Annual Pollution Report

to the Legislature

March 2006

Minnesota Pollution Control Agency

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

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Foreword

The Annual Pollution Report statute requires the Minnesota Pollution Control Agency (MPCA) to estimate 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 has prepared this report since 1996. It has evolved to include new kinds of information, such as discharges of toxic air pollutants, greenhouse gas emissions, and emerging contaminants of concern as these kinds of data have become available. The following observations of some strengths and shortcomings of the current reporting process are presented for interested parties to help determine if and how the report should be changed.

Strengths

- 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

Shortcomings

- 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. The volume figures also do not convey whether such emissions and discharges are acceptable or unacceptable from a risk 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.

Shortcomings, cont.

- 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.

As with the 2005 report, this year's report presents some of the information differently. For example:

- Air pollution estimates for point source emissions are based on the Minnesota emission inventory.

- Nonpoint source water pollutant estimates are being highlighted in basin-loading studies, which attempt to quantify the amounts of specific pollutants entering a given watershed from specific sources, both point and nonpoint. While this falls short of being able to quantify nonpoint source discharges statewide, it represents an important first step to better understanding the relative contributions of point and nonpoint sources to specific watersheds, which in turn can guide local and state officials in planning for water quality improvements.

The examples noted above are presented to help the reader get a sense for the dilemmas the MPCA faces in attempting to deliver accurate, timely and useful information about what is discharged into Minnesota's air and water.

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 by Minnesota Statutes, Chapter 116.011 to submit to the Legislature an annual report of the volume of pollution emitted or discharged to the state's air and water resources. In addition to gross amounts, the MPCA must report the annual percentage increase or decrease of pollutants for the most recent year for which data are available. The report must also demonstrate the magnitude of the various sources of air and water pollution. The basis of the MPCA's 2006 Annual Pollution Report is the 2002 and 2004 Minnesota Criteria Pollutant Emission Inventories, the 2002 Air Toxics Emission Inventory and the 2004 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

The MPCA reports data from its own Minnesota Criteria Pollutant Emission Inventory, using data generated in the state. Prior to the 2004 report, EPA data was used. The major air pollutants summarized in this report include carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), volatile organic compounds (VOCs), particulate matter (PM_{10} and $PM_{2.5}$) and lead. These are known as the criteria pollutants. The most recent emissions data available from large facilities for these pollutants are from 2004.

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 2004, facilities with MPCA permits had until April 1, 2005 to submit their 2004 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 2005. Facilities completed their review by November, 2005. MPCA staff then reviewed the changes and completed the inventory for 2004 in January 2006.

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 U.S. EPA's National Emission Inventory. MPCA staff develop 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.

Global climate change is a continuing concern worldwide. Therefore, Minnesota emissions of the principal greenhouse gas, carbon dioxide (CO_2), are included for 2004. The statewide emissions were calculated using a variety of fuel use data sources.

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 because many air toxics are also VOCs. The most recent inventory of air toxics emissions is from 2002.

Table 1 lists the total statewide emissions of the major air pollutants from 2000 to 2004. The percent change from 2003 to 2004 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. Trends should be viewed over several years of data. In addition, emission estimates fluctuate as a result of changes and improvements in the inventory.

The MPCA releases a complete emission inventory including criteria pollutants and air toxics every three years. Emissions of criteria pollutants from large facilities are estimated every year. Therefore, the 2004 emissions include 2004 criteria emissions from large facilities. The 2000-2001 numbers include 1999 data from smaller area and mobile sources. Updated 2002 emissions from area and mobile sources are used for 2002-2004.

Table 1: Minnesota Air Pollution Emission Estimates, 2000-2004
(thousand tons)*

Pollutant	2000	2001	2002	2003	2004	2003-2004 % Change
Carbon monoxide (CO)	2505	2503	2132	2125	2126	0.0%
Sulfur dioxide (SO_2)	156	150	159	167	161	-3.7%
Oxides of nitrogen (NO_x)	482	466	487	484	484	0.0%
Volatile organic compounds (VOCs)	395	393	369	367	367	0.0%
Particulate matter (PM_{10})**	862	851	782	783	783	0.0%
Total	4400	4362	3929	3925	3921	-0.1%

*1999 mobile and area emission estimates are used in 2001-2002. Preliminary 2002 mobile and area emission estimates were used in 2002-2004.
**PM_{10} emissions represent only primary formation; secondary formation is not included.

There may be differences in the total emission figures for a given year discussed in this report versus emission reports that the MPCA has published prior to 2004 because MPCA data are being used instead of EPA data. Differences in methodology exist between the two inventories. In addition, 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. These particles are not directly emitted but are formed downwind of the emission source. Although EPA-approved models to predict the secondary formation of fine particles do not currently exist, work is underway to develop these models. Direct emissions of fine particles ($PM_{2.5}$) from all categories are included for the first time this year in the Minnesota Criteria Pollutant Emission Inventory. $PM_{2.5}$ is not included in Table 1 since $PM_{2.5}$ emissions are a subset of the PM_{10} emissions.

Most pollutant emission estimates were unchanged between 2003 and 2004. Only sulfur dioxide decreased by nearly four percent due primarily to an estimated decrease in emissions from utilities. A similar increase in sulfur dioxide from utilities was seen in 2003. Many air toxics are also VOCs. To avoid double-counting, the preliminary 2002 air toxics emissions are given in the body of the report.

Water Discharges Summary

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. These data, which can be generated from either the EPA's Permit Compliance Tracking System (PCS) or the MPCA's DELTA database, are the basis for the point source discharge summary (Table 2).

Table 2: Minnesota Water Pollution Discharge Estimates From Major Point Sources, 2000-2004 (thousand kilograms)

Pollutant	2000	2001	2002	2003	2004	2003 to 2004 % Change
Total suspended solids	5,100	8,600	7,500	5,700	4,600	-19.3
Biochemical oxygen demand (BOD)	3,500	4,900	4,200	3,700	3,000	-18.9
Phosphorus	1,400	1,400	1,300	1,600	920	-42.5
Ammonia Nitrogen (NH_3)	1,300	1,000	1,100	1,300	830	-36.2
Nitrate Nitrogen (NO_3)	4,700	4,300	4,200	3,100	3,400	+8.8
Total	16,000	20,200	21,300	15,400	12,750	-17.2

In Table 2, discharge estimates for 2000-2002 were generated from PCS, while data for 2003-2004 were generated from DELTA. The reported 2002 values represent the previously reported statewide totals calculated by PCS, adjusted by substituting a few values from DELTA. Data for years prior to 2002 have not been examined in any detail using DELTA. The MPCA began using DELTA to generate the reports on which this section is based when inconsistencies in EPA's Compliance Tracking System database were noted, beginning with the 2003 data summary. Using DELTA allows uniform assumptions about loading to be made throughout MPCA's water programs. The MPCA intends to use DELTA as a basis for this and similar reports for 2003 and beyond.

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 an important step in improving the agency's capacity to accurately perform loading analyses. Due to the multi-year life of permit requirements, however, many permits do not yet contain monitoring and reporting requirements that enable efficient, computerized calculations of total pollutant loadings. As the agency re-issues permits and further assesses the data, it will continue to build capability in this area.

In some cases, values calculated using DELTA vary substantially from those previously derived from PCS. One difference between the totals from PCS and those from DELTA results 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% of the reported numerical component of the value in its calculations; in the calculations performed using DELTA for this report, 50% of the reported numerical value was used.

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:

- Over 30,000 individually reported values have been incorporated into the yearly totals, often in ways that are optimized for concentration-based compliance determination, not environmental assessment.
- The loading calculations incorporate a number of data processing decisions that can legitimately be made using a variety of methods.
- Reporting requirements can vary with each permit issuance, resulting in variation in parameters reported with time 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 from day-to-day and year-to-year.

