Minnesota Pollution Control Agency

Annual Pollution Report

to the Legislature

March 2008

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Foreword

The Annual Pollution Report statute requires the Minnesota Pollution Control Agency (MPCA) to estimate to the best of its ability 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 for interested parties to add context and invite suggestions for improvements.

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 much better estimates of pollutant loads from nonpoint sources to be made in recent years. Reasonable estimates of benefits from soil loss and phosphorus reductions from implementation of best management practices (BMPs) may now be made on a statewide basis 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 which sets up a cap-and-trade system for 28 states to help lower emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), which are implicated in acid rain, particle and ozone formation and visibility impairment. CAIR should result in a significant decrease in SO_2 and NO_x in Minnesota. http://www.epa.gov/interstateairquality/index.html

- **Visibility State Implementation Plan:** In Spring 2008, 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 of reducing 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. http://www.pca.state.mn.us/air/regionalhaze.html

- **Cleaner Diesel:** Diesel exhaust emissions from trucks and buses contribute to many of the priority air issues in Minnesota. Work is being done to lower diesel emissions by providing cleaner diesel fuel and building and retrofitting engines so they run more cleanly.

  Clean Air Highway Diesel Rule: This rule requires a 97 percent reduction in the sulfur content of highway diesel fuel, from its current level of 500 parts per million (ppm), to 15 ppm. As of October 2006, Ultra-Low Sulfur Diesel (USLD) is available at most retail stations. ULSD is needed to allow engine and vehicle manufacturers to meet 2007 emission standards. As a result, each 2007 and newer truck and bus will be more than 90 percent cleaner than current models. http://www.epa.gov/otaq/highway-diesel/index.htm

  Cleaner On-Road Vehicles: A $500,000 grant from the federal Congestion Mitigation and Air Quality (CMAQ) Improvement Program along with a $125,000 match from the MPCA will retrofit 200 public diesel on-road vehicles in St. Paul, Minneapolis, Hennepin County and Ramsey County.

Project Green Fleet: The Minnesota Environmental Initiative's Clean Air Minnesota oversees Project Green Fleet, which reduces emissions from diesel school buses by installing control equipment. Five hundred buses have been retrofitted as of 2007. These retrofits can reduce tailpipe emissions of certain air pollutants by 40 to 90 percent and dramatically reduce pollution inside the bus. The Minnesota State Legislature appropriated an additional $2.4 million for school bus retrofits and reduced fuel consumption in small trucking firms. This appropriation will enable retrofits for 650 more buses in 2008. In addition, Project Green Fleet received a grant from Blue Skyways Collaboration to retrofit an additional 75 buses. http://www.projectgreenfleet.org/

Stationary Diesel Engines New Source Performance Standards: In June, 2006, the EPA issued final standards which will limit emissions of nitrogen oxides (NO_x), particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), and hydrocarbons (HC) from stationary diesel internal combustion engines to the same stringent levels required by EPA's non-road diesel engine regulations. At full implementation, EPA estimates that the total pollutant reductions will be more than 68,000 tons per year in 2015. The final rule will reduce emissions gradually from 2005 to 2015, with overall reductions of 90 percent or more from baseline levels in some cases. http://www.epa.gov/ttn/caaa/t3/fact_sheets/ci_nsps_fnl_fs.html

- **Mercury Reduction:** Minnesota's Mercury Total Maximum Daily Load (TMDL) assessment established an air emission target of 789 lbs, a 78 percent reduction compared to estimated 2005 emissions of 3,583 lbs. The Mercury Reduction Act of 2006 requires Minnesota's largest three power plants to reduce emissions by about 1,200 lbs by the end of 2014. In addition, the MPCA has convened a stakeholder group to recommend strategies and timeframes, including interim targets, for achieving additional reductions needed to meet the new goal. Recommendations from this group are expected by mid-2008.

- **Next Generation Energy Act of 2007:** In February 2007, Governor Pawlenty signed the Next Generation Energy Act of 2007. It set statewide greenhouse gas emission reduction goals of at least 15 percent by 2015, at least 30 percent by 2025, and at least 80 percent by 2050 from 2005 levels. The Minnesota Climate Change Advisory Group (MCCAG) was organized to evaluate and compile a set of recommended policy options to aggressively reduce greenhouse gas emissions in Minnesota during the coming years. The MCCAG submitted its recommendations to the Legislature in February 2008. http://www.mnclimatechange.us/index.cfm

- **Midwestern Greenhouse Gas Accord, 2007**: In November 2007, Governor Pawlenty signed the Midwestern Greenhouse Gas Accord, which sets a course of action to address climate change. The accord creates a framework for establishing greenhouse gas reduction targets and timeframes, developing a cap-and-trade system and a system to track entities that reduce greenhouse gas emissions and developing and implementing the steps necessary to achieve reduction targets including low-carbon fuel standards and regional incentives and funding. http://www.governor.state.mn.us/mediacenter/pressreleases/PROD008606.html

- **Energy Independence and Security Act of 2007:** The Energy Independence and Security Act (P.L. 110-140, H.R. 6) is an omnibus energy policy law that consists mainly of provisions designed to increase energy efficiency and the availability of renewable energy. It includes a Corporate Average Fuel Economy (CAFE) standard that sets a target of 35 miles per gallon for cars and light trucks by 2020; a Renewable Fuels Standard (RFS) that sets a renewable fuel goal that starts at 9 billion gallons in 2008 and rises to 36 billion gallons by 2022; and an Energy Efficiency Equipment Standard that includes a variety of new standards for lighting and for residential and commercial appliance equipment. http://energy.senate.gov/public/_files/RL342941.pdf

- **Metropolitan Emissions Reduction Project:** In March 2004, the Minnesota Public Utilities Commission approved a proposal by Xcel Energy to retrofit several of its coal-fired power plants to achieve impressive emission reductions while increasing available capacity on Xcel Energy's system. The Allen S. King power plant in Oak Park Heights will be renovated with state-of-the-art pollution controls. The refurbished plant started operations with its pollution control system in April 2007. St. Paul's High Bridge power plant and Minneapolis' Riverside power plant will both be changed from coal to cleaner-burning natural gas. High Bridge ceased coal generation in August 2007, and started its gas generation in February 2008. The re-powered Riverside plant is planned to begin commercial operation in May 2009. In its entirety, this project is expected to achieve a projected 95 percent reduction in nitrogen oxides and sulfur dioxide emissions, an 81 percent reduction in mercury emissions, a 70 percent reduction in particulate matter with a diameter less than 10 microns and a nine percent reduction in carbon dioxide.
- **Emissions Reductions in Northeast Minnesota:** In October 2005, Minnesota Power initiated air pollution control reduction programs at its Laskin and Taconite Harbor coal-fired generating stations for nitrogen oxides, sulfur dioxide and mercury. One year later, Minnesota Power began a second project at its Boswell generating station Unit 3 to lower particulate matter, nitrogen oxides, sulfur dioxides and mercury. Together, these projects will result in at least a 70 percent reduction in nitrogen oxides, sulfur dioxide and mercury from these electric generating units in the Arrowhead region.

- **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 surface and ground water; provides resources to develop specific plans to clean up Minnesota's most contaminated waters; 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 TMDL development as one-time appropriations from the General Fund for the FY2008-2009 biennium.

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

- **Water Quality Standards for Herbicides:** As part of its triennial review of Minnesota's statewide water-quality rule, the MPCA is proposing water quality standards for new corn herbicides: acetochlor and metolachlor. These herbicides were added because the Minnesota Department of Agriculture identified them as priority pesticides, frequently detected in their surface water monitoring network. Minnesota is the first state to have water quality standards for acetochlor and the first to have a metolachlor standard based on aquatic plants. The proposed standards, which are expected to be finalized in June 2008, will protect the designated beneficial uses of surface waters: aquatic community and human health protection.

- **Lake Nutrient Standards:** The MPCA is proposing numeric standards for phosphorus and two indicators of increased nutrient loading that measure the response of lakes to excess phosphorus. The two indicators are chlorophyll-a (a green pigment that measures the abundance of algae), and Secchi disk transparency or Secchi depth (a measure of water clarity). The standards, which should be finalized in June 2008, will help protect lakes for recreational uses such as swimming and boating, a healthy aquatic community including game fish and aquatic plants, and the aesthetic enjoyment of lakes.

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 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 2008 Annual Pollution Report is the 2006 MPCA Greenhouse Gas Inventory, the 2002 and 2006 Minnesota Criteria Pollutant Emission Inventories, the 2002 Air Toxics Emission Inventory and the 2006 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.

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.

Global climate change is a continuing concern worldwide. Therefore, Minnesota emissions of the principal greenhouse gas, carbon dioxide, are included for 2006. The statewide emissions were calculated using a variety of fuel use data sources. In 2006, 111,812 thousand short tons of CO_2 were emitted in Minnesota.

The MPCA reports data from its own Minnesota Criteria Pollutant Emission Inventory, using data generated in the state. 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. The most recent emissions data available from large facilities for these

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 2006, facilities with MPCA permits had until April 1, 2007 to submit their 2006 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 2007. Facilities completed their review by November, 2007. MPCA staff then reviewed the changes and completed the inventory for 2006 in January 2008.

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.

pollutants are from 2006. Emissions from smaller sources are available for 2002. The Minnesota Air Toxics Emission Inventory estimates emissions of 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 2002 with 80,000 tons emitted.

Table 1 lists the total statewide emissions of the major air pollutants from 2002 to 2006. The percent change from 2005 to 2006 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.

The MPCA prepares a greenhouse gas inventory each year. Emissions of criteria pollutants from large facilities are estimated every year; however, emissions from smaller sources are estimated only every three years and the 2005 estimates are not yet finalized. Therefore, the final 2002 emissions from area and mobile sources are currently used for 2002-2006 criteria emission estimates. Next year the 2005 and 2006 estimates will be updated with 2005 emission estimates from smaller sources.

Table 1: Minnesota Air Pollution Emission Estimates, 2002-2006
(thousand tons)*

Pollutant	2002	2003	2004	2005	2006	2005-2006 % Change
Carbon dioxide	113,516	114,986	114,688	115,305	111,813	-3.0%
Particulate matter (PM_{10})**	779	780	781	777	776	-0.1%
Sulfur dioxide (SO_2)	160	168	163	160	148	-7.5%
Oxides of nitrogen (NO_x)	484	480	480	479	466	-2.7%
Volatile organic Compounds (VOCs)	365	363	363	363	361	-0.6%
Carbon monoxide (CO)	1,983	1,976	1,977	1,978	1978	0.0%
Total Criteria Pollutants (no CO_2)	3,772	3,767	3,764	3,757	3,729	-0.7%

*Final 2002 mobile and area emission estimates were used in the 2002-2006 emission estimates.
**PM_{10} emissions represent only primary formation; secondary formation is not included.

All pollutant emission estimates decreased between 2005 and 2006 except CO which remained constant. Sulfur dioxide and NO_x had the greatest decrease in estimated emissions due to throughput decreases in the utilities sector. The Allen S. King power plant in Oak Park Heights was off-line for a portion of 2006 for modifications as part of Xcel Energy's Metropolitan Emissions Reduction Project. In addition, Minneapolis' Riverside power plant had more outages due to thermal discharge limits necessary from low river flow during the dry hot summer.

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. However, $PM_{2.5}$ emissions are a subset of the 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 2006, 34 tons of lead were estimated to have been emitted in Minnesota and 3300 pounds of mercury were estimated to have been emitted in 2005.

Water Discharges

Owners or operators of any disposal system or point source are required by Minnesota Statutes, Chapter 115.03(7) to maintain records and make reports of any discharges to waters of the state. These self-monitoring reports submitted to MPCA are commonly referred to as Discharge Monitoring Reports (DMRs). Data in the DMRs are compiled in Effluent Discharge Mass Loading Reports, which can be generated from either U.S. EPA's Permit Compliance Tracking System or DELTA, a compliance tracking system maintained by MPCA data specialists. As explained further below, both systems are the basis for the point source discharge summary (Table 2).

Table 2: Minnesota Water Pollution Discharge Estimates from Major Point Sources, 2002-2006 (thousand kilograms)

Pollutant	2002	2003	2004	2005	2006	2005 to 2006 % Change
Total suspended solids	7,500	5,700	4,600	4,400	3,600	-18.2%
Biochemical oxygen demand (BOD)	4,200	3,700	3,000	2,700	2,100	-22.2%
Phosphorus	1,300	1,600	920	770	680	-11.7%
Ammonia (NH_3)	1,100	1,300	830	630	370	-41.3%
Nitrate (NO_3)	4,320	3,100	3,400	3,600	3,900	+7.7%
Total*	18,300	15,400	12,700	12,000	10,700	-10.8%

* Totals may not be identical to the sum of individual parameters due to rounding.

In Table 2, discharge estimates for 2002 were generated from U.S. EPA's Permit Compliance Tracking System (PCS), while data for 2003-2006 were generated from DELTA, the MPCA database. The reported 2002 values represent the previously reported statewide totals calculated by PCS, adjusted by substituting a few values from DELTA. 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 U.S. EPA's Compliance Tracking System through 2002 are reliable, but we are now using the DELTA database, maintained by our own data specialists, as a basis for this and similar reports for 2003 and beyond. The 2008 Annual Pollution Report marks the first time the MPCA is reporting four consecutive years (2003-2006) of discharge data from 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 of our permits do not yet contain monitoring and reporting requirements that enable efficient, computerized calculations of total pollutant loadings. As we re-issue permits and further assess our data, we will continue to build our capability in this area.

Beginning in 2009, the five-year trend in water discharge data (2003-2007) will be calculated using DELTA exclusively, avoiding the problem of trying to compare data generated by PCS with data generated using DELTA. In some cases, values calculated using DELTA vary substantially from those previously derived from PCS. There are two substantial, documented differences between the totals from PCS and those from DELTA. Both of these differences result in the loadings calculated by PCS being greater than those calculated using DELTA.

- When accounting for reported values that are less than a detection limit, PCS uses 100 percent of the reported numerical component of the value in its calculations; in the calculations performed using DELTA for this report, 50 percent of the reported numerical value was used.
- Due to errors arising from the complexity of the permit, the PCS-calculated loadings for the City of Austin for 2003 were from 10 to 60 times greater than actual loadings.

In addition to the specific variances and adjustments highlighted above, there are a number of additional sources of variation, both up and down, that 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 the 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 significant variation in parameters and limit types, unmonitored parameters and unmonitored reporting periods, making year-by-year comparisons difficult.
- The loading calculations do not currently account for unmonitored or missing parameters and periods, so a facility that only monitors or reports quarterly on a pollutant, for example, 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.

The 2006 figures represent the combined loading from 88 major municipal and industrial discharges of more than one million gallons per day to waters of the state. These major facilities represent approximately 85% of the total volume of discharge to waters of the state from point sources. The remaining 15% 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 88 major facilities reporting in 2006, 35 showed an increase in total loading over 2005, 51 showed a decrease in total loading, and two facilities did not have reporting data for 2005 so that a trend could not be determined. In 2006, the total statewide loading continued the downward trend established over the previous five years, decreasing from 11,990,000 kilograms in 2005 to 10,696,000 kilograms in 2006 (a decrease of 10.8 percent). The overall decrease in total discharges since 2003 (84 facilities discharging 15,400,000 kilograms) to 2006 (88 facilities discharging 10,696,000 kilograms) is over 30 percent, suggesting that recent improvements in treatment plant technology and operation are having a measurable positive effect on Minnesota's water resources, at least as far as point source discharges are concerned.

The above trends should be viewed in the context of overall climatological events in Minnesota in recent years and previous vagaries of the database, which we believe we have now fully addressed. In 2003, spring snowmelt, runoff and precipitation followed a fairly "normal" pattern, in contrast to the previous two years which had above normal precipitation and, in 2001, spring flooding that resulted in the Mississippi River at Saint Paul being above flood stage for over a month. The unusual precipitation patterns of 2001-2002, combined with uncertainties in the PCS database used at that time make interpretation of year-to-year statewide discharge trends from that time period difficult, if not impossible.

The overall decrease in total loading from 2003 to 2004 (and coinciding with full implementation of DELTA), as shown by decreases in total suspended solids (TSS), biochemical oxygen demand (BOD), phosphorus (P) and ammonia (NH3) for the statewide database, represents a return to the year-to-year downward trend noted from 1997-2000. 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, mainly in northern Minnesota. The drought deepened into late summer 2007, but quickly subsided in response to widespread heavy, even torrential fall rains that relieved the drought conditions in almost all of Minnesota by the end of the year.

When examining overall trends in pollutant loadings over the years, it should be noted that improvements intended to enhance biological phosphorus removal at the Metropolitan Council Environmental Services (MCES) Metropolitan Plant (Metro Plant), the largest wastewater treatment plant in Minnesota, have significantly improved the plant's overall performance, particularly in the secondary clarifier. Due to the volume of waste treated by the Metro Plant, these improvements are a major contributor to verifiable reductions in the reported water pollutant loadings over the last several years. For example, during the period 2003-2005, phosphorus loading from the Metro Plant was reduced by 66 percent and total loading was reduced by 72 percent. It is also worth mentioning that in 2006, all eight reporting MCES treatment plants showed a decrease in total loading from the previous year.

Point source contributions of nitrate and phosphorus to waters of the state are still small compared to nonpoint contributions of these pollutants from sources such as agriculture and urban runoff. Point sources tend to have the greatest impact on receiving waters during periods of low precipitation and stream flow, while nonpoint sources are most significant during periods of high precipitation and stream flow. However, it is difficult to measure directly the effects of nonpoint pollution on Minnesota's lakes, rivers and 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.

