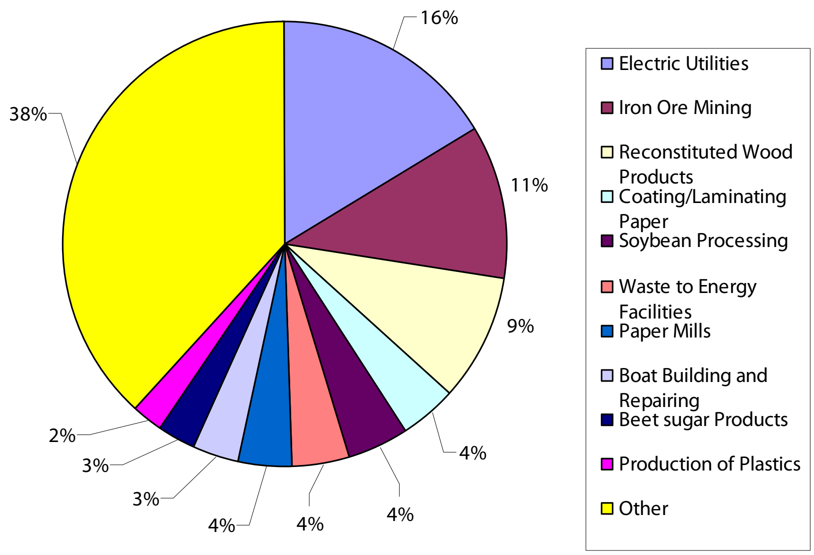
Contribution of Principal Source Categories to
2005 Air Toxics Emissions in Minnesota



Total air toxics emissions in 2005: 72,500 tons

A more detailed breakdown of emissions for each principal source category is shown in the following four pie charts. For point sources, no one source category dominates the air toxics emissions. The largest source category is electric utilities, which accounts for 16 percent of point source emissions.

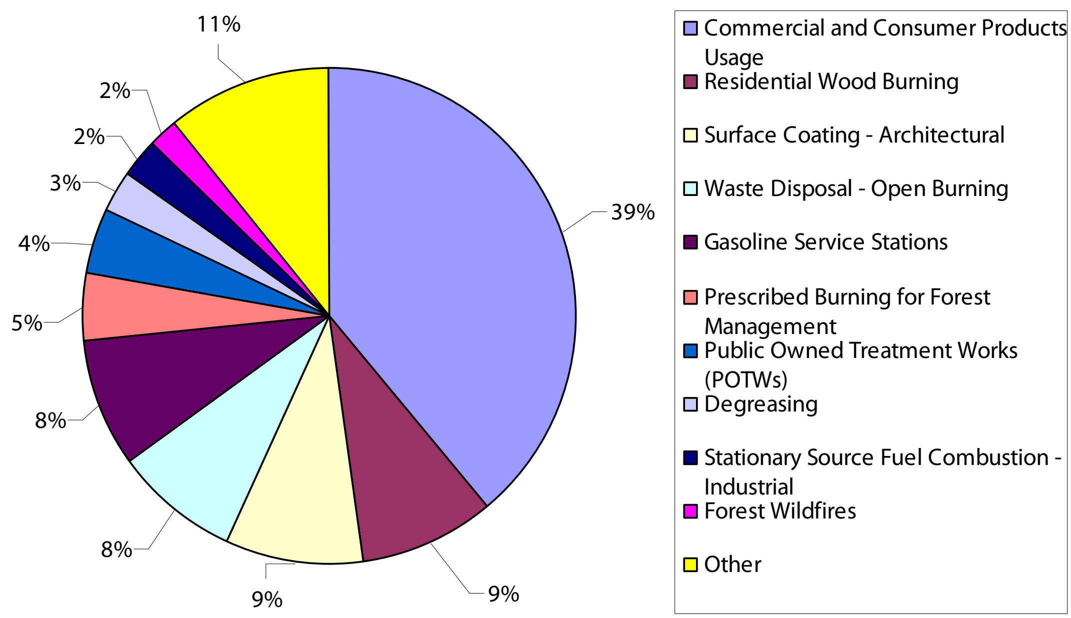
Contribution of Major Categories to 2005 Point Source
Air Toxic Emissions in Minnesota



Total air toxics point source emissions in 2005: 11,700 tons

For nonpoint sources, the major contributors of emissions are industrial surface coating, commercial and consumer products usage and residential wood burning. Approximately 57 percent of the nonpoint source emissions are attributed to these three categories.

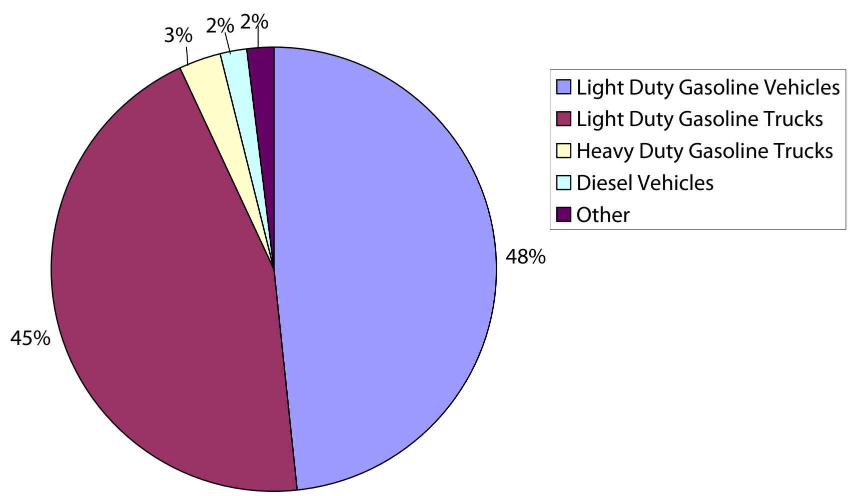
Contribution of Major Categories to 2005 Nonpoint Source Air Toxics Emissions in Minnesota



Total air toxics nonpoint source emissions in 2005: 16,100 tons

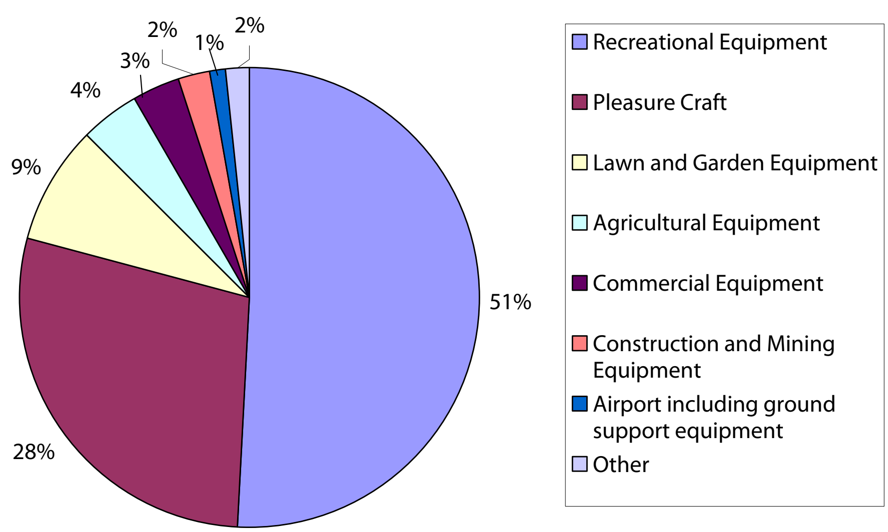
For on-road mobile sources, the largest emission contributor is light duty gasoline vehicles, which accounted for 48 percent of total mobile source emissions in 2005. The second largest contributor of on-road mobile source emissions is light duty gasoline trucks, which accounts for another 45 percent of mobile source air toxics emissions. For non-road mobile sources, the largest emission contributor is recreational equipment (all-terrain vehicles, snowmobiles, etc.), which accounted for approximately half of all of the emissions. The second largest contributor is pleasure craft (boats, jet skis, etc,), which accounted for another 28 percent of the emissions.

Contribution of Major Categories to 2005 On-road Mobile Source Air Toxics Emissions in Minnesota



Total air toxics on-road mobile source emissions in 2005: 22,700 tons

Contribution of Major Categories to 2005 Non-road Mobile Source Air Toxics Emissions in Minnesota



Total non-road mobile source emissions in 2005: 24,200 tons

For more information on air toxics, the Minnesota Air Toxics Emission Inventory and the Great Lakes Air Emissions Inventory, see the following web sites:

http://www.pca.state.mn.us/air/airtoxics.html

http://www.pca.state.mn.us/air/toxics/toxicsinventory.html

http://www.epa.gov/ttn/atw/index.html

http://www.glc.org/air/

Chapter 2: Water Pollutant Discharges Overview

Minnesota's rivers, streams and lakes provide great natural beauty, and supply the water necessary for recreation, industry, agriculture and aquatic life. The major goal of the MPCA's water quality program is to enable Minnesotans to protect and improve the state's rivers, lakes, wetlands and groundwater so that they support healthy aquatic communities and designated public uses such as fishing, swimming and drinking water. The key strategies for accomplishing this goal include regulating point source discharges, controlling nonpoint sources of pollution, and assessing water quality to provide data and information to make sound environmental management decisions.

Point sources consist mainly of municipal and industrial wastewater discharges. Point sources have the greatest potential to impact the environment during periods of low precipitation and stream flow. Nonpoint sources include runoff from agricultural fields, feedlots, urban areas, and on-site sewage treatment (septic) systems. Nonpoint sources are most significant during periods of high precipitation and stream flow.

Minnesota has been successful in controlling end-of-pipe discharges from wastewater treatment plants and industries to our state's waters. But at the same time, the challenges posed by nonpoint sources of pollution are increasing as land use changes and population expands. The federal Clean Water Act requires states to adopt water quality standards to protect the nation's waters. 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 or industrial purposes.

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 that fails to meet water quality standards. Rivers and streams may have several TMDLs, each one determining the limit for a different pollutant. Many of Minnesota's water resources cannot currently meet their designated uses because of pollution from a combination of point and nonpoint sources.

At the state level, the Clean Water Legacy Act (CWLA) of 2006 provided one-time funding to the MPCA to conduct accelerated testing of Minnesota's surface water and groundwater and to develop TMDL plans to clean up those waters that do not meet water quality standards.