The 2004 figures represent the combined loading from 89 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 89 major facilities reporting in 2004, 39 showed an increase in total loading over 2003, 46 showed a decrease in total loading, and four facilities reported insufficient data to allow a determination to be made. The decrease in total loading to waters of the state (Table 2) represents a return to the year-to-year downward trend noted from 1997-2000 before the flood year of 2001 (when the Mississippi River was above flood stage for over a month during the spring) and 2002 (a record wet year in many areas, with frequent high-intensity rainfall events). In 2003, spring snowmelt, runoff and precipitation returned to a more "normal" pattern, and this is one factor that may be reflected in the overall decrease in total loading for 2004, as shown by decreases in total suspended solids (TSS), biochemical oxygen demand (BOD), phosphorus (P) and ammonia nitrogen (NH_3) for the statewide database.

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% of water pollution in Minnesota can be attributed to nonpoint sources, while about 14% 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. The 2004 and 2005 Annual Pollution Reports included case histories of the Crow River basin, the Minneapolis chain of lakes, and the Shingle Creek watershed. This year's report includes a further look at the Shingle Creek watershed where best management practices (BMPs) are being implemented to reduce the impact of road salt and other deicing chemicals on waters of 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.

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_{10}), sulfur dioxide (SO_2), nitrogen oxides (NO_x), ozone (O_3), carbon monoxide (CO) and lead (Pb). Fine particles ($PM_{2.5}$) were later included as a criteria pollutant. 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. $PM_{2.5}$ was calculated 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 2005.

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.

Air Toxics

Many other chemicals are released in smaller amounts than the criteria pollutants, but are still toxic. The EPA refers to chemicals that can cause serious health and environmental hazards as hazardous air pollutants or air toxics. Air toxics include chemicals such as benzene, formaldehyde, acrolein, mercury and polycyclic organic matter. Minnesota data come from the preliminary 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: Progress and Priorities—2005 Report to the Legislative
http://www.pca.state.mn.us/publications/reports/lr-airqualityreport-2005.html

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

Air Toxics Monitoring in the Twin Cities Metropolitan Area Preliminary Report
http://www.pca.state.mn.us/hot/legislature/reports/2003/lr-airtoxmonitoring-1sy03.pdf

Criteria Air Pollutant Emissions

Minnesota's Emission Inventory Rule requires all facilities in Minnesota that have an air emissions permit to submit an annual emission inventory report to the Minnesota Pollution Control Agency (MPCA). The report quantifies emissions of the regulated pollutants listed below:

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

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 is then used to calculate an annual emission fee for each facility. Starting with the 2002 inventory, MPCA has also begun estimating $PM_{2.5}$ 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 2004. Emission estimates are available for area and mobile sources for 2002. When 2004 summary data is given, it includes area and mobile data from 2002 and point source data from 2004. This report presents trend data for point sources from 2000-2004.

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 MPCA data is used starting with the 2004 report. Prior to 2004, EPA emissions data was used. Differences in methodology exist between the two inventories. Data may be also 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_{10}), estimated air emissions data in this report are based on direct releases from sources into the atmosphere. Secondary formation of pollutants is not included in the estimates because there is currently no reliable way to estimate their quantity. However, models to predict secondary formation of particles are under development.

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

See the MPCA Environmental Data Access web site to download MPCA emission estimates:
http://www.pca.state.mn.us/data/edaAir/index.cfm

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

See the 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 and $PM_{2.5}$. The AQI is currently calculated for the Brainerd area, Detroit Lakes, Duluth, Ely, Marshall, Rochester, St. Cloud, and the Twin Cities area. All pollutants are not necessarily monitored at each location.

The AQI translates each pollutant measurement to a common index, set at 100 to reflect where 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:

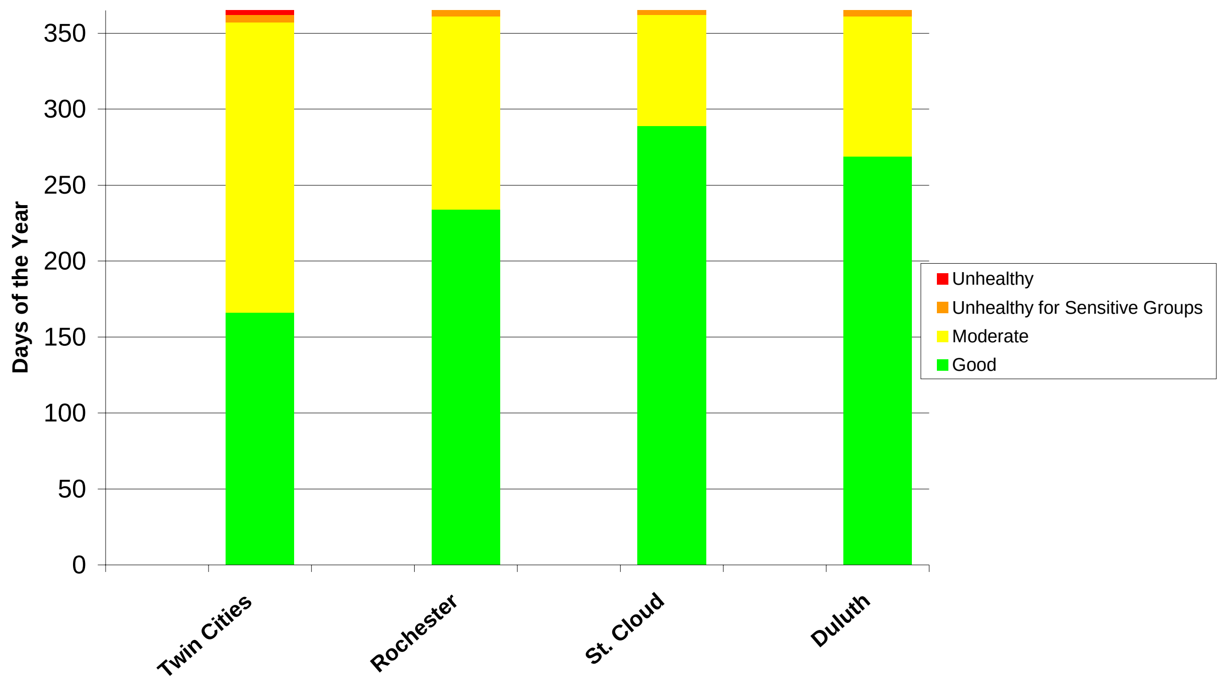
Good	0-50
Moderate	51-100
Unhealthy for Sensitive Groups	101-150
Unhealthy	151-200
Very Unhealthy	201-300

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, Unhealthy for Sensitive Groups and Unhealthy days for several cities in Minnesota that were monitored every day in 2005. Days are categorized by the highest AQI level calculated anytime during that day. The EPA may report different AQI summary totals for Minnesota because the MPCA and EPA use different methods to calculate the AQI.

In 2005, the Twin Cities had 166 Good air quality days, 191 Moderate air quality days, 5 days that were considered Unhealthy for Sensitive Groups and 3 Unhealthy days. The Twin Cities area likely has the highest number of Moderate and Unhealthy for Sensitive Groups days because it has a higher population and more sources of ozone and $PM_{2.5}$ than the other regions.

AQI Days for Selected Cities in Minnesota, 2005



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, including dust, dirt, soot, smoke, and liquid droplets. Some particles are seen as soot or smoke. Others are so small that they can only be detected with an electron microscope. Particles less than or equal to 2.5 micrometers (μm) in diameter, or $PM_{2.5}$, are known as “fine” particles. Those larger than 2.5 μm but less than or equal to 10 μm are known as “coarse” particles. PM_{10} refers to all particles less than or equal to 10 μm in diameter.