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 air pollutants released into the air. In order to understand how much pollution is released and to track the success of reduction strategies, the MPCA estimates the emissions of certain air pollutants released in Minnesota.

Greenhouse Gases

Although greenhouse gases do not necessarily 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.

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 ($PM_{2.5}$ & 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. $PM_{2.5}$ and ammonia (which contributes to $PM_{2.5}$ formation) emissions were estimated for the first time for the 2002 emissions inventory. 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 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 2002 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 several other reports that discuss air pollution trends and emissions in more detail. Please reference the following reports for more information regarding air pollution.

Air Quality in Minnesota: Challenges and Opportunities—2007 Report to the Legislature
http://www.pca.state.mn.us/publications/reports/lr-airqualityreport-2007.html

Air Quality in Minnesota: Progress and Priorities—2005 Report to the Legislature
http://www.pca.state.mn.us/publications/reports/lr-airqualityreport-2005.html

Air Quality in Minnesota: Into the Future—2003 Report to the Legislature
http://www.pca.state.mn.us/publications/reports/lr-airqualityreport-2003.html

Carbon Dioxide

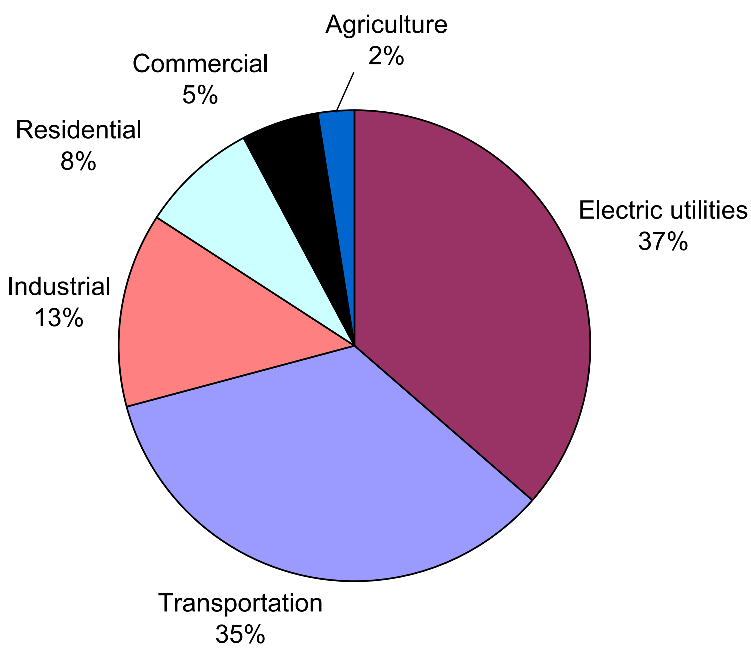
Carbon dioxide is a gas that is principally formed from the combustion of fossil fuels such as oil, gas, and coal. It is the most important greenhouse gas that contributes to warming of the earth's atmosphere. Many greenhouse gases occur naturally, but fossil fuel burning and other human activities are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

Emissions Data and Sources

The estimate for statewide emissions of carbon dioxide in 2006 is 111,813 thousand short tons.

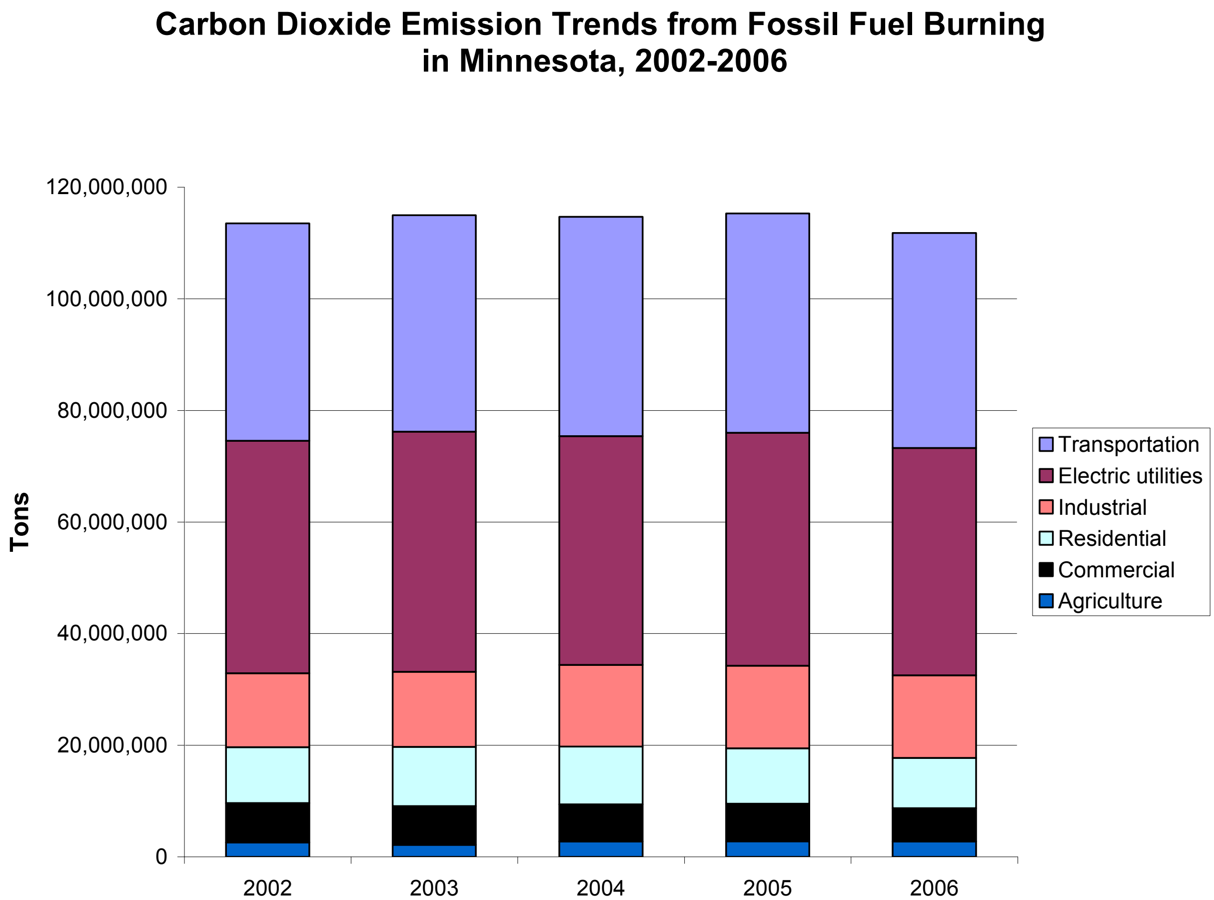
The pie chart below shows the breakdown of carbon dioxide emissions from fossil fuel burning by sector. The majority of the carbon dioxide emissions come from the electric utility (37 percent) and transportation (35 percent) sectors. The remaining 28 percent of the emissions come from fossil fuel combustion in the industrial, commercial, residential and agriculture 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.



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 with the 2002 inventory, MPCA has also begun estimating $PM_{2.5}$ and ammonia emissions.

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: area 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. **Area Sources**: Typically stationary sources, but generally smaller sources of emissions than point sources. Examples include dry cleaners, gasoline service stations and residential wood combustion. Area 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 2006. Emission estimates are available for area and mobile sources for 2002. When 2006 summary data are given, they includes area and mobile data from 2002 and point source data from 2006. This report presents trend data for point sources from 2002-2006.

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 facility specific emissions and facility ranking by emissions:
http://www.pca.state.mn.us/air/criteria-emissionsearch.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, Ely, Grand Portage, Marshall, Rochester, St. Cloud, and the Twin Cities area. 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:

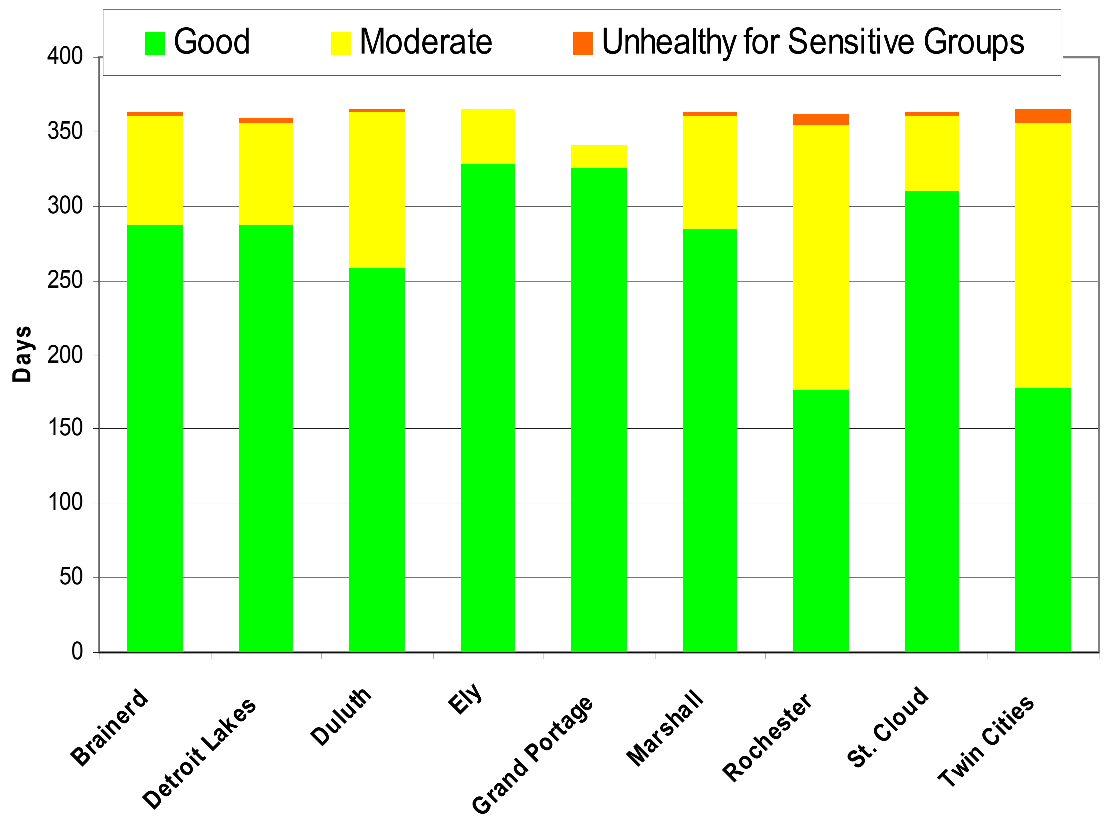
Good	0-50
Moderate	51-100
Unhealthy for Sensitive Groups	101-150
Unhealthy	151-200
Very Unhealthy	201-300

The AQI in Minnesota cities rarely reaches the Unhealthy range; however, many citizens are affected by air quality in the Unhealthy for Sensitive Groups category.

The chart on the next page displays the number of Good, Moderate and Unhealthy for Sensitive Groups days for several cities in Minnesota that were monitored every day in 2007. The AQI did not reach the Unhealthy range in Minnesota in 2007. Days are categorized by the highest AQI level calculated anytime during that day. The EPA may report slightly different AQI summary totals for Minnesota because the MPCA and EPA use different methods to calculate the AQI.

Yearly variations in weather patterns can affect air quality. The Twin Cities and Rochester had the worst air quality in the state with nine and eight days respectively that were considered Unhealthy for Sensitive Groups. Of these days, all except one resulted from high levels of fine particles in the air with one Unhealthy for Sensitive Group day in the Twin Cities due to high levels of ozone. For the rest of the year, half of the days in each of the two cities had air quality that fell in the good range and half in the moderate range.

AQI Days for Cities in Minnesota, 2007



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 the general term for particles found in the air. Some particles are seen as soot or smoke while others are so small they can only be detected with an electron microscope. Particles less than or equal to 2.5 microns (µm) in diameter are known as "fine" particles. PM_{10} refers to all particles less than or equal to 10 µm in diameter.

Both PM_{10} and $PM_{2.5}$ can be inhaled into the lungs. These particles then accumulate in the respiratory system and are associated with numerous adverse health effects, which are briefly described in the following sections.

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.

$PM_{2.5}$

Fine particles are a chemically and physically diverse mixture of different sizes of very small particles. Most are smaller than 2.5 microns. These particles contain a complex mixture of chemicals, including ammonium sulfate, ammonium nitrate, particle-bound water, black carbon (elemental carbon), hundreds or thousands of organic compounds, and inorganic material including soil and metals.

Fine particles can be inhaled deeply into the lung. These particles then accumulate in the respiratory system. Some of the very small particles enter the bloodstream where they can result in a range of serious health effects. Studies of exposures to $PM_{2.5}$ have been linked with increased hospital admissions and deaths from cardiovascular and respiratory problems. Specifically, elevated fine particles are associated with a rise in heart attacks; acute and chronic bronchitis; asthma attacks; respiratory symptoms; and reduced lung function growth and increased respiratory illness in children.

Emissions Data and Sources

$PM_{2.5}$ is present in the air as a result of many different emission sources. Some fine particles are directly emitted to the air as solid or liquid particles. Others result "secondarily" from chemical reactions between gaseous pollutants (called precursors) and natural materials in the atmosphere. These "secondarily" formed particles may be relatively more or less abundant depending on the presence of the precursor chemicals and the atmospheric conditions, such as temperature, sunlight, and humidity.

The MPCA estimate for statewide direct emissions of $PM_{2.5}$ in 2002 is 169,000 tons. This includes the $PM_{2.5}$ directly emitted from sources included in the MPCA emission inventory; however, it does not include secondarily formed $PM_{2.5}$.

While the figure below shows important direct emission sources of $PM_{2.5}$, it does not accurately explain the sources contributing to $PM_{2.5}$ in the ambient air for the following reasons.

- Secondarily formed particles can be an important, though changing, fraction of the fine particles in the air particularly during the summer months;

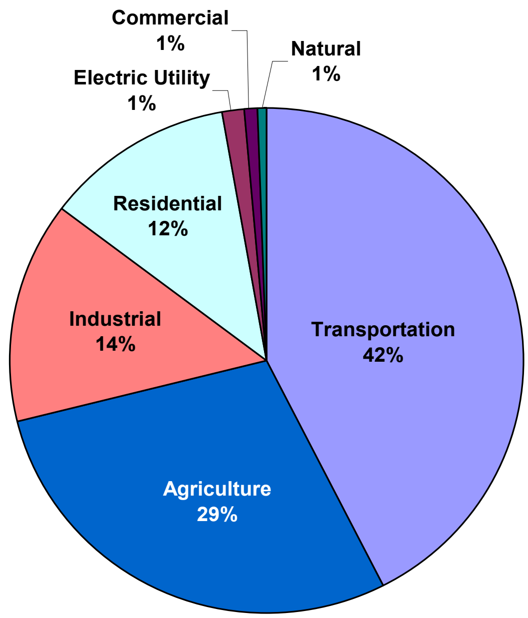
- Whether directly emitted or chemically formed in the air, $PM_{2.5}$ can travel hundreds or thousands of miles, and a significant amount of the $PM_{2.5}$ in Minnesota air results from emissions elsewhere;

- The composition of $PM_{2.5}$ can change over time;

- The larger heavier particles in $PM_{2.5}$ may settle from the air in the vicinity of the emission source; and,

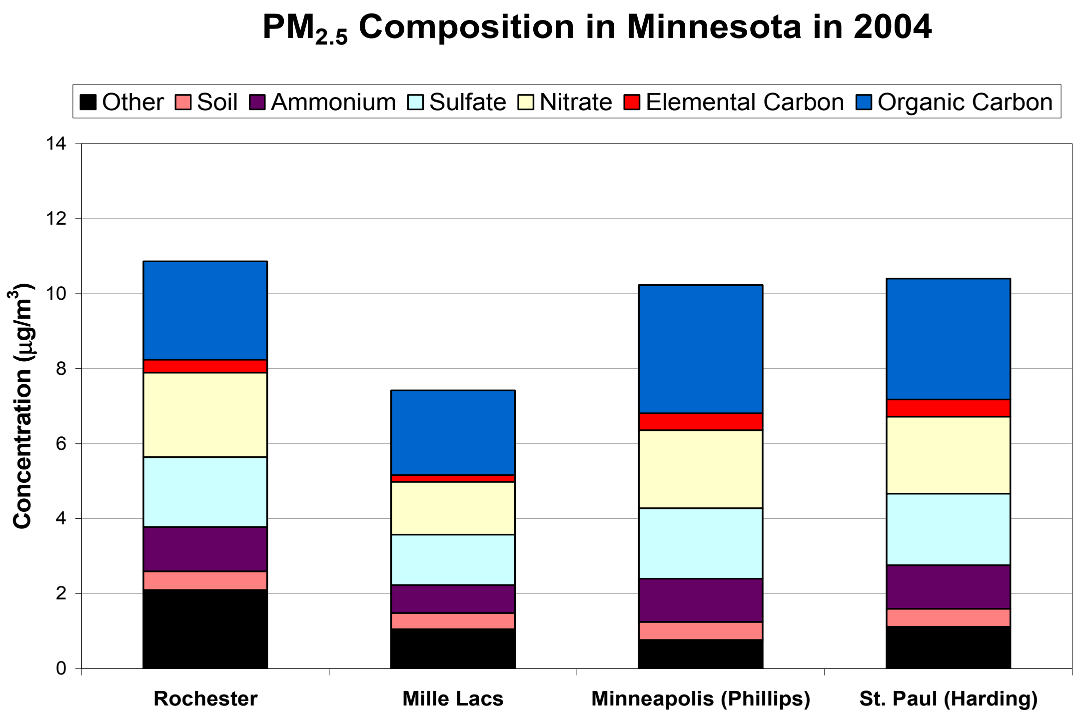
- Some natural processes which cause direct $PM_{2.5}$ emissions (for example, blowing dust) are not included in the inventory.

