Minnesota Pollution Control Agency

Annual Pollution Report to the Legislature

A Summary of Minnesota's Air Emissions and Water Discharges

March 2009

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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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 MPCA prepares numerous scientific, policy and program progress reports on a routine basis. The Annual Pollution Report, prepared each year since 1996, is unique in its approach among the many MPCA reports and publications. It 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. The following observations of some advantages and limitations of this kind of report are presented to add context for interested parties.

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, for a category highly culpable for water quality impairments. 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 benefits from soil loss and phosphorus reductions from implementation of best management practices (BMPs) may now be made statewide and these are discussed in this report.

Challenges cont.

- 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 methodologies for estimating emissions are still evolving.

Outlook

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

- Clean Air Interstate Rule: 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). These emissions are tied to acid rain, particle and ozone formation and visibility impairment. CAIR has been subject to considerable legal uncertainty; the D.C. Circuit Court of Appeals found several flaws in the rule, and has directed EPA to craft a new rule to address those flaws. Until a new rule is completed, CAIR remains in effect for most states. However, since one of the problems identified was EPA's lack of consideration of data that may show Minnesota did not meet the threshold for inclusion in CAIR, EPA has indicated that they will stay application of CAIR in Minnesota until a new rulemaking is complete.

- Visibility State Implementation Plan: In Spring 2009, the MPCA will submit to EPA Minnesota's Regional Haze State Implementation Plan. The goal of the regional haze plan is to restore natural visibility conditions in the Boundary Water Canoe Area Wilderness and Voyageurs National Park by 2064. There are intermediate goals for visibility improvement in the intervening years, with the first in 2018. Visibility is improved through reducing precursor emissions that form haze-causing fine particulates. The main precursor emissions are NO_X and SO_2. Specific to the regional haze plan is a goal to reduce emissions of NO_X and SO_2 from point sources in the six-county northeastern Minnesota area by 20 percent by 2012 and 30 percent by 2018. The plan also calls for research into potential emission control technologies for taconite processing. More information is available at the following web page: http://www.pca.state.mn.us/air/regionalhaze.html

- EnviroFlash: The MPCA's new EnviroFlash notification system delivers free instant air quality information that citizens can customize for their individual needs, helping them take steps to protect the health of themselves and their families. With EnviroFlash, subscribers can receive air quality forecasts via e-mail or text message. Subscribers decide how often they receive messages: every day, only when the AQI is forecasted to be Moderate, only when the AQI is forecasted to be Unhealthy for Sensitive Groups, or only when MPCA issues an air pollution health advisory or alert. Forecasts are available for the Twin Cities and Rochester and all forecasts include estimated conditions for the current and next day, as well as an extended five-day outlook. EnviroFlash is a partnership between the Environmental Protection Agency and the MPCA. To sign up, visit http://mn.enviroflash.info.

- 2008 Greenhouse Gas Legislation: The 2008 state legislature passed several specific 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 first reports were due January 15, 2009. Other requirements of 2008 greenhouse gas legislation include:

    - Motor vehicle manufacturers must have reported air conditioning system leakage rates to the MPCA beginning January 1, 2009 before vehicles can be offered for sale in the state. These rates are currently posted on the MPCA website at http://www.pca.state.mn.us/climatechange/mobileair.html

    - Manufactured and certain users of high global warming gases (engineered gases) were required to report to the MPCA beginning in October 2008. The MPCA will report to the Legislature on the uses, emissions, options for reduction, and cost of reduction of these gases in spring 2009.

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

    - The MPCA is a major partner of Clean Air Minnesota (CAM) and its school bus retrofit program called Project Green Fleet. The project completed over 1,000 tailpipe retrofits of diesel school buses by the end of 2008. 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. In 2008, both MPCA and Project Green Fleet expanded retrofit work to other heavy-duty diesel vehicles, such as snow plows, waste haulers and transit buses.
    - The MPCA has been working over the last two 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 from one to 1.5 gallons per hour of idling down to just two-tenths of a gallon per hour. This results in lower carbon dioxide, nitrogen oxides, particulate matter and air toxic emissions.
    - The federal government has mandated ultra low sulfur diesel fuel, phased in late in 2006, and cleaner diesel technology mandated in 2007 highway vehicles. In 2007 and newer diesel engines, the particulate emissions are expected to be reduced by 90 percent.

- Clean Water Legacy Act (CWLA): In June 2006, the Legislature passed and Governor Pawlenty signed this important new water quality law. The CWLA accelerates testing of Minnesota's lakes and streams; provides resources to develop specific plans to clean up Minnesota's most contaminated waters and prevent clean waters from becoming polluted; and designates funding to existing state and local programs to improve water quality. The CWLA emphasizes leveraging additional federal, local and private resources where possible. The Act creates an advisory group called the Clean Water Council. The 2007 Legislature provided the MPCA with $12.6 million for monitoring and assessment, and $18 million for Total Maximum Daily Load (TMDL) development as one-time appropriations from the General Fund for the FY2008-2009 biennium.

- Clean Water, Wildlife, Cultural Heritage and Natural Areas Amendment: In November 2008, Minnesota voters approved this new amendment to the state constitution that increases the state sales tax by three-eighths of a percent beginning July 1, 2009 and extending for 25 years. According to the law, 33 percent of the money raised (estimated at about $80 million per year) is to be allocated to a clean water fund. Money deposited into the fund may be spent only to protect, enhance and restore water quality in lakes, rivers and streams, and to protect ground water from degradation. At least five percent of the fund must be spent only to protect drinking water sources.

- Phosphorus Rulemaking: The MPCA has adopted a 1 milligram per liter phosphorus effluent discharge limit for all new or expanding point sources discharging more than 1,800 pounds phosphorus per year, which is approximately 200,000 gallons per day for typical wastewater phosphorus concentrations (3 mg/L). The new law took effect on May 1, 2008. Application of this rule will result in reducing the point source contribution of phosphorus to waters of the state from approximately 25 percent to 13 percent.

The MPCA has significantly expanded and improved public access to environmental data available electronically through its Environmental Data Access Initiative, funded by the Legislature. 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 2006 MPCA Greenhouse Gas Inventory, the 2005 and 2007 Minnesota Criteria Pollutant Emission Inventories, the 2005 Air Toxics Emission Inventory and the 2007 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 2007, facilities with MPCA permits had until April 1, 2008 to submit their 2007 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 2008. Facilities completed their review by November, 2007. MPCA staff then reviewed the changes and completed the inventory for 2007 in January 2009.

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 United States Environmental Protection Agency's (U.S. EPA) 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 2006.

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. Emissions of criteria pollutants from large facilities are estimated every year with data from 2007 currently available. However, emissions from smaller sources are estimated every three years with 2002 and 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 with 73,200 tons emitted.

Table 1 lists the total statewide emissions of the major air pollutants from 2003 to 2007. The percent change from 2006 to 2007 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.

Table 1: Minnesota Air Pollution Emission Estimates, 2003-2007*
(thousand tons)

Pollutant	2003	2004	2005	2006	2007	2006-2007 % Change
Carbon dioxide (CO_2)	126,000	126,800	127,500	125,800	NA	NA
Particulate matter (PM_{10})**	781	781	778	776	777	0.1%
Sulfur dioxide (SO_2)	168	163	159	148	138	-6.8%
Nitrogen oxides (NO_x)	480	480	422	409	408	-0.2%
Volatile organic compounds (VOCs)	363	364	349	347	347	0.0%
Carbon monoxide (CO)	1,974	1,974	1,771	1,771	1,773	0.1%
Total Criteria Pollutants (not including CO_2)	3,776	3,762	3,479	3,451	3,443	-0.2%

*2002 mobile and nonpoint emission estimates were used in the 2003-2004 emission estimates.
2005 mobile and nonpoint emission estimates were used in the 2005-2007 emission estimates.
**PM_{10} emissions represent only primary formation; secondary formation is not included.

There was little overall change in emission estimates between 2006 and 2007 for criteria pollutants except for a seven percent decrease in sulfur dioxide. This decrease was mainly due to a reduction in emissions from electric utilities as a result of modifications as part of Xcel Energy's Metropolitan Emissions Reduction Project (MERP). The Allen S. King power plant in Oak Park Heights was off-line for a portion of 2006 and most of 2007. This reduction in coal burned resulted in a decrease in SO_2 emissions. The High Bridge power plant in St. Paul also began its conversion from coal to natural gas, resulting in lower SO_2 emissions in 2007.

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 2007, 21 tons of lead was estimated to have been emitted in Minnesota and 3,300 pounds of mercury was 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. This system is the basis for the point source discharge summary in Table 2.

Table 2: Minnesota Water Pollution Discharge Estimates
from Major Point Sources, 2003-2007
(thousand kilograms)

Pollutant	2003	**2004**	**2005**	**2006**	**2007**	2006-2007 % Change
Total suspended solids	5,700	4,600	5,600	3,700	4,200	14%
Biochemical oxygen demand	3,700	3,000	2,700	2,100	2,600	24%
Total phosphorus	1,600	920	770	1,570	660	-58%
Ammonia	1,300	830	620	490	530	8%
Nitrate	3,100	3,400	3,600	3,900	4,000	3%
Total	15,400	12,700	13,200	11,800	12,000	2%

The MPCA began using DELTA to generate the reports on which this section is based when inconsistencies in U. S. EPA's Compliance Tracking System database were noted, beginning with the 2003 data summary. The MPCA believes data assembled from the U. S. EPA's Compliance Tracking System through 2002 are reliable, but is now using the DELTA database exclusively, maintained by the agency's data specialists, as a basis for this and similar reports for 2003 and beyond. Therefore, the 2009 Annual Pollution Report marks the first time the agency is able to report five consecutive years (2003-2007) of discharge data from DELTA, thus avoiding the problem of trying to compare data generated by the U. S. EPA's Compliance Tracking System with that generated using DELTA.

The MPCA's water quality program is evolving 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 our capacity to accurately perform loading analyses. Due to the multi-year life of permit requirements, however, many MPCA permits do not yet contain monitoring and reporting requirements that enable efficient, computerized calculations of total annual pollutant loadings. As the MPCA re-issues permits and conducts ongoing review of its data, it will continue to build capability in that area and assessment of pollutant trends over multiple years will become more reliable.

This year's report looks at water discharge data for five commonly measured water pollutants covering the five most recent years (2003-2007) for which reasonably complete data are available. Data from 2008 will be incorporated into the 2010 Annual Pollution Report. Since this is the first year that all the data has been drawn from DELTA, agency staff examined the database in more detail for the period 2005-2007 and made some adjustments 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 Table 2 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, a facility that only monitors or reports quarterly on a pollutant is presumed to discharge that pollutant only in the months that were reported.
- 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.

The 2007 figures represent the combined loading from 90 major municipal and industrial discharges of more than one million gallons per day to waters of the state. One mining facility has two discharges, each to a different watershed, so a total of 89 facilities are represented in the database. The year 2007 saw the addition of two new major dischargers to the database, the Delano and Otsego East wastewater treatment plants (WWTPs). Taken together, the major facilities represent approximately 85 percent of the total volume of discharges to waters of the state from point sources. The remaining 15 percent comes from many smaller municipal and industrial facilities. Although discharges from these facilities are small, they can have significant impacts on individual lakes and stream segments.

Of the 90 discharges from the 89 major facilities reporting in 2007, 54 showed an increase in total loading over 2006, 34 showed a decrease in total loading, and the two new WWTPs did not have data for 2006 so that a trend could not be determined. In 2007, the total statewide loading from major dischargers reversed the downward trend established over the past five years, as it increased from 10,696,000 kilograms in 2006 to 11,984,000 kilograms in 2007. This is still slightly less than the 11,990,000 kilograms reported in 2005. The overall decrease in total discharges since 2003 (84 facilities discharging 15,400,000 kilograms) to 2007 (89 facilities discharging 11,984,000 kilograms) is close to 30 percent, suggesting that recent improvements to treatment plant technology and operation are having a measurable positive effect on Minnesota's water resources, at least as far as major point source discharges are concerned.

The above trends should be viewed in the context of overall climatological events in Minnesota for the years reported. The overall decrease in total loading from 2003 to 2004 represents a return to the year-to-year downward trend which was interrupted by unusual precipitation patterns, including spring flooding in 2001-2002. 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.

When examining overall trends in pollutant loading from year-to-year, it should be noted that improvements intended to increase biological nutrient removal at WWTPs across the state are beginning to have an effect in terms of improving the overall quality of discharges to Minnesota's surface waters. Although there are exceptions over the years (for example, total phosphorus loadings increased from 2005 to 2006, but then dropped 58 percent in 2007), as discussed above, the trend in total loading of all pollutants examined has been generally been downward during the five years of record, 2003-2007, and this is encouraging for the status of Minnesota's surface waters.

As a specific example, biological phosphorus removal at the Metropolitan Council Environmental Services (MCES) Metropolitan Plant (Metro Plant), particularly in the secondary clarifiers, has significantly improved the plant's overall performance. Due to the large volume of waste treated by the Metro Plant, improvements like this have been a major contributor 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% and total loading was reduced by 72 percent. From 2006 to 2007, phosphorus loading fell from 154,000 kilograms to 133,500 kilograms.

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 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 ground water. 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 Total Maximum Daily Load (TMDL) program. As the MPCA continues to deploy the major watershed impaired waters approach and the corresponding intensive watershed monitoring, a better picture of nonpoint source contribution to water quality impairments will emerge.

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

Although ambient levels of greenhouse gases do not directly harm human health, their increase in concentration 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 2006. More information is available on climate change and greenhouse gases in the MPCA's 2009 report at the following link:

http://portal.stage.state.mn.us/mn/externalDocs/Commerce/Greenhouse_Gas_Emissions_Reduction_Report_012009032551_GreenhouseGasEmissions.pdf

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 2007. 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 2007.