Both coarse and fine particles 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 can be inhaled deeply into the lung. These particles then accumulate in the respiratory system and are linked to a range of serious health effects. Studies of short term peaks in $PM_{2.5}$ and/or of long term exposures have found fine particles associated with increased cardiovascular and respiratory hospital admissions, emergency room visits, and deaths; heart attacks; chronic bronchitis; reduced lung function growth and increased respiratory illness in children; asthma attacks; and lung cancer deaths.

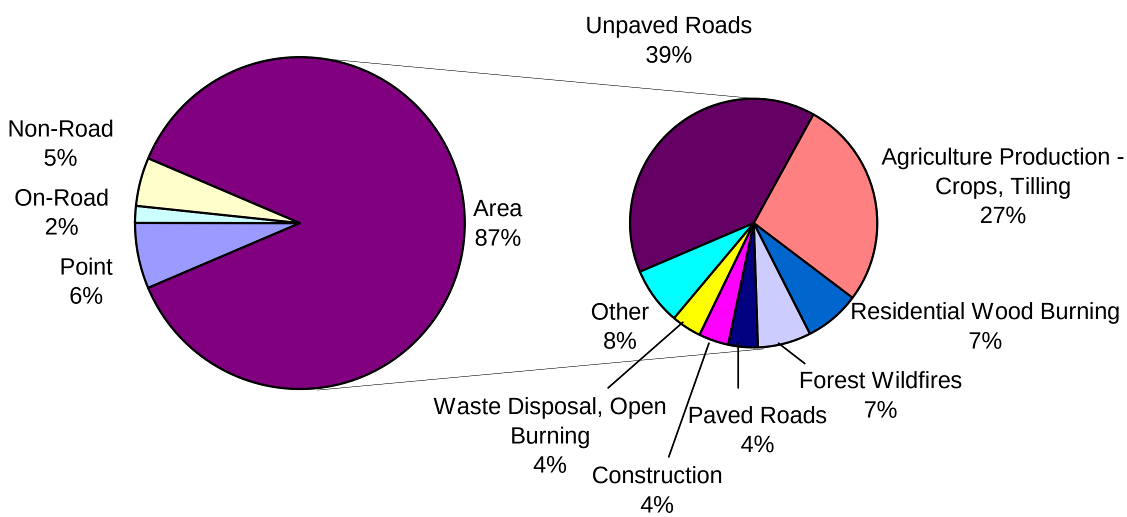
For five days in 2005, levels of fine particles were either Unhealthy or Unhealthy for Sensitive Groups in the Twin Cities area. $PM_{2.5}$ was also responsible for the majority of Moderate air quality days. The number of Moderate days is significant because EPA estimates greater overall health risks associated with the Moderate days than the relatively fewer Unhealthy or Unhealthy for Sensitive Groups days.

Emissions Data and Sources

The MPCA estimate for statewide direct emissions of $PM_{2.5}$ in 2002 is 181,650 tons.

The figure below shows estimated sources of 2002 $PM_{2.5}$ direct emissions.

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



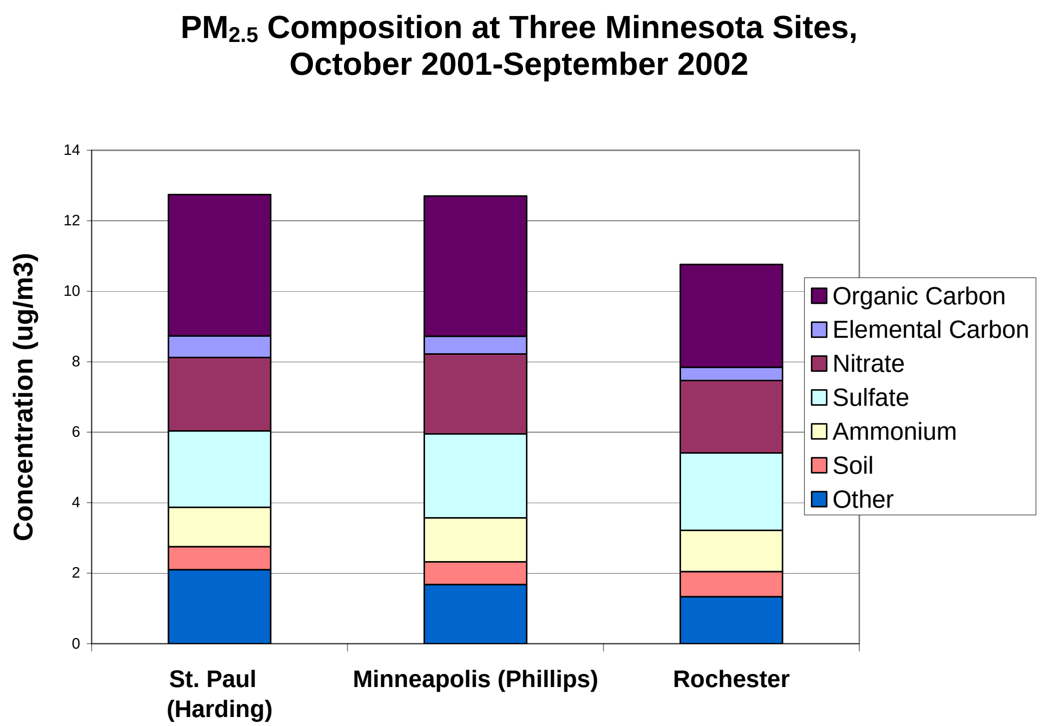
Direct source emissions of $PM_{2.5}$ are included in the 2002 inventory. However, secondarily formed particles, which are not directly emitted but are formed downwind of the emission source, are not included because this formation cannot be accurately quantified at this time. This is significant because secondary particles are a major component of the mass of ambient $PM_{2.5}$.

The majority of the mass of direct emissions come from soil. These sources are of less concern from a human health perspective. Fine particles released directly from combustion, for example, when coal, gasoline, diesel, other fossil fuels and wood are burned, are believed to pose greater health risks.

Many particles are also formed secondarily in the atmosphere from chemical reactions involving gaseous pollutants such as nitrogen oxides, sulfur oxides, some volatile organic compounds and ammonia. Major sources of fine particles are cars, trucks, buses, diesel construction equipment, coal-fired power plants, biomass (wood, vegetation, etc.) burning and agriculture.

Because they are tiny and light, fine particles can be carried by the wind for hundreds of miles, making exposure to these pollutants a regional problem. Unlike ozone, which is typically elevated in the hot summer months, fine particles can be a problem throughout the year.

To further understand the sources of fine particles, the MPCA had three monitors in St. Paul, Minneapolis and Rochester set up to help determine the source of particles in urban areas. The figure below shows the results of a preliminary analysis of the major $PM_{2.5}$ components from these monitors.



The concentrations of the different fractions of $PM_{2.5}$ are very similar across the three monitors. The largest fraction is organic carbon, followed by sulfate and nitrate. Getting a sense of the composition of fine particles in Minnesota can help to pinpoint the sources of these particles.

Organic carbon particles: These can be either primary particles or can be formed secondarily from the reaction of some volatile organic compounds. They can result from human activities (fossil fuel consumption, prescribed fires, cooking) or biogenic activities (vegetative material, biogenic gases, naturally occurring forest fires). Scientists are unsure at this point whether the majority of organic carbon particles are of primary or secondary origin. See the Volatile Organic Compounds section on page 19 of this report for Minnesota's 2004 VOC emissions associated with human activities.

Fine sulfate particles: These result from the oxidation of sulfur dioxide, forming sulfuric acid, which can then react with ammonia. Most sulfur dioxide emissions result from human sources including coal-fired power plants and other industrial sources such as smelters, boilers and oil refineries. See the Sulfur Dioxide section on page 23 of this report for Minnesota's 2004 SO_2 emissions.