Sources of Direct Fine Particulate ($PM_{2.5}$) Emissions in Minnesota, 2002



Almost half of the mass of included direct $PM_{2.5}$ emissions come from transportation sources, mainly fugitive dust from unpaved and paved roads. The remainder comes from the combustion of gasoline and diesel fuels and to a lesser extent tire and brake wear. The second largest source of direct emissions is from agriculture with crop tilling being the majority contributor. Combustion of fuels in farm equipment and field burning also emits $PM_{2.5}$. The major industrial sources are from construction and fuel burning. Residential use of fireplaces and woodstoves as well as the burning of household waste emits $PM_{2.5}$ along with the use of recreational vehicles and lawn and garden equipment.

To further understand the sources of fine particles, the MPCA has measured the composition of particles at several locations. The figure on the next page shows the major $PM_{2.5}$ components measured in Rochester, Mille Lacs, Minneapolis and St. Paul.



The relative concentrations of the different fractions of $PM_{2.5}$ are similar across the four monitors. The largest fraction is organic carbon, followed by sulfate and nitrate. The soil component contains the larger, directly emitted $PM_{2.5}$ particles which often result from mechanical processes. This includes wind-blown dust, road dust, and particles released by abrasion, crushing, and grinding activities. Other examples of "direct" emissions include elemental carbon (soot) from diesel engines or fires; condensable organic particles from gasoline engines, cooking, or incomplete combustion of fossil fuels and biomass; and metals such as arsenic, selenium, and zinc from combustion or smelting.

Examples of "secondary" particle formation include the formation of ammonium sulfate from sulfur dioxide emitted by coal-fired power plants and ammonium nitrate from nitrogen oxides emitted by vehicles or coal-fired power plants. The ammonia comes mainly from fertilizer application and animal waste used in agricultural production.

Other examples of secondarily formed particles include organic carbon compounds formed from volatile organic compounds such as toluene, xylene and trimethyl benzene. Sources of these aromatic gases include transportation, petrochemical manufacturing and some solvents. Natural sources of $PM_{2.5}$ precursors, such as terpenes from some trees, contribute to $PM_{2.5}$ formation in the warmer periods of the year. Additional research is needed to better understand the sources contributing to the organic fraction of $PM_{2.5}$. The MPCA is currently modeling this composition data to determine what sources contribute to total $PM_{2.5}$ concentrations in Minnesota.

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}

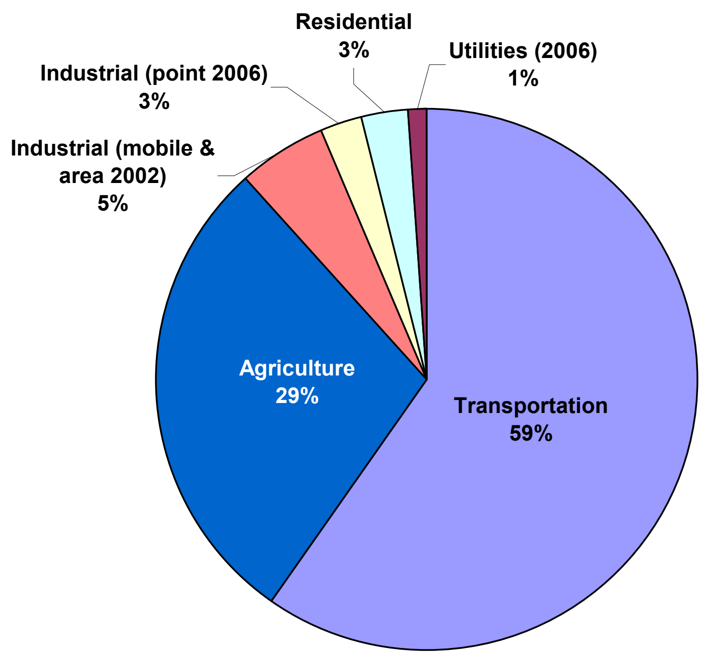
Exposure to PM_{10} particles is primarily associated with the aggravation of respiratory conditions such as asthma. PM_{10} has also been linked to cardiovascular mortality and related health effects, but many studies indicate a stronger association between $PM_{2.5}$ and these health effects. PM_{10} includes all particles with aerodynamic diameters less than 10 microns.

PM_{10} particles are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, and crushing and grinding operations, and windblown dust. These particles can settle rapidly from the atmosphere within hours, and their spatial impact is typically limited (compared to $PM_{2.5}$) because they tend to fall out of the air in the downwind area near their emissions point.

Emissions Data and Sources

The MPCA estimate for statewide direct emissions of PM_{10} in 2006 is 776,000 tons. The figure below shows estimated sources of 2006 PM_{10} direct emissions.

Sources of Direct PM_{10} Emissions in Minnesota, 2002 & 2006



Utility and industrial point source data are from the 2006 Emissions Inventory. All other data are from the 2002 Emissions Inventory.

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.

Transportation sources contribute 59 percent of direct PM_{10} emissions. The majority of transportation source emissions are the result of dust from roads. Agricultural production contributes 29 percent of direct PM_{10} emissions with dust from tilling as the largest contributor. Combustion of fuels in farm equipment and field burning also emits PM_{10}.

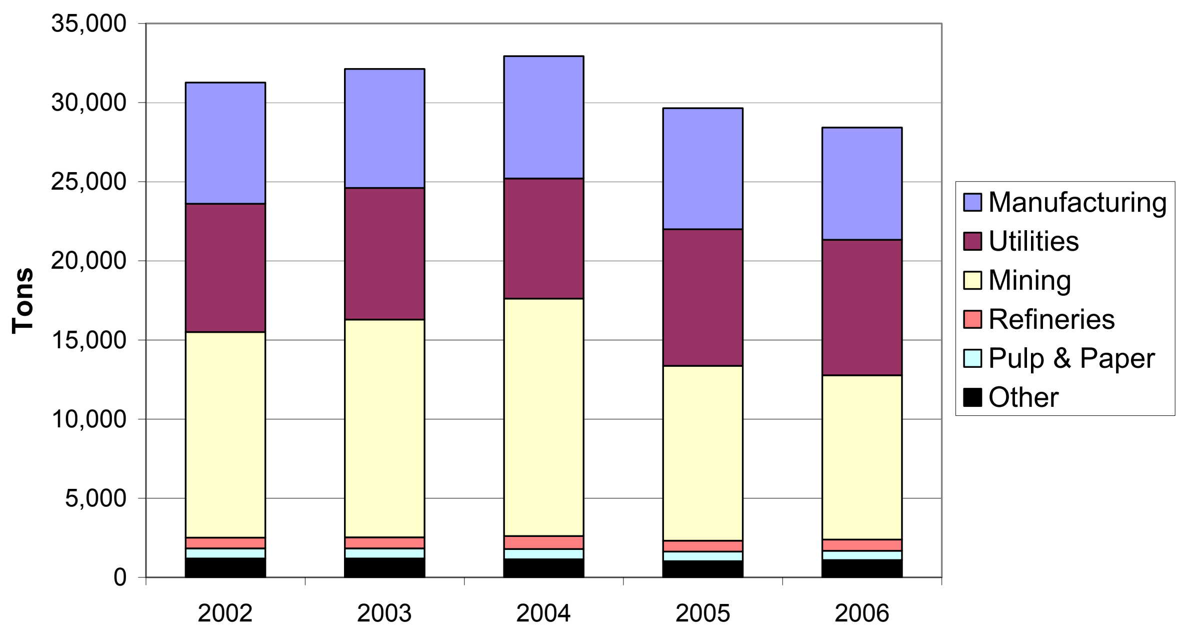
The major industrial sources are from construction and fuel burning. Residential use of fireplaces and woodstoves as well as the burning of household waste emits PM_{10} along with the use of recreational vehicles and lawn and garden equipment

Although most of the mass of PM_{10} emissions come from soils carried by the wind, these sources tend to be located away from people and are often larger particles, which are less of a human health concern. Particles emitted from combustion sources such as cars, wood stoves, and industrial and commercial combustion are generally smaller, more toxic and more often released in populated areas.

Trends

In 2006, point sources contributed 4 percent to the total state PM_{10} emissions. PM_{10} emissions had been slowly increasing since 2002 until 2005 when there was a drop in emissions from the mining sector due to methodology and emission factor changes including new stack test factors. There was a decrease in all sectors except refineries between 2005 and 2006.

PM_{10} Point-Source Emission Trends By Sector in Minnesota, 2002-2006



References/Web Links

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

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

Ammonia

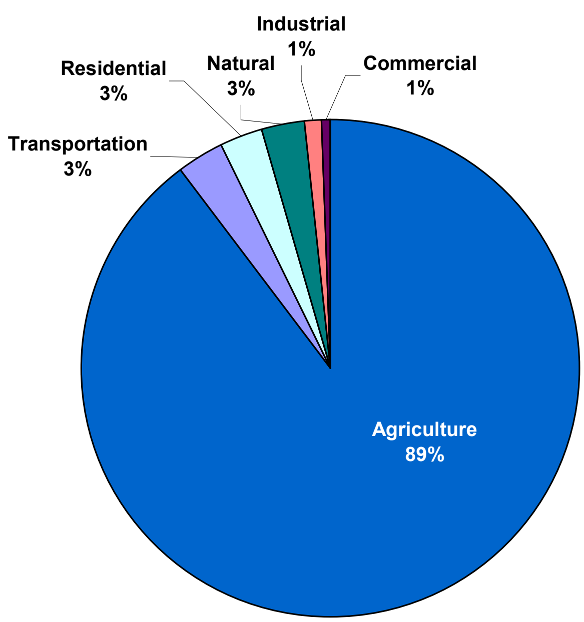
Ammonia is a significant component of fine particulate ($PM_{2.5}$). Ammonia combines with sulfur dioxide and nitrogen dioxides to form ammonium sulfate and ammonium nitrate particles.

Ammonia is included for the first time in the 2002 Minnesota Criteria Pollutant Emission Inventory.

Emissions Data and Sources

The MPCA estimate for statewide emissions of ammonia in 2002 is 179,000 tons. Almost all ammonia emissions were from agricultural production, primarily fertilizer application and animal waste.

Sources of Ammonia Emissions in Minnesota, 2002



Trends

Since 2002 was the first year that ammonia emissions data were collected, there is currently no trend information available.

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 metal smelting and other industrial processes.

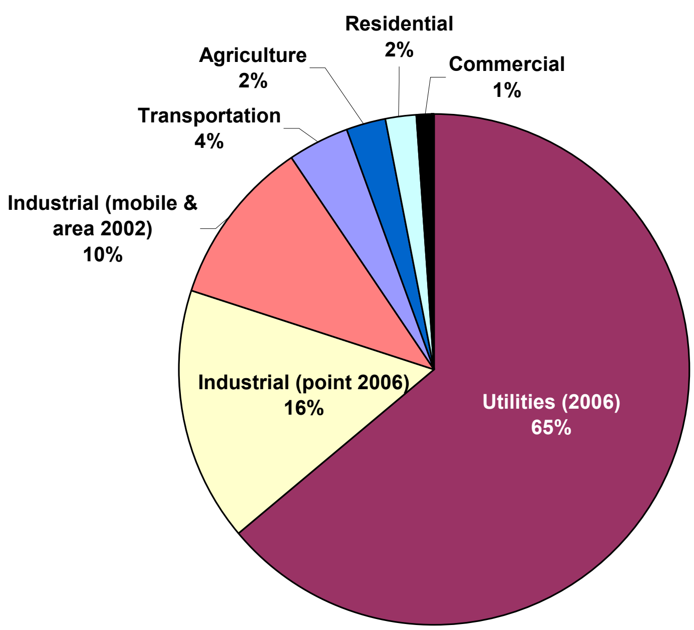
SO_2 reacts with other chemicals in the air to form tiny sulfate particles. It is difficult to distinguish between health effects due to SO_2 exposure and those due to fine particulate exposure. The major health effects of concern associated with exposures to high concentrations of SO_2, sulfate aerosols 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 and the elderly 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 2006 is 148,000 tons. The figure below shows sources of 2002 and 2006 SO_2 emissions.

Sources of Sulfur Dioxide Emissions in Minnesota, 2002 & 2006

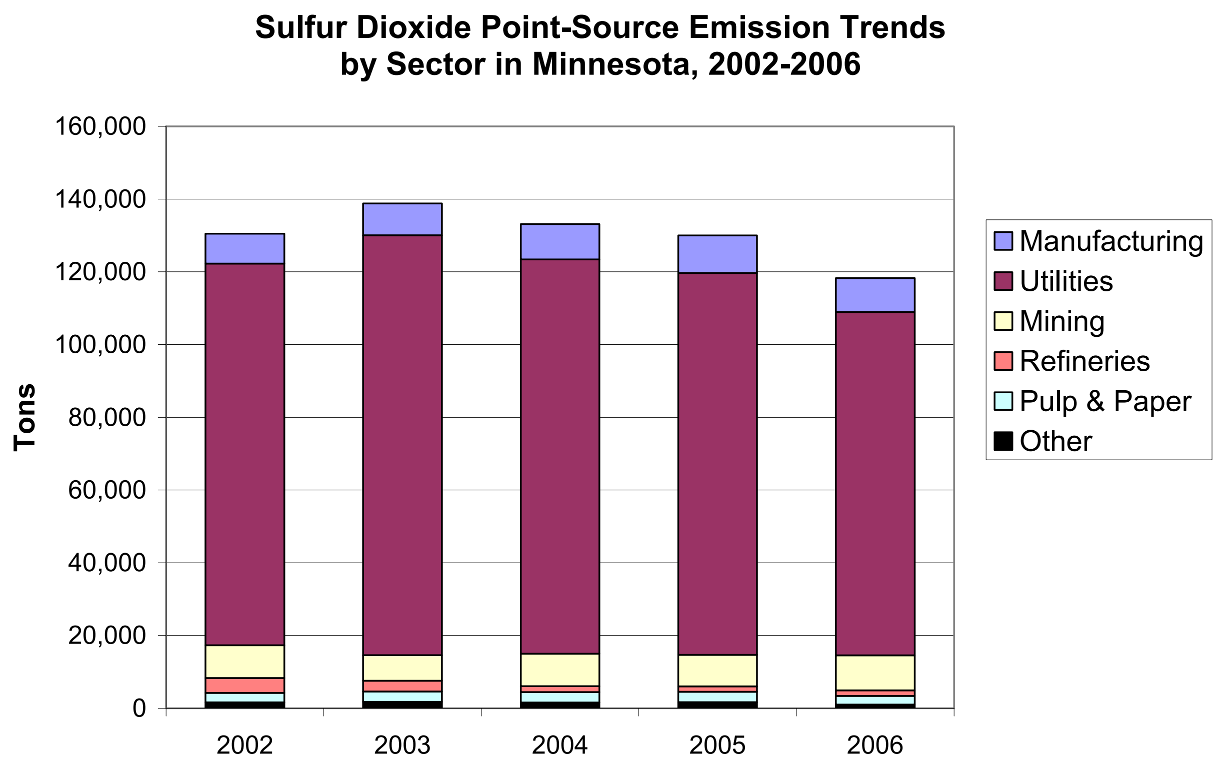


Utility and industrial point source data are from the 2006 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

The majority (65 percent) of SO_2 emissions come from utilities, primarily coal-burning electricity generation sources. Sixteen percent comes from industrial point sources while 10 percent is the result of smaller industrial burning of coal, distillate oil and prescribed burning. Burning diesel fuel and distillate oil for transportation, agriculture, residential and commercial use makes up the bulk of remaining SO_2 emissions.

Trends

Point sources contribute 81 percent to the total state SO_2 emissions with coal-burning utilities the greatest emitters. Emissions from point sources have been decreasing since 2003 with a pronounced decrease in 2006. Between 2005 and 2006, emissions decreased in all point source categories except mining and refineries where emission estimates increased slightly. The biggest decrease was in the utility sector. The Allen S. King power plant in Oak Park Heights was off-line for a portion of 2006 for modifications as part of Xcel Energy's Metropolitan Emissions Reduction Project. This reduction in coal burned resulted in a 9,000 ton decrease in SO_2 emissions. In addition, Minneapolis' Riverside power plant 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 from 2005 of over 2,000 tons of SO_2 from the Riverside facility.



References/Web Links

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

http://www.epa.gov/oar/urbanair/so2/index.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 yellowish-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.