Air toxics

Many other chemicals are released in smaller amounts than some of the criteria pollutants, but are still toxic. The U.S. 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, 2009
http://www.pca.state.mn.us/air/monitoringnetwork.html

Carbon Dioxide

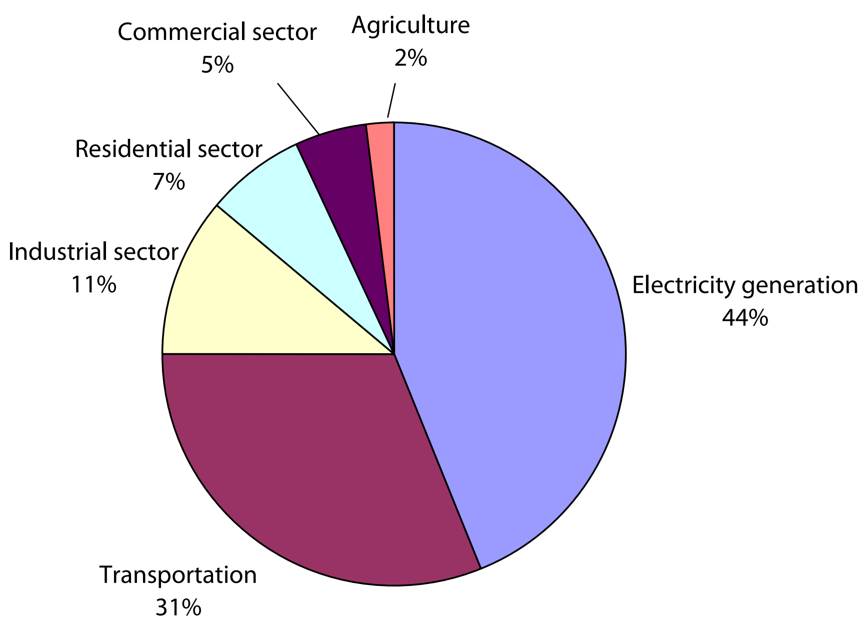
Carbon dioxide is a gas that is principally formed from the combustion of fossil fuels such as oil, gas, and coal. It is the most important greenhouse gas that contributes to warming of the earth's atmosphere. Many greenhouse gases occur naturally, but fossil fuel burning and other human activities are adding gases to the natural mix at an accelerated rate. Emissions of CO_2 accounted for about 85 percent of all greenhouse gas emissions in 2006 from Minnesota.

Emissions data and sources

The most recent estimate for statewide emissions of carbon dioxide in 2006 is 125.8 million short tons.

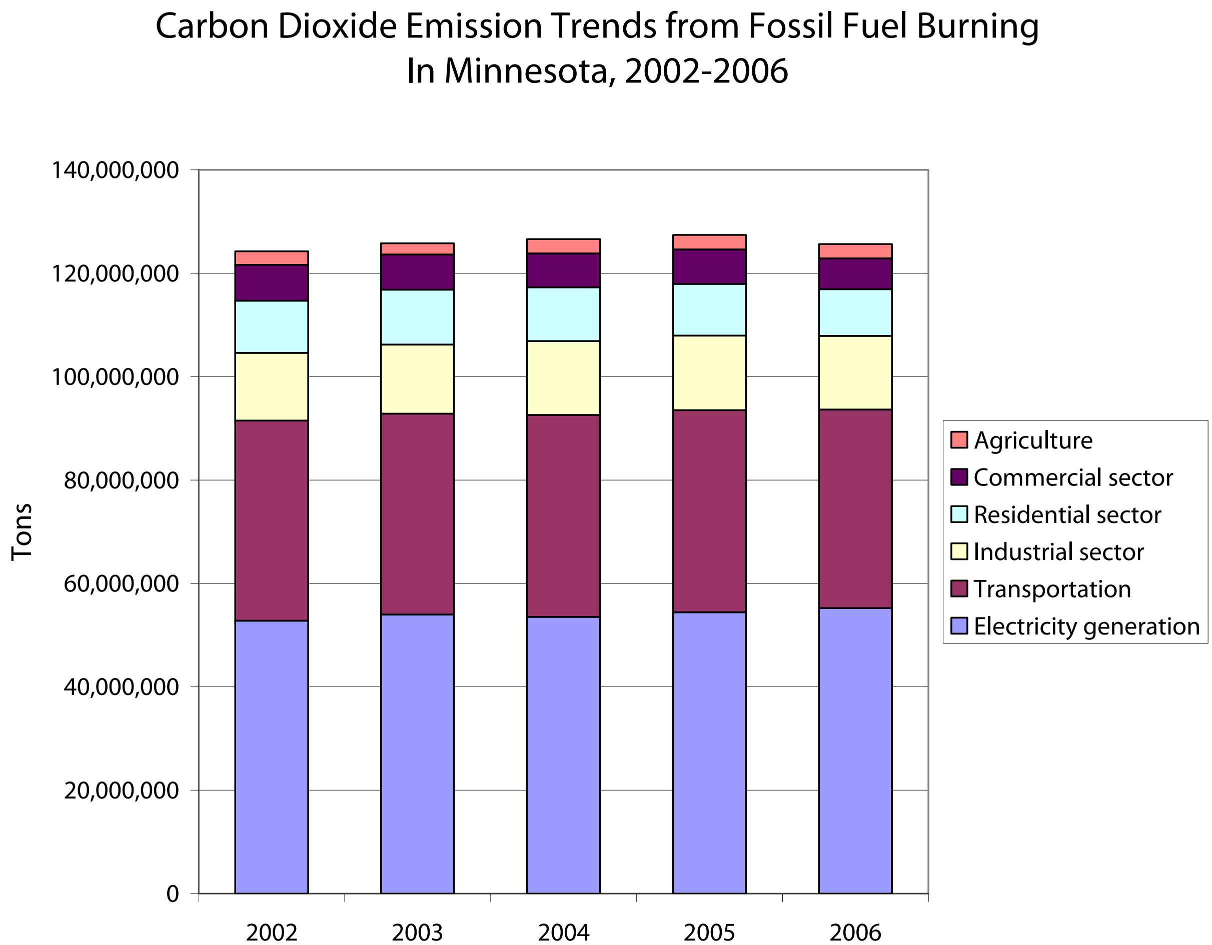
The pie chart below shows the breakdown of carbon dioxide emissions from fossil fuel burning by sector. The majority of the carbon dioxide emissions come from the electric utility (44 percent) and transportation (31percent) sectors. The remaining 25 percent of the emissions come from fossil fuel combustion in the industrial, residential, commercial, agricultural and waste sectors.

Sources of Carbon Dioxide Emissions from Fossil Fuel Burning in Minnesota, 2006



Trends

Carbon dioxide emissions from fossil fuel burning in Minnesota have remained relatively flat since 2002.



References/web links

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

http://portal.stage.state.mn.us/mn/externalDocs/Commerce/Greenhouse_Gas_Emissions_Reduction_Report 012009032551_GreenhouseGasEmissions.pdf

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 regulated pollutants listed below:

- 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 actual 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 2007. Emission estimates are available for nonpoint and mobile sources for 2005. When 2007 summary data are given, they include nonpoint and mobile data from 2005 and point source data from 2007. This report presents trend data for point sources from 2003-2007.

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:
http://www.pca.state.mn.us/data/edaAir/index.cfm

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

See the U.S. EPA 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.

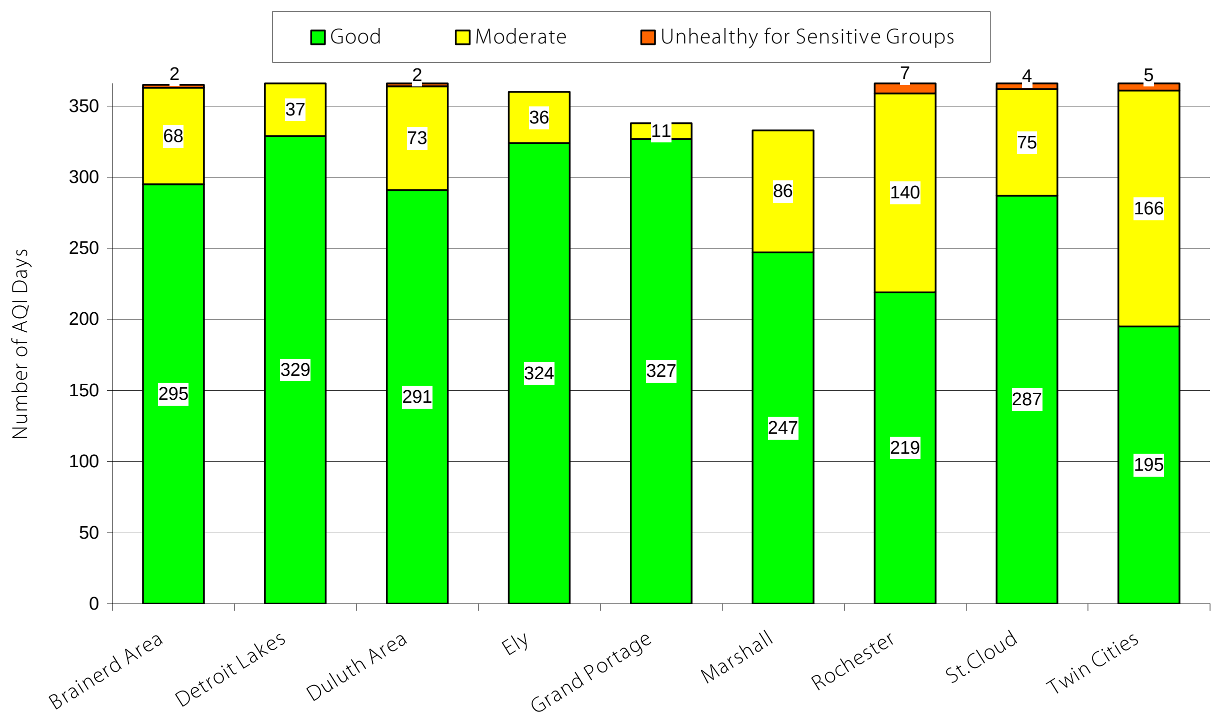
AQI Color Legend

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 and Unhealthy for Sensitive Groups days for all monitored regions in 2008. The AQI did not reach the Unhealthy range in Minnesota in 2008. The U.S. 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 2008, as cooler summer temperatures kept ozone concentrations well within the good and moderate AQI range. Overall, air quality in Minnesota improved in 2008, as the proportion of good and moderate AQI days increased throughout the state. The Twin Cities and Rochester experienced the highest number of Unhealthy for Sensitive Groups days, with five and seven days, respectively. Of these days, all resulted from high levels of fine particles and the majority occurred during the month of February.

2008 Air Quality 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. Particulate air pollution contains many different chemicals, occurs in different shapes and exists over a wide range of small sizes.

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 water bodies, 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 (i.e., lead, cadmium, vanadium, nickel, copper, zinc, manganese, iron and many others), and water.

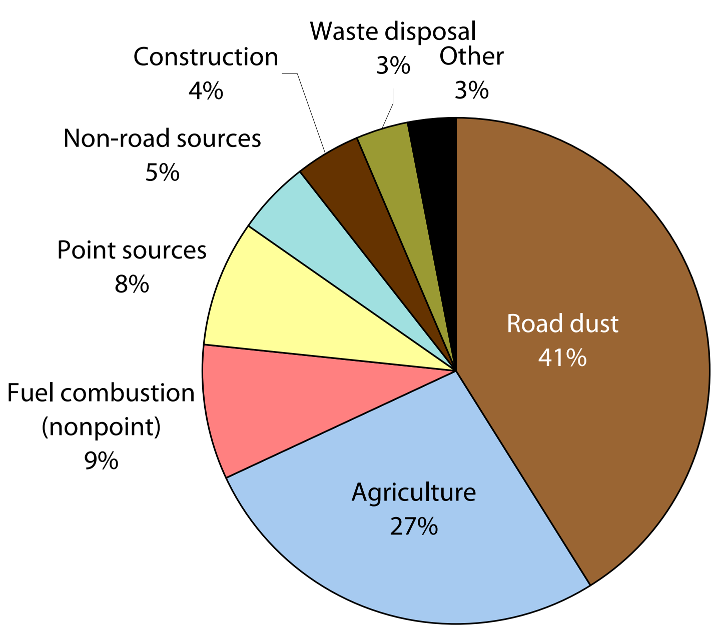
Studies have shown that ambient $PM_{2.5}$ concentrations are linked with increased hospital admissions and deaths from cardiovascular and respiratory problems. Elevated $PM_{2.5}$ concentrations are also associated with a number of adverse effects including heart attacks; atherosclerosis; acute and 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 $PM_{2.5}$.

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



Over 40 percent of the estimated mass of primary, man-made $PM_{2.5}$ emissions come 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" $PM_{2.5}$.

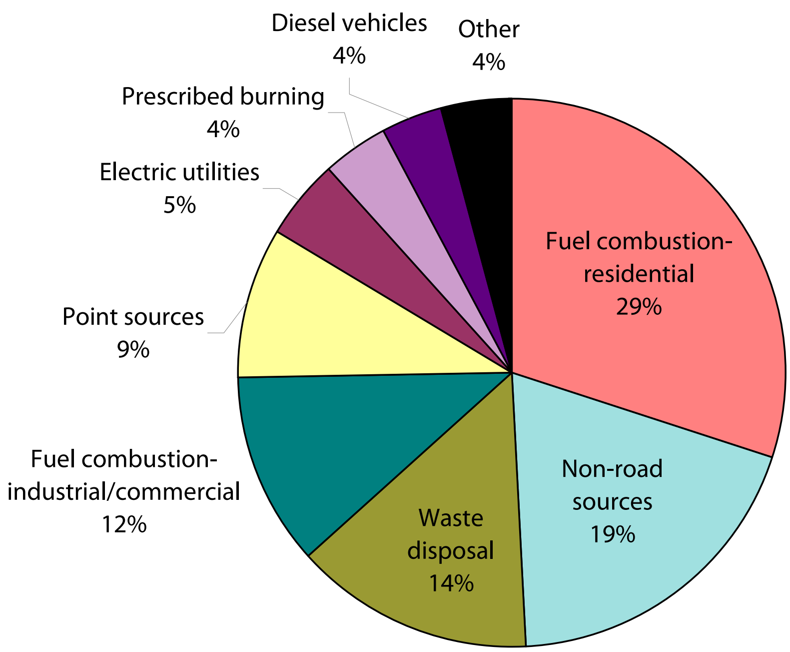
At least half of the ambient fine particles measured in the Twin Cities and Rochester, and a proportionally larger fraction of the ambient $PM_{2.5}$ measured in rural areas, were found to result from $PM_{2.5}$ "precursor" gases. The following table describes the sources associated with the most common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

MPCA's current strategic plan includes an objective focused on reducing direct emissions of $PM_{2.5}$, including emissions from sources such as combustion and heated metal sources which emit some of the smaller manmade $PM_{2.5}$. These particles may result in relatively greater human health effects. The chart below shows 2005 estimates for the direct primary emissions of these fine particles.