Nitrate particles: These particles form from the oxidation of nitrogen oxides. Nitrogen oxide gases are released from virtually all combustion activities, especially those involving cars, trucks, buses, off-road sources (e.g., construction equipment, lawn mowers and boats), coal-fired power plants and other industrial sources. See the Nitrogen Oxides section on page 17 of this report for Minnesota's 2004 NO_x emissions.

Elemental carbon particles: These particles are commonly called soot. They are smaller than most particles and tend to absorb rather than scatter light. These particles are emitted into the air from virtually all combustion activity, but are especially prevalent in diesel exhaust and smoke from the burning of wood, other biomass and wastes.

Ammonia: Most of the ammonia emitted in Minnesota is generated from livestock waste management and fertilizer production. The ammonia is in the form of ammonium ions in particles.

Soil Fraction: This fraction consists of primary particles that are eroded from the landscape.

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_{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.

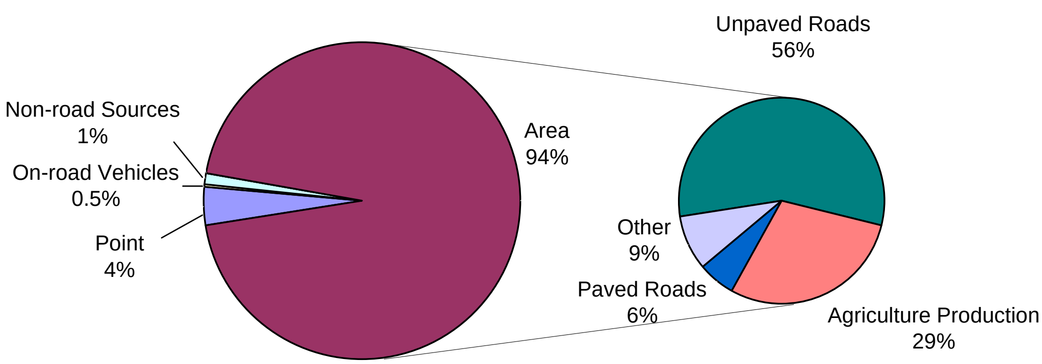
PM_{10} particles are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, and crushing and grinding operations, and windblown dust. These particles can settle rapidly from the atmosphere within hours, and their spatial impact is typically limited (compared 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 2004 is 783,466 tons.

The figure below shows estimated sources of 2004 PM_{10} direct emissions.

Sources of PM_{10} Emissions in Minnesota, 2004



Point source data is from the 2004 Emissions Inventory.
All other data is 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. Area sources contribute 94 percent of PM_{10} emissions. The majority of area source emissions are the result of dust from unpaved roads (56 percent) and agriculture production (29 percent). Fugitive dust from paved roads and construction and combustion sources make up the remainder of the area source contribution.

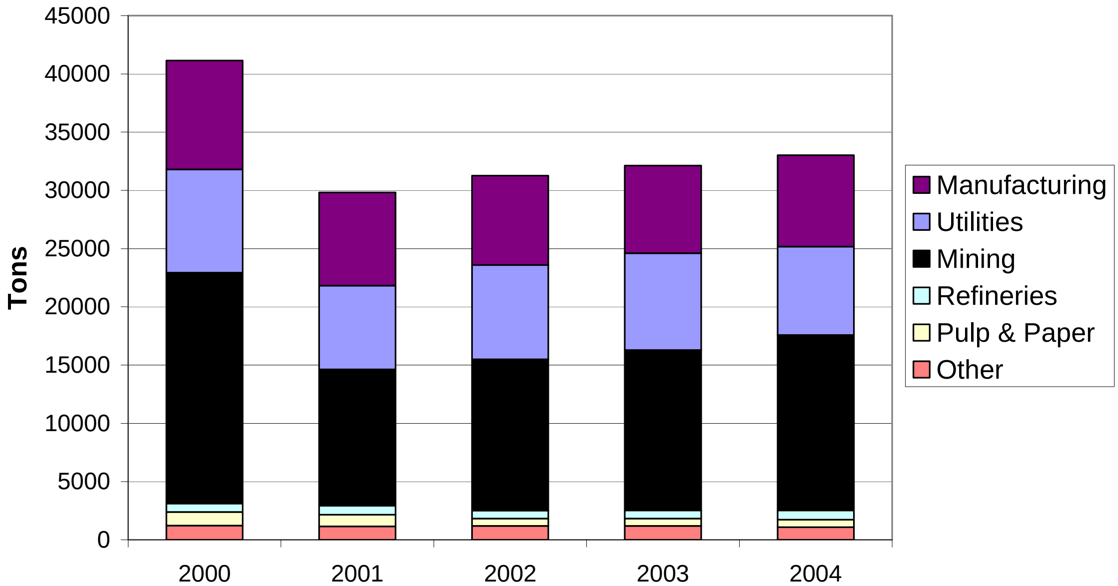
Point sources account for 4 percent of PM_{10} emissions. These emissions come primarily from the mining, manufacturing and utility sectors. On-road vehicles and non-road mobile sources make up about 2 percent of total PM_{10}.

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 2004, point sources contributed 4 percent to the total state PM_{10} emissions. Emissions from the mining sector decreased significantly in 2001. This decrease in mining emissions of PM_{10} was due primarily to the closing of LTV Steel Company. PM_{10} emissions have been slowly increasing since 2001, which may be due to a gradual economic recovery from the 2001 recession. Emissions increased slightly between 2003 and 2004 in all sectors except utilities.

PM_{10} Point Source Emission Trends by Sector in Minnesota, 2000-2004



References/Web Links

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

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

http://www.epa.gov/airtrends/aqtrnd04/pm.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 automobiles 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 2004 emissions of ozone precursors.

References/Web Links

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

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

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

http://www.pca.state.mn.us/air/ozonestudy.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 contributes 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 particulate matter (PM). As discussed in the ozone and PM sections of this report, exposure to these pollutants is associated with serious adverse health effects.

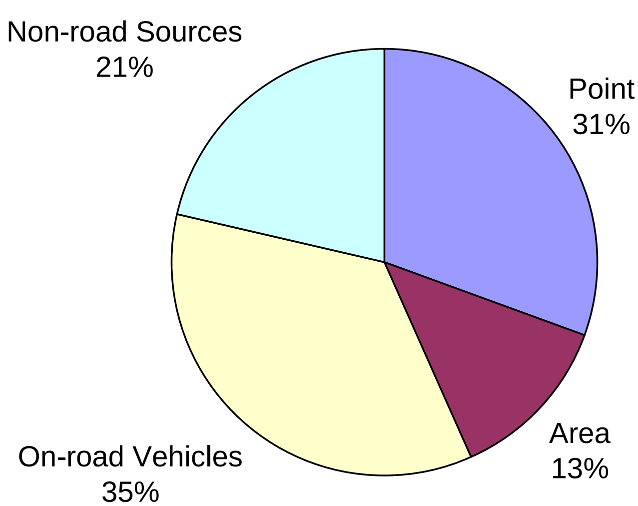
High NO_x concentrations also have environmental impacts. Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland and aquatic systems. This can result in changes in species number and composition such as the reduction of fish and shellfish populations. 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 2002 is 483,628 tons.

The figure below shows sources of 2004 NO_x emissions.