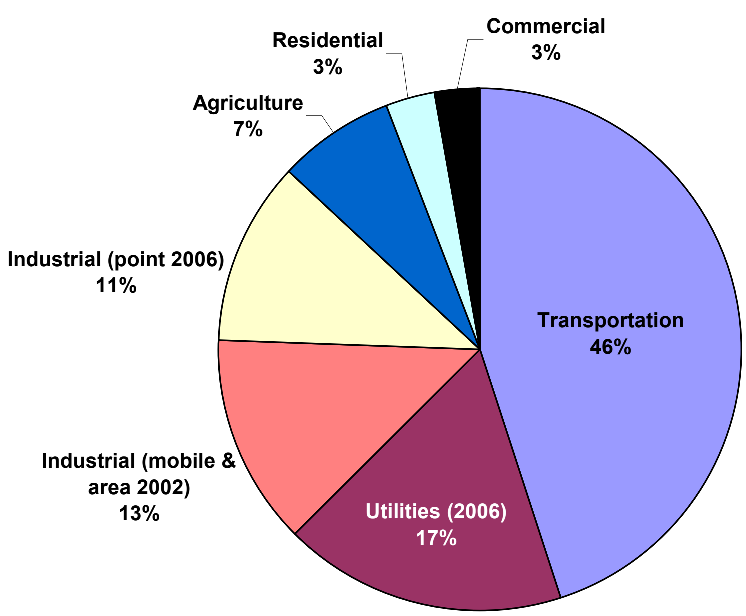
NO_x contribute to a wide range of human health effects. NO_2 can irritate the lungs and lower resistance to respiratory infection (such as influenza). More importantly, NO_x are a major precursor both to ozone and to fine particulate matter ($PM_{2.5}$). As discussed in the ozone and $PM_{2.5}$ sections 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. In addition, nitrous oxide (N_2O), another component of NO_x, is a greenhouse gas that contributes to global warming.

Emissions Data and Sources

The MPCA estimate for statewide emissions of NO_x in 2006 is 466,000 tons. The figure below shows sources of 2002 and 2006 NO_x emissions.

Sources of Nitrogen Oxide Emissions in Minnesota, 2002 & 2006



Utility and industrial point source data are from the 2006 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

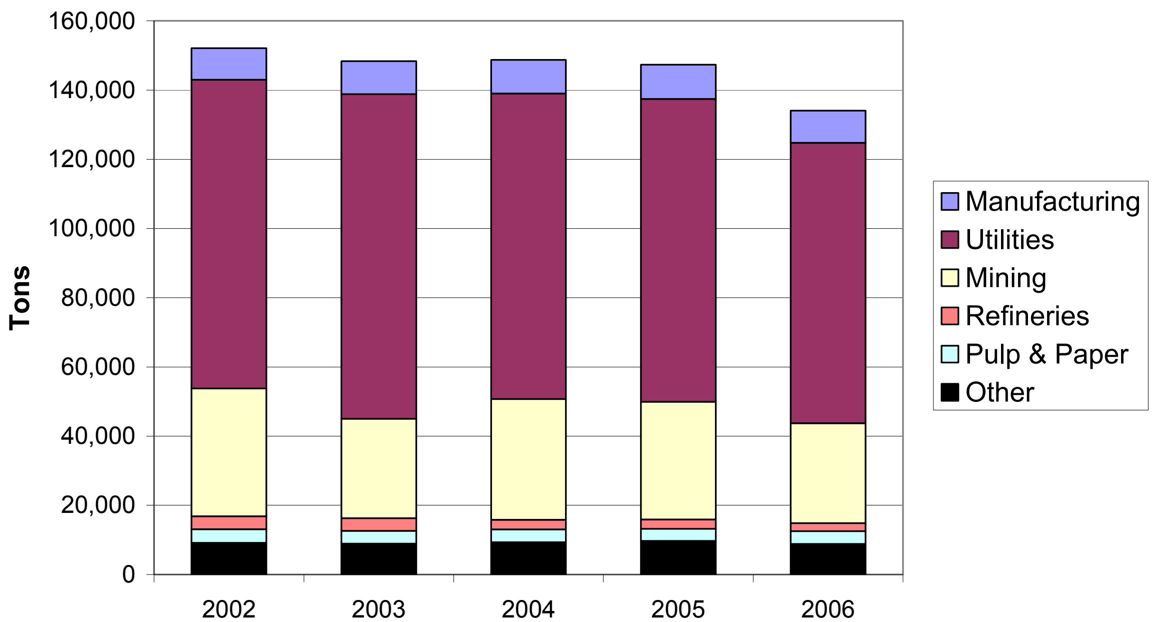
Nearly half of NO_x emissions come from the transportation sector, primarily from highway vehicles and railroads burning diesel and gasoline fuels. Utilities contribute 17 percent of NO_x emissions. The largest utility emitters are coal-fired power plants. Natural-gas fired mining facilities also contribute significant NO_x emissions. Industrial sources emit 24 percent of total NO_x largely from burning distillate oil and coal in boilers and from burning liquid petroleum gas (LPG) and diesel fuel in industrial and construction equipment. The remaining 13 percent of NO_x emissions are mainly the result of fuel burning in agricultural equipment, residential and commercial heating, and non-road vehicles and equipment.

Trends

Point sources contribute 28 percent of the NO_x emissions in the state. In Minnesota, NO_x emission estimates from point sources had stayed relatively constant since 2002; however, there was a pronounced decrease in 2006 due to emission estimate reductions in the mining and utilities sectors. Mining emissions vary annually depending on the demand for taconite pellets. The kilns used to bake the pellets burn natural gas, which results in NO_x emissions.

The biggest decrease was in the utility sector. The Allen S. King power plant in Oak Park Heights was off-line for a portion of 2006 for modifications as a part of Xcel Energy's Metropolitan Emissions Reduction Project. This reduction in coal burned resulted in a 3,500 ton decrease in NO_x emissions. In addition, Minneapolis' Riverside power plant 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 an overall emission reduction from 2005 of over 2,900 tons of NO_x from the Riverside facility.

Nitrogen Oxide Point-Source Emission Trends by Sector in Minnesota, 2002-2006



References/Web Links

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

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

Ozone

Ozone is an odorless, 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 irritate the respiratory system, reduce lung function, aggravate asthma, increase people's susceptibility to respiratory illnesses such as pneumonia and bronchitis, and cause permanent lung damage. Children, active adults, and people with respiratory diseases are particularly sensitive to ozone.

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.

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 2006 emissions of ozone precursors.

References/Web Links

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

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

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.

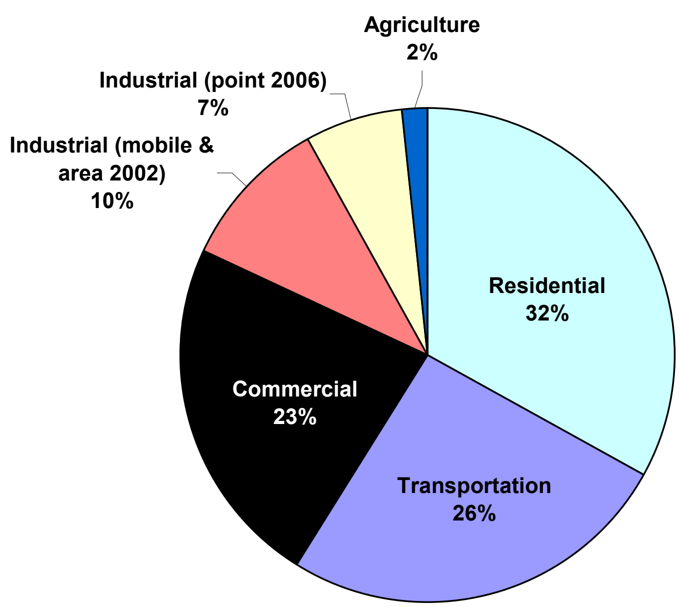
Many VOCs are also air toxics and can have harmful effects on human health and the environment. However, VOCs are regulated as a criteria pollutant because they are precursors to ozone. See the sections on ozone and air toxics for related human health and environmental effects.

Emissions Data and Sources

The MPCA estimate for statewide emissions of VOCs in 2006 is 361,000 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 2006.

Sources of Volatile Organic Compound Emissions in Minnesota, 2002 & 2006



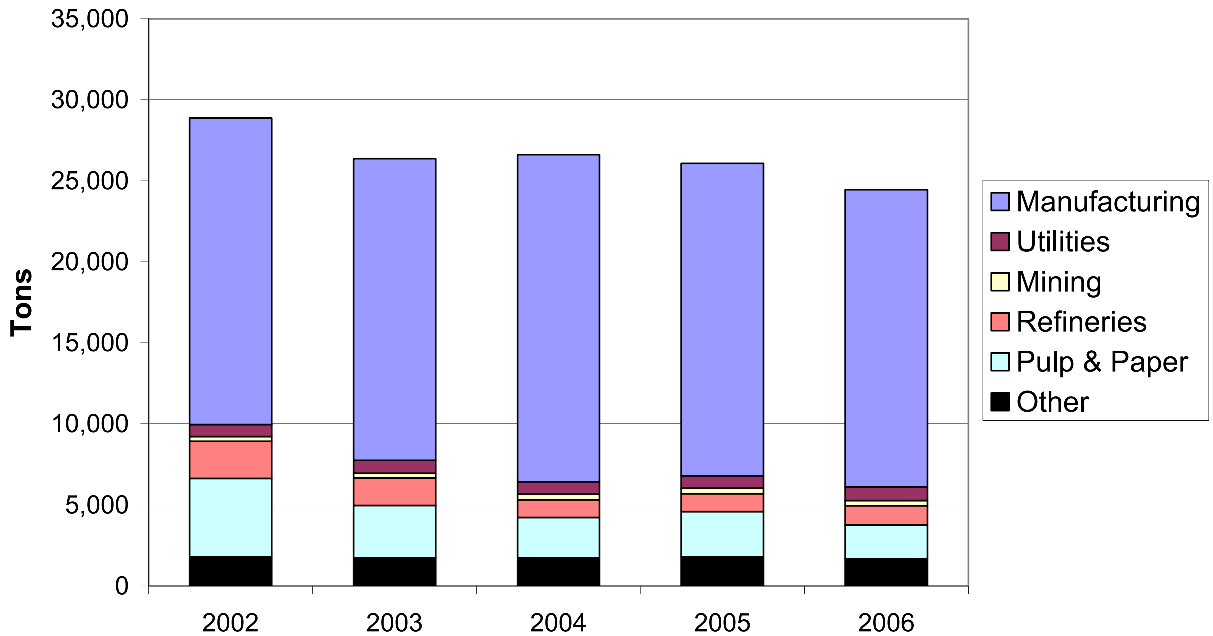
Utility and industrial point source data are from the 2006 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

Over 30 percent of VOC emissions come from residential use of gasoline in recreational vehicles such as snowmobiles, boats, and ATVs, as well as lawn and garden equipment. Residential burning of wood in fireplaces and woodstoves and household waste burning also emits significant VOCs. The transportation sector emits 26 percent of VOC emissions, while the storage and transport of gasoline, pesticide applications, and surface coatings contribute the bulk of the 23 percent of VOC emissions from the commercial sector. The remaining 19 percent of emissions come primarily from industrial surface coating and degreasing and fuel combustion in industrial and agriculture equipment.

Trends

Point sources contribute seven percent of the VOC emissions in the state. Reductions in the pulp and paper and refineries sectors resulted in decreased emission estimates between 2002 and 2003. Most of the refinery decreases were due to VOC abatement measures undertaken by Flint Hills Resources. Between 2005 and 2006, emission estimates decreased in all sectors except for refineries where there was a slight increase.

Volatile Organic Compound Point-Source Emission Trends by Sector in Minnesota, 2002-2006



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.

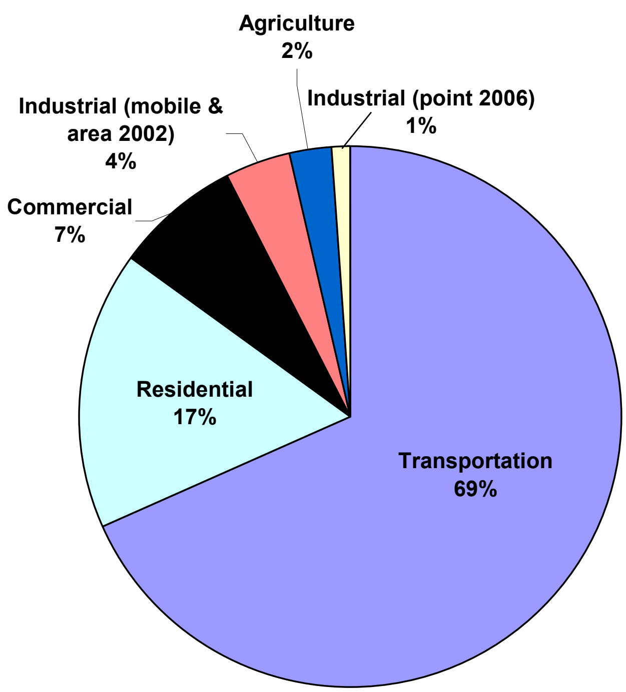
CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease. At higher concentrations it also affects healthy individuals. Exposure to elevated CO levels is associated with impaired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

Emissions Data and Sources

The MPCA estimate for statewide emissions of CO in 2006 is 1,978,000 tons. The figure below shows sources of 2006 CO emissions.

Sources of Carbon Monoxide Emissions in Minnesota, 2002 & 2006



Industrial point source data are from the 2006 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

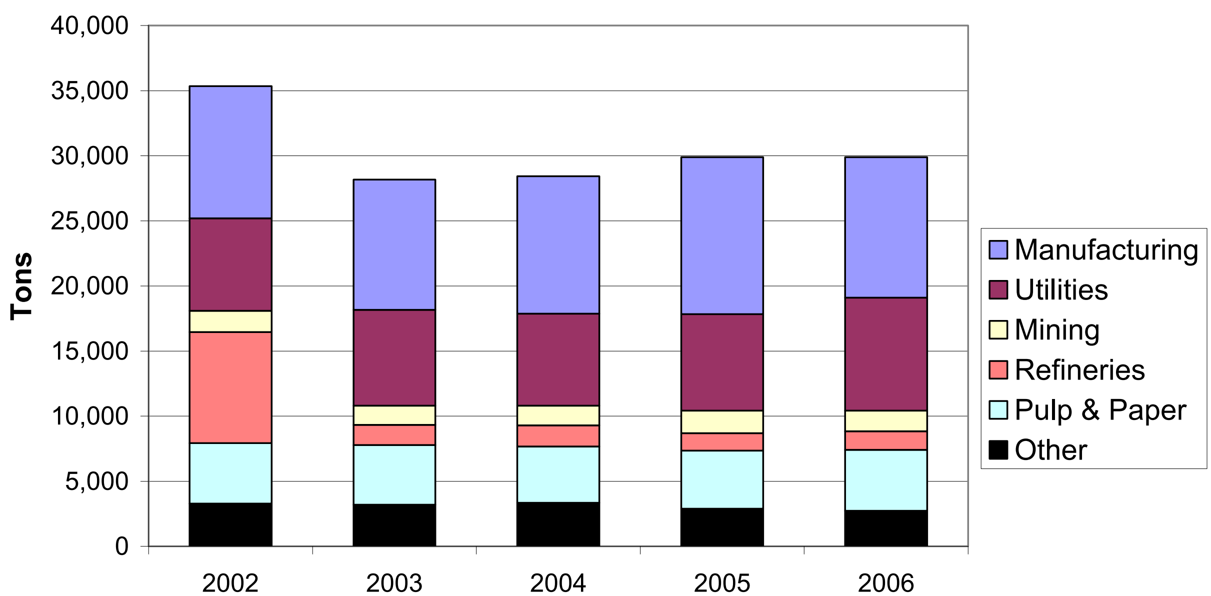
The majority of CO emissions come from the transportation sector, mainly from the combustion of gasoline in highway vehicles. Residential burning of wood in woodstoves and fireplaces and combustion of fuels in recreational vehicles such as snowmobiles, boats, golf carts, and ATVs as well as lawn and garden equipment contribute 17 percent to CO emissions. The remaining 14 percent of emissions comes from commercial, industrial and agricultural combustion sources.

Trends

Point sources contributed only 1 percent to the total Minnesota CO emissions in 2006. The CO values have been generally flat or decreasing except for high refinery values in 2002. This increase was mainly from Marathon Ashland refinery. Normally, the refinery runs its catalyst regenerator in full burn mode, meaning in excess oxygen. In 2002, the refinery's catalyst regenerator ran in both full and partial burn mode, which resulted in higher emissions estimates. The emission estimates have returned to normal since 2002.

Total emissions of CO from point sources stayed relatively constant between 2005 and 2006 with an increase in the utilities sector being off-set by decreases in the manufacturing sector.

Carbon Monoxide Point-Source Emission Trends by Sector in Minnesota, 2002-2006



References/Web Links

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

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

Lead

Lead (Pb) 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.

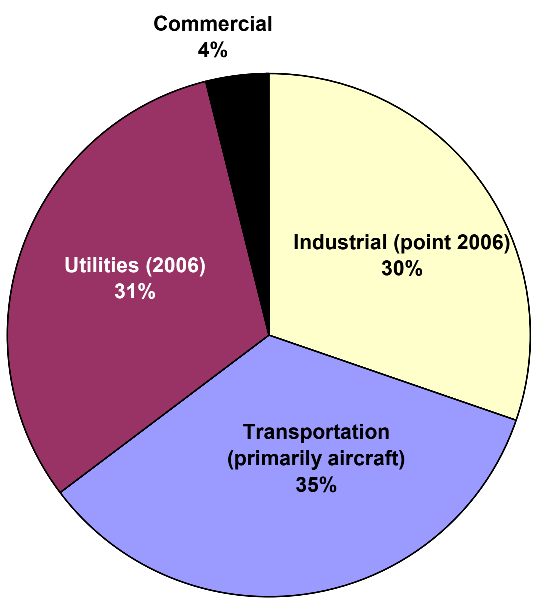
Lead causes damage to organs such as the kidneys and liver and may lead to high blood pressure and increased heart disease. In addition, exposure to lead may contribute to osteoporosis and reproductive disorders. Most importantly, lead exposure causes brain and nerve damage to fetuses and young children, resulting in seizures, behavioral disorders, memory problems, mood changes, learning deficits and lowered IQ.