In November 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment to the state constitution. The Amendment increases the sales tax rate by three-eighths of one percent on taxable sales, starting July 1, 2009, continuing through 2034. Of those funds, approximately 33 percent will be dedicated to a Clean Water Fund to protect, enhance, and restore water quality in lakes, rivers, streams, and groundwater, with at least five percent of the fund targeted to protect drinking water sources. Total funding appropriated by the legislature for the FY2010-2011 biennium is approximated $150.8 million, going to seven state agencies.

Of this total, the legislature provided the MPCA with $51.16 million specifically for monitoring and assessment, TMDL development, protection and restoration activities and for groundwater assessment and drinking water protection. These resources will allow the MPCA to continue the accelerated assessment and TMDL development efforts from previous CWLA one-time funding and to more fully integrate MPCA water resource management and protection efforts in cooperation with local governments and stakeholders.

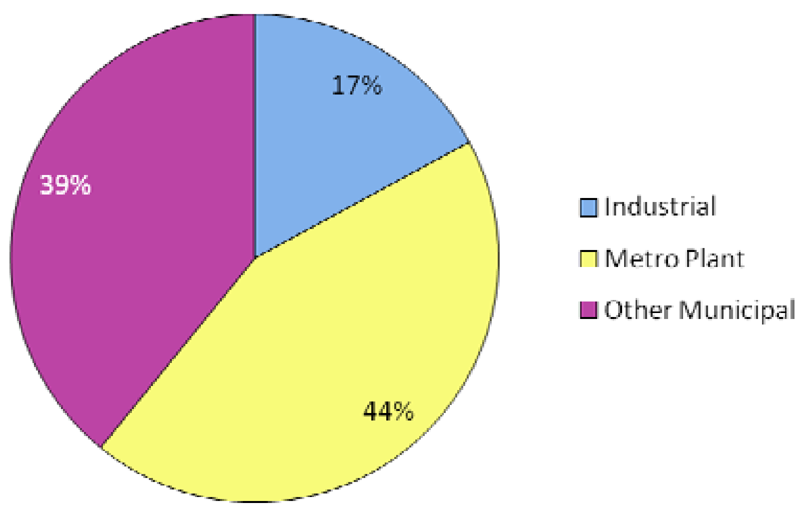
Major Water Discharge Parameters, Flow and Trends

Improvements intended to increase biological nutrient removal at wastewater treatment plants across the state are beginning to have an effect in improving the overall quality of discharges to Minnesota's surface waters. Although exceptions exist (for example, total phosphorus loadings increased from 2005 to 2006, but then dropped 58 percent in 2007), the general trend in total loading of all pollutants examined has been downward during the five most recent years of record, 2004-2008. This is encouraging for the status of Minnesota's surface waters.

As a specific example, phosphorus data at the Metropolitan Council Environmental Services Metropolitan Wastewater Treatment Plant (Metro Plant), the largest treatment plant in Minnesota, show that biological phosphorus removal has significantly improved the plant's overall performance. Due to the large volume of waste treated by the Metro Plant, improvements like this have contributed to verifiable reductions in reported water pollutant loadings over the past several years. During the period 2003-2005, phosphorus loading from the Metro Plant was reduced by 66 percent and total loading was reduced by 72 percent. From 2006-2007, phosphorus loading fell from 154,000 kilograms to 133,500 kilograms. From 2007-2008, phosphorus loading fell again by nearly 13,000 kilograms to 120,900 kilograms.

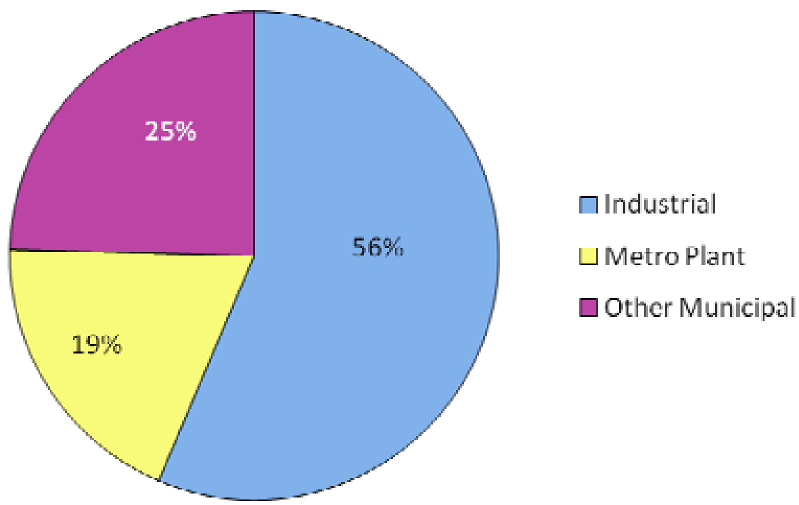
In addition to pollutant loads, the volume of flow through a wastewater treatment plant (WWTP) is also important in assessing the statewide data. For example, the figure below shows that the Metro Plant contributes nearly 44 percent of the total load of the five parameters examined as compared with strictly major industrial and other major municipal dischargers.

Relative Contribution to 2008 Load (Mass) from Major Industrial Facilities, the Metro Plant and Other Major Municipal Facilities



However, when relative contributions to flow are examined, the Metro Plant contributes only 19 percent of the total (see figure below.)

Relative Contribution to 2008 Flow from Major Industrial Facilities, the Metro Plant and Other Major Municipal Facilities

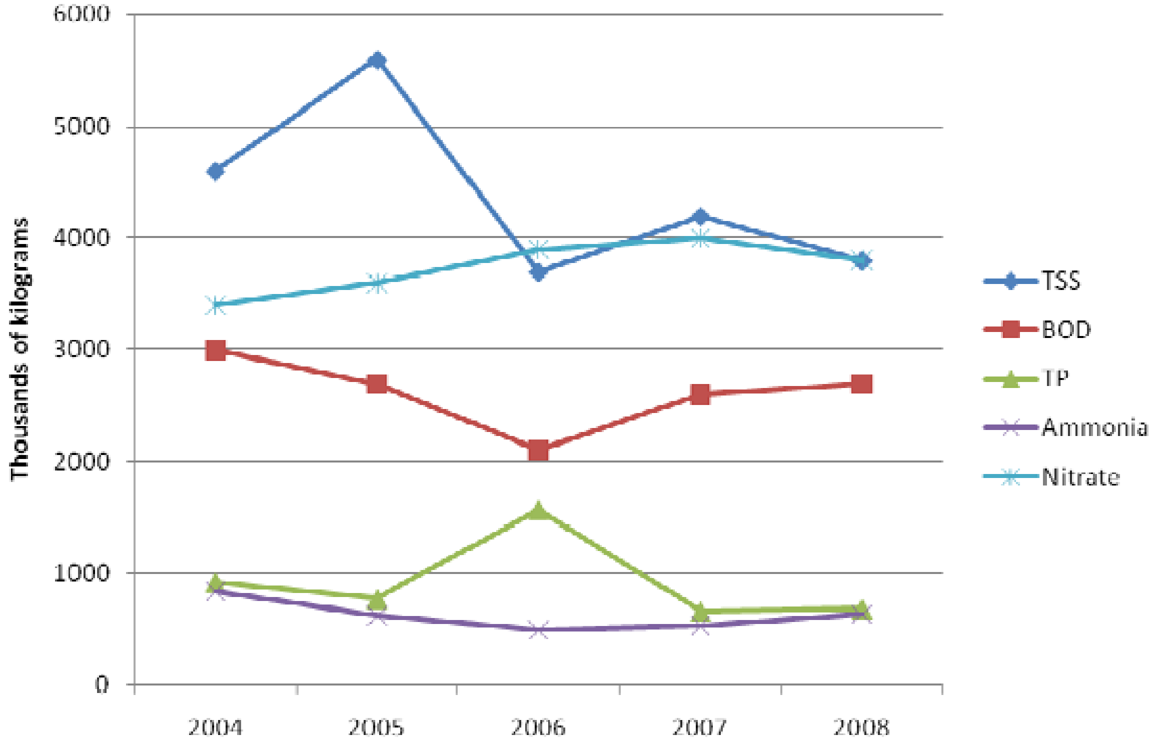


Point source contributions of nitrate and phosphorus to waters of the state are still small compared to nonpoint contributions of these pollutants from sources such as agriculture and urban runoff. Point sources tend to have the greatest impact on receiving waters during periods of low precipitation and stream flow, while nonpoint sources are most significant during periods of high precipitation and stream flow. However, it is difficult to measure directly the effects of nonpoint pollution on Minnesota's lakes, rivers and groundwater. Best estimates suggest that approximately 86 percent of water pollution in Minnesota can be attributed to nonpoint sources, while about 14 percent comes from point sources.

The MPCA continues to investigate better ways to assess and measure nonpoint pollution, but nonpoint source monitoring is expensive and often requires a more complex, labor-intensive (and therefore more costly) monitoring network than measuring volume and quality of discharge from pipes. The MPCA continues to conduct loading studies for a number of watersheds in the state as a part of the TMDL program.

Discharge information is presented below for the following water pollutants that are released from major facilities (point sources) into Minnesota's waters: total suspended solids (TSS); biochemical oxygen demand (BOD); total phosphorus (TP); ammonia (NH_3) and nitrate (NO_3). Since the MPCA is now trying to address water pollution problems on a holistic, watershed approach, it is presenting the following discharge summaries by major watershed, rather than on a county-by-county basis. By plotting individual discharge points rather than aggregating the data, it is hoped that the reader gets a clearer picture of how discharges from major treatment facilities impact watersheds statewide. A table of the data from 2004-2008 (the five most recent years for which data are available) is found on page 4 of this report. In addition, the statewide data are plotted by pollutant in graphical form in the figure on the next page.