Sources of Direct $PM_{2.5}$ Emissions in Minnesota Targeted by the Direct $PM_{2.5}$ Reduction Objective in MPCA's 2008 Strategic Plan (based on 2005 data)



Almost a third of these estimated emissions come from residential wood burning in woodstoves, outdoor wood boilers, furnaces, fireplaces and outdoor recreational fires. Another 19 percent come from non-road sources such as agricultural, recreational and construction equipment as well as railroad and aircraft. Waste disposal through residential open-burning emits 14 percent of these emissions. The other third of direct emissions are contributed by industrial and commercial fuel combustion, various industrial processes, electric utilities, prescribed burning and on-road diesel vehicles.

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}

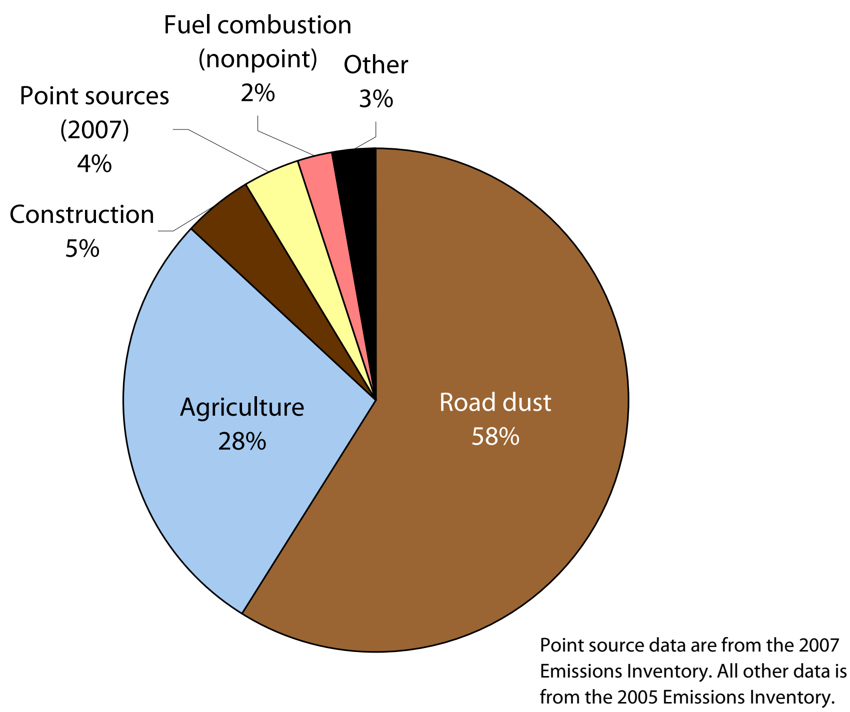
PM_{10} includes all particles with aerodynamic diameters less than 10 microns. Roughly half of the mass of Minnesota's ambient PM_{10} particles are of particles within the $PM_{2.5}$ size and so the direct and secondary formation and the health effects discussed for $PM_{2.5}$ have relevance for PM_{10}. 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 2007 is 777,000 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 & 2007

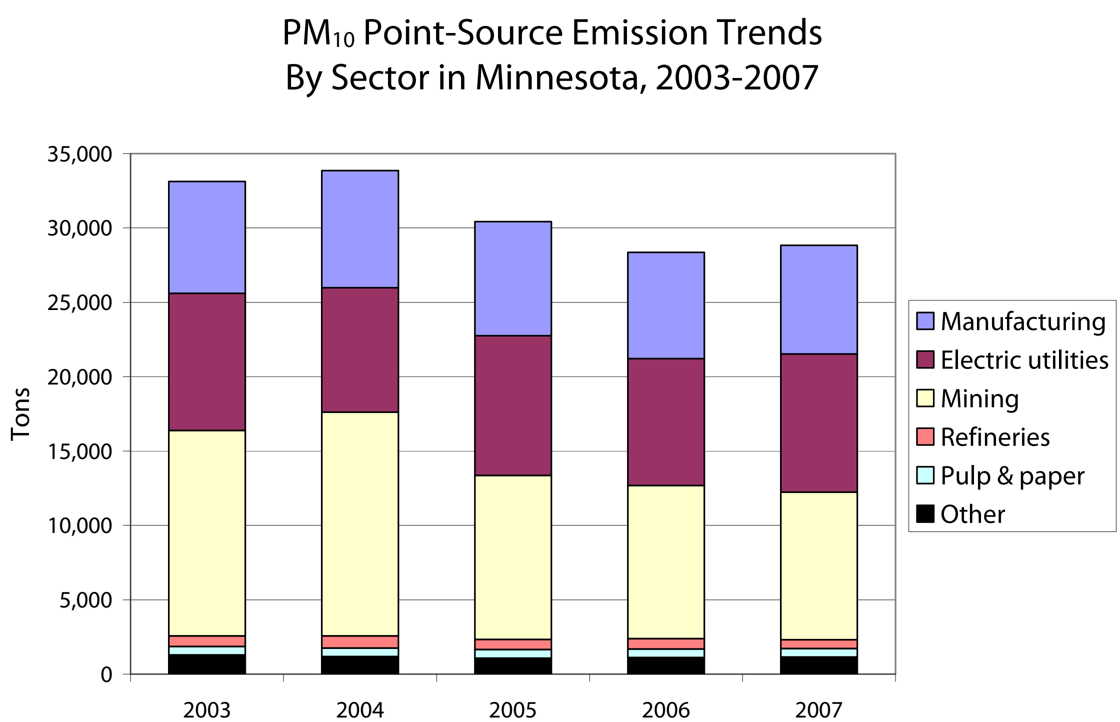


Almost 60 percent of the mass of direct primary PM_{10} emissions come from fugitive dust from unpaved and paved roads. Over a quarter of emissions come from agricultural tilling. Five percent is emitted from construction. The remainder comes from a variety of large facilities such as electric utilities 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 2007, 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 2006 and 2007 except for a slight increase in estimated emissions from electric utilities.



References/web links

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

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

Ammonia

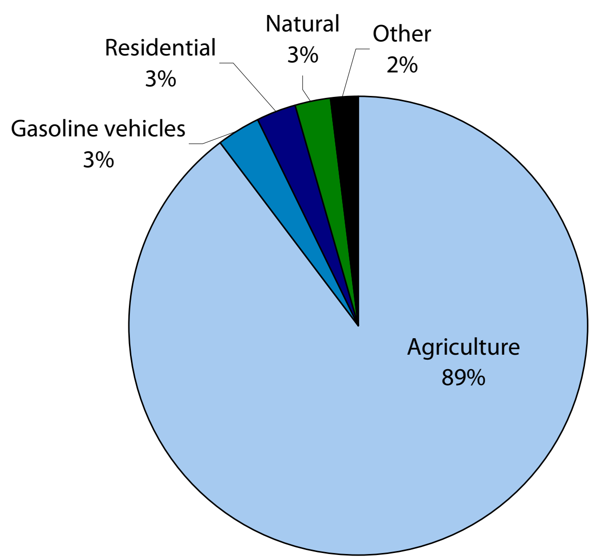
Ammonia is a colorless gas with a distinctive odor. Ammonia gas in the air results primarily from livestock waste and fertilizer application. It can be smelled at a concentration near 50 ppm, but, human health effects are not expected at that level. Exposure to high levels of ammonia may irritate the 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 sulfates 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. It is a colorless gas that can be detected by taste and odor at concentrations as low as 0.3 parts per million. Sulfur oxide gases are formed when fuel containing sulfur (mainly coal and oil) is burned and during gasoline production and metal smelting.

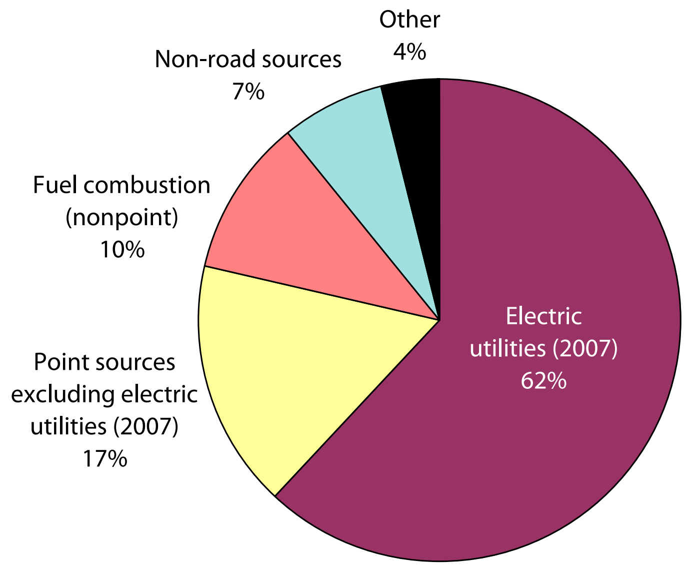
Exposure to SO_2 in the air can cause asthma episodes, respiratory illness and may aggravate existing heart disease. SO_2 also reacts with other chemicals in the air to form tiny sulfate particles. It is difficult to distinguish between health effects due to SO_2 exposure and those due to fine particulate exposure. The major health effects of concern associated with exposures to high concentrations of SO_2, sulfate aerosols and fine particles include impaired breathing, respiratory illness, alterations in the lung's defenses, aggravation of existing respiratory and cardiovascular disease, and mortality. Children, asthmatics, the elderly and people with heart or lung disease may be particularly sensitive.

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 2007 is 138,000 tons. The figure below shows sources of 2005 and 2007 SO_2 emissions.

Sources of Sulfur Dioxide Emissions in Minnesota, 2005 & 2007



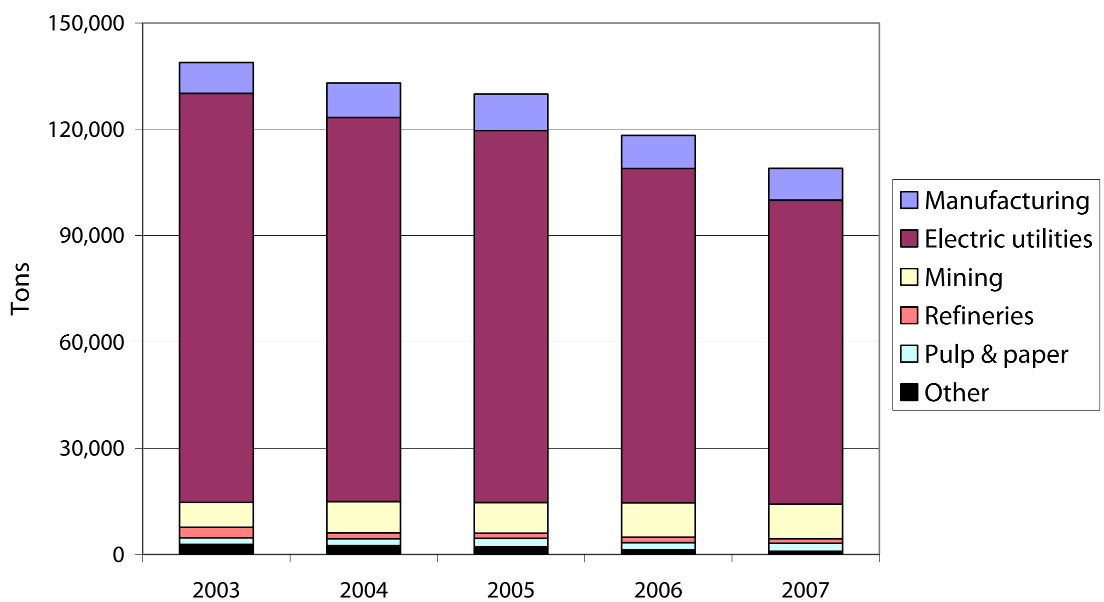
Electric utilities and point sources excluding electric utilities data are from the 2007 Emissions Inventory. All other data is from the 2005 Emissions Inventory.

The majority (62 percent) of SO_2 emissions come from coal-burning electric utilities. Seventeen percent comes from industrial point sources while 10 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 2003 with a pronounced decrease in 2006 and 2007 due mainly to reductions in emissions from electric utilities. In 2006, the Riverside power plant in Minneapolis had more outages due to thermal discharge limits necessary from low river flow during the dry hot summer. This reduction in coal burned resulted in a corresponding emission reduction. The Allen S. King power plant in Oak Park Heights was off-line for a portion of 2006 and most of 2007 for modifications as part of Xcel Energy's Metropolitan Emissions Reduction Project (MERP). This reduction in coal burned resulted in a decrease in SO_2 emissions. The High Bridge power plant in St. Paul also began its conversion from coal to natural gas, resulting in lower SO_2 emissions in 2007.

Sulfur Dioxide Point-Source Emission Trends
By Sector in Minnesota, 2003-2007



References/web links

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

http://www.epa.gov/air/urbanair/so2/

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. NO is the principal oxide of nitrogen produced in combustion processes.

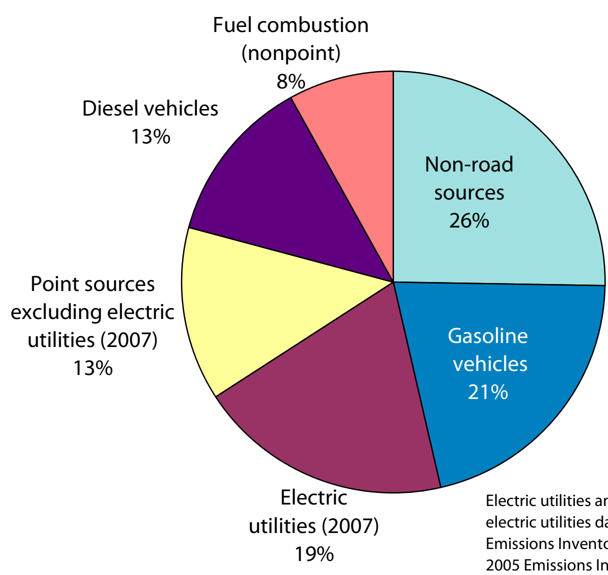
NO_x contribute to a wide range of human health effects. NO_2 can cause respiratory illnesses and increased airway reactivity in asthmatics. NO_x also readily reacts with other chemicals in the air to form a wide variety of toxic products such as the nitrate radical, nitroarenes and nitrosamines. More importantly, 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 Class 1 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 2007 is 408,000 tons. The figure below shows sources of 2005 and 2007 NO_x emissions.

Sources of Nitrogen Oxide Emissions in Minnesota, 2005 & 2007



Electric utilities and point sources excluding electric utilities data are from the 2007 Emissions Inventory. All other data is from the 2005 Emissions Inventory.