Sources of Nitrogen Oxide Emissions in Minnesota, 2004



Point source data is from the 2004 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

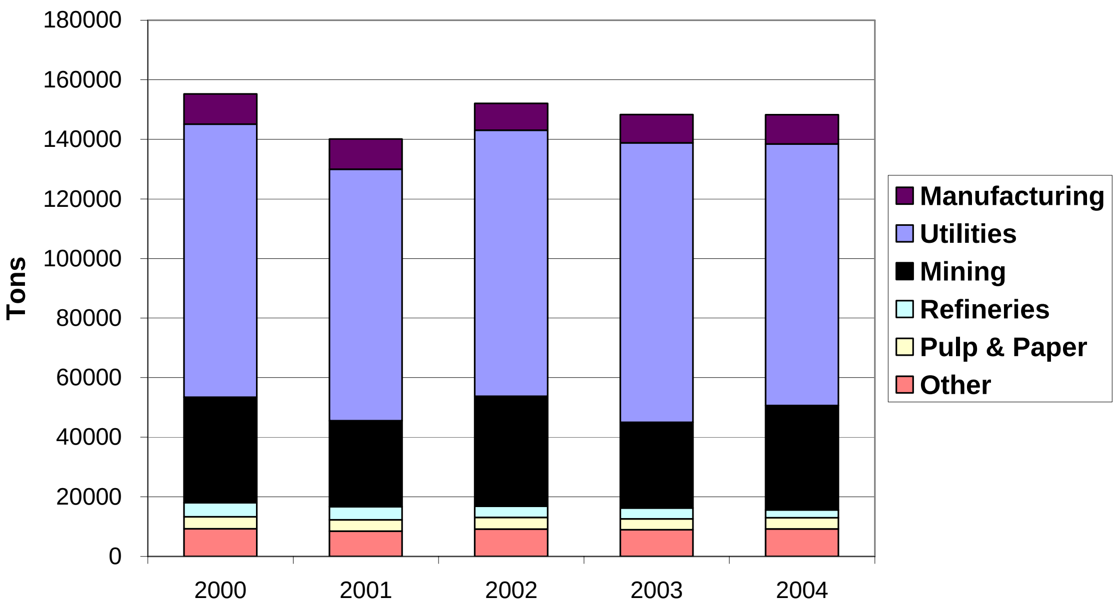
The majority of NO_x emissions come from the transportation sector, which consists of on-road vehicles and non-road sources. On-road vehicles contribute 35 percent of total statewide NO_x emissions, while non-road sources contribute 21 percent of total NO_x emissions. Gasoline engines contribute the majority of emissions from the transportation sector. Thirty-one percent of NO_x emissions come from point sources, primarily from the utility and mining sectors. Area sources are responsible for the remaining 13 percent of NO_x emissions. Residential and small industrial and commercial combustion makes up the majority of area source emissions.

Trends

Point sources contribute 31 percent of the NO_x emissions in the state. In Minnesota, NO_x emission estimates from point sources have stayed relatively constant since 2000 with some fluctuation between years. The biggest changes have been in the mining sector. 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.

Emissions of NO_X were relatively flat between 2003 and 2004. Utilities and refineries had slightly decreased emissions while the other sectors slightly increased their NO_X emissions.

Nitrogen Oxide Point Source Emission Trends by Sector in Minnesota, 2000-2004



References/Web Links

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

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

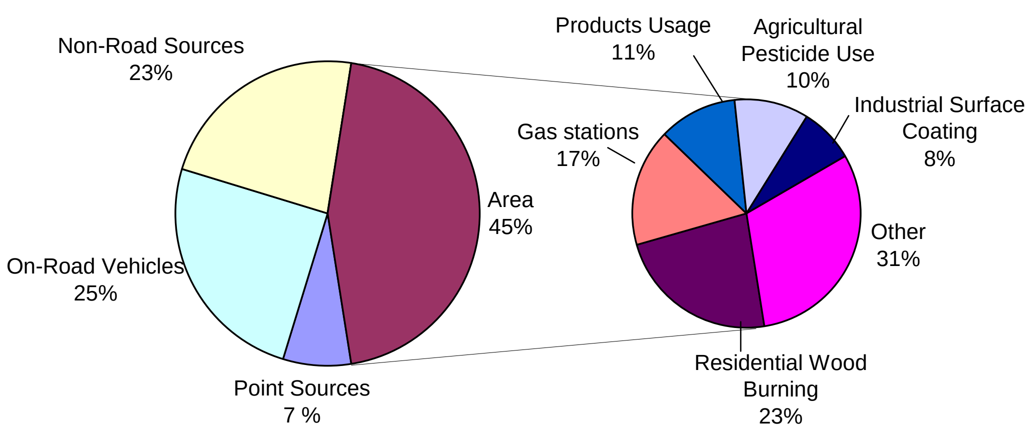
Many VOCs are also air toxics and can have harmful effects on human health and the environment. However, VOCs are regulated as a criteria pollutant because they are precursors to ozone. See the sections on ozone and air toxics for related human health and environmental effects.

Emissions Data and Sources

The MPCA estimate for statewide emissions of VOCs in 2004 is 367,175 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 2004.

Sources of VOC Emissions in Minnesota, 2004



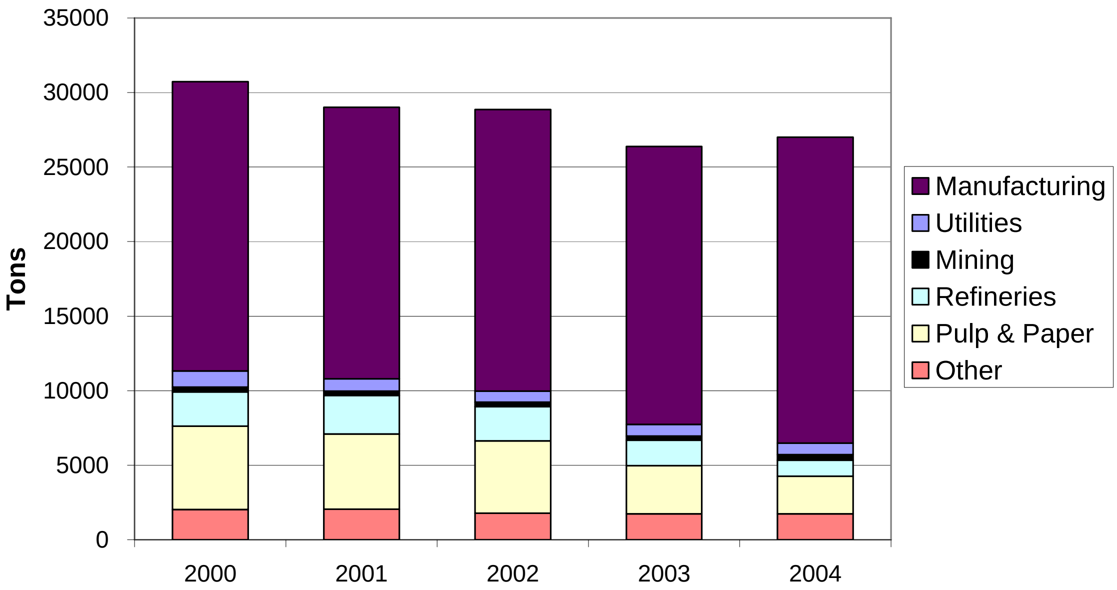
Point source data is from the 2004 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

A little less than half of the emissions come from the transportation sector, which consists of on-road vehicles and non-road sources. Twenty-five percent of emissions come from on-road vehicles and 23 percent come from non-road sources. Non-road sources include recreational equipment, pleasure boats, and lawn and garden equipment as well as other agricultural and commercial equipment. Area sources contribute 45 percent of VOC emissions, primarily from residential wood burning, gas stations, products usage, agricultural pesticide use and industrial surface coating. The final seven percent of emissions come from point sources such as the manufacturing and pulp and paper operations.

Trends

Point sources contribute seven percent of the VOC emissions in the state. VOC point source emission estimates gradually decreased in Minnesota between 2000 and 2003. Emissions increased slightly in 2004. Increases in manufacturing VOC emissions were partially offset by decreases in the pulp and paper and refineries sectors. Most of the refinery decreases were due to VOC abatement measures undertaken by Flint Hills Resources.