Minnesota Water Pollution Discharge Loading Trends from Major Point Sources, 2004-2008, in thousand kilograms

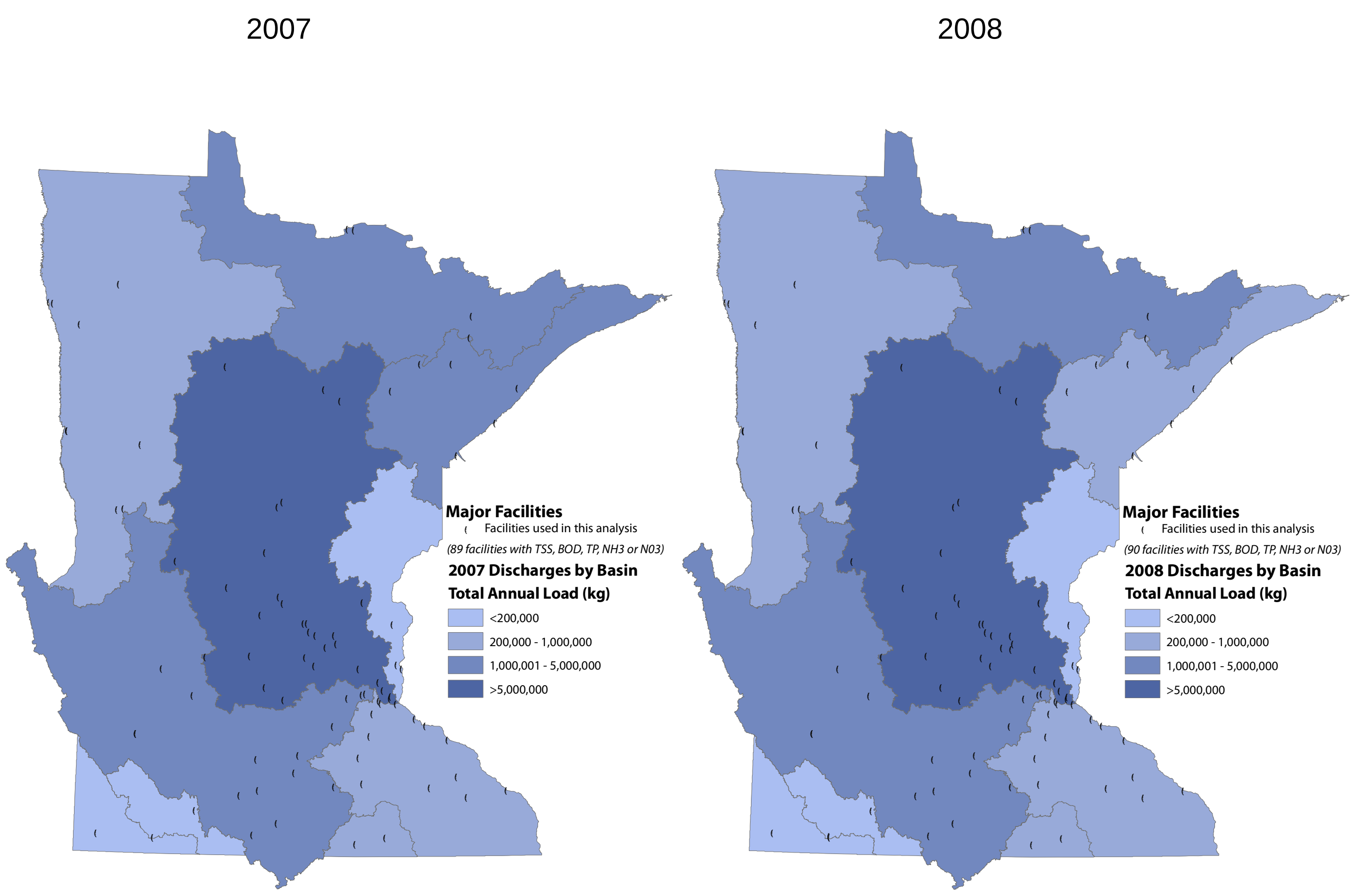


Total Annual Pollutant Load by Drainage Basin

The total statewide annual pollutant load from major treatment facilities to Minnesota waters for 2008 showed a decrease to 11,600,000 kilograms from the 12,000,000 kilograms reported in 2007. This is still slightly less than the 11,800,000 kilograms reported in 2006.

The figure below shows the statewide distribution of pollutant loading by major river basin for 2007 and 2008. The Upper Mississippi River Basin contributed about 6.95 million kilograms (up slightly from about 6.75 million kilograms in 2007), while the Minnesota River Basin contributed 1,160,140 kilograms (down slightly from 1,160,775 kilograms in 2007). Together, these two river basins account for over two-thirds of pollutants discharged from major WWTPs in the state. Following is a discussion of the statewide loadings of several individual pollutants that contribute to total loading and trends in discharge for those parameters noted in recent years.

Total Annual Pollutant Load by Basin from
Major Wastewater Treatment Facilities, 2007 and 2008

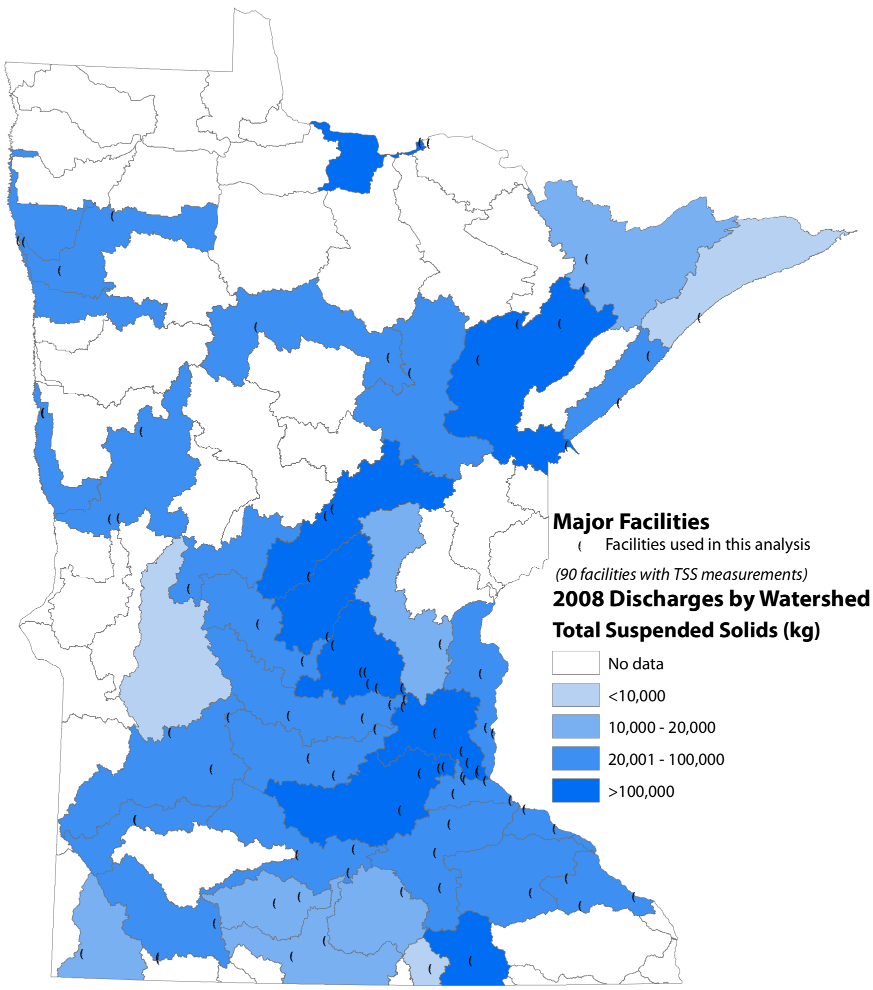


Total Suspended Solids

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

Based on results of Discharge Monitoring Reports for 90 major treatment facilities, the estimated discharge of TSS to waters of the state for 2008 was approximately 3,800,000 kilograms, a decrease of 10 percent from that reported in 2007. The map below shows the 2008 TSS discharges to surface waters by major point sources of water pollution by watershed.

Total Suspended Solids Discharges from Major Point Sources
by Major Watershed, 2008

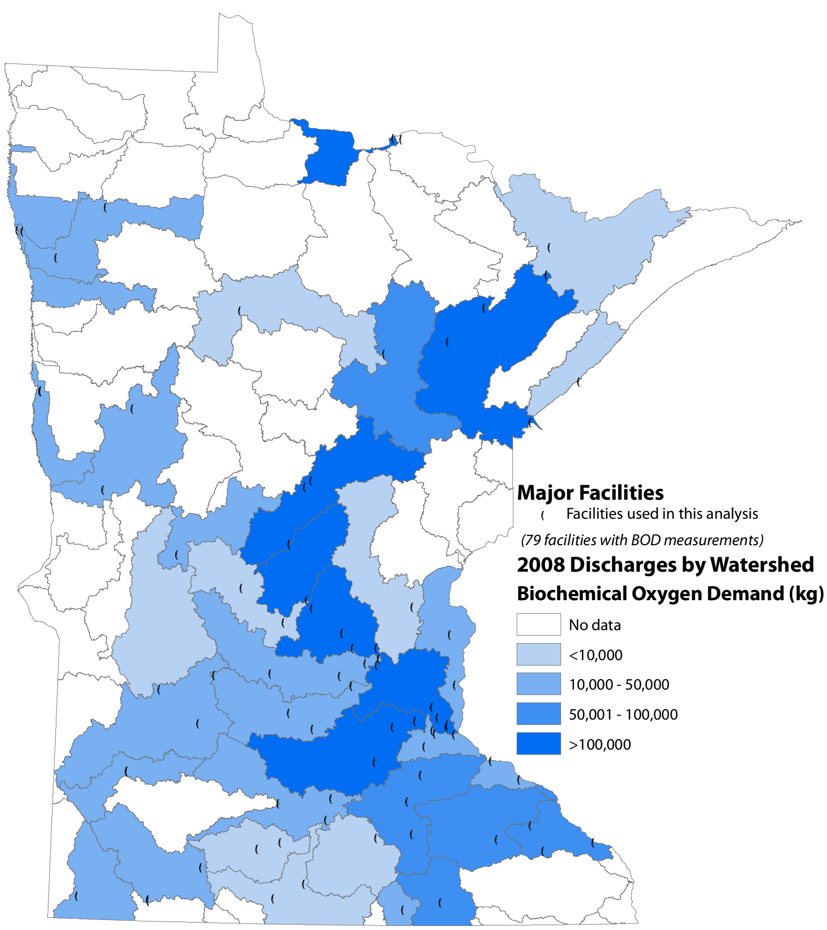


Biochemical Oxygen Demand (BOD)

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) is the amount of oxygen required for microorganisms to decompose waste carbonaceous materials. Both BOD and CBOD are indicators of the strength of waste effluent and effectiveness of treatment. For purposes of this report, BOD data were used wherever available; CBOD data were used only if BOD was not reported. A high demand for oxygen causes reduction in the concentration of oxygen in the receiving waters. Depletion of oxygen deteriorates water quality and impacts aquatic life, including fish and other organisms.