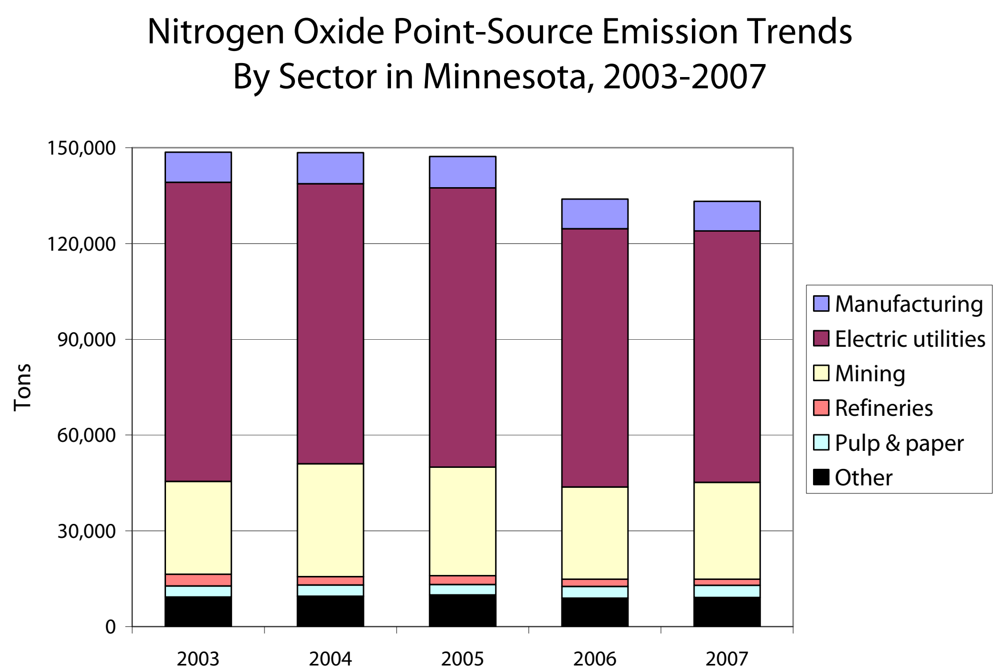
Over a quarter of NO_x emissions comes from non-road sources such as railroads and agricultural, construction and recreational equipment. Another 21 percent comes from on-road gasoline vehicles. Electric utilities contribute 19 percent of NO_x emissions. Combustion from other large point sources and diesel vehicles each 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 32 percent of the NO_x emissions in Minnesota. NO_x emission estimates from point sources were relatively constant from 2003 through 2005; however, there was a pronounced decrease in 2006 due to emission estimate reductions in the mining and electric utilities sectors.

The biggest decrease was in the electric utility sector. The Allen S. King power plant in Oak Park Heights was off-line for a portion of 2006 and most of 2007 for modifications as part of Xcel Energy's Metropolitan Emissions Reduction Project (MERP). This reduction in coal burned resulted in a decrease in NO_x emissions. The High Bridge power plant in St. Paul also began its conversion from coal to natural gas, resulting in lower NO_x emissions in 2007. In addition, the Riverside power plant in Minneapolis had more outages due to thermal discharge limits necessary from low river flow during the dry hot summer in 2006.

Mining emissions were also lower in 2006 and 2007. 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.



References/web links

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

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

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 including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema and asthma. Ground-level ozone also can reduce lung function and inflame the linings of the lungs. Repeated exposure may permanently damage lung tissue. Children, active adults and people with respiratory diseases are particularly sensitive to ozone.

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.

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 2007 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.

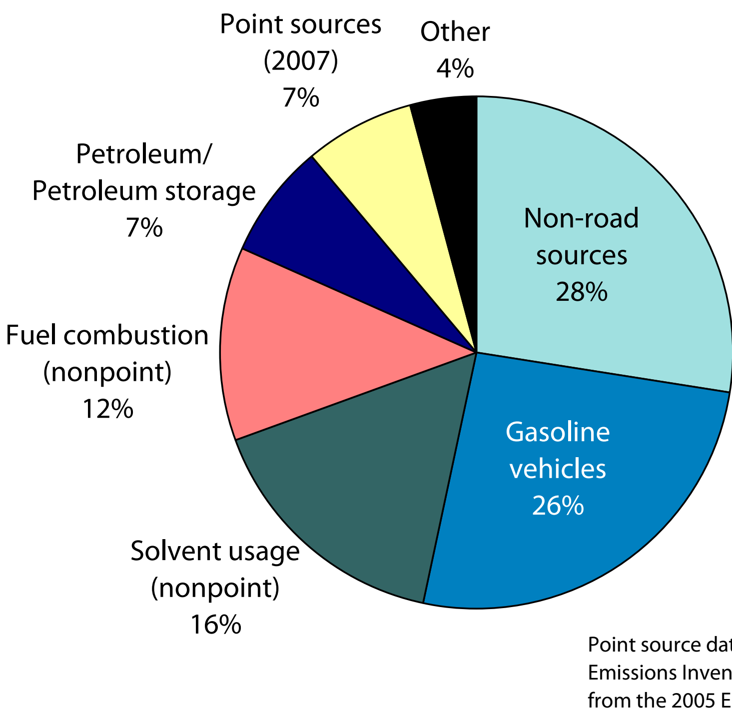
Many VOCs are also air toxics and can have harmful effects on human health and the environment. However, VOCs are regulated as a criteria pollutant because they are precursors to ozone. See the sections on ozone and air toxics for related human health and environmental effects.

Emissions data and sources

The MPCA estimate for statewide emissions of VOCs in 2007 is 347,000 tons.

VOCs are emitted from a variety of sources: including industrial sources, motor vehicles, consumer products and natural sources such as soils and vegetation. The figure below shows only manmade Minnesota sources of VOCs in 2007.

Sources of Volatile Organic Compound Emissions in Minnesota, 2005 & 2007



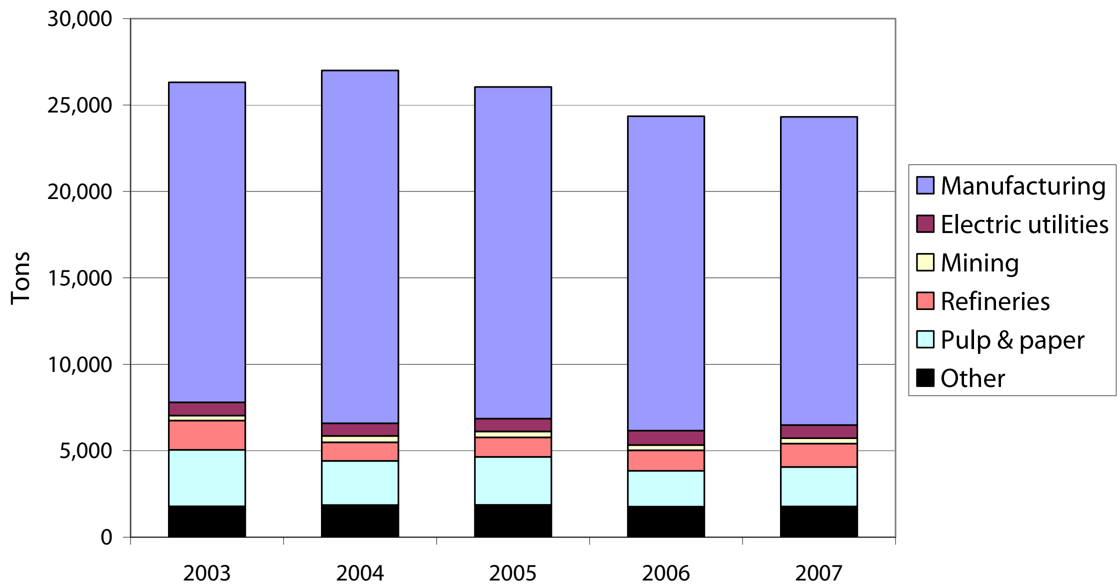
Point source data are from the 2007 Emissions Inventory. All other data is from the 2005 Emissions Inventory.

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 seven percent of the VOC emissions in the state. Emissions in 2006 and 2007 have decreased since 2003-2005. Slightly increased refinery and mining emissions were balanced out by decreases in the other sectors in 2007.

Volatile Organic Compound Point-Source Emission Trends
By Sector in Minnesota, 2003-2007



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 sources 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.

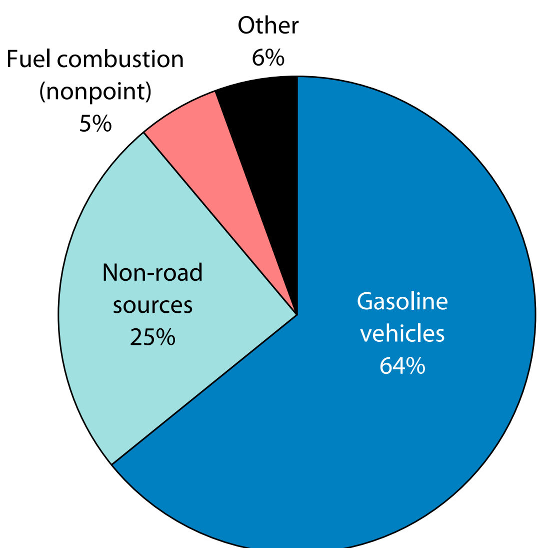
CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease. At higher concentrations it also affects healthy individuals. Exposure to elevated CO levels is associated with impaired 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.

Emissions data and sources

The MPCA estimate for statewide emissions of CO in 2007 is 1,773,000 tons. The figure below shows sources of 2007 CO emissions.

Sources of Carbon Monoxide Emissions in Minnesota, 2005 & 2007



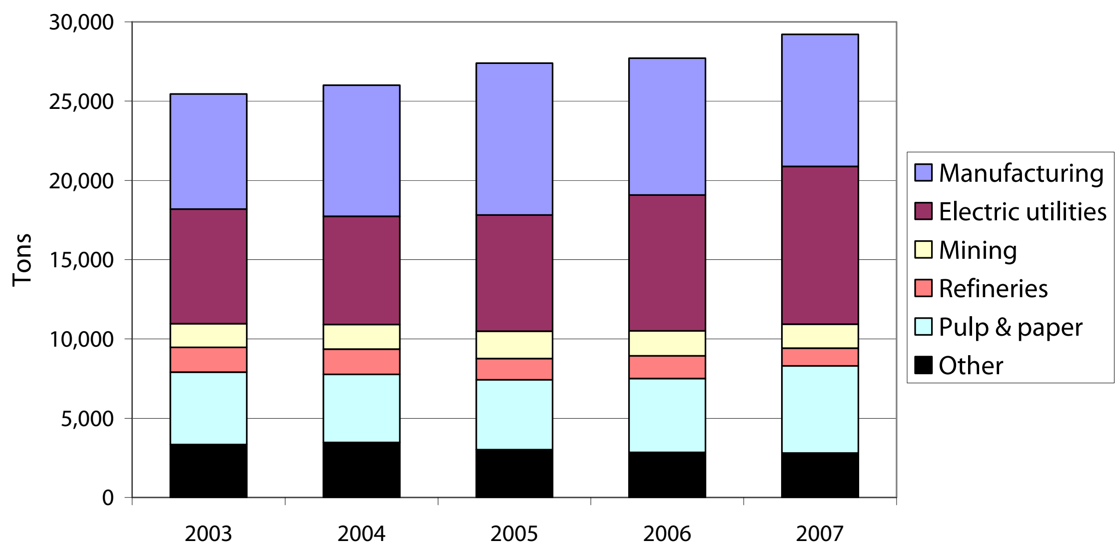
A portion of the other category includes point source data from the 2007 Emissions Inventory. All other data is from the 2005 Emissions Inventory.

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 two percent of the total Minnesota CO emissions in 2007. The CO values have been gradually increasing since 2003. 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.

Carbon Monoxide Point-Source Emission Trends By Sector in Minnesota, 2003-2007



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

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.

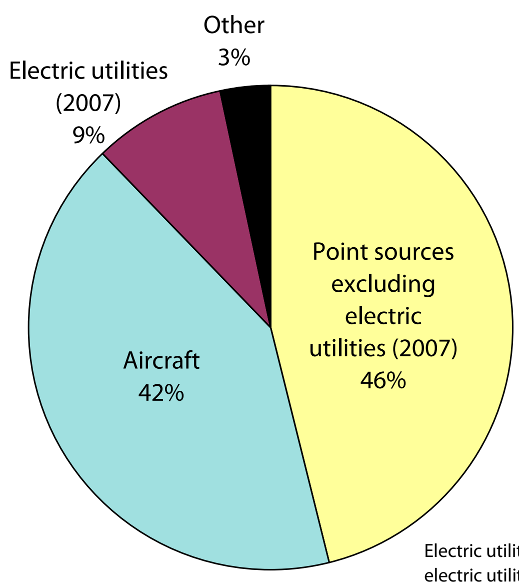
Scientific evidence about the health effects of lead has expanded significantly in the last 30 years. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory and behavior. There is no known safe level of lead in the body.

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 2007 is 21 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 2007 lead emissions.

Sources of Lead Emissions in Minnesota, 2005 & 2007

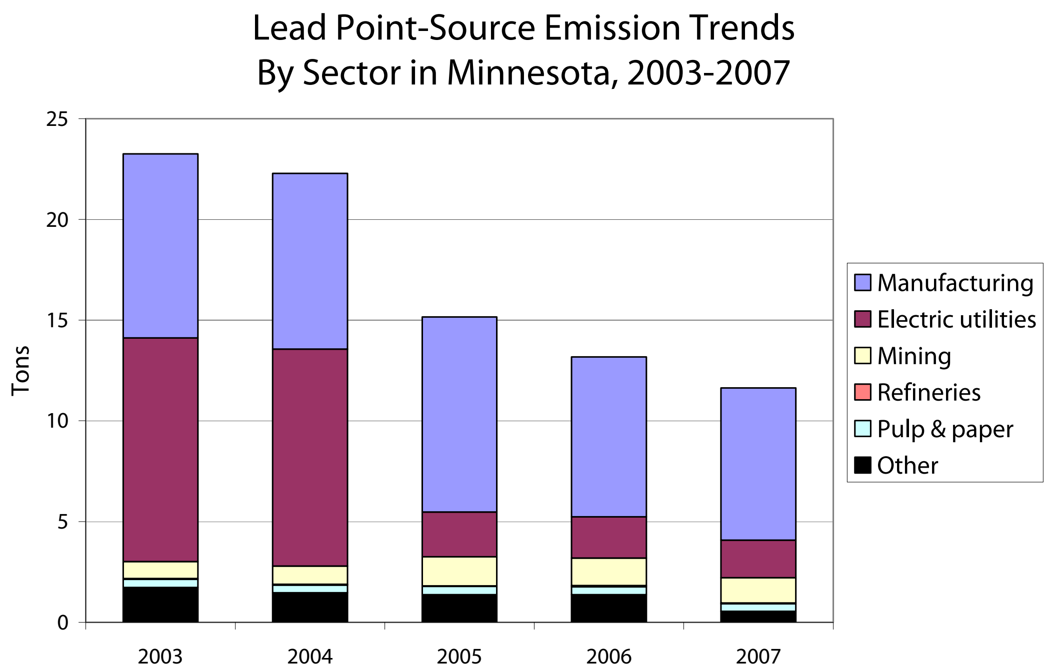


Electric utilities and point sources excluding electric utilities data are from the 2007 Emissions Inventory. All other data is from the 2005 Emissions Inventory.