Volatile Organic Compound Point Source Emission Trends by Sector in Minnesota, 2000-2004



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 in high concentrations 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.

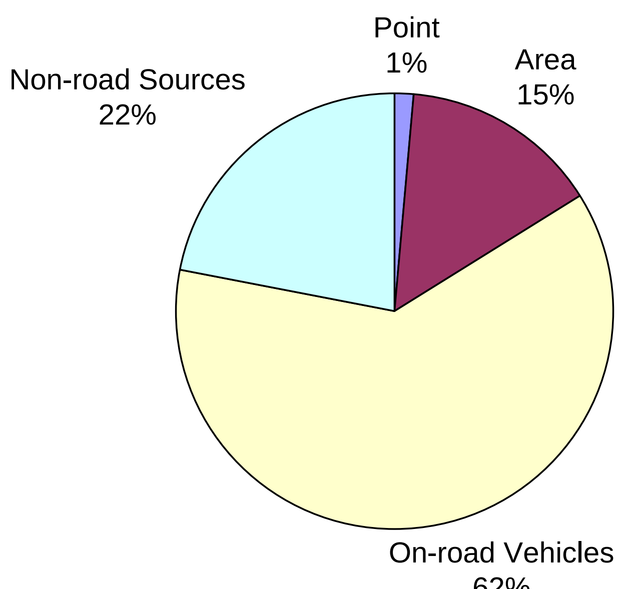
At concentrations commonly found in the ambient air, CO does not appear to have adverse effects on plants, wildlife or materials. However, CO is oxidized to form carbon dioxide (CO_2), a contributor to global warming.

Emissions Data and Sources

The MPCA estimate for statewide emissions of CO in 2004 is 2,125,861 tons.

The figure below shows sources of 2004 CO emissions.

Sources of Carbon Monoxide Emissions in Minnesota, 2004



Point source data is from the 2004 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

The majority of CO emissions come from the transportation sector, which consists of on-road vehicles and non-road sources. On-road vehicles contribute 62 percent of total statewide CO emissions, while non-road sources contribute 22 percent of total CO emissions. Non-road emissions come primarily from gasoline consumption by lawn and garden, recreational and commercial equipment.

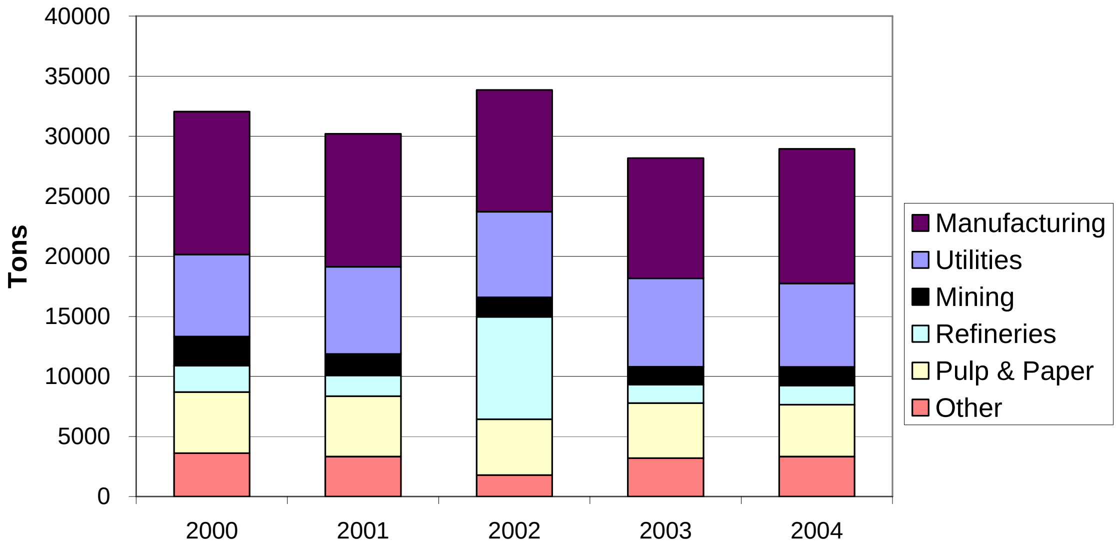
The remaining 16 percent of emissions come from point and area sources. Area source emissions are primarily from prescribed burning, residential wood burning, forest fires and waste disposal through open burning. Major point source contributors to CO emissions are from the manufacturing and utility sectors.

Trends

Point sources contribute only 1 percent to the total Minnesota CO emissions. The CO values have been generally flat or decreasing except for high refinery values in 2002. This increase was primarily from Marathon Ashland refinery. Normally, the refinery runs its FCC catalyst regenerator in full burn mode, meaning in excess oxygen. In 2002, the refinery's FCC catalyst regenerator ran in both full and partial burn mode, which resulted in higher emissions estimates. The emission estimates returned to normal in 2003 and 2004.

Emissions of CO from point sources were relatively flat between 2003 and 2004 with a small decrease from utilities and pulp and paper and a small increase in the manufacturing sector.

Carbon Monoxide Point Source Emission Trends by Sector in Minnesota, 2000-2004



References/Web Links

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

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

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 ppm. 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. In fact, sulfate aerosols make up the largest single component of fine particulate matter. 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.

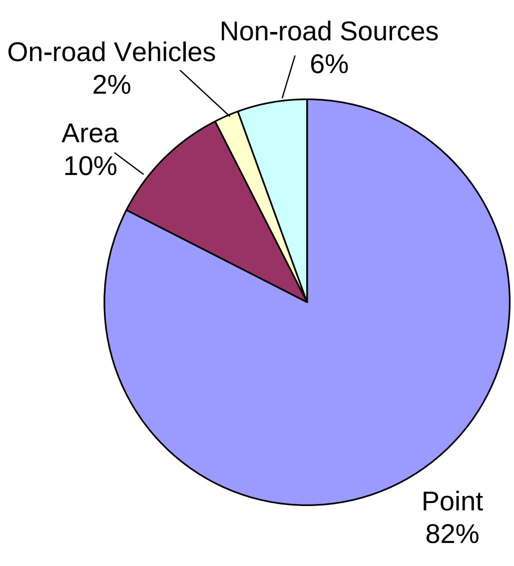
SO_2 also causes significant environmental damage. SO_2 reacts with other substances in the air to form acids, which fall to earth as rain, fog, snow, or dry particles. Acid rain damages forests and crops, changes the makeup of soil, and makes lakes and streams acidic and unsuitable for fish. Continued 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 2004 is 161,179 tons.

The figure below shows sources of 2004 SO_2 emissions.