Based on results of Discharge Monitoring Reports for 79 major treatment facilities, the estimated discharge of BOD to waters of the state for 2008 was approximately 2,700,000 kilograms, an increase of 4 percent from 2007. The map below shows the 2008 BOD discharges to surface waters by major point sources of water pollution by watershed.

Biochemical Oxygen Demand Discharges
from Major Point Sources, 2008

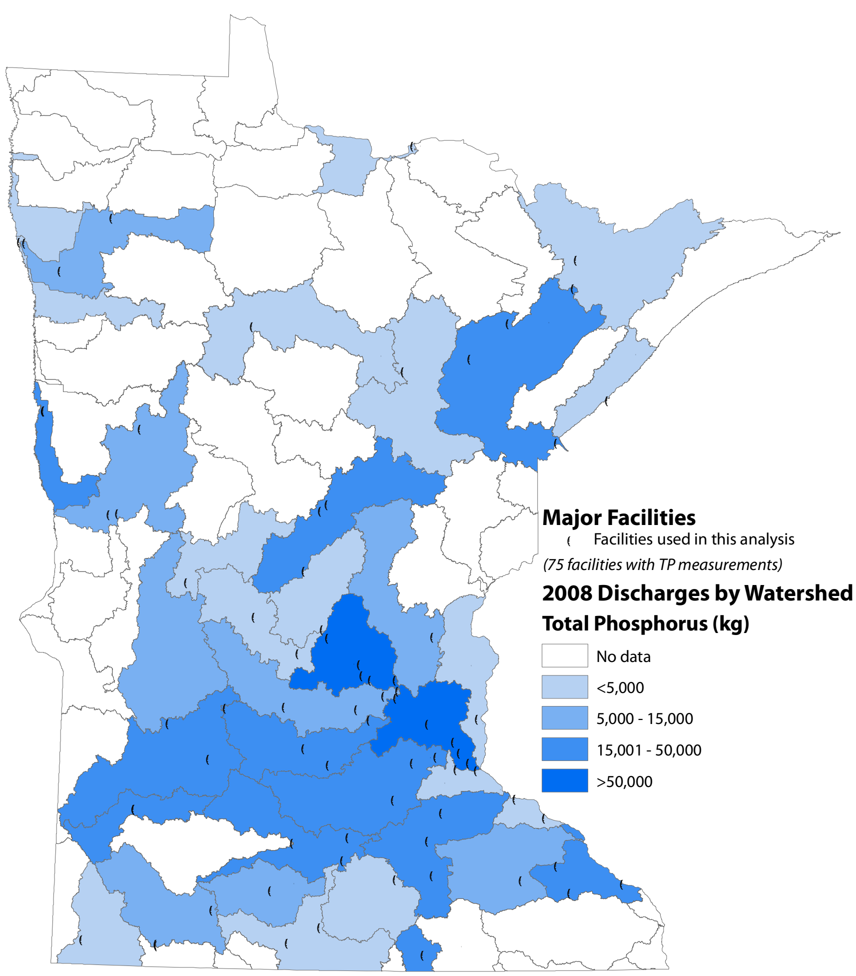


Total Phosphorus

Total phosphorus (TP) is the primary pollutant associated with eutrophication of surface water from anthropogenic sources (sources that result from human activities). Excess phosphorus 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. Minnesota has had point source effluent limitations for phosphorus since the early 1970s.

Based on the results of Discharge Monitoring Reports for 75 major treatment facilities, the estimated discharge of TP to waters of the state for 2008 was approximately 680,000 kilograms, an increase of 3 percent from 2007. Note that only 71 facilities reported TP data in 2007. Many treatment plants are now using advanced methods for phosphorus removal. It is encouraging when TP discharges decrease because, as a headwaters state, Minnesota seeks to do its share to reduce its contribution from phosphorus to national problems, like the hypoxic zone in the Gulf of Mexico. Although there was a slight increase noted in the most recent data, it is significant that since 2004, TP discharges have decreased 26 percent. The map below shows the 2008 TP discharges to surface waters by major point sources of water pollutants by watershed.

Total Phosphorus Discharges from Major Point Sources, 2008

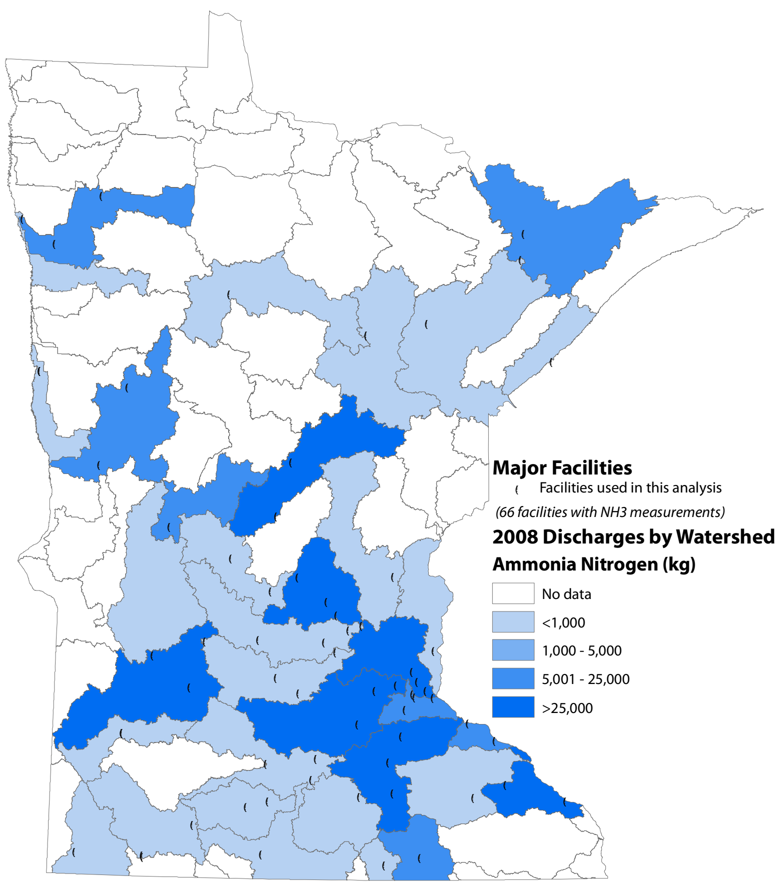


Nitrogen

Nitrogen, generally occurring as either nitrate or ammonia is present in a wide variety of effluents including sewage (wastewater treatment plants and on-site septic systems), food processing wastes, mining effluents, landfill leachate, and agricultural and urban runoff. Nitrate and/or ammonia concentrations in most of these sources are monitored under permit requirements. Nitrogen as ammonia can be toxic to aquatic life and nitrogen in the form of nitrate can be a significant problem in groundwater supplies. Nonpoint sources of nitrogen from agricultural and urban runoff are an important source of loading to waters of the state, although very little of this contribution is captured through Discharge Monitoring Reports required by permit.

Based on the results of Discharge Monitoring Reports for 66 major treatment facilities, the estimated discharges for 2008 were 630,000 kilograms of ammonia, an increase of 19 percent from 2007. This still represents a 24 percent decline from the 830,000 kilograms discharged from major facilities in 2004. A close examination of the facility-specific data shows that during the first four months of 2008, a WWTP which had just undergone expansion reported abnormally high ammonia results. The anomalous results may have occurred during the time that the treatment plant operators were adjusting the new system. It should be noted that during the last eight months of 2008, the ammonia results reported by the WWTP returned to much the same order as they were in 2007. This is an example of why making statewide comparisons of data from year-to-year must be done cautiously, with an appreciation of the variability that can occur within individual treatment systems.

Ammonia Discharges from Major Point Sources, 2008



Nonpoint Source Pollution

As previously discussed, Minnesota has made significant progress in cleaning up point sources of water pollution as measured by discharges of pollutants in municipal and industrial wastewater. An indicator of this success is shown by the fact that 90 major treatment facilities discharging more than one million gallons per day of treated effluent have cut their total amount of pollutants discharged to waters of the state by approximately 1,100,000 kilograms in the period 2004-2008, despite year-to-year variation in levels of individual pollutants due to factors such as climate variability, change in flow conditions, and even fluctuations in the economy.

It is the nonpoint sources of pollution from rainfall or snowmelt moving over or through the ground carrying natural and human-made pollutants into lakes, rivers, wetlands and groundwater that now pose the greater challenge for cleanup. Both point and nonpoint sources of pollution must be controlled to reach the Clean Water Act goal of fishable, swimmable waters in the state. Despite significant improvements in recent years, too much phosphorus and nitrogen continue to reach our waters, carried in soil erosion and runoff from roads, yards, farms and septic systems.

Over the past few years, more regulatory controls for sources like feedlots, septic systems and stormwater have been implemented, but these sources of nonpoint pollution can be diffuse and difficult to assess and manage. Much of the work to control nonpoint sources of pollution thus far has used financial incentives to encourage voluntary adoption of best management practices (BMPs). As described below, the Board of Water and Soil Resources (BWSR) reports the amount of nonpoint source pollutants like nitrogen, phosphorus and sediment avoided by use of BMPs.