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 42 percent of lead emissions from burning leaded fuel. Coal-burning power plants add an additional 9 percent of lead to the environment while other small sources contribute the final 3 percent.

Trends

Point sources contribute 54 percent of the state's lead emissions. In Minnesota, the estimated lead emissions from point sources went down dramatically between 2004 and 2005, 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 to 1 tons of lead. 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 electric utilities.



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

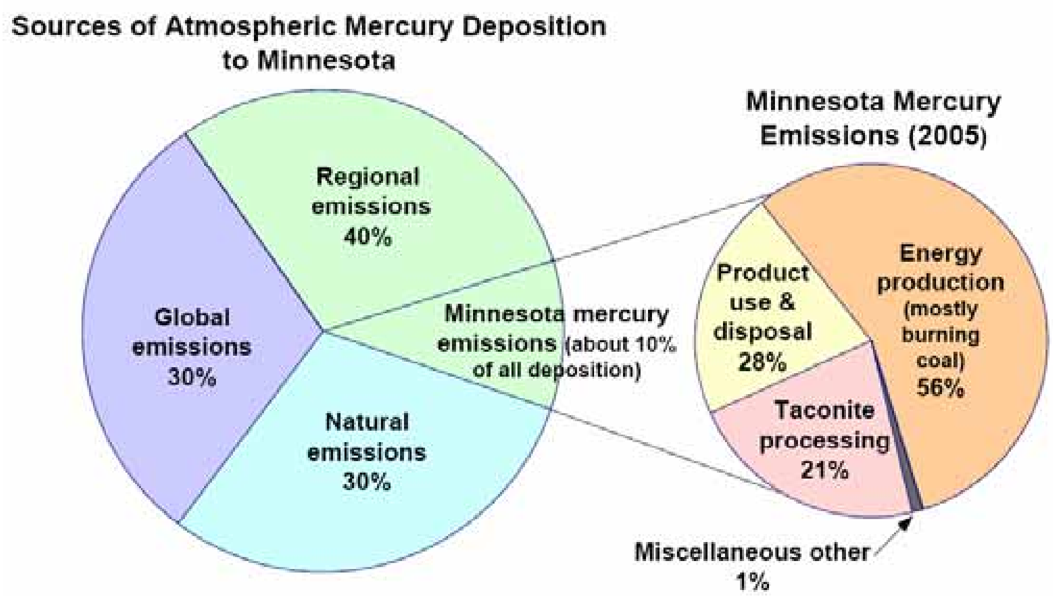
http://www.pca.state.mn.us/air/lead.html

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. That is why citizens are advised to restrict our 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.



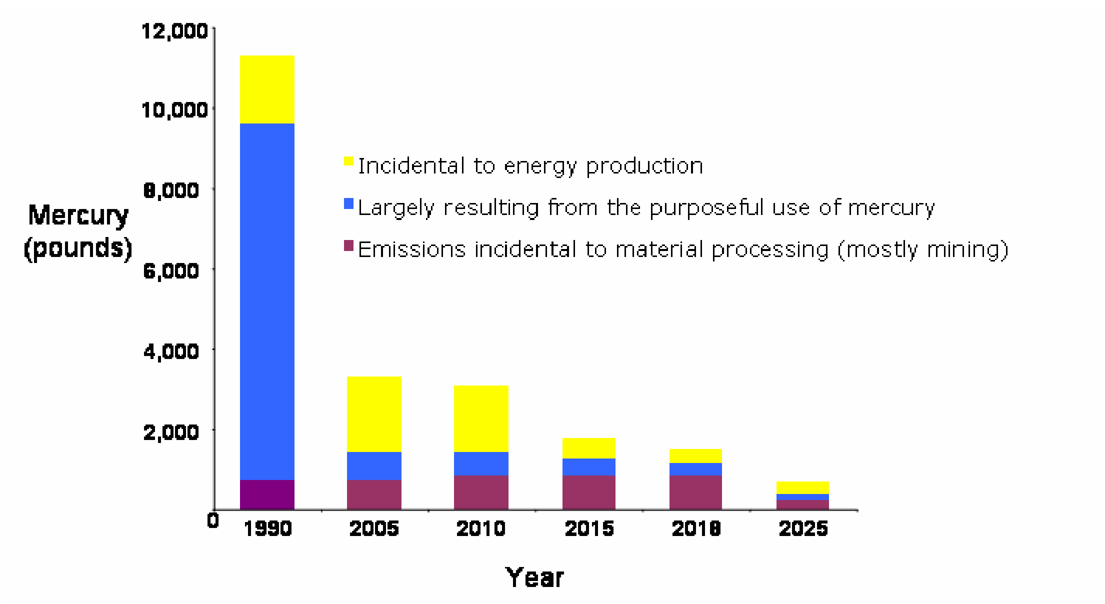
MPCA scientists calculate that for larger fish, such as walleye and northern pike, to be safely eaten more often, mercury pollution sources worldwide will need to reduce their emissions to the atmosphere by about 93 percent from 1990 levels. Accordingly, Minnesota has established a goal of reducing emissions 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 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 U.S., or factors associated with global climate change, or both. 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/

Air Toxics

The U.S. EPA s 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.

One of the clean air goals in the MPCA's strategic plan is to meet all environmental and human health benchmarks for toxic air pollutants. Of the more than 60 gaseous air toxics measured by the MPCA that have health benchmarks, none commonly has concentrations above health benchmarks in Minnesota.

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, area, and mobile sources.

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

MPCA staff compiled the emissions estimates for point and nonpoint sources in the 2005 inventory. The results for aircraft (including ground support equipment), and locomotives were also estimated by the MPCA. The estimates for commercial marine vessels were gtown 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 U.S. 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. 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	5.8	8	78	8	7
Benz[a]Anthracene	6.3	1	96	2	2
Benzo[a]Pyrene	1.9	4	88	4	5
Benzo[b]Fluoranthene	2.2	<1	93	3	3
Benzo[g,h,i,]Perylene	2.6	1	83	5	11
Benzo[k]Fluoranthene	1.1	1	87	6	6
Chrysene	4.4	1	96	1	2
Dibenzo[a,h]Anthracene	0.1	10	88	<1	2
Fluoranthene	8.0	1	83	6	11
Fluorene	9.6	5	72	8	16
Indeno[1,2,3-c,d]Pyrene	1.8	38	55	2	5
Naphthalene	323.1	5	69	16	9
Phenanthrene	27.4	2	83	4	11
Pyrene	9.8	1	82	6	10
PAHs (non-specified)	6.5	26	70	<1	3
PAH Total	**477.3**	**5**	**74**	**13**	**8**
Metal Compounds					
Antimony	1.2	95	4		1
Arsenic	7.9	92	2	2	4
Beryllium	0.3	79	12		9
Cadmium	1.2	80	17		2
Chromium	7.8	93	4	3	<1
Chromium VI	0.9	91	2	6	1
Cobalt	2.8	97	3		<1
Copper	8.0	98	2		<1
Lead	38.6	75	2		23
Manganese	46.2	99	1	<1	<1
Mercury	1.8	81	19	<1	<1
Nickel	18.9	92	6	1	1
Selenium	3.9	88	12		<1
Metal Total	**139.5**	**90**	**3**	**1**	**7**
Non-Metal Compounds (Excluding PAHs)					
Acetaldehyde	2160	8	26	39	27
Acetamide	0.0003		100		
Acetone	914	57	40		3
Acetonitrile	105	2	98		
Acetophenone	0.3	61	39		
Acrolein	223	26	27	25	22
Acrylamide	0.3	100			
Acrylic Acid	12.7	100	<1		
Acrylonitrile	48.	39	61		
Aldehydes	42.5	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 (%)
Allyl Chloride	0.005	100			
Aniline	0.00005	100			
Atrazine	96.8		100		
Benzaldehyde	70.3	2	80		19
Benzene	6092	2	23	52	23
Benzyl Chloride	2.0	91	9		
Biphenyl	1.6	69	31		
Dichloroethyl Ether (Bis[2-Chloroethyl]Ether)	<1	100			
Bromoform	0.41	98	2		
Methyl Bromide (Bromomethane)	532	1	99		
1,3-Butadiene	784	<1	10	42	48
Butyraldehyde	13.6	6			94
Carbon Disulfide	1.9	77	23		
Carbon Tetrachloride	8.6	95	5		
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	215	5	95		
Chloroacetic Acid	0.2	100			
Chlorobenzene	170	<1	100		
Ethyl Chloride	3.2	72	28		
Chloroform	204.3	3	97		
2-Chloroacetophenone	0.07	98	2		
Cresol/Cresylic Acid (Mixed Isomers)	1.1	100			
m-Cresol	0.02	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	13	87		
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)	7.4	83	17		
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	0.09	100			
1,3-Dichloropropene	376	<1	100		
Diethyl Sulfate	0.002	100			
Diethanolamine	1.4	34	66		

Table 4: 2005 Minnesota Air Toxics Emissions Inventory Statewide Summary

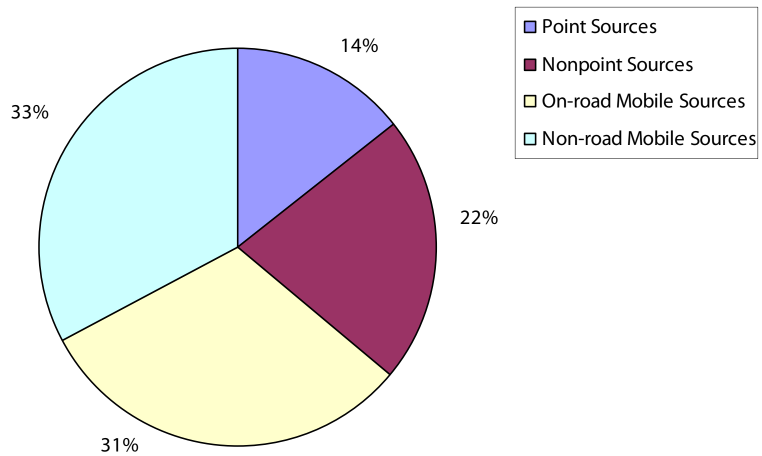
Pollutant Name	Total (short tons)	Point sources (%)	Nonpoint sources (%)	On-road mobile (%)	Non-road mobile (%)
Dimethyl Phthalate	5.6	99	1		
Dimethyl Sulfate	0.5	98	2		
N,N-Dimethylformamide	21.1	100	<1		
Dimethylaniline(N,N-Dimethylaniline)	0.05	100			
4,6-Dinitro-o-Cresol (Including Salts)	0.0001	100			
2,4-Dinitrophenol	0.01	100			
2,4-Dinitrotoluene	0.09	100	<1		
Bis(2-Ethylhexyl)Phthalate (Dehp)	2.7	91	9		
Di-N-Octylphthalate	0.08	100			
p-Dioxane	2.1	52	48		
Epichlorohydrin	0.01	100			
1,2-Epoxybutane	0.02	100			
Ethyl Acrylate	0.50	100			
Ethyl Carbamate (Urethane) Chloride (Chloroeth	0.08	100			
Ethylbenzene	2042	5	6	55	33
Ethylene Glycol	469	14	86		
Ethylene Oxide	158	2	98		
Formaldehyde	3341	15	15	34	36
Glycol Ethers	529	33	67		
Hydrochloric Acid (Hydrogen Chloride [Gas	3503	88	12		
Hexachlorocyclopentadiene	0.00005	100			
Hexamethylene Diisocyanate	1.6	100			
Hexane	3939	38	22	21	20
Hexachloroethane	0.00009	100			
Hexachlorobutadiene	0.1	100			
Hexachlorobenzene	0.004	1	99		
Hydrogen Fluoride (Hydrofluoric Acid)	581	94	6		
Hydroquinone	1.6	100			
Isophorone	17.8	85	15		
Maleic Anhydride	0.27	100			
Methyl Ethyl Ketone (2-Butanone)	695	37	63		
Methylhydrazine	1.8	98	2		
Methyl Iodide (Iodomethane)	0.01	100			
Methyl Isobutyl Ketone (Hexone)	177	59	41		
Methyl Isocyanate	0.001	100			
Methyl Methacrylate	45.0	98	2		
Methyl Tert-Butyl Ether	0.8	92	8	<1	
Methanol	2448	24	76		
4,4'-Methylenediphenyl Diisocyanate (MDI)	4.0	75	25		
Methyl Chloride (Chloromethane)	57.9	11	89		
Methylene Chloride (Dichloromethane)	208	30	70		
Nitrobenzene	0.03	100			
4-Nitrophenol	0.24	12	88		
2-Nitropropane	0.01		100		
N-Nitrosodimethylamine	0.004	100			
Parathion	0.09	100			
Polychlorinated Biphenyls (Aroclors)	0.57	<1	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 (%)
Polychlorinated Dibenzodioxins, Total	0.02	98	2	<1	<1
Polychlorinated Dibenzo-P-Dioxins and Furans, Total	0.001	100			
Polychlorinated Dibenzofurans, Total	0.001	77	20	1	1
Pentachlorophenol	0.28	96	4		
Tetrachloroethylene (Perchloroethylene)	247	37	63		
Phenol	428	21	79		<1
Phosphine	0.99	58	42		
Phosphorus	1.9	95	4		1
Phthalic Anhydride	0.13	100			
Polycyclic Organic Matter	24.6	35	65		<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	100			
Quinoline	0.001	100			
Quinone (p-Benzoquinone)	0.9	100			
Styrene	1135	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)	992	<1	100		<1
1,1,2,2-Tetrachloroethane	3.1	69	31		
Toluene	20118	3	12	38	47
2,4-Toluene Diisocyanate	1.0	86	14		
o-Toluidine	0.00003	100			
Trichloroethylene	149	94	6		
1,2,4-Trichlorobenzene	9.1	100	<1		
1,1,2-Trichloroethane	0.5	100			
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	7699	<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)	1.6	6	94		
Vinyl Acetate	24.9	97	3		
Vinyl Chloride	9.0	23	77		
m-Xylene	6.9	60	40		
p-Xylene	2.0	100			
Xylenes (Mixed Isomers)	10,565	5	10	41	44
Non-Metal Total	**72,598**	**14**	**21**	**31**	**33**
Grand Total	**73,200**	**14**	**22**	**31**	**33**

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.