Sources of Sulfur Dioxide Emissions in Minnesota, 2004



Point source data is from the 2004 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

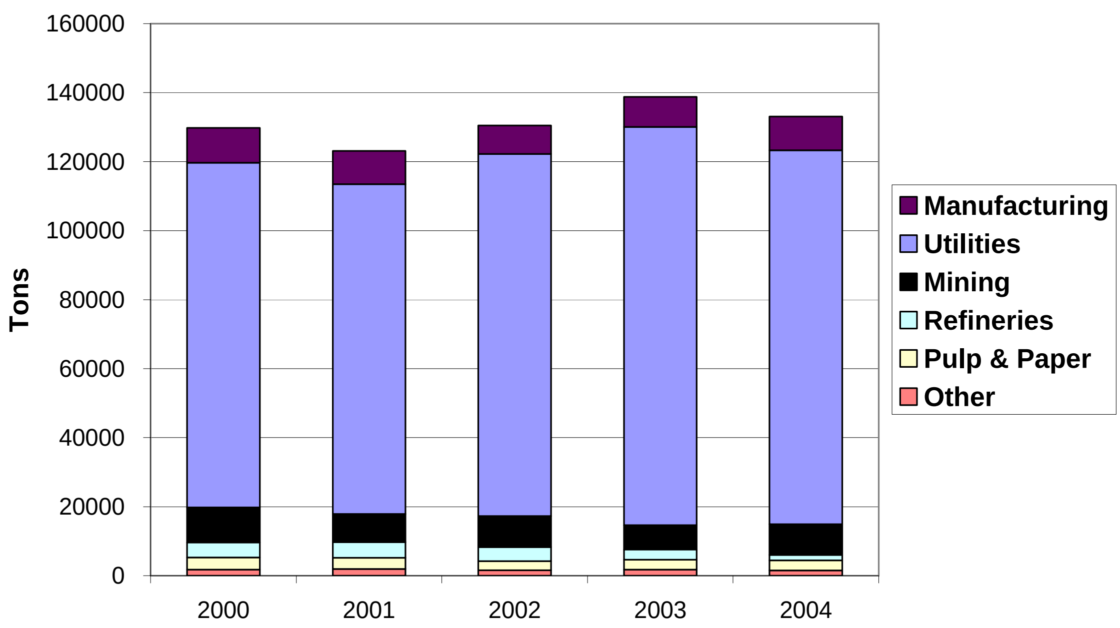
More than 80 percent of SO_2 emissions come from point sources. Electric utilities burning coal emit the majority of SO_2 attributed to point sources. Non-road sources emit 6 percent of SO_2. Non-road source emissions come primarily from agricultural equipment, marine vessels, trains and construction and mining equipment. On-road vehicles contribute 2 percent of the emissions. These emissions are divided between gasoline-powered cars, trucks and motorcycles, and diesel vehicles.

The remaining 10 percent of area emissions of SO_2 result from fuel combustion by small industrial and commercial facilities and residences.

Trends

Point sources contribute 82 percent to the total state SO_2 emissions. Emissions from point sources have remained relatively constant since 2000. Coal-burning utilities are the greatest emitters of SO_2. Total SO_2 estimated emissions decreased slightly between 2003 and 2004 with emissions from the utilities, pulp and paper and refinery sectors decreasing slightly and emissions from the mining and manufacturing sectors increasing slightly.

Sulfur Dioxide Point Source Emission Trends by Sector in Minnesota, 2000-2004



References/Web Links

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

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

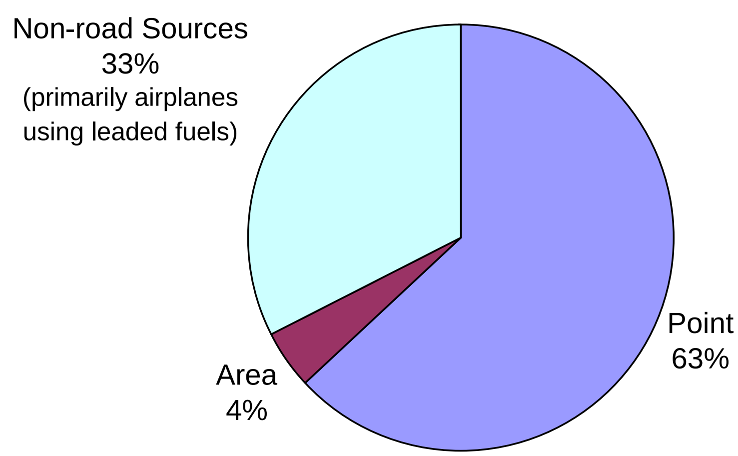
Lead causes damage to organs such as the kidneys and liver and may lead to high blood pressure and increased heart disease. In addition, exposure to lead may contribute to osteoporosis and reproductive disorders. Most importantly, lead exposure causes brain and nerve damage to fetuses and young children, 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 2002 is 35 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 2004 lead emissions.

Sources of Lead Emissions in Minnesota, 2004

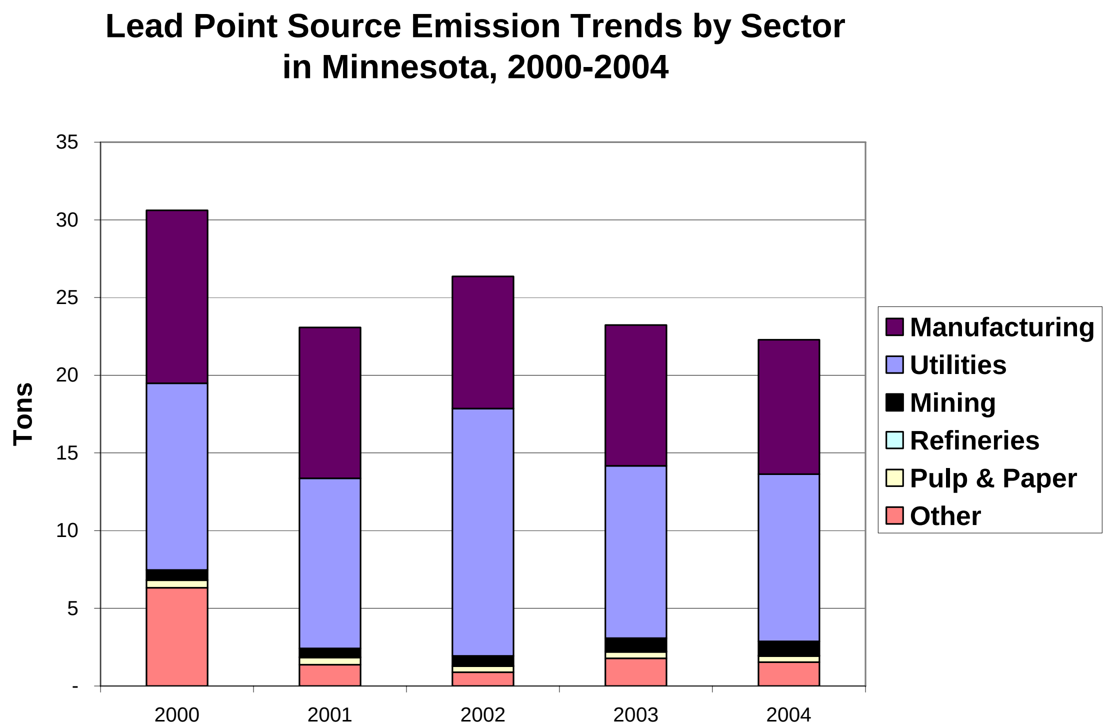


Point source data is from the 2004 Emissions Inventory. All other data is from the 2002 Emissions Inventory.

Non-road sources (primarily airplanes using leaded fuels) contribute 33 percent of Minnesota's lead emissions. Point sources such as utilities and metal processing (including lead and other metal smelters) add an additional 63 percent of lead to the environment. Area sources contribute the final 4 percent of lead emissions. Area source lead emissions result from auto body refinishing, tank cleaning and fuel combustion.

Trends

Point sources contribute 63 percent of the total state lead emissions. In Minnesota, estimated lead emissions from point sources have decreased since 2002. All sector emissions decreased or remained relatively constant between 2003 and 2004.