Elevated lead levels are also detrimental to animals and to the environment. Wild and domestic animals experience the same kind of effects as people exposed to lead. Elevated levels of lead in the water can cause reproductive damage in some aquatic life and cause blood and neurological changes in fish.

Emissions Data and Sources

The MPCA estimate for statewide emissions of lead in 2006 is 34 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 2006 lead emissions.

Sources of Lead Emissions in Minnesota, 2002 & 2006

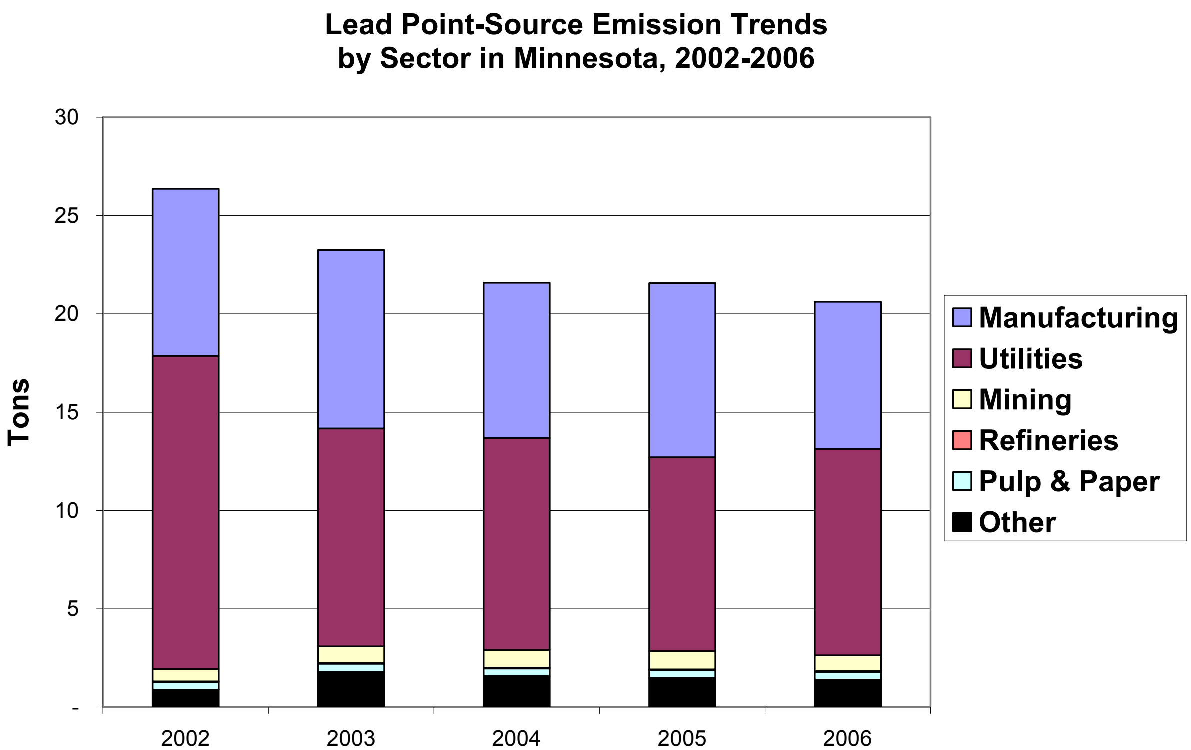


Utility and industrial point source data are from the 2006 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

Transportation sources (primarily airplanes using leaded fuels) contribute 35 percent of Minnesota's lead emissions. Coal-burning power plants add an additional 31 percent of lead to the environment. Industrial sources (including lead and other metal smelters) emit 30 percent of lead emissions. Commercial sources such as auto body refinishing, tank cleaning and fuel combustion contribute the final four percent of lead emissions.

Trends

Point sources contribute 61 percent of the total state lead emissions. In Minnesota, estimated lead emissions from point sources have decreased since 2002. Total lead emissions decreased slightly between 2005 and 2006 with an increase in the utilities sector being off-set by a decrease in the manufacturing sector.



References/Web Links

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

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

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

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

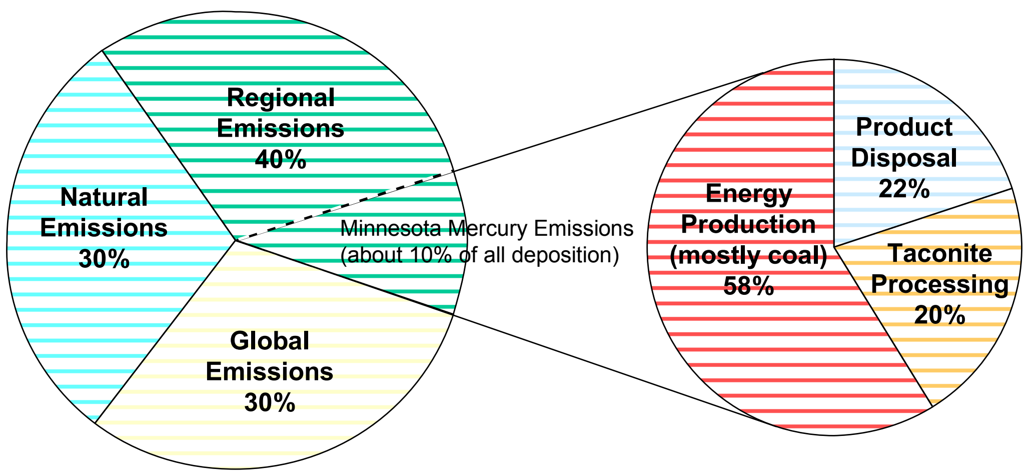
Mercury

Mercury contamination of fish is a well documented problem in Minnesota. The Minnesota Department of Health advises people to restrict their consumption of fish because of elevated mercury concentrations in fish from virtually every lake tested. Nearly all — more than 95 percent — of the mercury in Minnesota lakes and rivers comes from the atmosphere. Consequently, the data presented here only include atmospheric releases.

Emissions Data and Sources

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

Sources of Atmospheric Mercury Deposition to Minnesota	Minnesota Mercury Emissions 2005



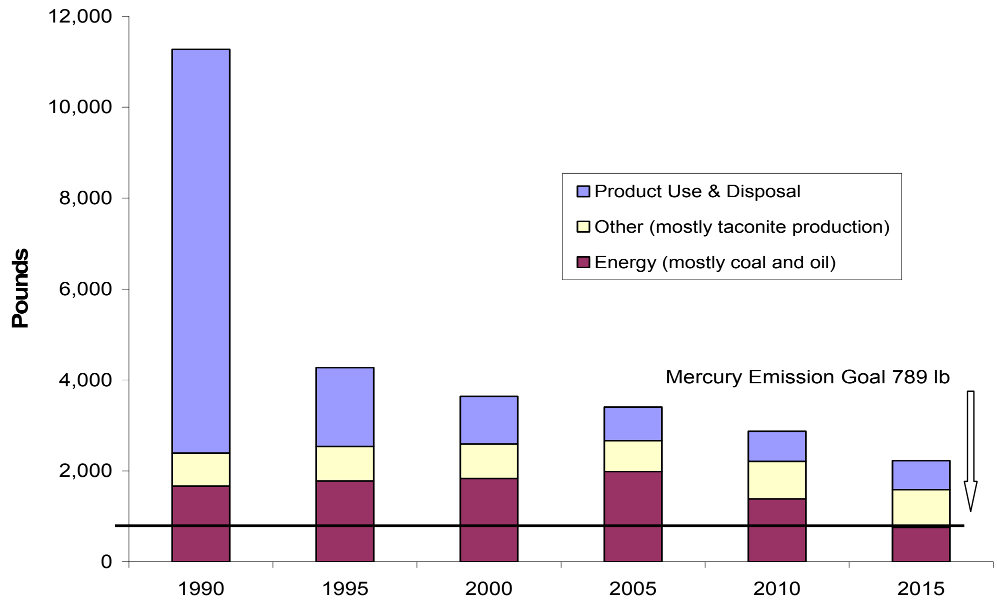
Because mercury vapor can be transported long distances by the atmosphere, most of Minnesota's emissions are deposited in other states and countries, and Minnesota receives their emissions. Minnesota emits about as much mercury as the state receives, and about 90 percent of Minnesota's emissions are carried by the wind out of state. MPCA staff estimates that only about 10 percent of mercury deposition in Minnesota is the result of emissions originating within the state.

MPCA staff estimates that the remaining 90 percent of the deposition is derived from three roughly equal categories: 30 percent from human-generated sources in the rest of North America, 30 percent from human sources in the rest of the world, and 30 percent naturally cycling mercury.

Trends

MPCA staff estimates that total mercury emissions in Minnesota declined significantly from 1990 to 2000. In 1990, emissions are estimated to have been about 11,300 pounds. By 2005, mostly due to discontinued use of mercury in products and mandated controls on incineration of solid waste, emissions were about 3,600 pounds, roughly a 70% reduction from 1990 levels.

Trends in Minnesota Mercury Emissions from Human Activities, 1990-2015



Sediment core studies from lakes in Minnesota and elsewhere show slight declines in atmospheric deposition relative to a peak in the 1970s and 1980s. Analysis by MPCA staff has shown mercury concentrations in northern pike and walleye decreased significantly through the mid-1990s but has since been increasing. The increasing mercury levels in fish may be a result of one or more environmental changes, such as an increase in the global emissions of mercury or an increase in the mercury bioavailability. The latter could be a consequence of changes associated with climate change. The MPCA's Statewide Mercury TMDL, approved by EPA in March 2007, established a goal of 93 percent mercury reduction in air emissions (compared to 1990 levels) to achieve the water quality standard of 0.2 ppm mercury in fish. A stakeholder group is working on the implementation plan to achieve the mercury reduction goal in Minnesota's emissions. Because most of the mercury deposited in Minnesota is emitted outside the state, the increasing trend of mercury in Minnesota fish underscores the need for mercury emission reductions beyond Minnesota's borders.

To address the state's largest emissions sources, the Mercury Reduction Act of 2006 requires three large electric power plants in the state to reduce emissions by 90 percent by 2014. This will result in a decrease of about 1,200 pounds from current levels. This reduction, added to cuts pledged at other coal-fired plants in the state, means that emissions in the state will continue to decline overall despite anticipated increases from new mining and power generation and increases from electric generation at remaining coal plants. Planning for these reductions is currently underway and decreases will begin as early as 2010. By 2015, the MPCA predicts that emissions will have declined about 80 percent from 1990 levels.

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

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 from 2002. 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. **Area Sources**: Typically stationary sources, but generally smaller sources of emissions than point sources. Examples include dry cleaners, gasoline service stations and residential wood combustion. Area 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 area sources in the 2002 inventory. The results for on-road vehicles, aircraft (including ground support equipment), and locomotives were also estimated by the MPCA. The estimates for commercial marine vessels were adopted from the Central Regional Air Planning Association. For all non-road equipment except snowmobiles and pleasure craft, MPCA used estimates from the EPA's National Mobile Inventory Model prepared by the Lake Michigan Air Directors Consortium. For snowmobiles and pleasure craft, MPCA revised the results with survey data on fuel usage from the Minnesota Department of Natural Resources.

Table 3 provides a summary of air toxics emissions from principal source categories taken from the 2002 Minnesota Air Toxics Emission Inventory. The table gives total statewide emissions of each chemical, along with the percent from point, area, on-road, and non-road mobile sources. The inventory includes 167 chemicals: 16 polycyclic aromatic hydrocarbon compounds (PAHs), 138 non-metal compounds, and 12 metal compounds.

Table 3: 2002 Minnesota Air Toxics Inventory Statewide Summary

Pollutant name	Total (short tons)	Point Sources (%)	Area Source (%)	On-Road Mobile (%)	Non-Road Mobile (%)
PAHs					
Acenaphthene	39	90	7	1	2
Acenaphthylene	56.7		92	4	4
Anthracene	5.8	8	76	9	8
Benz[a]Anthracene	6.2	1	95	2	2
Benzo[a]Pyrene	1.9	3	88	4	5
Benzo[b]Fluoranthene	2.2		92	4	3
Benzo[g,h,i,]Perylene	2.7	1	80	6	13
Benzo[k]Fluoranthene	1.1		86	7	6
Chrysene	4.3	1	96	2	2
Dibenzo[a,h]Anthracene	0.1	10	89	0	2
Fluoranthene	8.3	2	79	6	12
Fluorene	9.8	4	70	9	17
Indeno[1,2,3-c,d]Pyrene	1.9	38	54	2	6
Naphthalene	387	6	70	16	8
Phenanthrene	27.5	2	81	5	11
Pyrene	10.2	3	78	7	12
Other PAHs not included above	4.6	4	96		
PAH Total	**569**	**11**	**70**	**12**	**7**
Metal Compounds					
Antimony	1.8	99	1		1
Arsenic	7.4	92	2	6	
Beryllium	0.2	73	17		10
Cadmium	1.7	87	12		1
Chromium	8.0	90	3	7	
Chromium VI	1.0	86	2	11	1
Cobalt	3.3	98	1		
Copper	13.5	96	1	3	
Lead	40.2	67	4		29
Manganese	51.9	97	1	1	
Nickel	15.3	93	3	3	1
Selenium	4.0	89	11		
Metal Total*	**148**	**89**	**3**	**2**	**8**
* mercury addressed separately					
Non-Metal Compounds (Excluding PAHs)					
Acetaldehyde	2094	14	19	38	29
Acetamide	0.0003		100		
Acetone	1343	28	47	24	1
Acetonitrile	103.5	1	99		
Acetophenone	1.0	23	77		
Acrolein	271	36	22	21	21

Table 3: 2002 Minnesota Air Toxics Inventory Statewide Summary

Pollutant name	Total (short tons)	Point Sources (%)	Area Source (%)	On-Road Mobile (%)	Non-Road Mobile (%)
Acrylamide	0.08	100			
Acrylic Acid	7.1	100			
Acrylonitrile	5.0	54	46		
Aldehydes	31.1	100			
Aniline	0.0000036	100			
Atrazine	129		100		
Benzaldehyde	90.3	3		86	12
Benzene	6,217	2	24	54	21
Benzyl Chloride	2.1	93	7		
Biphenyl	5.3	91	9		
Bromoform	0.4	98	2		
Methyl Bromide (Bromomethane)	518	2	98		
1,3-Butadiene	710		6	46	48
Butyraldehyde	57.6	1		85	14
Carbon Disulfide	1.1	69	31		
Carbon Tetrachloride	1.2	62	38		
Carbonyl Sulfide	1.1	76	24		
Catechol	0.06	100			
Trichlorofluoromethane (CFC-11, R-11)	1.8	60	40		
Trichlorotrifluoromethane (CFC-113, R-113)	365	1	99		
Chlorine	149	17	82		
Chlorobenzene	165	1	99		
Ethyl Chloride	28	16	84		
Chloroform	195	1	99		
Chloroprene	0.0011	100			
2-Chloroacetophenone	0.08	98	2		
Cresol/Cresylic Acid (Mixed Isomers)	1.3	100			
m-Cresol	0.03	100			
o-Cresol	0.1	42	58		
p-Cresol	0.2	41	59		
Crotonaldehyde	43.4	3	0	67	30
Cumene	30.9	45	55		
Cyanide Compounds	232	13	87		
2,4-D (2,4-Dichlorophenoxyacetic Acid)	27.7		100		
Dibenzofuran	1.0	20	80		
Ethylene Dibromide (Dibromoethane)	0.5	98	2		
Dibutyl Phthalate	0.9	80	20		
Ethylene Dichloride (1,2-Dichloroethane)	2.7	56	44		
Dichlorvos	0.0010	100			
1,4-Dichlorobenzene	188		100		
M-Dichlorobenzene	1.6	44	56		
O-Dichlorobenzene	214	0	100		

Table 3: 2002 Minnesota Air Toxics Inventory Statewide Summary

Pollutant name	Total (short tons)	Point Sources (%)	Area Source (%)	On-Road Mobile (%)	Non-Road Mobile (%)
Dichlorobenzenes	0.13	29	71		
Ethylidene Dichloride (1,1-Dichloroethane)	1.3	49	51		
Cis-1,2-Dichloroethylene	0.43	100			
Cis-1,3-Dichloropropene	0.09	100			
1,3-Dichloropropene	363		100		
Diethyl Sulfate	0.000005	100			
Diethanolamine	0.3	81	19		
Dimethyl Phthalate	2.7	99	1		
Dimethyl Sulfate	0.5	98	2		
N,N-Dimethylformamide	31	33	67		
Dimethylaniline(N,N-Dimethylaniline)	0.04	100			
2,4-Dinitrophenol	0.07	100			
2,4-Dinitrotoluene	0.03	100			
Bis(2-Ethylhexyl)Phthalate (Dehp)	3.6	99	1		
Di-N-Octylphthalate	0.02	100			
p-Dioxane	1.3	95	5		
Epichlorohydrin	0.02	100			
Ethyl Acrylate	2.1	100			
Ethylbenzene	2,073	5	12	52	31
Ethylene Glycol	125	25	75		
Ethylene Oxide	17.8	12	88		
Fine Mineral Fibers	1.7	100			
Formaldehyde	3,247	15	10	36	39
Glycol Ethers	1,457	30	70		
Hydrochloric Acid (Hydrogen Chloride [Gas	3,173	88	12		
Hexamethylene Diisocyanate	1.2	100			
Hexane	4,013	22	42	19	17
Hexachlorobenzene	0.0049		100		
Hydrogen Fluoride (Hydrofluoric Acid)	480	94	6		
Hydroquinone	8.1	42	58		
Isophorone	18.0	51	49		
Lindane, (All Isomers)	0.0015	100			
Maleic Anhydride	0.37	100			
4,4'-Methylene bis(2-Chloroaniline)	0.0055	100			
Methyl Ethyl Ketone (2-Butanone)	2,059	18	82		
Methylhydrazine	1.9	98	2		
Methyl Iodide (Iodomethane)	0.003	100			
Methyl Isobutyl Ketone (Hexone)	919	12	88		
Methyl Isocyanate	0.014	100			
Methyl Methacrylate	34.7	100			
Methyl Tert-Butyl Ether	0.5	87	13		
Methanol	2,552	29	71		