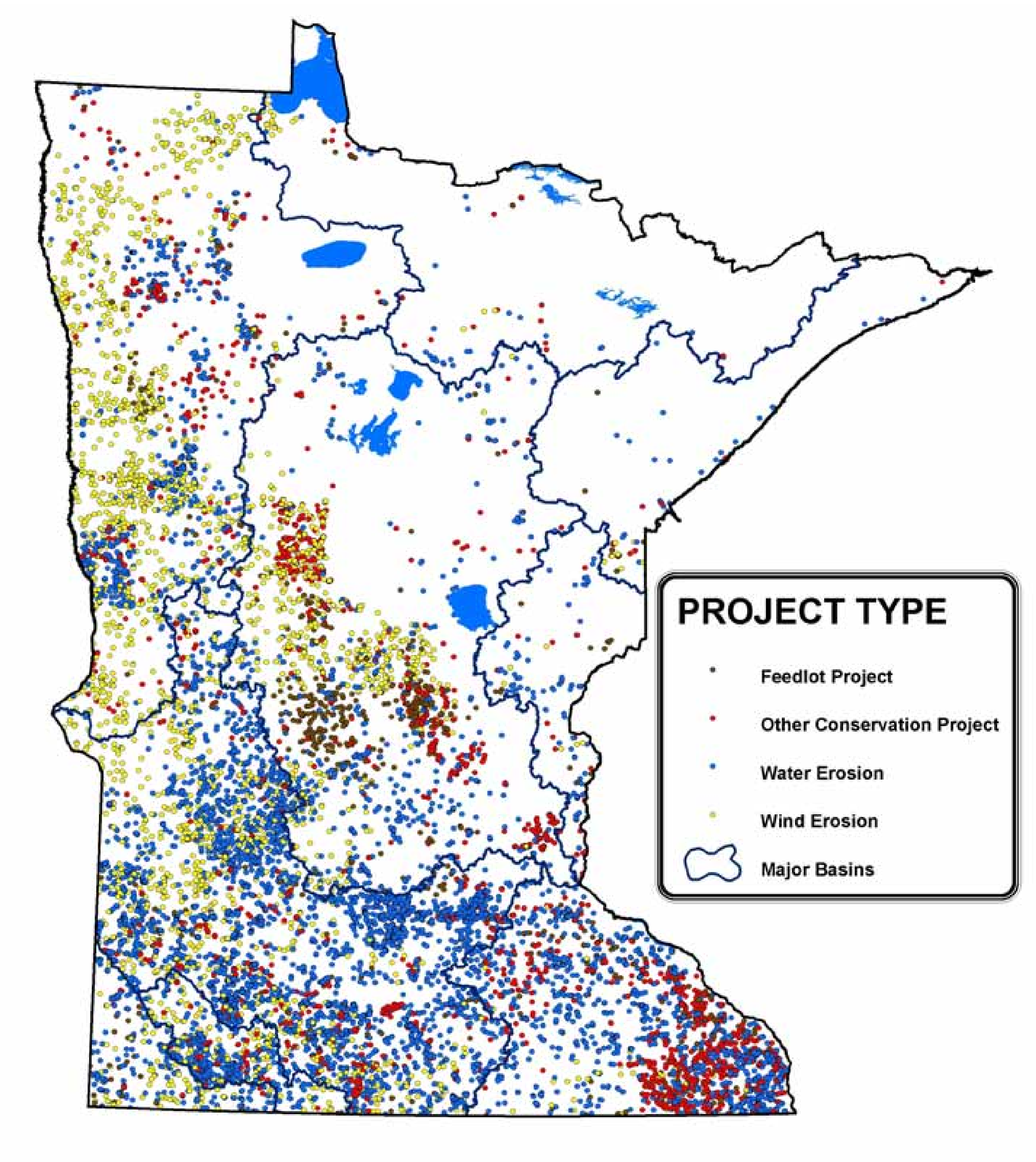
Recent action by the Minnesota Legislature to pass the Clean Water Legacy Act and by Minnesota voters to approve the Clean Water, Land and Legacy Amendment to the state constitution is helping to ensure that more effort will go toward monitoring to help assess the effectiveness of BMPs and other restorative measures. Many of the stresses from nonpoint sources of pollution that affect Minnesota's surface and groundwater resources are the result of choices that individuals make everyday such as lawn care practices, watercraft operation and waste disposal. The daily decisions that homeowners, developers, farmers and businesses make regarding land use are crucial to protecting water resources from the effects of nonpoint source pollution. Once a water resource declines in quality, recovery is costly and can take many years. Clearly, prevention is the key when it comes to nonpoint source pollution.

Soil Loss Reduction in Minnesota

Among the many conservation projects in Minnesota, easements prevent thousands of tons of soil, sediment and other pollutants from leaving fields and becoming airborne or flowing into rivers and lakes. Soil erosion means not only the valuable loss of topsoil, decrease in productivity of the land and higher fertilizer requirements, but also damage to surface water in the form of silt that chokes off rivers, lakes and wetlands, and possible groundwater contamination from over-application of fertilizer.

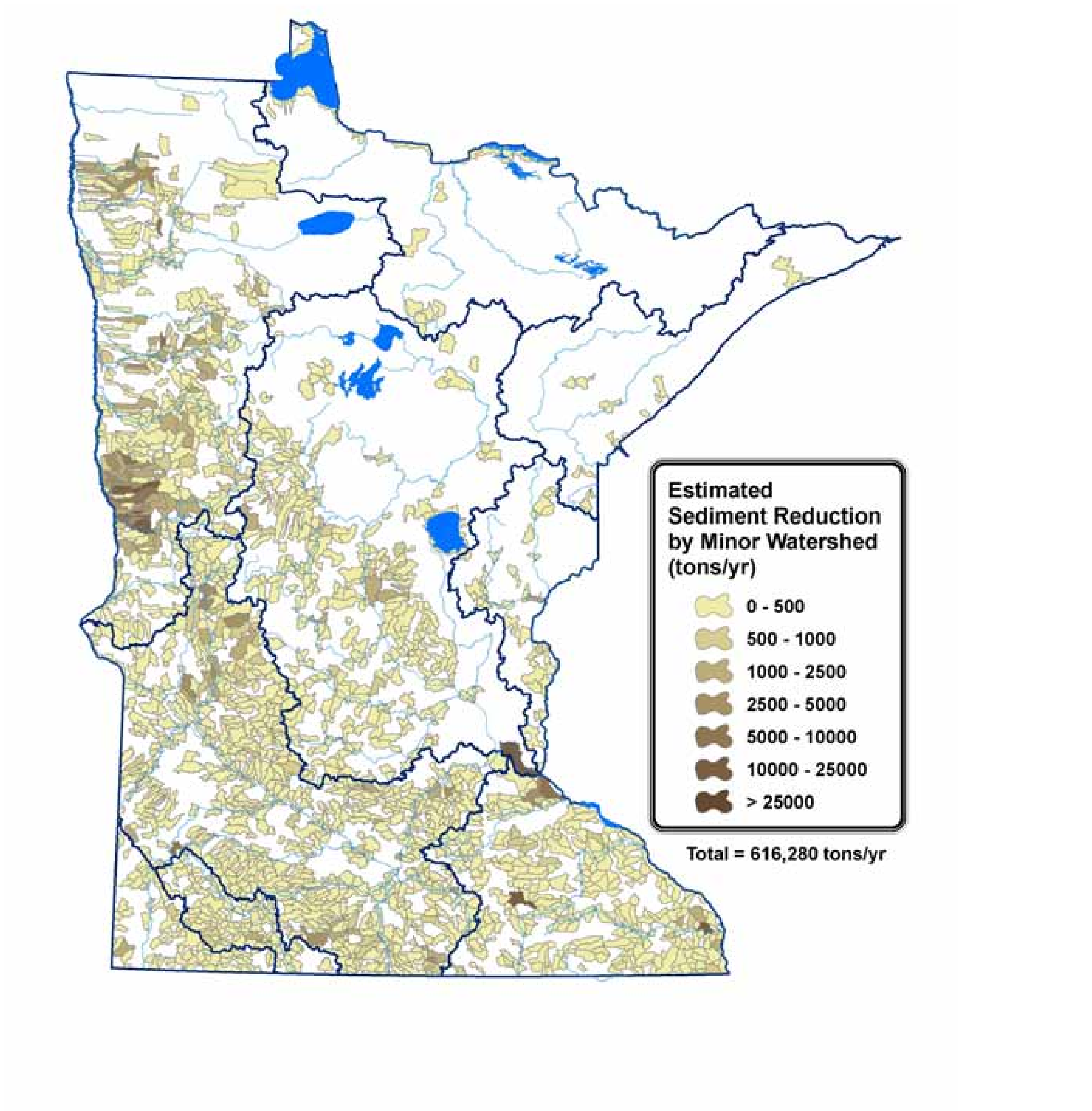
BWSR tracks soil loss and BMPs to reduce pollution from soil loss and sedimentation using the eLINK database (http://www.bwsr.state.mn.us/outreach/eLINK/). The figure on the next page shows the locations of projects tracked by eLINK as reported by county soil conservation offices and local officials for the six-year period 2003-2008. Sites are classified as preventative measures for wind erosion, preventative measures for water erosion, preventative measures associated with animal feedlot construction and operation, and other conservation measures.

Location of Conservation and Best Management Projects
Reported by e-LINK (2003-2008)



From 2003-2008, soil loss reduction statewide attributed to pollutant reduction measures was estimated to average about 616,000 tons per year. Most common pollution-reduction BMPs include gully stabilization; sheet and rill erosion control; stream and ditch stabilization; filter strips to trap sediment; and wind erosion control. Even at the minor watershed level, some areas of west-central Minnesota showed soil loss reductions of more than 25,000 tons/year. The map below shows soil loss reduction benefits from conservation and management practices by watershed during the period 2003-2008.