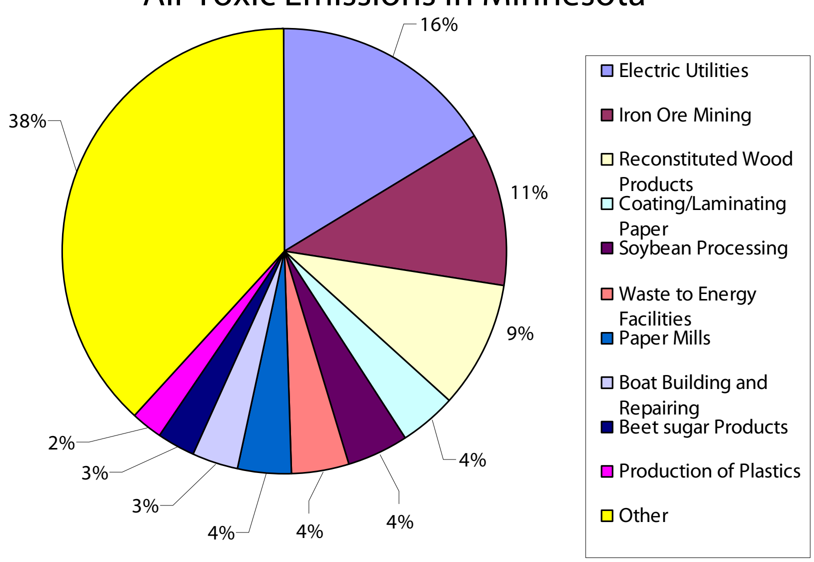
Contribution of Principal Source Categories to 2005 Air Toxics Emissions in Minnesota



Total air toxics emissions in 2005: 73,200 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.

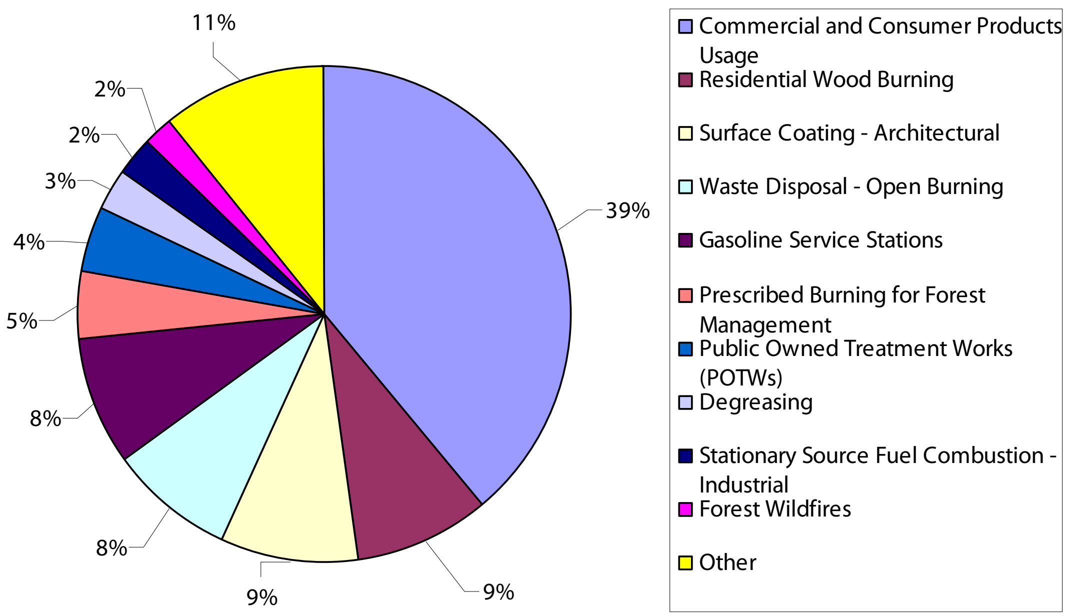
Contribution of Major Categories to 2005 Point Source Air Toxic Emissions in Minnesota



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

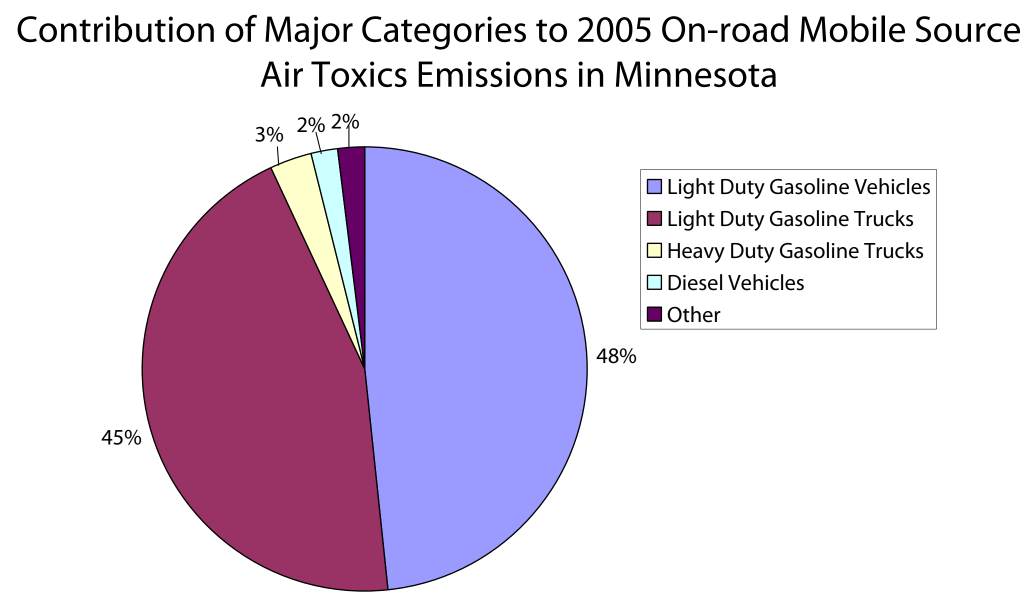
For nonpoint sources, the major contributors of emissions are industrial surface coating, commercial and consumer products usage and residential wood burning. Approximately 58 percent of the nonpoint source emissions are attributed to these two categories.

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

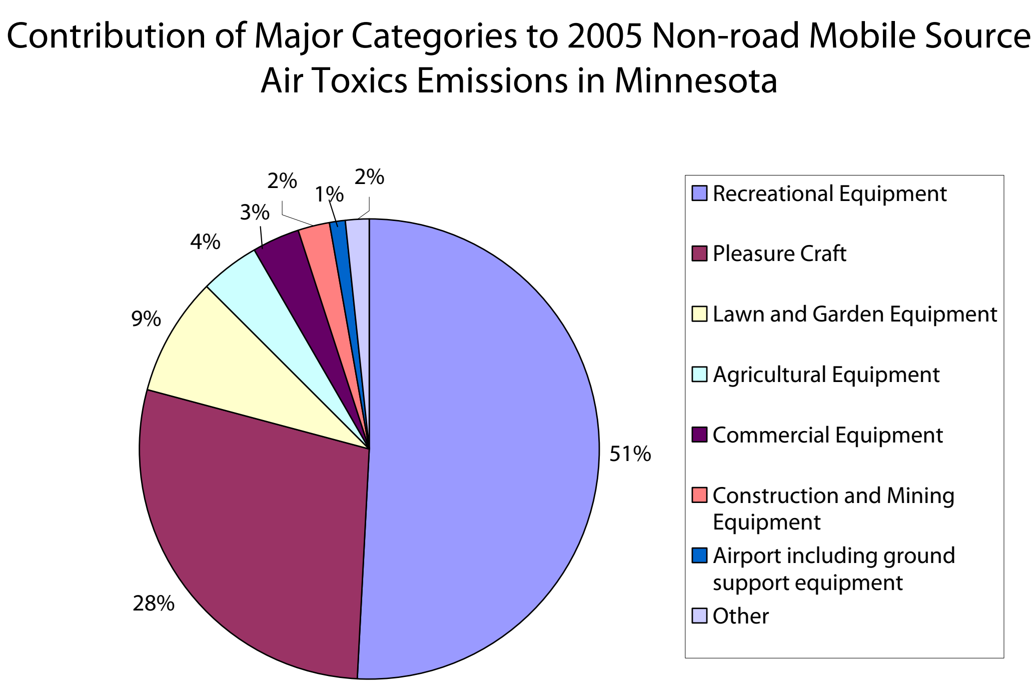


Total air toxics nonpoint source emissions in 2005: 16,100 tons

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.



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



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 ground water 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 ground water 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 body 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.

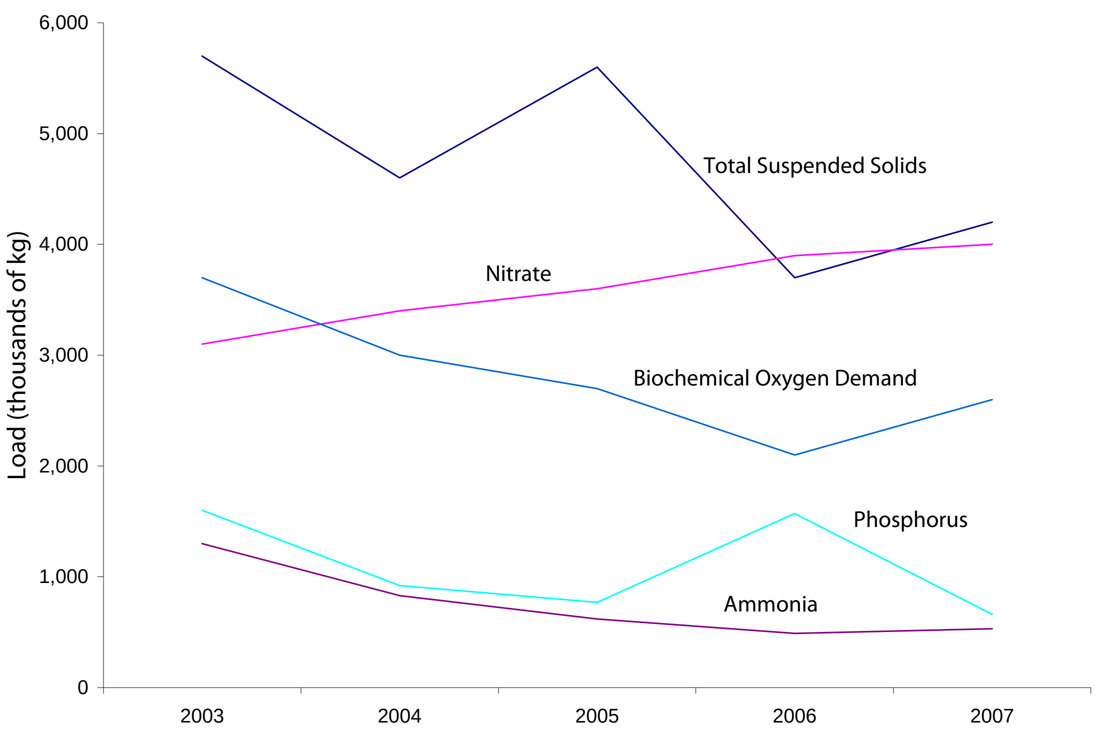
At the state level, the Clean Water Legacy Act (CWLA) of 2006 provides for accelerated testing of Minnesota's lakes and streams; provides resources to develop specific plans to clean up Minnesota's most contaminated waters and prevent clean waters from becoming polluted; and designates funding to existing state and local programs to improve water quality. The 2007 Legislature provided the MPCA with $12.6 million for monitoring and assessment, and $18 million for TMDL development as one-time appropriations from the general fund for the FY2008-2009 Biennium.

In November 2008, Minnesota voters approved the Clean Water, Wildlife, Cultural Heritage and Natural Areas amendment to the state constitution that increases the state sales tax by three-eights of a percent beginning July 1, 2009 and extending for 25 years. According to the law, 33% of the money raised (estimated at about $80 million a year) is to be allocated to a clean water fund. Money deposited into the fund may be spent only to protect, enhance and restore water quality in lakes, rivers and streams, and to protect ground water from degradation. At least five percent of the fund must be spent only to protect drinking water sources.

Major Water Discharge Parameters and Trends

This section presents discharge information 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 MPCA is now trying to address water pollution problems on a holistic, watershed approach, we have elected to present the following discharge summaries by major watershed, rather than on a county-by-county basis as in previous Annual Pollution Reports. By plotting individual discharge points rather than aggregating the data by county, we hope that the reader gets a clearer picture of how discharges from major treatment facilities impact watersheds statewide. A summary table of the data from 2003-2007 (the five most recent years for which data are available) is found on page 2 of this report. In addition, the statewide data are plotted by pollutant in graphical form in the figure below.