Table 3: 2002 Minnesota Air Toxics Inventory Statewide Summary

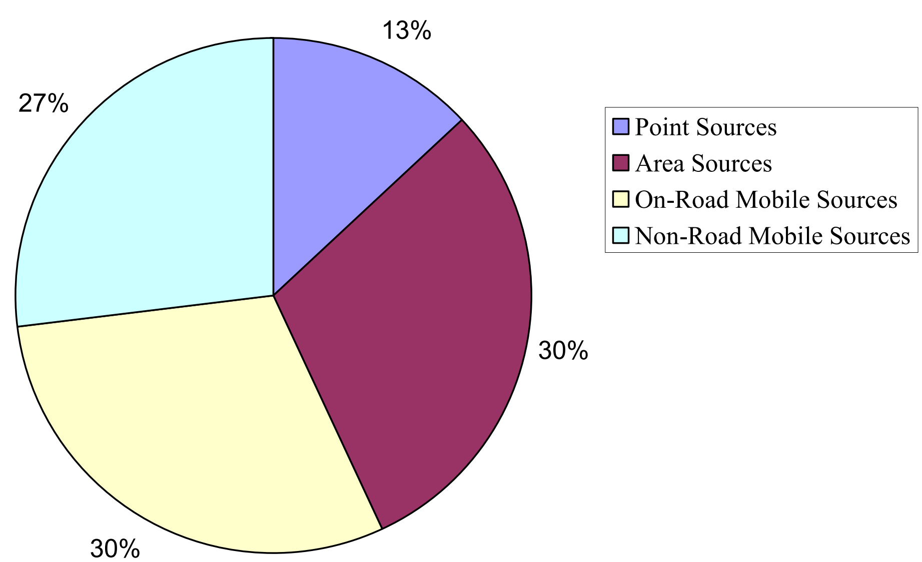
Pollutant name	Total (short tons)	Point Sources (%)	Area Source (%)	On-Road Mobile (%)	Non-Road Mobile (%)
4,4'-Methylenedianiline	0.0000028	100			
4,4'-Methylenediphenyl Diisocyanate (MDI)	2.9	100			
Methyl Chloride (Chloromethane)	41.3	20	80		
Methylene Chloride (Dichloromethane)	400	23	77		
Nitrobenzene	0.2	100			
4-Nitrophenol	0.5	60	40		
2-Nitropropane	0.01	25	75		
Polychlorinated Biphenyls (Aroclors)	0.6	1	99		
Polychlorinated Dibenzodioxins, Total	0.02	96	4		
Polychlorinated Dibenzo-P-Dioxins and Furans, Total	0.00007	100			
Polychlorinated Dibenzofurans, Total	0.0002	26	72		2
Pentachlorophenol	0.12	90	10		
Tetrachloroethylene (Perchloroethylene)	235	33	67		
Phenol	453	24	76		0
p-Phenylenediamine	0.06	100			
Phosphine	2.2	78	22		
Phosphorus	1.4	97	1		2
Phthalic Anhydride	0.7	100			
Polycyclic Organic Matter	17.6	31	69		
Propionaldehyde	201	5	2	31	62
Propoxur	0.000000004	100			
Propylene Dichloride (1,2-Dichloropropane)	0.6	76	24		
Propylene Oxide	0.6	100			
Quinone (p-Benzoquinone)	1.1	100			
Styrene	1117	55	17	20	8
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	0.000002	47	45		7
2,3,7,8-Tetrachlorodibenzofuran	0.00002	41	58		2
Dioxin and Furans (2,3,7,8-TCDD Equivalents)	0.000007	46	1	53	
Methyl Chloroform (1,1,1-Trichloroethane)	904	1	99		
1,1,2,2-Tetrachloroethane	1.4	46	54		
Toluene	21,133	4	23	34	40
2,4-Toluene Diisocyanate	1.1	100			
o-Toluidine	0.0004	28	72		
Trichloroethylene	212	96	4		
1,2,4-Trichlorobenzene	5.9	100			
1,1,2-Trichloroethane	0.3	100			
2,4,6-Trichlorophenol	0.0002	97	3		
Triethylamine	7.1	67	33		
Trifluralin	19.9		100		
2,2,4-Trimethylpentane	7,008		3	43	54
1,2,4-Trimethylbenzene	1,381	5	1	94	

Table 3: 2002 Minnesota Air Toxics Inventory Statewide Summary

Pollutant name	Total (short tons)	Point Sources (%)	Area Source (%)	On-Road Mobile (%)	Non-Road Mobile (%)
1,3,5-Trimethylbenzene	468			100	
Trimethylbenzene	31	6	94		
Vinylidene Chloride (1,1-Dichloroethylene)	1.6	15	85		
Vinyl Acetate	27	64	36		
Vinyl Chloride	9.0	25	75		
m-Xylene	7.5	71	29		
o-Xylene	97	4	96		
p-Xylene	0.6	100			
Xylenes (Mixed Isomers)	12,470	6	27	33	34
Non-Metal Total	**80,088**	**13**	**30**	**30**	**27**
Grand Total	**80,806**	**13**	**30**	**30**	**27**

The following chart summarizes air toxics pollutant emissions in Minnesota from 2002. On-road and non-road mobile sources account for 57 percent of the emissions. Area sources contributed 30 percent of total emissions and point sources contributed 13 percent of emissions. This is a change from the 1999 inventory when each principal source category was responsible for about a quarter of total emissions.

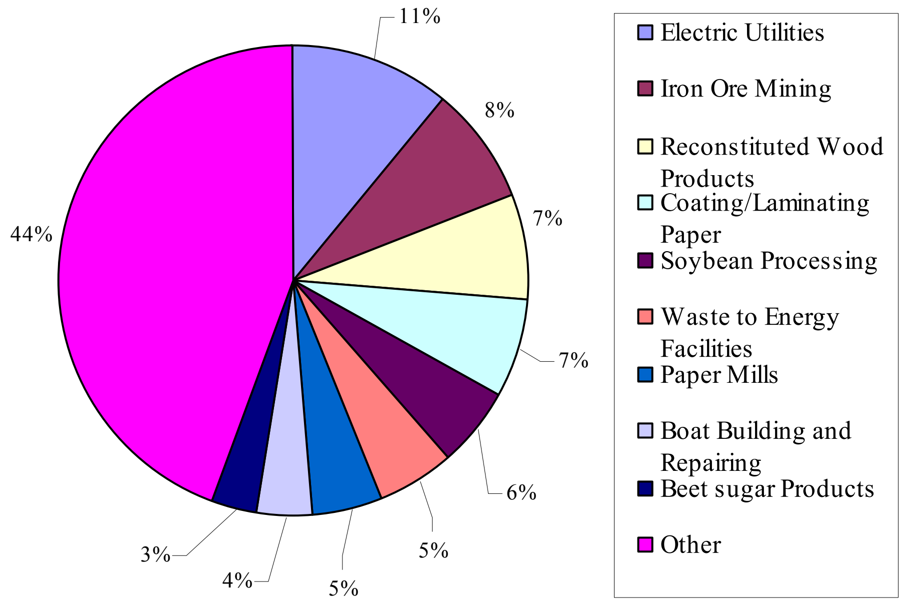
Contribution of Principal Source Categories to 2002 Air Toxics Emissions in Minnesota



Total air toxics emissions in 2002: 80,800 tons

A more detailed breakdown of emissions for each principal source category is shown in the following three pie charts. For point sources, no one source category dominates the air toxics emissions. The largest source category is electric utilities which account for 11 percent of point source emissions.

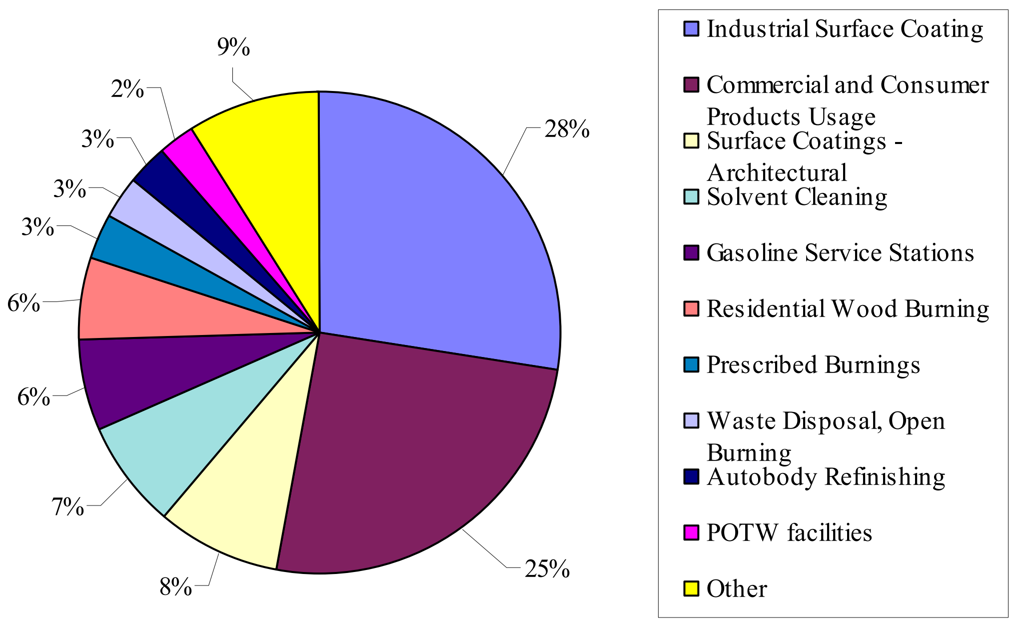
Contribution of Major Categories to 2002 Point Source Air Toxic Emissions in Minnesota



Total air toxics point source emissions in 2002 is 10,600 tons

For area sources, the major contributors of emissions are Industrial Surface Coating and Commercial and Consumer Products Usage. About half of the area source emissions are attributed to these two categories.

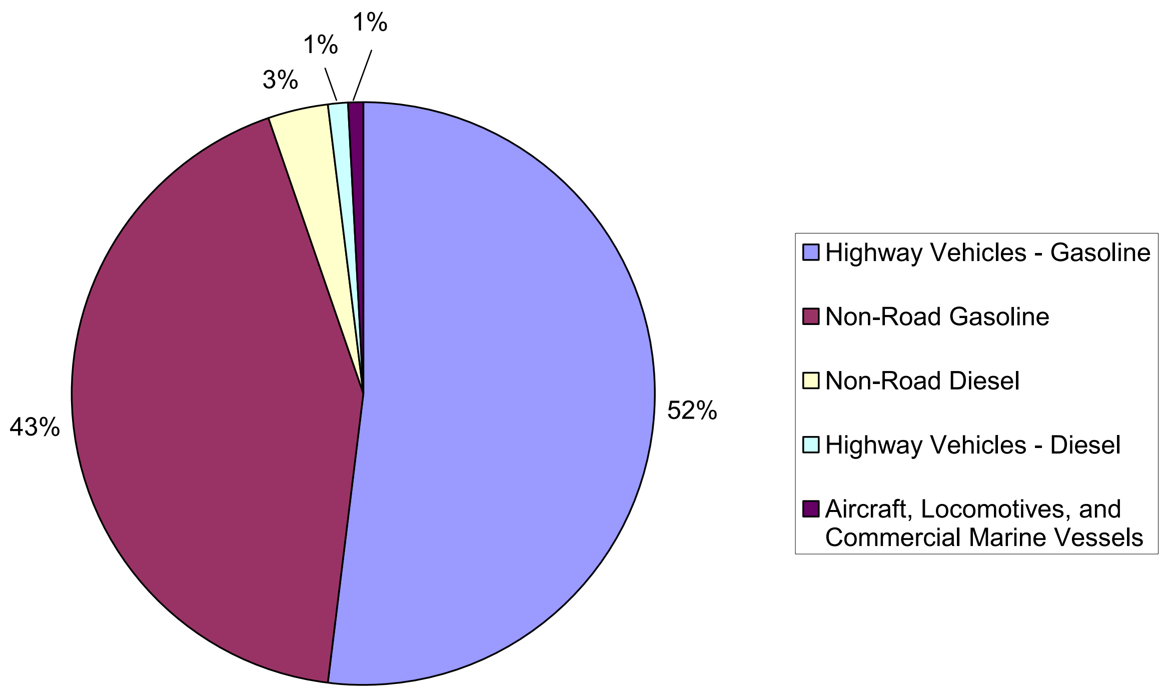
Contribution of Major Categories to 2002 Area Source Air Toxics Emissions in Minnesota



Total air toxics area source emissions in 2002: 24,300 tons

For mobile sources, the largest emission contributor is Highway Vehicles - Gasoline, which accounted for 52 percent of total mobile source emissions in 2002. The second largest contributor of mobile source emissions is Non-road – Gasoline, which accounts for 43 percent of mobile source air toxics emissions.

Contribution of Major Categories to 2002 Mobile Source Air Toxics Emissions in Minnesota



Total air toxics mobile source emissions in 2002: 46,000 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 protect and improve Minnesota'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 information and data to make sound environmental management decisions.

Point sources consist mainly of municipal and industrial wastewater discharges. Point sources are most significant 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 in proportion with changing land uses and expanding population and development. 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.
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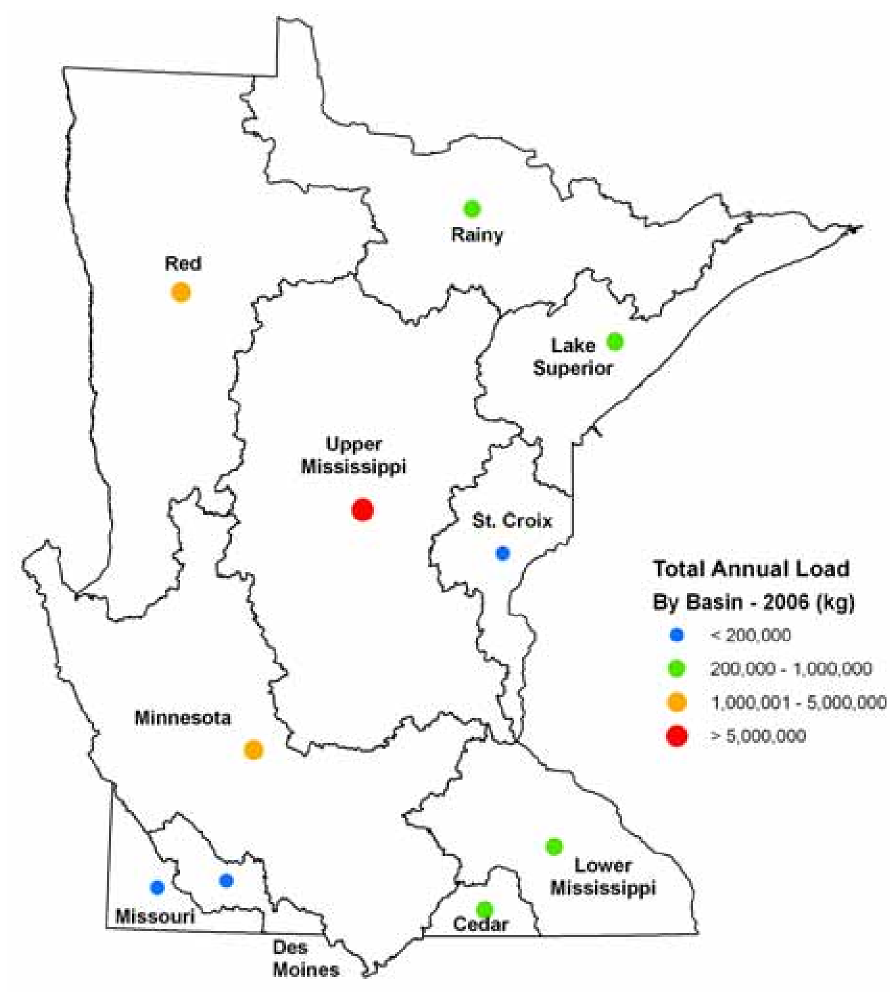
Major Water Discharge Parameters and Trends

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); and ammonia (NH_3). A summary table of the data from 2002-2006 (the five most recent years for which data are available), and an analysis of trends for these pollutants is found on page 3 of this report.