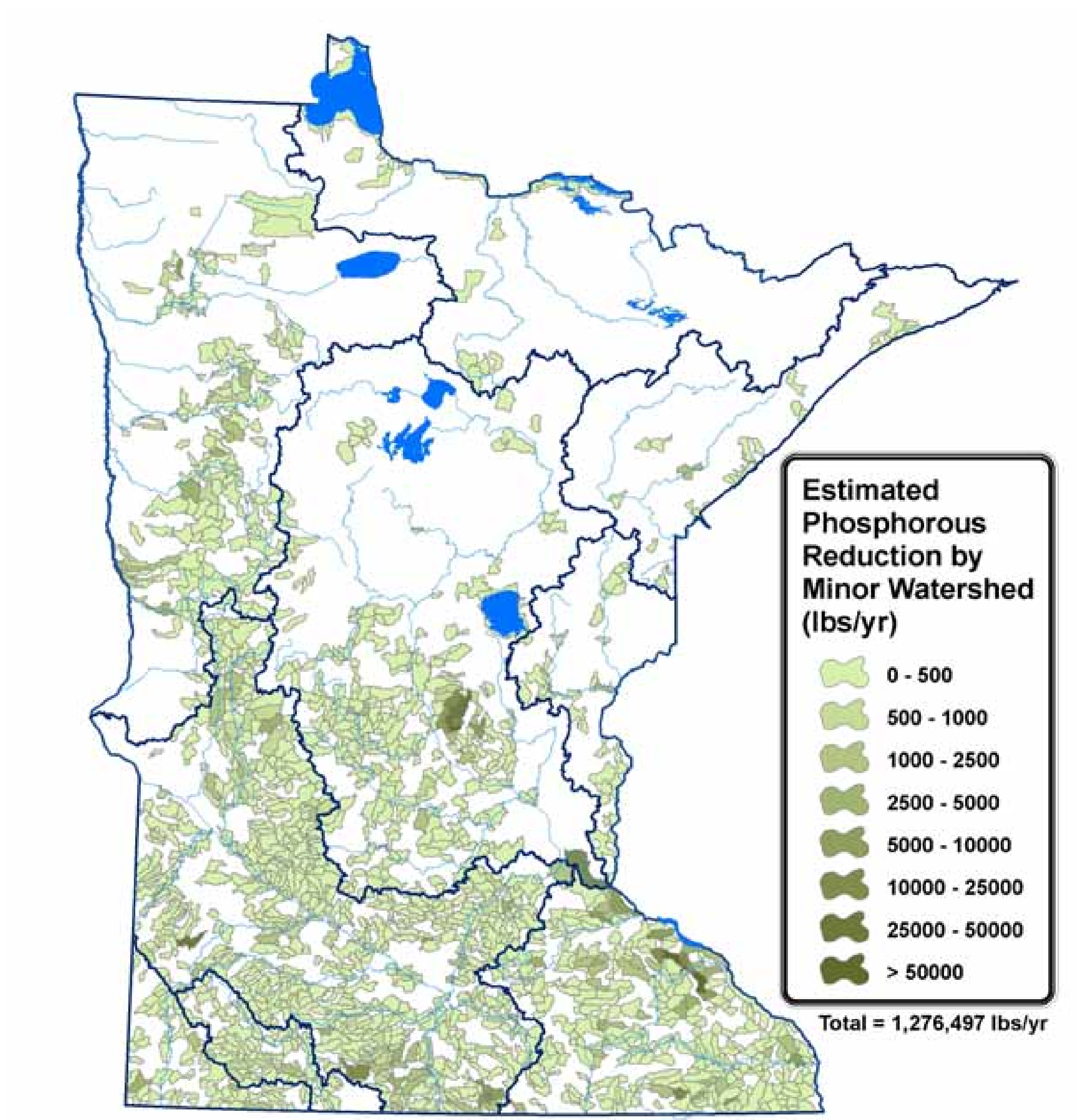
Soil Loss Reduction Benefits from Conservation and Management Practices
Reported Via eLINK (2003-2008)



Not only can sediment cause silting problems, but it can also carry chemicals attached to it into the water. One of these chemicals is phosphorus, a common element of fertilizer, which can create problems in surface water such as algae blooms. The proliferation of algae and other aquatic vegetation takes oxygen from the water, suffocating fish, discouraging wildlife and making lakes and waterways unsuitable for recreational use.

From 2003-2008, phosphorus loss reduction statewide was estimated at about 1.28 million pounds/year. The map below shows phosphorus reduction benefits from conservation and management practices during the period 2003-2008.

Phosphorus Reduction Benefits from Conservation and Management Practices Reported by eLINK (2003-2008)



Emerging Issues of Concern in Minnesota’s Environment

There are a number of newly recognized environmental contaminants and other issues that are not fully understood but which have the potential to cause known or suspected adverse ecological and/or human health effects. “Emerging Issues” are new areas of environmental concern that are not currently incorporated into regular environmental protection activities in Minnesota or elsewhere.

Chemical contaminants, for example, can enter the environment through consumer products, solid waste disposal, agricultural and urban runoff, residential and industrial wastewater, and long-range atmospheric transport. The release of these substances to the environment may have occurred long ago, but remained unrecognized because analytical methods to detect them at low concentrations did not exist. In other cases, the synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of contamination. Several studies have demonstrated that some contaminants cause adverse effects on fish and wildlife, such as the feminization of male fish.

The risks posed to humans from exposure to these contaminants at low concentrations are not well understood. While monitoring and analytical lab advances make it possible to detect these compounds at tiny concentrations, such as parts per trillion, there are very few established environmental standards or benchmarks for comparison and risk characterization. Much research is underway around the world to better understand how these compounds behave in the environment and in the human body.

The MPCA is attempting to stay abreast of newly recognized environmental contaminants and other issues that have the potential to cause known or suspected adverse ecological or human health effects but are not well understood, to help inform lawmakers, regulators, the public and industry. The Legislature approved funding for some of these efforts in recent biennial budgets. Partnering with other scientists at universities, state agencies and federal agencies, the MPCA is conducting specific investigations of several key emerging issues of importance to Minnesota. Examples include:

- Pharmaceuticals, household and industrial-use products
- Endocrine disrupting compounds
- Perfluorinated chemicals (PFCs)

Pharmaceuticals, household and industrial-use products

In 2002, the U.S. Geological Survey (USGS) published results of the first nationwide survey of pharmaceuticals, hormones, and household and industrial products in surface waters. The compounds analyzed in the study encompassed a wide variety of compounds including: antibiotics, over-the-counter pharmaceuticals, hormones, detergents, disinfectants, plasticizers, fire retardants, insecticides and musks used in the production of fragrances. The USGS included certain compounds in their survey because they are biologically active, such as pharmaceuticals or chemicals that are suspected endocrine disruptors. These products are widely used in consumer and industrial products and are continuously released into the environment through human activities. Sources of these chemicals can include wastewater discharge, manure from confined animal feedlots, landfill leachate, and urban runoff.

In Minnesota, the MPCA has been collaborating with researchers from the local and national USGS offices since 2000 and St. Cloud State University since 2004 to further monitor and define health effects associated with this suite of compounds in Minnesota's waters. The first state reconnaissance study by the USGS, the MPCA and the Minnesota Department of Health showed that industrial and household-use compounds and pharmaceuticals are present in streams, groundwater, wastewater and landfill effluents. Steroids, nonprescription drugs and insect repellents were the chemical groups most frequently detected, with detergent degradates and plasticizers measured in the highest concentrations. The complete report may be found at: http://water.usgs.gov/pubs/sir/2004/5138/. The MPCA also will sample 150 stream locations for about 25 pharmaceuticals in 2010 as part of a larger streams study funded by the U.S. Environmental Protection Agency.

The MPCA has also worked since 2002 with several partner organizations and the Minnesota Hospital Association to improve environmental compliance and pollution prevention throughout healthcare facilities in Minnesota. Compliance evaluations of healthcare facilities had revealed widespread mismanagement of complex hazardous wastes such as pharmaceuticals, laboratory solvents and reagents, and mercury-containing wastes. As a result of this collaboration, hospitals have been changing their waste management methods. Fiscal year 2006 resulted in 28 metro area hospitals properly managing 75 tons of pharmaceuticals and 30 tons of laboratory wastes as hazardous waste. Twelve hazardous waste compliance training events have been presented throughout the state in FY 2006 with over 500 healthcare professionals in attendance. Partner organizations participating in this effort include the Solid Waste Management Coordinating Board, the Minnesota Technical Assistance Program, and the MCES. Since 2006, the healthcare hazardous waste initiative has expanded to include clinics, long-term care facilities, veterinarians and dentists. More information on these efforts can be found at: http://www.pca.state.mn.us/industry/healthcare.html.

Endocrine Disrupting Chemicals

Endocrine disruption is a broad term referring to both natural and synthetic compounds that cause adverse effects in humans, fish, or wildlife by mimicking or altering the endocrine or hormone systems. Originally, studies of endocrine disrupting chemicals (EDCs) focused on those chemicals affecting the estrogenic, androgenic (testosterone), or thyroid systems of humans and wildlife. However, the scope of interest has expanded to include other signaling chemicals in humans and wildlife, such as neurochemicals. Because endocrine disruption encompasses numerous sources, exposures, and organisms, scientists are addressing endocrine disruption in the context of environmental protection through a multidisciplinary and collaborative approach. MPCA has been supporting Minnesota-based EDC studies and researchers that build on national studies and perspectives.

Building on the results of the 2002 USGS survey of pharmaceuticals, household and industrial products in the aquatic environment, scientists from the USGS, St. Cloud State University (SCSU), the University of Minnesota, the University of St. Thomas, and the MPCA continue to investigate the significance, sources, and occurrence of compounds with endocrine-disrupting activity in Minnesota's waste streams and waters. This multidisciplinary team of experts has designed a phased approach from laboratory to field studies to discover what effects these compounds have on aquatic organisms.

In January 2008, the MPCA completed a report to the Minnesota Legislature titled *Endocrine Disrupting Compounds*. This report summarizes what is understood about the range of EDCs and their effects on humans, fish, and wildlife, as well as reviewing possibilities for preventing the release of EDCs to the environment and the options for treatment at waste water treatment plants. The report is available at: http://www.pca.state.mn.us/publications/reports/lrp-ei-1sy08.pdf.

In cooperation with USGS and SCSU, the MPCA completed the Statewide EDC Study in June, 2009, which included the analysis of surface water and sediment in 12 Minnesota lakes and four rivers and streams. This study also included an analysis of effects in fish collected from the same locations. The results of this study can be found at http://www.pca.state.mn.us/water/edc.html.

MPCA is currently pursuing three projects focused on EDCs and organic wastewater compounds in the environment. The first study is a survey of 20 wastewater treatment plants across Minnesota, which includes chemical analysis of surface water and sediment as well as limited study of fish at those locations. Preliminary data from this study will be available in April, 2010, with a final report due June, 2011.

The second study continues the 2007-2009 Statewide EDC Study and will examine in more detail the presence and effects of EDCs on a single Minnesota lake from a variety of point and nonpoint sources. Results of this study will be reported in June, 2011.

Finally, the MPCA is undertaking a survey of groundwater in 2010 that will include the sampling of 35 wells in the ambient monitoring network and five wells that are located down gradient of landfills. Ambient wells will be selected in areas that reflect sewered residential, residential areas with septic systems, commercial and industrial land use. Groundwater samples will be analyzed for a suite of chemicals including hormones, pharmaceuticals, EDCs, and other chemicals associated with wastewater effluent.