Minnesota Water Pollution Discharge Loading Trends from Major Point Sources, 2003-2007, in thousand kilograms

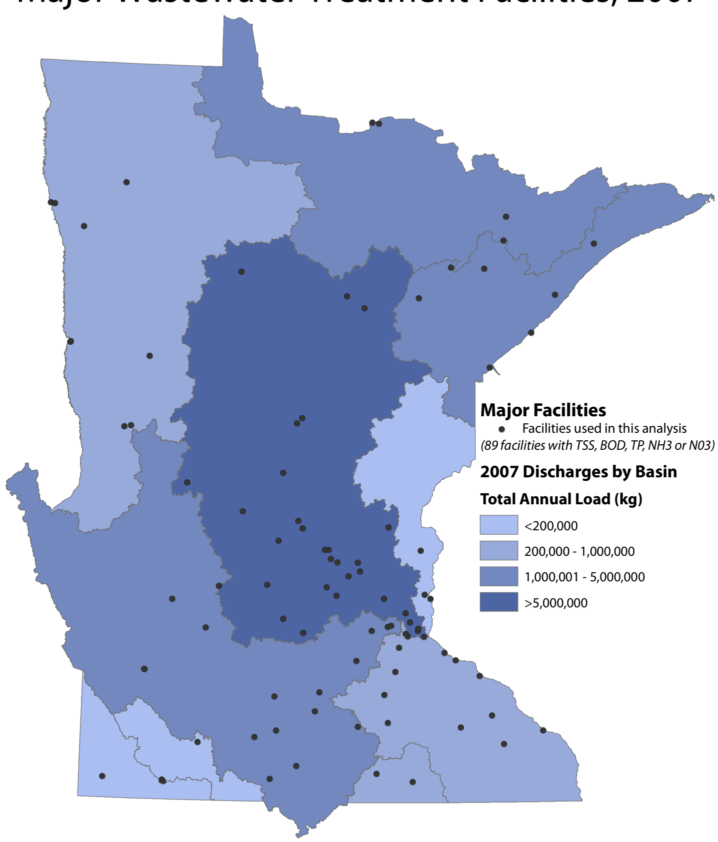


Total Annual Pollutant Load by Drainage Basin

The total statewide annual pollutant load from major treatment facilities to Minnesota waters for 2007 showed an increase to 11,984,000 kilograms from the 10,696,000 kilograms reported in 2006. This is still slightly less than the 11,990,000 kilograms reported in 2005. As previously mentioned, climate can influence discharges from year to year since during wet years, more effluent flow is generated and therefore more mass is typically discharged than in drier years. Recall that 2006 was a dry year, even resulting in moderate drought conditions in parts of Minnesota. Although the first half of 2007 was dry almost statewide, the second half of the year brought heavy precipitation to many areas, especially to southeast and northwest Minnesota, alleviating and even eliminating drought conditions in much of the state. Of note were the torrential rains of August 2007 which damaged infrastructure in southeast Minnesota and brought record discharges to several river basins there.

The figure below shows the distribution of pollutant loading by major river basin for 2007. The Upper Mississippi River Basin contributed 6,800,000 kilograms (down slightly from just over 7,000,000 kilograms in 2006), while the Minnesota River Basin contributed 1,160,000 kilograms (up slightly from just over 1,000,000 in 2006). Together, these two river basins account for over two-thirds of pollutants discharged from major wastewater treatment facilities 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

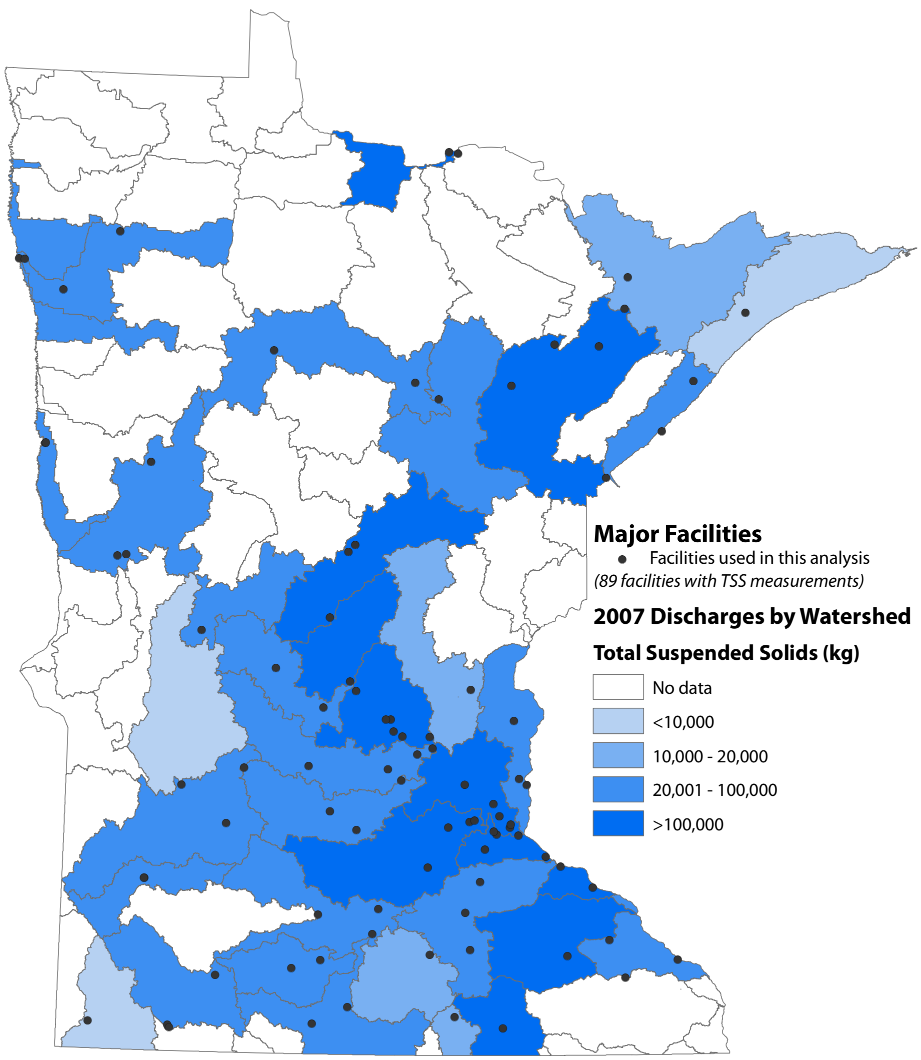


Total Suspended Solids

Total suspended solids (TSS) is a measure of the material suspended in water or wastewater. TSS cause 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 89 major treatment facilities, the estimated discharge of TSS to waters of the state for 2007 was approximately 4,200,000 kilograms, an increase of 14% from that reported in 2006. The map below shows the 2007 TSS discharges to surface waters by major point sources of water pollution on a watershed basis.

Total Suspended Solids Discharges from Major Point Sources by Major Watershed, 2007

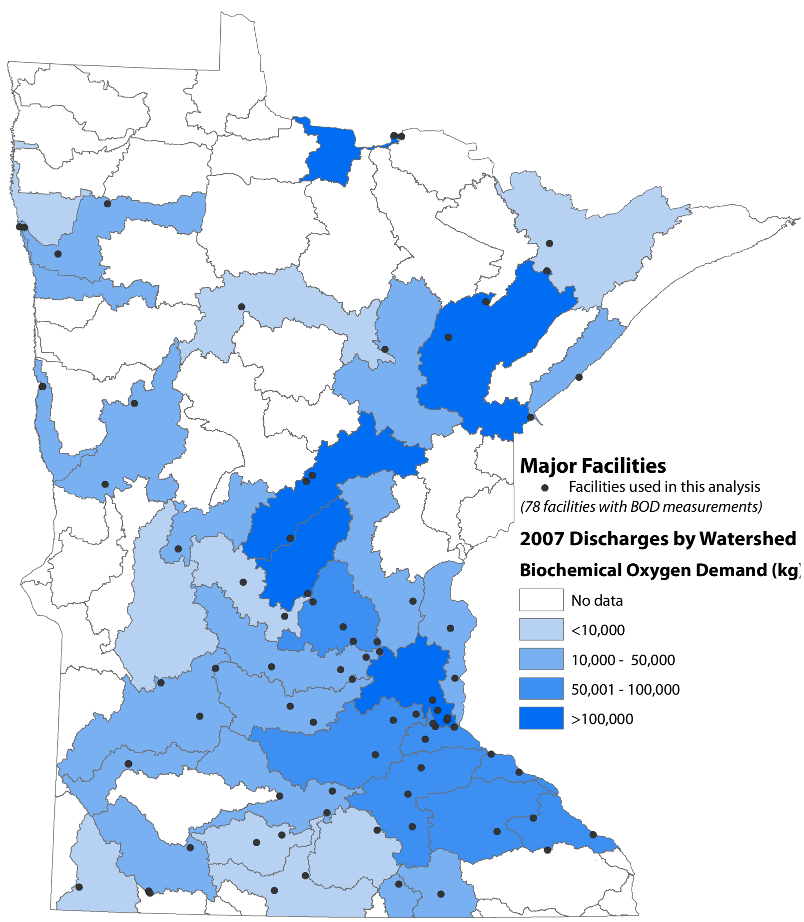


Biochemical Oxygen Demand (BOD)

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 78 major treatment facilities, the estimated discharge of BOD to waters of the state for 2007 was approximately 2,600,000 kilograms, an increase of 24% from 2006. The map below shows the 2007 BOD discharges to surface waters by major point sources of water pollution on a watershed basis.

Biochemical Oxygen Demand Discharges from Major Point Sources, 2007

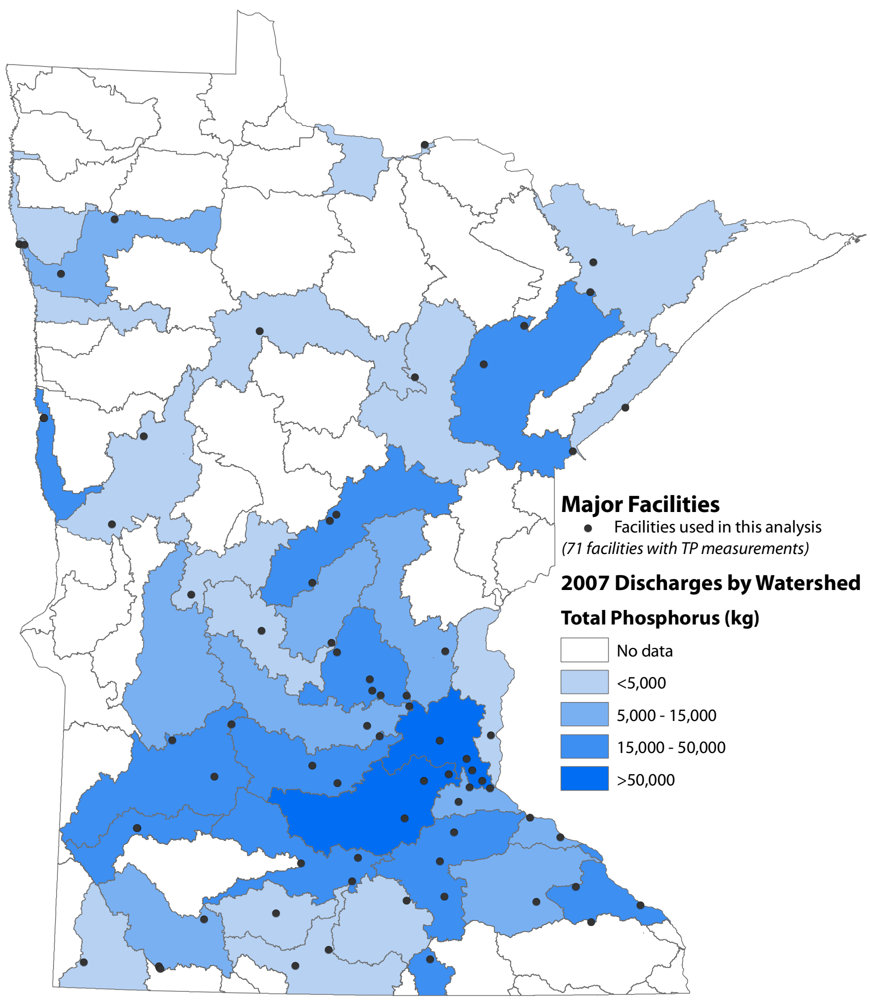


Total Phosphorus

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 71 major treatment facilities, the estimated discharge of TP to waters of the state for 2007 was approximately 660,000 kilograms, a decrease of 58% from 2006. Many treatment plants are now using advanced methods for phosphorus removal. It is encouraging to see TP discharges decreasing 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. The map below shows the 2007 TP discharges to surface waters by major point sources of water pollutants on a watershed basis.

Total Phosphorus Discharges from Major Point Sources, 2007

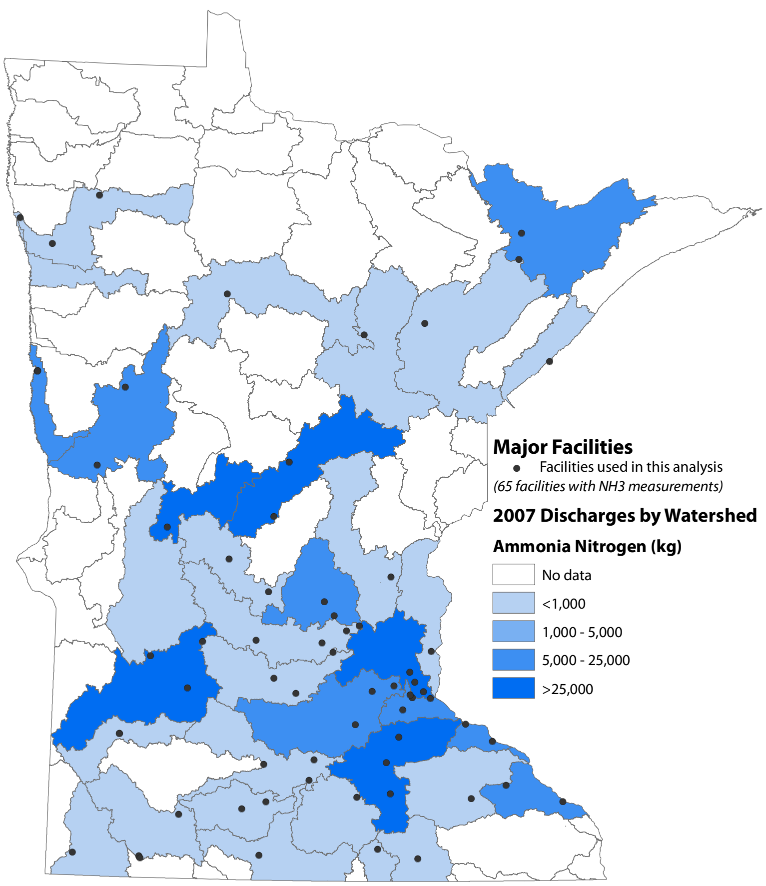


Nitrogen

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 ground water 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 65 major treatment facilities, the estimated discharges for 2007 were 530,000 kilograms of ammonia, an increase of 8% from 2006. This still represents a significant decline from the 1,300,000 kilograms discharged from major facilities in 2003. Like phosphorus, nitrogen in its various forms can also contribute to the hypoxic zone in the Gulf of Mexico, so it is a positive indication when contributions from point source discharges can be reduced over time. The map below shows 2007 ammonia discharges to surface waters by major point sources of water pollutants on a watershed basis. A similar analysis was not attempted for nitrate because an insufficient number of data points were available.