Total Annual Pollutant Load by Basin

The total annual pollutant load from major treatment facilities to Minnesota waters for 2006 was approximately 10,700,000 kilograms, representing a decrease of approximately 10.8 percent from 2005. The figure below shows the distribution of pollutant loading by major river basin for 2006. The Upper Mississippi River Basin contributed over 7,000,000 kilograms, while the Minnesota River Basin contributed just over 1,000,000 kilograms. Following is a discussion of the statewide loadings of several individual parameters 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, 2006

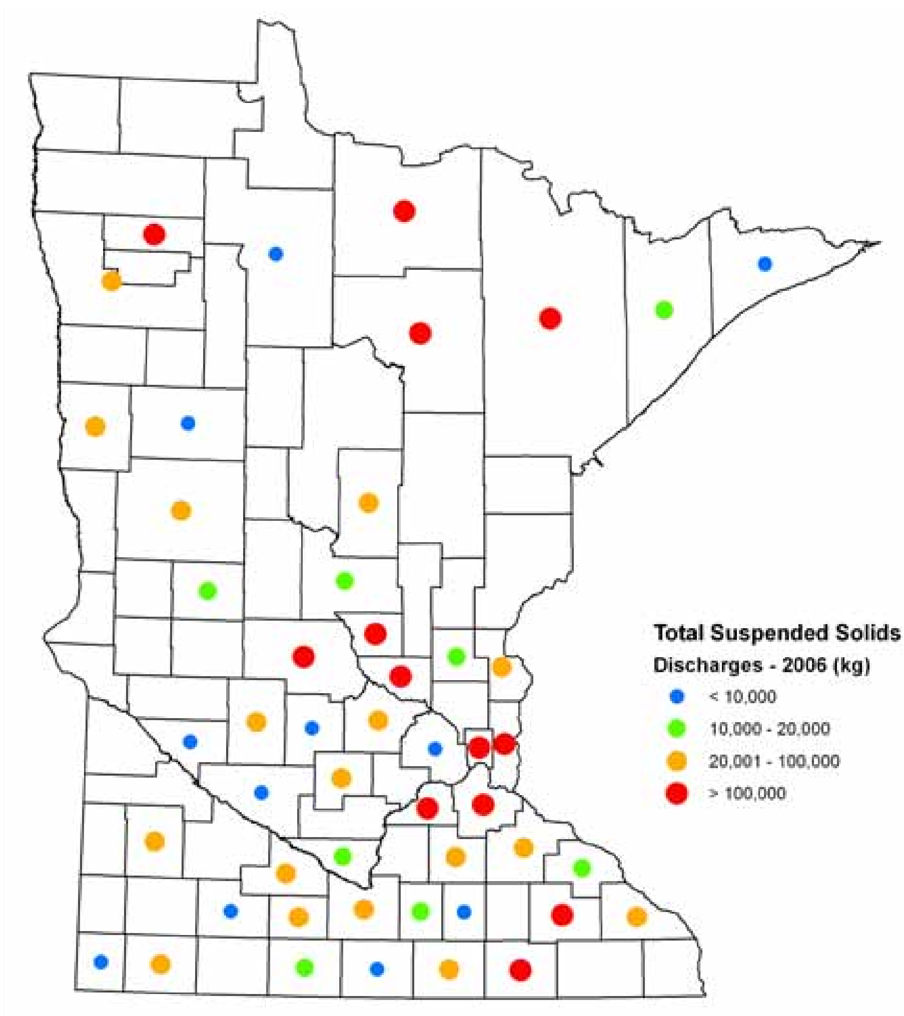


Total Suspended Solids

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 88 major treatment facilities, the estimated discharge of TSS to waters of the state for the year 2006 was approximately 3,600,000 kilograms, a decrease of 18.2 percent from that reported in 2005.

The figure below shows the 2006 TSS discharges to surface waters by major point sources of water pollutants, aggregated by county.

Total Suspended Solids Discharges from Major Point Sources, 2006

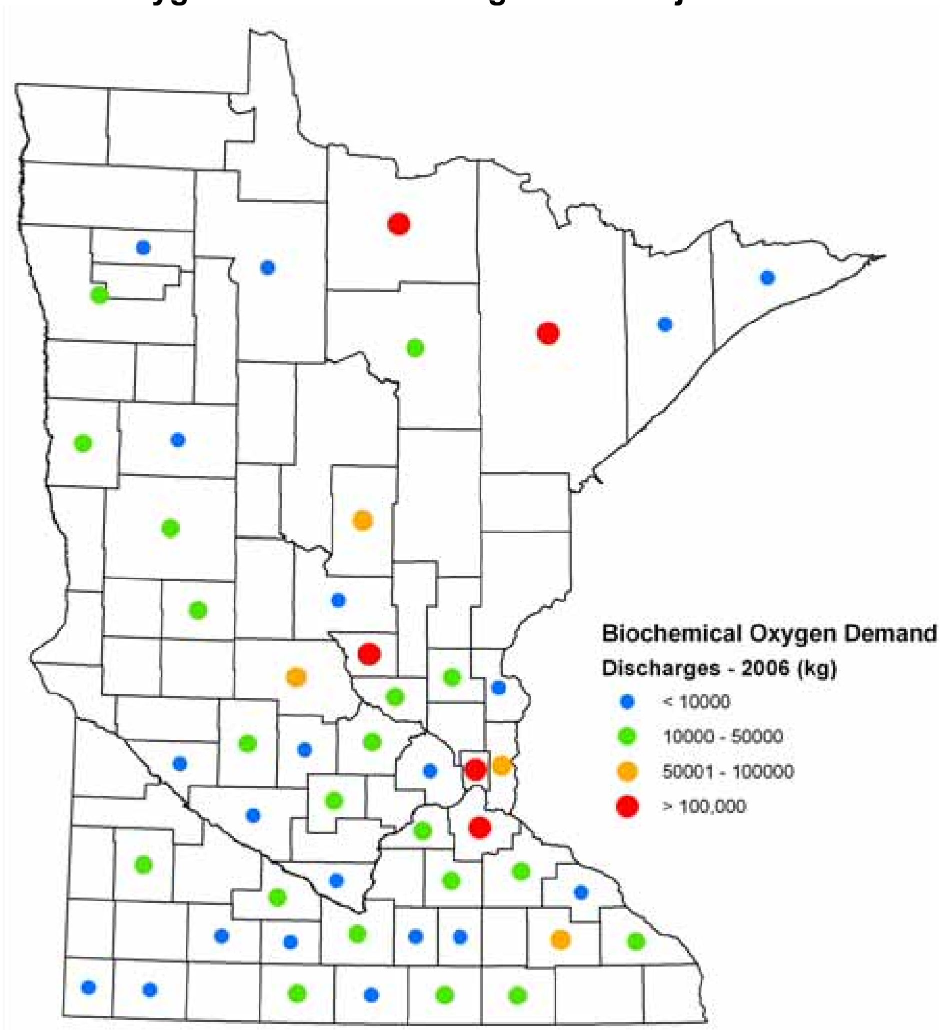


Biochemical Oxygen Demand

When organic wastes are introduced into water, they require oxygen to break down. High concentrations of organic materials characterize untreated domestic wastes and many industrial wastes. The amount of oxygen required for decomposition of organic wastes by microorganisms is known as 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 whenever available; CBOD data were used only if BOD was not reported. A high demand for oxygen causes reduction in the concentration of dissolved 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 76 major treatment facilities, the estimated discharge of BOD to waters of the state for 2006 was approximately 2,100,000 kilograms, a decrease of 22.2 percent from 2005. The combined BOD discharge to waters of the state has decreased each year since 2002, when it peaked at approximately 4,200,000 kilograms. The figure below shows the 2006 BOD discharges to surface waters by major point sources of water pollution, aggregated by county.

Biochemical Oxygen Demand Discharges from Major Point Sources, 2006

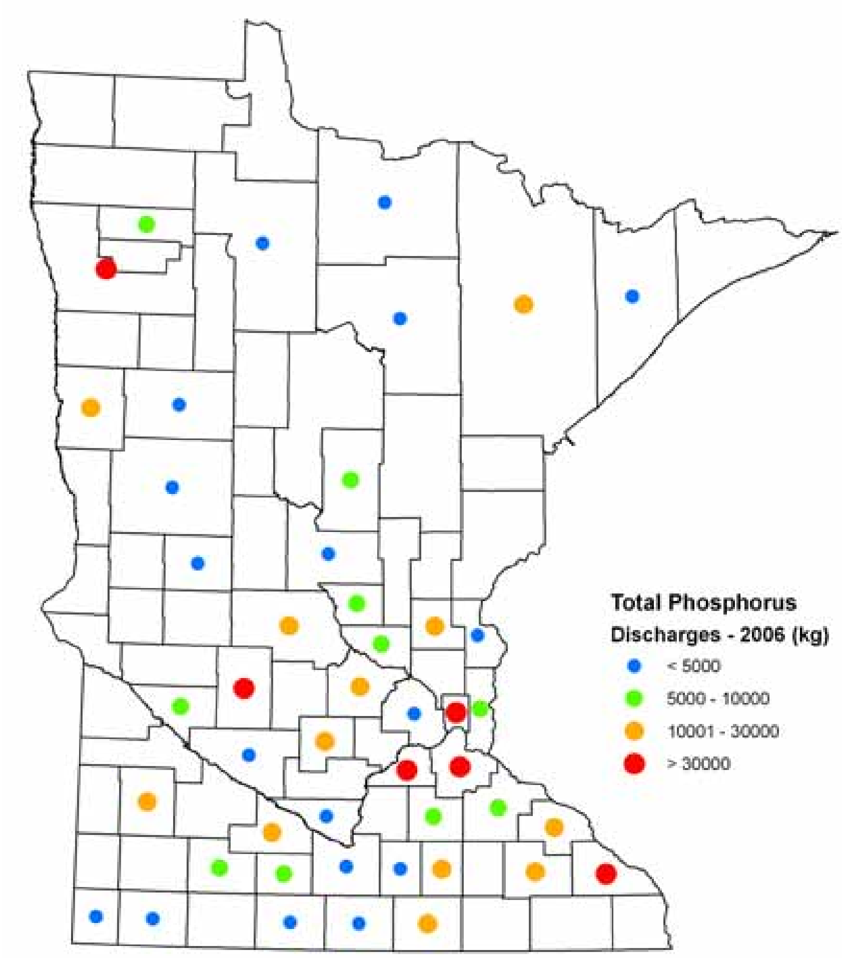


Total Phosphorus

Total phosphorus (TP) is the primary pollutant associated with the 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. According to Minn. Rule 7050.0211 subp. 1, "Where the discharge of effluent is directly to or affects a lake or reservoir, phosphorus removal to one milligram per liter shall be required. In addition, removal of nutrients from all wastes shall be provided to the fullest practical extent whenever sources of nutrients are considered to be actually or potentially detrimental to the preservation or enhancement of designated waters."

Based on the results of Discharge Monitoring Reports for 69 major treatment facilities, the estimated discharge of TP to waters of the state for the year 2006 was approximately 680,000 kilograms, a decrease of 11.7 percent from 2005. Many treatment plants are now using advanced treatment 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 figure below shows the 2006 TP discharges to surface waters by major point sources of water pollutants, aggregated by county.

Total Phosphorus Discharges from Major Point Sources, 2006

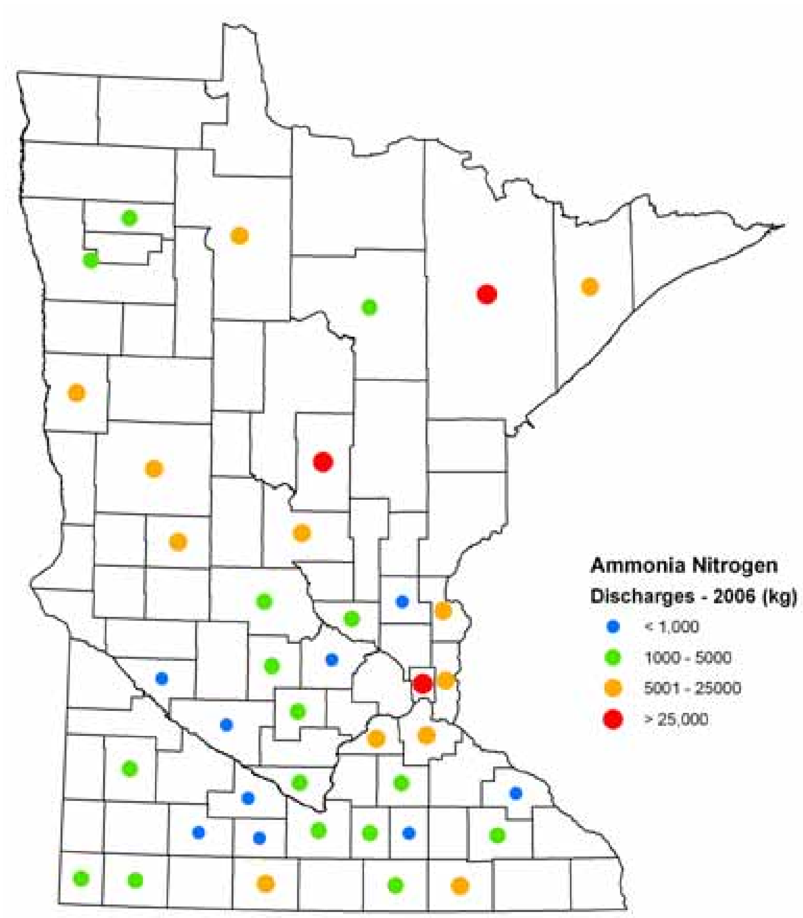


Nitrogen

Nitrogen, generally occurring as either nitrate or ammonia is present in a wide variety of effluents including sewage (wastewater treatment plants and on-site sewage 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 the year 2006 were 370,000 kilograms of ammonia, a decrease of 41.3 percent from 2005. Some of the decrease leading up to 2006 results from a substantial, documented decrease in ammonia nitrogren from the Metropolitan Council Environmental Services Metro Plant. Like total phosphorus, above, 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 from year to year. The figure below shows the 2006 ammonia discharges to surface waters by major point sources of water pollutants. A similar analysis was not attempted for nitrate because an insufficient number of data points were available to make a county-by-county analysis.

Ammonia Discharges from Major Point Sources, 2006



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 the 88 major treatment facilities discharging more than one million gallons per day of treated effluent have cut their total amount of pollutants discharged to waters of the state by nearly 8,000,000 kilograms since 2002, 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 snow melt 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.

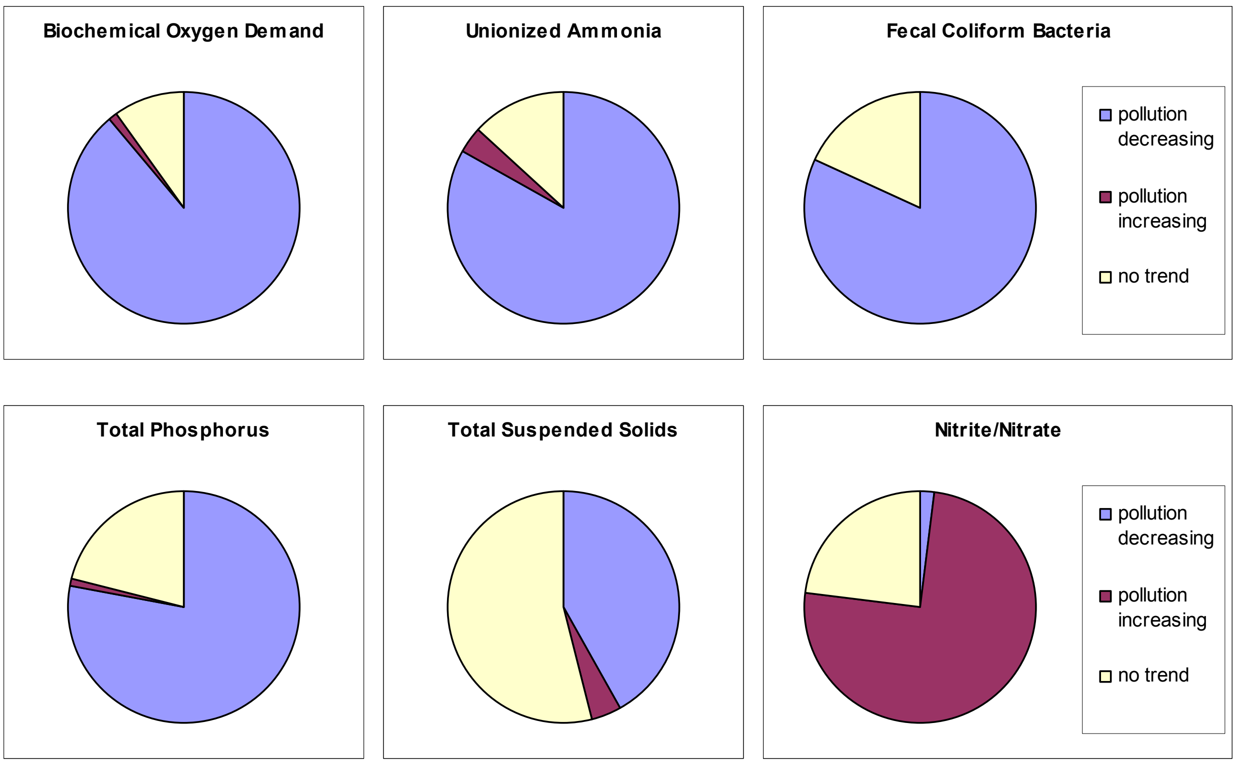
Over the past few years, more regulatory controls for sources like feedlots, septic systems and stormwater have been implemented, but these sources of nonpoint pollution can be diffuse and difficult to manage. Much of the work to control nonpoint source pollution thus far has used financial incentives to encourage voluntary adoption of best management practices (BMPs). The Board of Water and Soil Resources (BWSR) has attempted to quantify the amount of nonpoint source pollutants like nitrogen, phosphorus and sediment avoided by use of BMPs. See pages 5-7 of the 2006 “Watershed Achievements” report at: http://www.pca.state.mn.us/publications/wq-cwp8-06.pdf

The big news in nonpoint source restoration and impaired waters reduction is that the Minnesota Legislature passed a policy bill and initial funding as a part of the Clean Water Legacy Act. The Act provides for $24 million in funding, with over 11 million earmarked for nonpoint source restoration. In addition, over $1.1 million 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 every day, 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.