Perfluorinated chemicals (PFCs)

Perfluorinated chemicals (PFCs) such as PFOS, PFOA, PFBA and others, are manmade chemicals used to manufacture products that are heat and stain resistant and repel water. PFCs used in emulsifier and surfactant applications are found in fabric, carpet and paper coatings, floor polish, shampoos, fire-fighting foam and certain insecticides. PFCs are used to make fluoropolymers, which then are used in the production of many personal care products, textiles, non-stick surfaces and fire-fighting foam. PFCs are widespread and persistent in the environment and they have been found in animals and people all over the globe. However, little is known about their toxicity to humans and wildlife.

In Minnesota, 3M manufactured PFOS and PFOA from approximately 1950 until they were phased out in 2002. During that time, tons of PFCs 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 PFC wastes legally prior to the advent of modern solid and hazardous waste laws and regulations aimed at protecting groundwater.

MPCA and Minnesota Department of Health (MDH) testing found PFOS, PFOA and PFBA in some municipal and private drinking water wells in municipalities near former waste disposal sites. The MPCA, MDH and 3M have cooperated to quickly provide clean drinking water in those communities where private and municipal wells were contaminated.

Under a May 2007 Consent Order, 3M agreed to clean up PFC disposal sites in Oakdale, Woodbury and Cottage Grove, and contribute $8 million toward the cleanup of the Washington County Landfill in Lake Elmo, a former municipal solid waste landfill that received 3M wastes but is now owned by the State of Minnesota. Extensive remedial action is underway at all four sites to remove wastes and treat PFC-contaminated groundwater with granular activated carbon.

MPCA studies also have detected PFOS at elevated concentrations in fish taken from the Mississippi River near the 3M Cottage Grove plant and downstream, and in metro area lakes with no known connection to 3M's manufacturing or waste disposal. Mississippi River Pool 2, which received 3M Cottage Grove effluent during the years of PFOS and PFOA manufacturing, is listed as an impaired water, due to PFOS. This is based on fish tissue PFOS concentrations that prompted the MDH to issue a one-meal per month consumption advisory for certain species in that pool. Preliminary work in advance of a PFOS TMDL for Pool 2 also is underway.

The Consent Order also provided 3M funds for the MPCA to investigate the broader presence of PFCs in the ambient environment and numerous studies are underway to do that. In addition to fish tissue, PFCs have been found in some shallow groundwater wells, in the influent, effluent and sludge of wastewater treatment plants, in ambient air, in blood of bald eagles, and in landfill leachate and gas.

The MPCA and the MDH continue to examine potential sources of exposure to PFCs. A extensive description of all MPCA and MDH activities, and links to many PFC-related reports and studies is available on the following web pages:

http://www.pca.state.mn.us/cleanup/pfc/index.html

http://www.health.state.mn.us/divs/eh/hazardous/topics/pfcshealth.html

Toxics in Products

In addition to the examples noted above, the Legislature directed the MPCA and the Minnesota Department of Health to examine questions surrounding toxic chemicals in consumer products, especially those used by children. The Minnesota Department of Health was also directed to publish a list of chemicals of high concern by July 1, 2010 and to identify a subset of these as high priority chemicals by February 1, 2011. A preliminary progress report on this work was delivered to the environment and health policy and finance committees in early January 2010, and is available on-line at http://www.pca.state.mn.us/publications/lrg-gen-7sy10.pdf

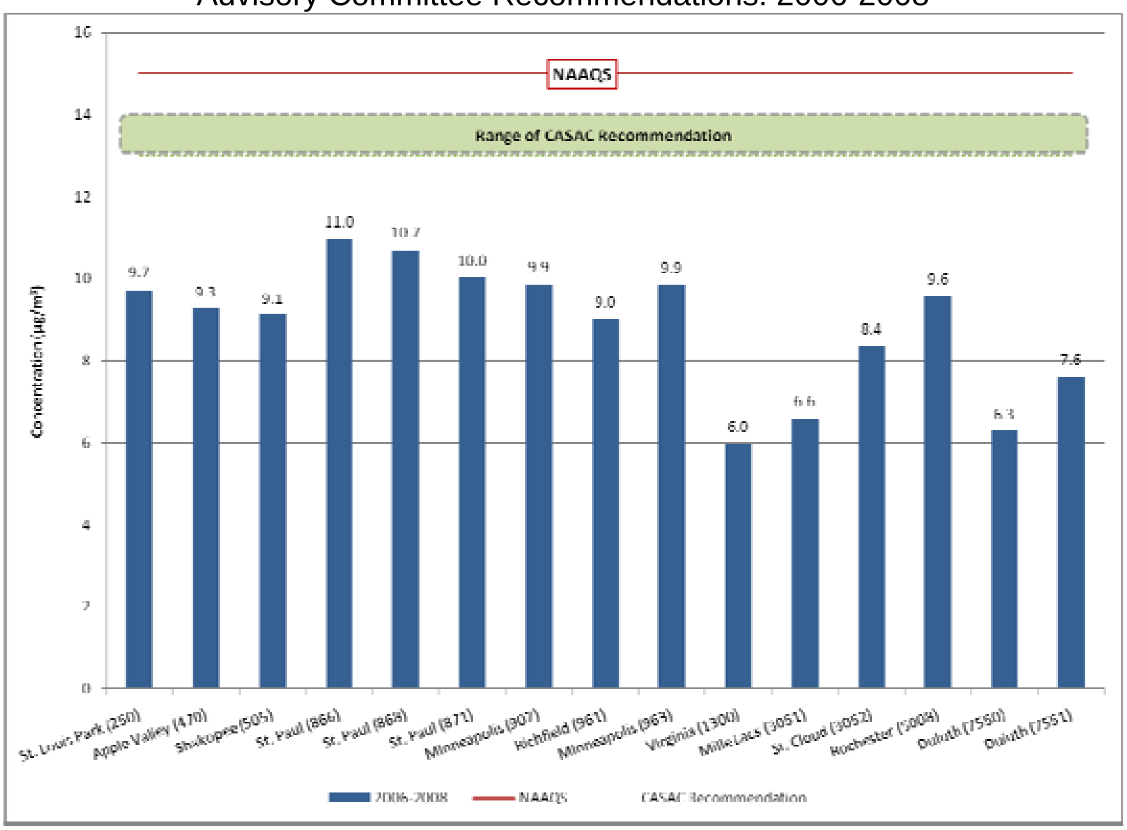
Appendix A: Comparison of Fine Particle Concentrations with 2005 Clean Air Scientific Advisory Committee Recommendations

The 1977 Clean Air Act Amendments established the Clean Air Scientific Advisory Committee (CASAC) to review the technical basis for the Environmental Protection Agency's (EPA) decisions on National Ambient Air Quality Standards (NAAQS). In finalizing the 2006 fine particle (also known as $PM_{2.5}$) NAAQS, the EPA adopted an annual standard for fine particles that is less stringent than the range recommended by CASAC. Per Minnesota Session Laws 2009, Chapter 37, Article 1, Subdivision 3, the Minnesota Pollution Control Agency must report a comparison of measured annual and daily fine particle concentrations to the standard ranges recommended by CASAC.

Comparison of $PM_{2.5}$ Annual Concentrations with CASAC Recommendations

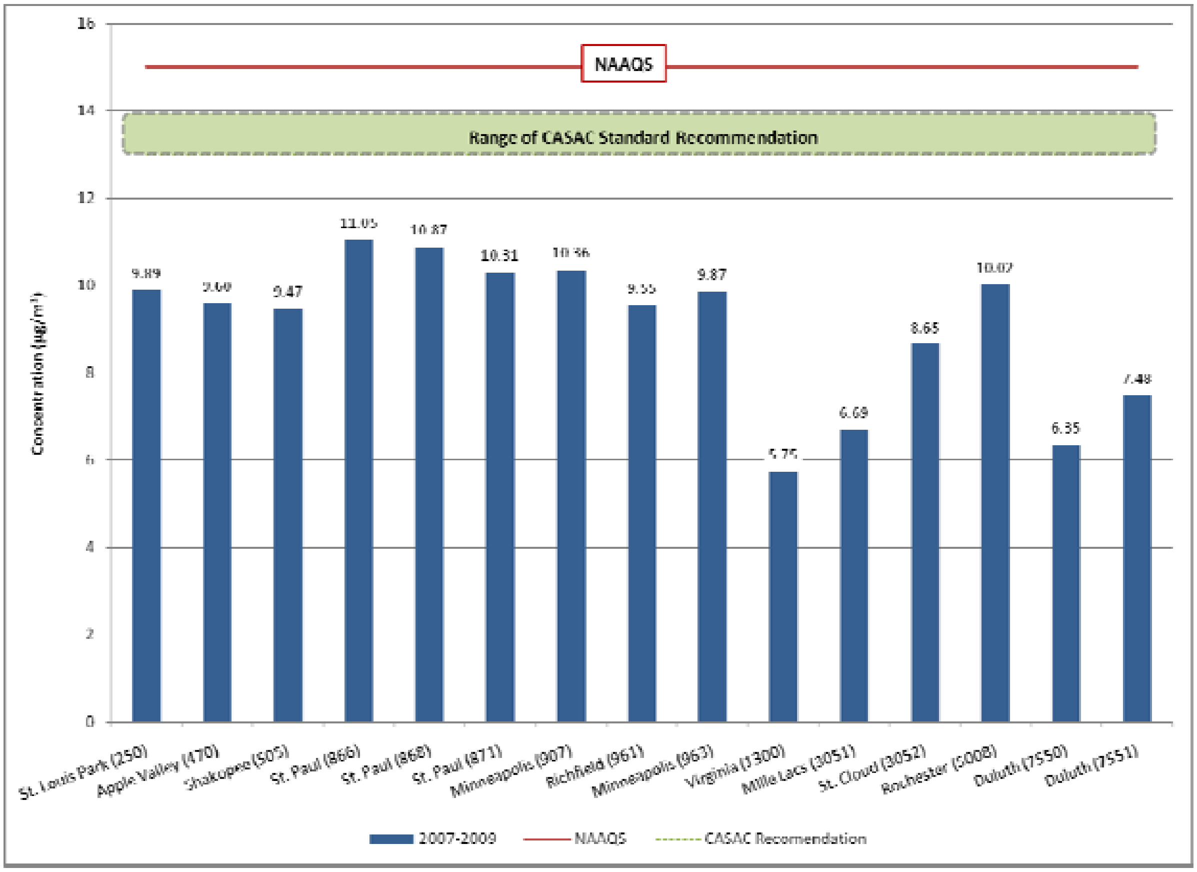
The 2006 fine particle NAAQS revision set the level of the annual standard at 15 $\mu g/m^3$. However, CASAC recommended a range of 13 to 14 $\mu g/m^3$. The figures below compare Minnesota concentrations of fine particles to the CASAC recommendations as well as the NAAQS. The concentrations are calculated as the 3-year NAAQS design value[1] for annual fine particle concentrations for monitoring years 2006-2008 and 2007-2009. Only monitors that follow the federal reference method (FRM) are included.