Ammonia Discharges from Major Point Sources, 2007



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 89 major treatment facilities discharging more that one million gallons per day of treated effluent have cut their total amount of pollutants discharged to waters of the state by approximately 3,600,000 kilograms in the period 2003-2007, 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 ground water 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, Wildlife, Cultural Heritage and Natural Areas amendment to the state constitution will help 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 ground water 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. What happens to Minnesota's water resources in the next 10 years will help determine the quality of those resources for the next 100 years.

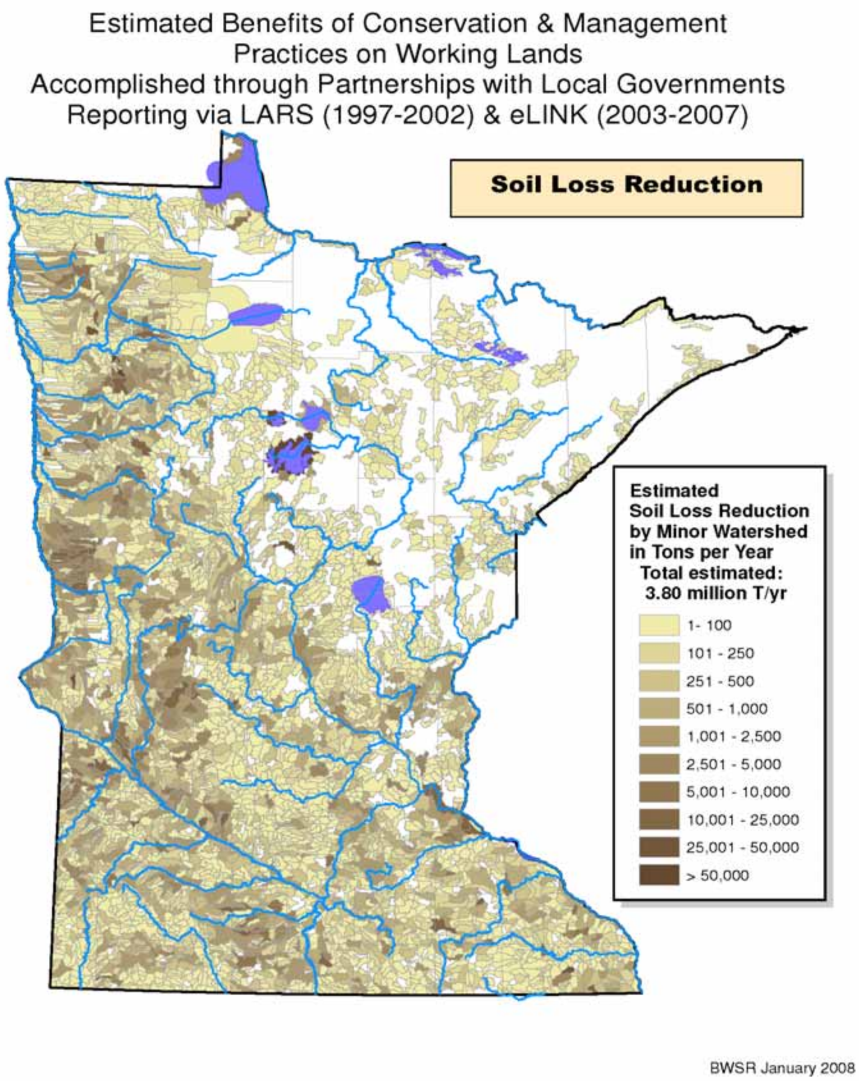
Soil loss reduction in Minnesota

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 ground water contamination from overapplication of fertilizer.

The Minnesota Board of Water and Soil Resources (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/).

As of January 2008, soil loss reduction statewide was estimated at 3.8 million tons per year as opposed to if no pollution reduction measures had been implemented. This is an increase from the 2.9 million tons per acre reduction reported as of March 2006 (MPCA Annual Pollution Report, 2007). 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 and southwest 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 on a watershed basis as of January 2008.

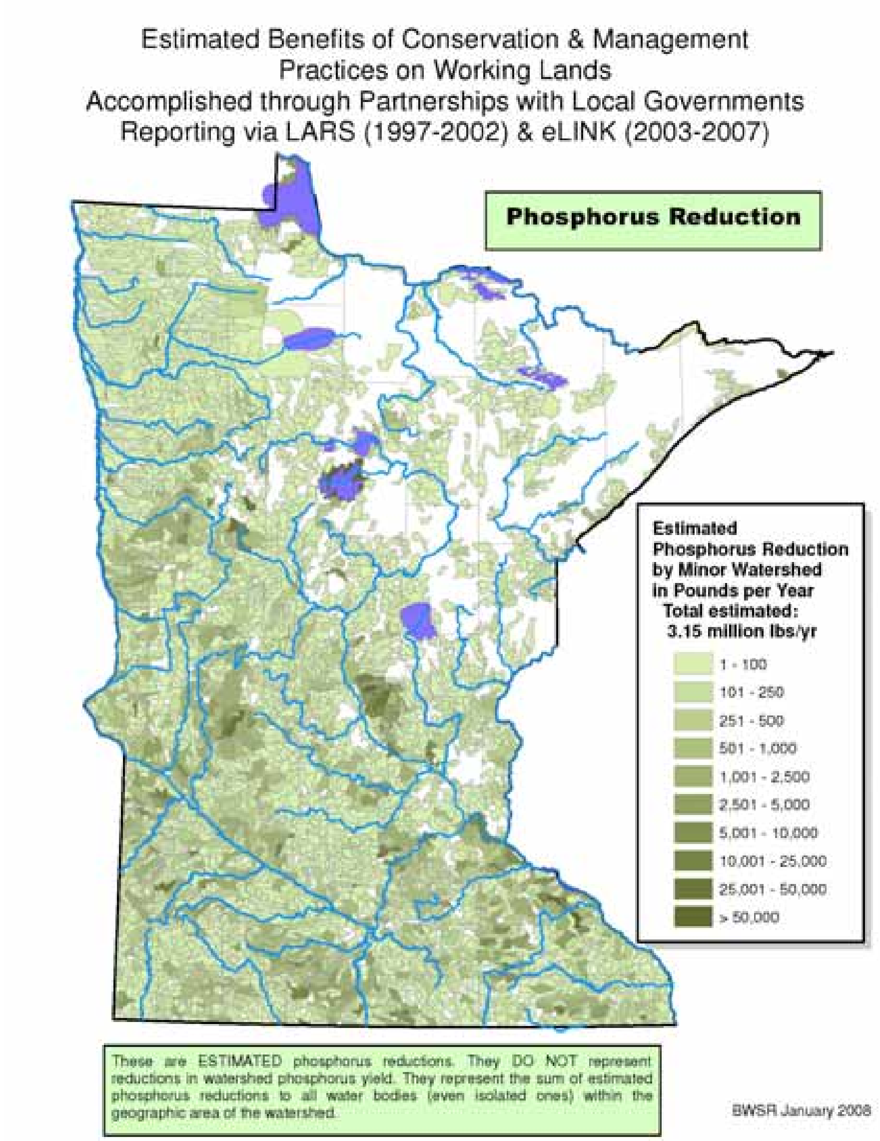
Soil Loss Reduction Benefits from Conservation and Management Practices, January 2008



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.

As reported in the MPCA's 2007 Annual Pollution Report, data from BWSR (March 2006) showed pollution reduction benefits statewide from phosphorus reduction of 2.14 million pounds/year. In January 2008, phosphorus loss reduction statewide was estimated at 3.15 million pounds/year as opposed to if no pollution reduction measures had been implemented, or an increase of phosphorus loss prevention of about a million pounds in just under two years. The map below shows phosphorus reduction benefits from conservation and management practices on a watershed basis as of January 2008.

Phosphorus Reduction Benefits from Conservation and Management Practices, January 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.

These stressors enter the environment through consumer products, solid waste disposal, agricultural and urban runoff, residential and industrial wastewater, and long-range atmospheric transport. In some cases, release of these substances to the environment occurred long ago, but may not have been recognized because methods to detect them at low concentrations did not exist. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of contamination. At the same time, observations of troubling effects, including feminization of male fish or malformed frogs, raise questions on causes. Public health experts often have an incomplete understanding of the toxicological effects of these contaminants, including the significance of long-term exposure.

Even with incomplete knowledge, science and policy must continue to ensure protection of human health and the environment through the process of identifying, assessing and preventing problems.

Here are a few examples of emerging issues currently being investigated in Minnesota:

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

Perfluorinated chemicals (PFCs)

Perfluorinated chemicals such as PFOS, PFOA, PFBA and others are manmade chemicals that are used in the manufacture of products that are heat and stain resistant and repel water. PFOS, used in emulsifier and surfactant applications, is found in fabric, carpet and paper coatings, floor polish, shampoos, fire-fighting foam and certain insecticides. PFOA is used in the manufacture of fluoropolymers that are used in the production of many personal care products, textiles, non-stick surfaces and fire-fighting foam. In Minnesota, 3M manufactured PFOS and PFOA from approximately 1950 until they were phased out in 2002.

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. MPCA and Minnesota Department of Health (MDH) testing has found PFOS and PFOA in some municipal and private drinking water wells in Oakdale and Lake Elmo. A potentially less-toxic but more mobile form, PFBA, also has been found in wells in Oakdale, Lake Elmo, Cottage Grove, Newport, St. Paul Park, Hastings, South St. Paul and Woodbury. PFOS and PFOA have not been detected in those areas.

MPCA studies have detected PFOS at elevated concentrations in fish taken from the Mississippi River near the 3M Cottage Grove plant and downstream as well as in several metro area lakes. In additional to fish tissue, PFCs have been found in some shallow ground water wells, in the effluent and sludge of wastewater treatment plants, and in landfill leachate and gas. The MPCA's recently completed a report on PFCs that is available at the following link:

http://www.pca.state.mn.us/publications/c-pfc1-02.pdf

MPCA and MDH continue to examine potential sources of exposure to PFCs. A complete description of all MPCA and MDH activities related to PFCs is available on the following web pages:

http://www.pca.state.mn.us/publications/gp5-18.pdf

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

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

Pharmaceuticals, household and industrial-use products

In 2002, the United States 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 comprised 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 have biological activity, 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 include wastewater discharge, manure from confined animal feedlots, landfill leachate, and urban runoff. Several studies show that many of these compounds can have harmful effects on wildlife at low concentrations.

This first statewide study, a result of collaboration between USGS, MPCA, and the MDH, showed that many industrial, household-use compounds, and pharmaceuticals are present in streams, ground water, wastewater and landfill effluents. Steroids, nonprescription drugs, and insect repellent were the chemical groups most frequently detected, with detergent degradates and plasticizers detected at the highest concentrations. (The complete report may be found at http://water.usgs.gov/pubs/sir/2004/5138/).

The MPCA continues its collaboration with the USGS and St. Cloud State University to monitor these compounds and assess their effects on fish in Minnesota's lakes and streams. Whereas previous studies focused exclusively on rivers and streams, the 2008 Statewide EDC Monitoring Study is focusing on several Minnesota lakes as well as rivers. This study will include a broad analysis of pharmaceuticals, endocrine disrupting compounds, hormones, and personal care products, and pesticides in surface water and sediment. It will also include a detailed examination of fish abnormalities in these aquatic systems.

In addition, the MPCA has worked since 2002 with the Minnesota Hospital Association and several partner organizations to improve environmental compliance and pollution prevention in Minnesota healthcare facilities. Compliance evaluations of healthcare facilities revealed widespread mishandling of complex hazardous wastes such as pharmaceuticals, laboratory solvents and reagents, and mercury-containing wastes. As a result of this collaboration, hospitals are 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 were held throughout the state in FY 2006, with over 500 healthcare professionals attending. Partner organizations participating in this effort include the Solid Waste Management Coordinating Board, the Minnesota Technical Assistance Program, and the Metropolitan Council Environmental Services. More information on these efforts can be found at http://www.pca.state.mn.us/industry/healthcare.html.

Endocrine-disrupting compounds (EDCs)

An endocrine-disrupting compound is anthropogenic chemical [human-made compound or natural compounds at unnatural concentrations due to human activity] that may have an adverse effect on reproduction or development, mediated directly through the endocrine system of fish, wildlife and humans. Originally, studies of endocrine-disrupting chemicals (EDCs) focused on those chemicals affecting the estrogenic, androgenic (testosterone), or thyroid hormones of humans and wildlife; however, the scope of interest has expanded to include other signaling chemicals in humans and wildlife, such as neurochemicals, in addition to other chemical signals in lower organisms and plants. Because endocrine disruption encompasses numerous sources, exposures, and organisms, it is critical to approach endocrine disruption in the context of environmental protection through a multidisciplinary and collaborative approach; to this end, MPCA has been supporting Minnesota-based EDC studies and researchers that build on national studies and perspectives.

Building on the results of a 2002 USGS monitoring study of pharmaceuticals, household and industrial products in Minnesota's surface water, the MPCA, USGS, and St. Cloud State University continue to investigate the significance, sources and occurrence of compounds with endocrine-disrupting activity in Minnesota's waters. This multidisciplinary team of experts has designed a phased approach from laboratory to field studies to discover what effects this diverse suite of compounds has on aquatic organisms.

Initial EDC studies focused on alkylphenols. Alkylphenols, including nonylphenol, are a class of chemicals resulting from the breakdown of widely used household and industrial surfactants (cleaning detergents, airplane deicers, surfactants used with pesticides, etc.). Their wide use has resulted in high concentrations detected in wastewater effluents. Nonylphenol, one of the most studied chemicals for EDC activity, demonstrates estrogenic activity in numerous species of fish with corresponding reproductive abnormalities.

MPCA is currently involved in a statewide EDC monitoring project with Richard Kiesling, Jeff Writer, Larry Barber (USGS) and Heiko Schoenfuss. This study—focused primarily on the presence and effects of an expanded list of EDCs in lakes across Minnesota—includes alkylphenols, bisphenol-A, various hormones and steroids and select pharmaceuticals. The results from this study, together with the results of previous studies on the Mississippi River and its tributaries will give MPCA a clearer picture of the extent and magnitude of EDCs in Minnesota's environment. MPCA may utilize the results of these studies to develop future water quality standards and management strategies. The Department of Natural Resources is also contributing technical expertise to the projects and receives results.

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 endocrine disrupting chemicals 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