Pollutant Trends at Minnesota Milestone Monitoring Sites

Measuring the effects of solely nonpoint source pollution can be difficult and expensive. The best long-term data about Minnesota streams comes from measuring six key pollutants at 80 stream locations over the past 40 years as part of the Minnesota Milestone Monitoring Program. These locations are chosen to not be unduly influenced by the effects of point source pollution, although the results certainly reflect the contribution of all discharges upstream of the monitoring point.

Pollutant Trends at Minnesota Milestone Sites



The results of the Milestone Monitoring Program generally agree with trends shown by point source discharges from Discharge Monitoring Reports. Improvements in BOD, fecal coliform bacteria, ammonia and phosphorus are likely indicative of success in dealing with municipal and industrial point sources. The increases in suspended solids and especially nitrate are likely due to increasing nonpoint source contributions. In the case of nitrate, increased nitrogen fertilization coupled with higher than normal precipitation (at least until 2004) and improved efficiency of drain tiling systems have resulted in increased nitrogen loading to rivers and streams.

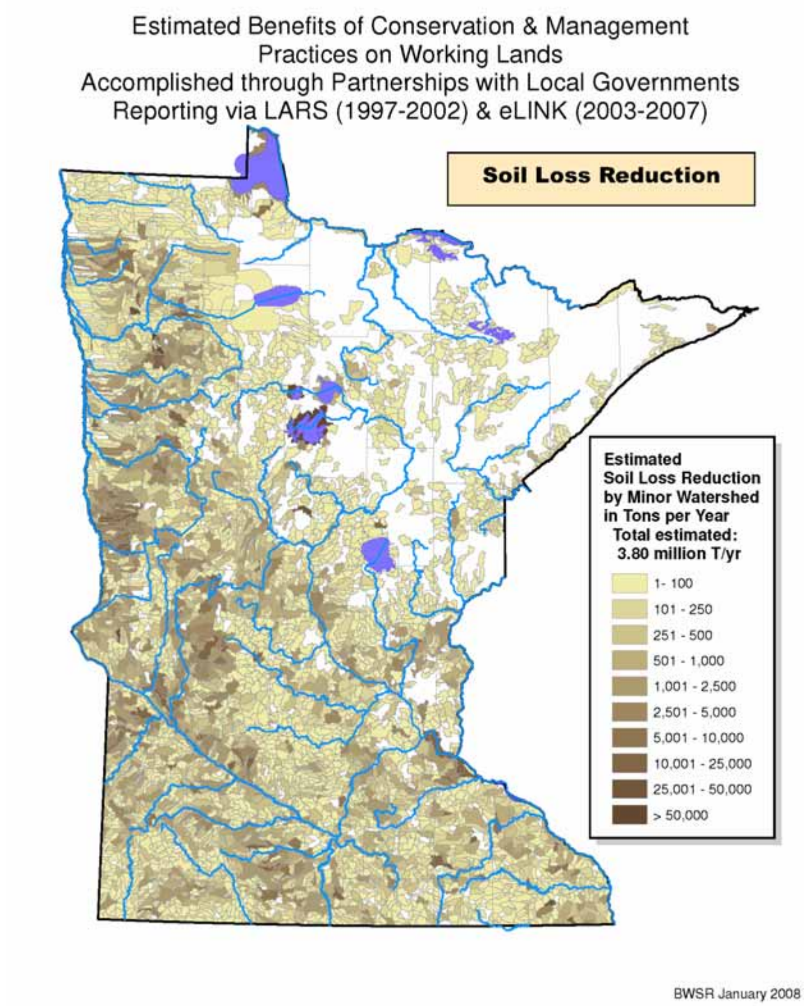
As another example, ground water data collected from several hundred wells across the state in aquifers that are sensitive to nitrate contamination showed that 60 percent of the wells monitored had nitrate levels above one part per million (ppm), suggesting possible anthropomorphic impacts to the aquifer that the well taps. Of these, 18 percent contained nitrates above the drinking water standard of 10 ppm. More about nitrates in Minnesota's ground water is discussed at:
http://www.pca.state.mn.us/water/groundwater/pubs/nitrate.pdf

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 and lakes 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 Local Annual Reporting System (LARS), (1997-2002) and its successor eLINK (2003-present). 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 up from the 2.9 million tons per year 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; 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.

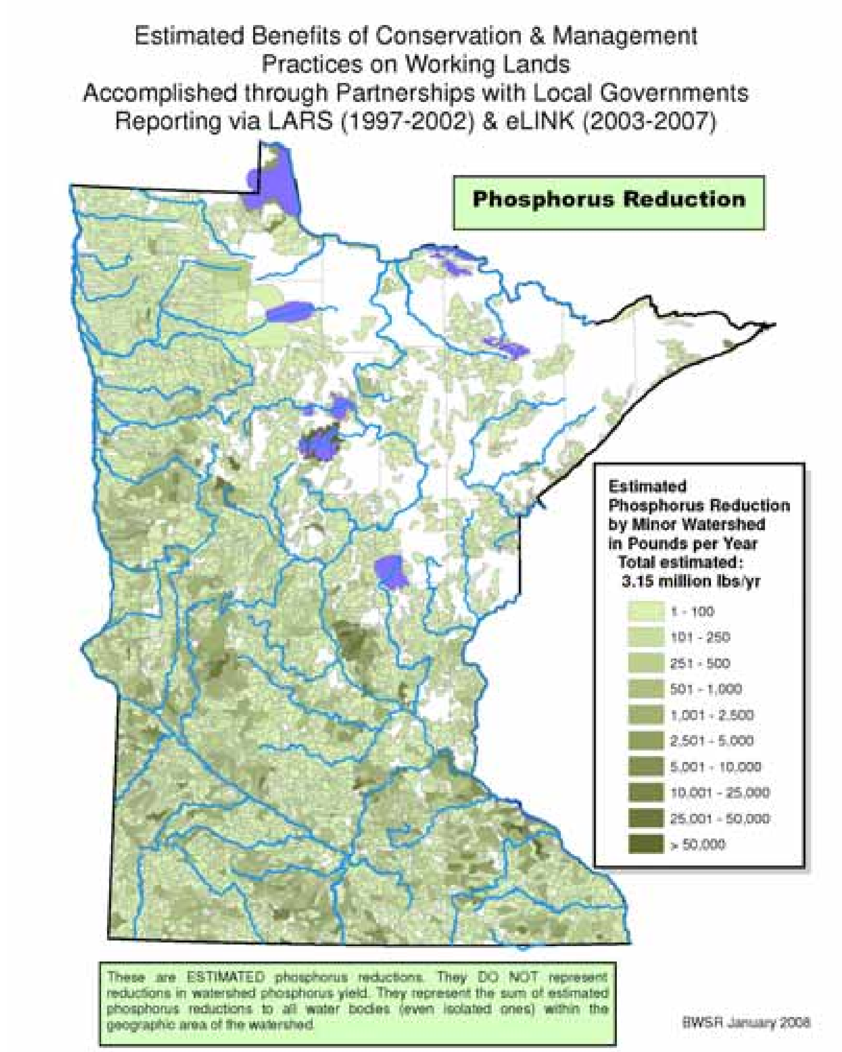
Soil Loss Reduction Benefits from Conservation and Management Practices, January 2008



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, recent data from BWSR using both LARS and eLINK (March 2006) shows 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 per 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.

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
- Polybrominated diphenyl ethers (PBDEs)

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 waste water treatment plants, and in landfill leachate and gas.

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 encompassed a wide variety of compounds including: antibiotics, over-the-counter pharmaceuticals, hormones, detergents, disinfectants, plasticizers, fire retardants, insecticides and musks used in the production of fragrances. The USGS included certain compounds in their survey because they have biological activity, such as pharmaceuticals or chemicals that are suspected endocrine disruptors. These products are widely used in consumer and industrial products and continuously released into the environment through human activities. Sources can include wastewater discharge, manure from confined animal feedlots, landfill leachate, and urban runoff.

The MPCA has been collaborating with Kathy Lee and Larry Barber (of the local and national U.S. Geological Survey offices) since 2000 and with Heiko Schoenfuss (St. Cloud State University) since 2004 to further monitor and define health effects associated with this suite of compounds in Minnesota's water resources. The first state reconnaissance study by USGS, MPCA and the MDH showed that industrial and 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 measured in the highest concentrations. The complete report may be found at http://water.usgs.gov/pubs/sir/2004/5138/

The MPCA has also worked since 2002 with several partner organizations and the Minnesota Hospital Association to improve environmental compliance and pollution prevention throughout healthcare facilities in Minnesota. Compliance evaluations of healthcare facilities had revealed widespread mismanagement of complex hazardous wastes such as pharmaceuticals, laboratory solvents and reagents, and mercury-containing wastes. As a result of this collaboration, hospitals have been changing their waste management methods. Fiscal year 2006 resulted in 28 metro area hospitals properly managing 75 tons of pharmaceuticals and 30 tons of laboratory wastes as hazardous waste. Twelve hazardous waste compliance training events have been presented throughout the state in FY 2006 with over 500 healthcare professionals in attendance. Partner organizations participating in this effort include the Solid Waste Management Coordinating Board, Minnesota Technical Assistance Program, and 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 dues 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 the 2002 USGS pharmaceuticals, household and industrial products survey, Kathy Lee and Larry Barber from the USGS, and Heiko Schoenfuss from St. Cloud State University continue to investigate the significance, sources, and occurrence of compounds with endocrine-disrupting activity in Minnesota's waste streams and waters. This multidisciplinary team of experts has designed a phased approach from laboratory to field studies to discover what effects this diverse suite of compounds has on hormonal activity in aquatic organisms.

Lee, Barber, and Schoenfuss began their examination of EDCs with 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 currently has three ongoing projects with Lee, Barber, and Schoenfuss. The results from these studies will include detailed monitoring results from four wastewater treatment plants and receiving water and a longitudinal study on the Mississippi River. MPCA will utilize the results for developing future water quality standards and helping determine 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

Polybrominated diphenyl ethers (PBDEs)

PBDEs (polybrominated diphenyl ethers) are manmade chemicals that are added to plastics and other products to reduce flammability. Products in which PBDEs or PBDE-containing material are commonly used include electrical appliances and equipment, textiles, furniture, building materials and automobiles.

There are three primary formulations of PBDEs. They are commonly referred to as Penta-BDE, Octa-BDE and Deca-BDE formulations. The Penta- and Octa-BDE formulations were voluntarily phased out by the sole U.S. manufacturer of these products in 2004, leaving only Deca-BDE in use in the U.S. Similarly, the European Union effectively banned the use of Penta- and Octa-BDE in legislation passed in 2003.

Legislation banning products containing Penta-, Octa- and Deca-BDE formulations was proposed in Minnesota during the 2007 session; however, only the ban pertaining to Penta- and Octa-BDE passed. The legislation included the requirement that the MPCA prepare a report about Deca-BDE. Currently, a revised bill that bans the use of Deca-BDE in television enclosures, residential furniture, and mattresses is being debated by the Minnesota Legislature.

PBDEs have been a subject of growing concern because they are now ubiquitous in the environment, and the detected concentrations are increasing. PBDEs have been detected in rivers, lakes and sediments; in indoor and outdoor air; in food; in sewage sludge; and in animals, including fish, birds, terrestrial and marine mammals, and people.

The concentrations of PBDEs in the blood and breast milk of North Americans (Canada and the U.S.) have also been increasing. Studies show that the body burden concentrations of PBDEs in North Americans are at least an order of magnitude higher than in Europeans.

The presence of PBDEs in the environment and in human blood and breast milk is of concern because of the association of these chemicals with endocrine disruption, reproductive toxicity, and developmental neurotoxicity in laboratory animal studies.

The PBDE congeners that make up the Penta-BDE formulation appear to be the main contributor to current environmental and body burden PBDE concentrations. While the Penta-BDE formulation has been withdrawn from the U.S. marketplace, recent studies have demonstrated that Deca-BDE, which is still in wide use, can debrominate by photolytic or biological mechanisms to form the PBDE congeners associated with the Penta-BDE formulation.

Dietary intake and inhalation and ingestion of indoor dust containing PBDEs are the primary ways that humans are exposed to PBDEs.

The MPCA has been involved in investigating the impacts of PBDE contamination in Minnesota for several years. A 2001 MPCA study found that PBDEs were present in different environmental settings, including fish and sediments from major river basins in Minnesota. This study also detected PBDEs in waste management processes, including landfill leachate, and wastewater treatment plant sludge.

In 2003, the MPCA conducted a study of PBDEs in Lake Superior sediment, water and fish tissue. Historical concentrations of PBDEs in the sediments were generally found to coincide with PBDE commercial production and use. Sediment samples dating to the late 1950s to the early 1960s showed the first detectable concentrations of PBDEs, with increased total concentrations and increased rates of deposition of PBDEs in sediment samples dating from more recent times and continuing through the present. PBDEs were also detected in fish tissue samples.

A scientific background paper *Flame Retardants: Polybrominated Diphenyl Ethers (PBDEs)* was published by the MPCA in February 2005, and is available at the following link to 2005 Legislative Reports: http://www.pca.state.mn.us/publications/reports/tdr-g1-02.pdf

At the request of the Minnesota Legislature, the MPCA prepared a report in 2007 on Decabromodiphenyl Ether (Deca-BDE), the only PBDE formulation still widely used in the United States. This report is available on the MPCA website at the following link:
http://www.pca.state.mn.us/publications/reports/lrp-ei-2sy08.pdf

Emerging Issues: a broader approach

To more effectively identify and evaluate issues that are developing, in late 2006 the MPCA asked five of its research scientists to monitor new environmental concerns that may be important to Minnesota.

The scientists operate as a team in the Environmental Analysis and Outcomes Division and direct a small percentage (less than 10%) of their time to:

- monitoring emerging issues;
- holding meetings with internal and external partners, including other state, federal, tribal, university, nonprofit, and business entities;
- identifying opportunities to collaborate on relevant research projects; and
- providing technical guidance to MPCA staff and managers on emerging, multimedia contaminant and technical issues that have a potential to impact Minnesota.

There are literally thousands of substances and stressors that could be categorized as emerging issues with potential environmental consequences, and it is not possible to pursue all of them at the same time. Therefore, one of the first tasks of the emerging issues staff team was to develop an approach for sorting and screening the numerous issues in a way that identifies those most important for Minnesota. Key considerations include: how widespread the contaminant or issue is, the current national or state regulatory stance on the issue, a characterization of the risk associated with the contaminant or issue, and the pertinence of the topic to Minnesota's environment.

Additional, more specific considerations used to screen—in a broad sense—identified emerging issues include the following:

- Is the issue likely to affect a large geographic area, population, or ecosystem?
- Is the issue pertinent to Minnesota or the upper Midwest/Great Lakes region?
  - If so, does it have particular relevance to Minnesota due to the production, use, or distribution of items comprising the emerging issue?
- Can the issue of concern be assessed with the information available to us?
  - If not, what information is needed?
- Are the physical-chemical properties of the emerging chemical or nanomaterial such that long-range transport, persistence, and/or bioaccumulation will result upon release to the environment?
- Could exposure to the emerging chemical, organism, or nanomaterial negatively impact human health or the environment?
- Is the issue within the purview of the MPCA, or is it likely to be another state or federal agency's area of responsibility?
- Is the issue currently regulated, or being evaluated, under a particular program at the Agency?
  - If so, are there gaps in current regulations or policies that allow the potentially important issue to "slip between the cracks?"

- Is the MPCA taking action to address these gaps?

- Is the U.S. EPA or another federal agency engaged on the topic? If so, are MPCA staff working collaboratively with them on the emerging issue?

Using this approach, the staff team screened a broad list of emerging issues and assembled basic information about those issues considered of most concern to Minnesotans. (Note that several of these—PFCs, EDCs, and PBDEs—were discussed at length during the 2007 legislative session, as described in previous paragraphs.) The staff team also suggested areas where proposed research projects could be augmented to help fill gaps in understanding about emerging issues most relevant to Minnesota.

During late 2007, the staff team broadened its approach for identifying and screening emerging issues by conducting interviews with lead staff from all areas of the MPCA. Staff were specifically asked to describe issues they consider emerging within the areas of their expertise or program activity. The results from the staff team's interviews, together with the scientists' routine monitoring of scientific literature, participation in conferences, and collaboration with other agencies and research institutions, are being reviewed and incorporated into an updated inventory of emerging issues.

The MPCA hopes that this approach and the future activities it may lead to will help Minnesota more effectively anticipate, prevent and respond to the most important current and future emerging issues, in collaboration with citizens, our colleges and universities, businesses and other governmental units.