Minnesota Annual $PM_{2.5}$ FRM Concentrations
Compared to the National Ambient Air Quality Standard and Clean Air Scientific Advisory Committee Recommendations: 2006-2008



[1] The term NAAQS design value refers to the calculation required to compare ambient air quality data to the NAAQS. For the annual standard, the NAAQS design value is calculated as the three-year average of the annual quarterly-weighted concentration mean. For the daily standard, the NAAQS design value is calculated as the three-year average of the annual 98th percentile 24-hour fine particle concentration.

Minnesota Annual $PM_{2.5}$ FRM Concentrations
Compared to the National Ambient Air Quality Standard and Clean Air Scientific Advisory Committee Recommendations: 2007-2009



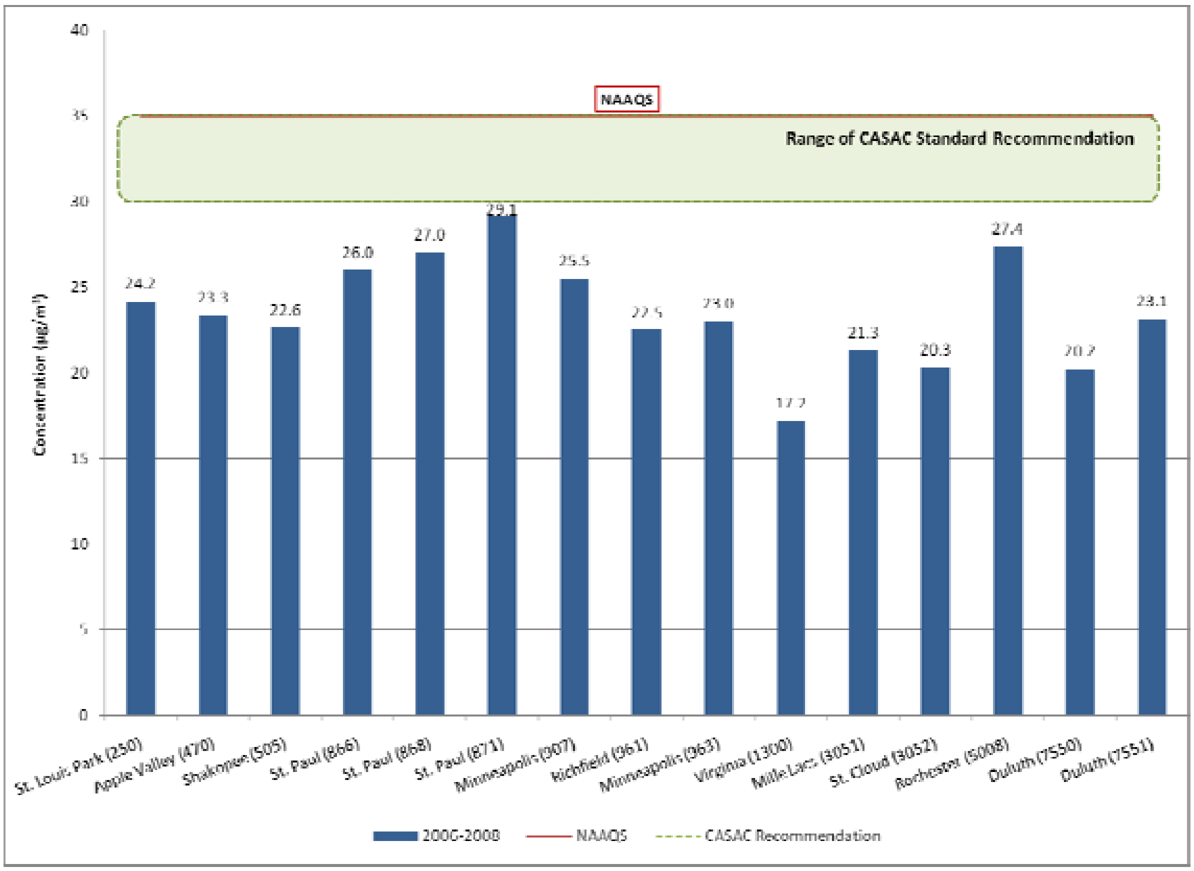
The 3-year design value for the annual fine particle standard at Minnesota monitors shows little variation from the 2006-2008 to 2007-2009 design years. On average, the 3-year value for each monitor increased by 0.2 µg/m^3 over this period. Despite this modest increase, all fine particle monitors in Minnesota currently meet the NAAQS and CASAC recommendations.

Comparison of Daily $PM_{2.5}$ Annual Concentrations with CASAC Recommendations

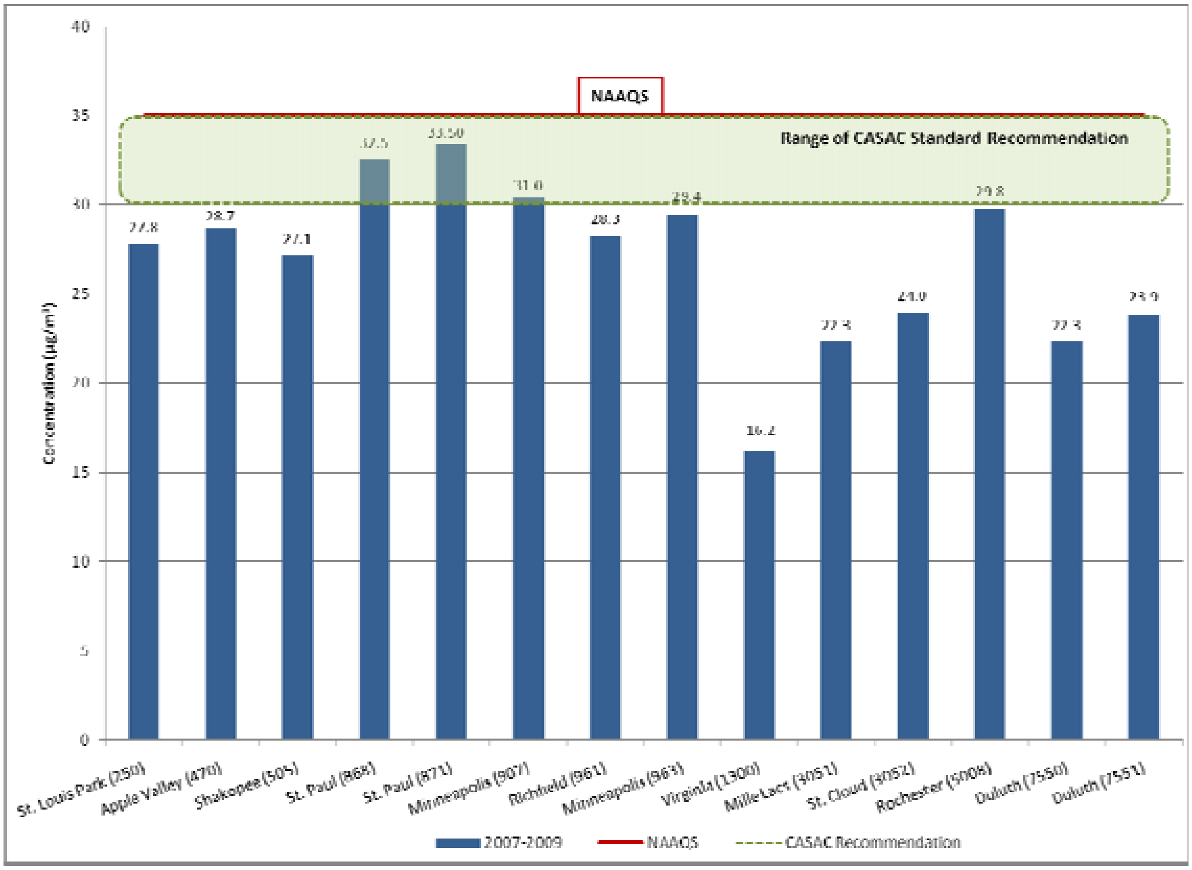
For the daily (24-hour concentration average) fine particle standard, CASAC recommended a range of 30-35 µg/m^3. The 2006 fine particle NAAQS revision lowered the level of the daily fine particle NAAQS from 65 µg/m^3 to 35 µg/m^3. To meet this standard, the 3-year average of the annual 98th percentile daily fine particle concentration must not exceed 35.4 µg/m^3.

The figures below compare Minnesota concentrations of fine particles to the CASAC recommendations as well as the NAAQS. The concentrations are calculated as the 3-year NAAQS design value for daily fine particle concentrations for monitoring years 2006-2008 and 2007-2009. Only monitors that follow the federal reference method (FRM) are included.

Minnesota Daily $PM_{2.5}$ FRM Concentrations
Compared to the National Ambient Air Quality Standard and Clean Air Scientific Advisory Committee Recommendations: 2006-2008



Minnesota Daily $PM_{2.5}$ FRM Concentrations
Compared to the National Ambient Air Quality Standard and Clean Air Scientific Advisory Committee Recommendations: 2007-2009



During the 2006-2008 monitoring period, all FRM fine particle monitors met the NAAQS and CASAC recommendations. While monitoring data continued to show compliance with the NAAQS during the 2007-2009 monitoring years, several monitoring locations, including St. Paul (868), St. Paul (871), and Minneapolis (907), now exceed the low end of the range recommended by CASAC.

Additional data and analysis are necessary to determine whether this increase in daily fine particle concentrations is a trend or an anomaly. It is valuable to note that while 2007 and 2008 daily fine particle concentrations were consistent with results from past years, the 2006 value was the lowest on record for the majority of monitoring sites and the 2009 value was the second highest since widespread fine particle monitoring began in 2001.