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#tips

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

Carbon Dioxide

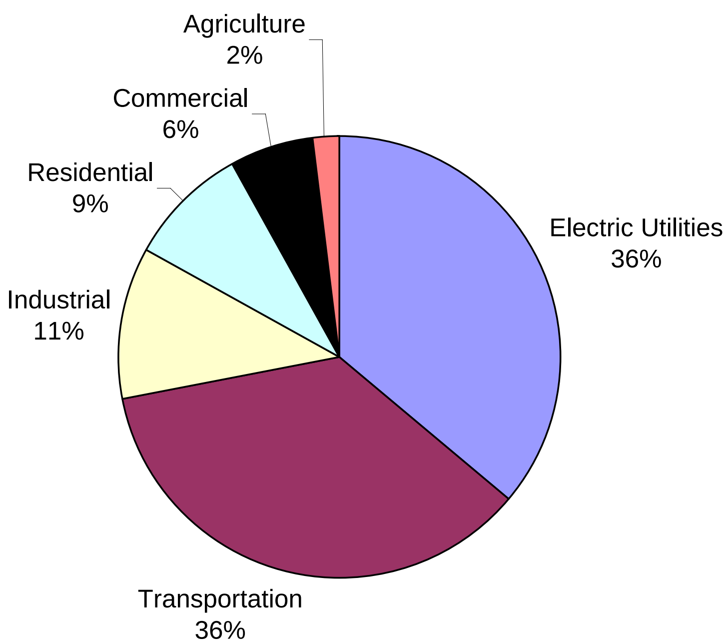
Carbon dioxide is a gas that is primarily formed from the combustion of fossil fuels such as oil, gas, and coal. It is the major greenhouse gas that contributes to warming of the earth's atmosphere. The earth's greenhouse effect is a natural phenomenon that helps regulate the temperature of our planet. 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 2004 is 113 million short tons.

The pie chart below shows the breakdown of carbon dioxide emissions from fossil fuel burning by sector. The majority of the carbon dioxide emissions come from the electric utility (36 percent) and transportation (36 percent) sectors. The remaining 28 percent of the emissions come from fossil fuel combustion in the industrial, commercial, residential and agriculture sectors.

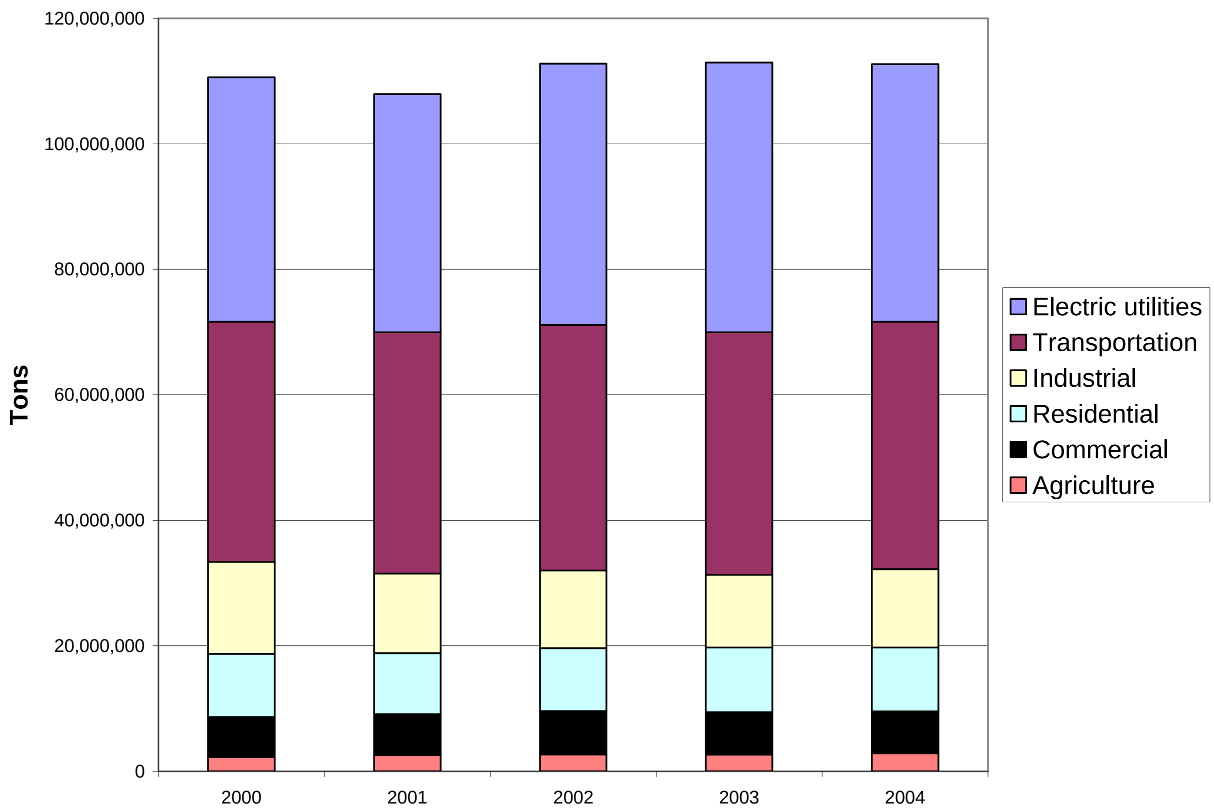
Sources of Carbon Dioxide Emissions from Fossil Fuel Burning in Minnesota, 2004



Trends

Carbon dioxide emissions from fossil fuel burning in Minnesota have remained relatively flat from 2002 to 2004. Emissions from electric power generation declined by about 2 million tons between 2003 and 2004, but most of that decline was offset by increases in other sectors.

Carbon Dioxide Emission Trends from Fossil Fuel Burning in Minnesota, 2000-2004

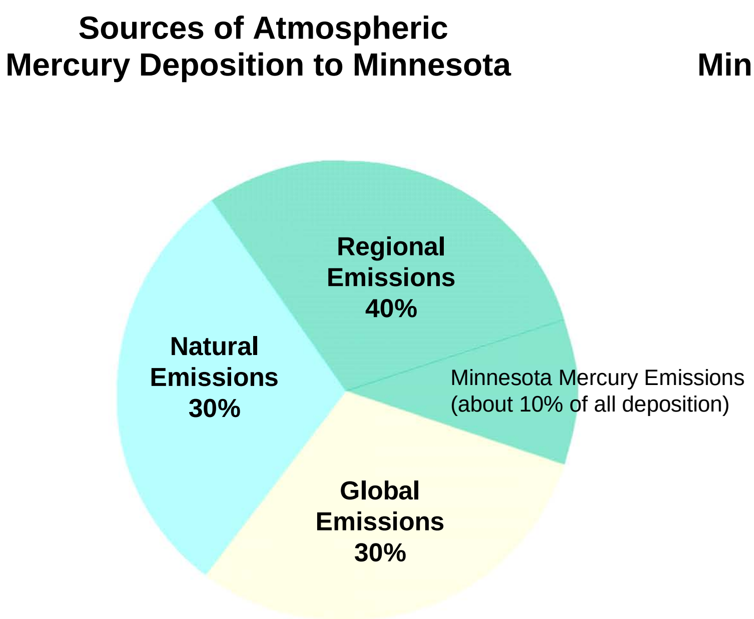


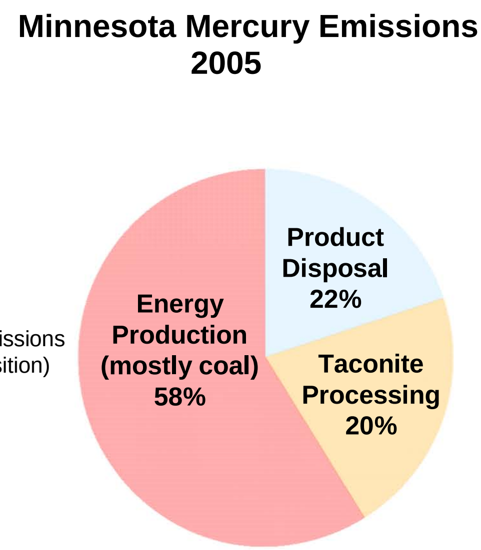
Mercury

Mercury contamination of fish is a well-documented problem in Minnesota. The Minnesota Department of Health advises people to restrict their consumption of fish due to mercury 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.





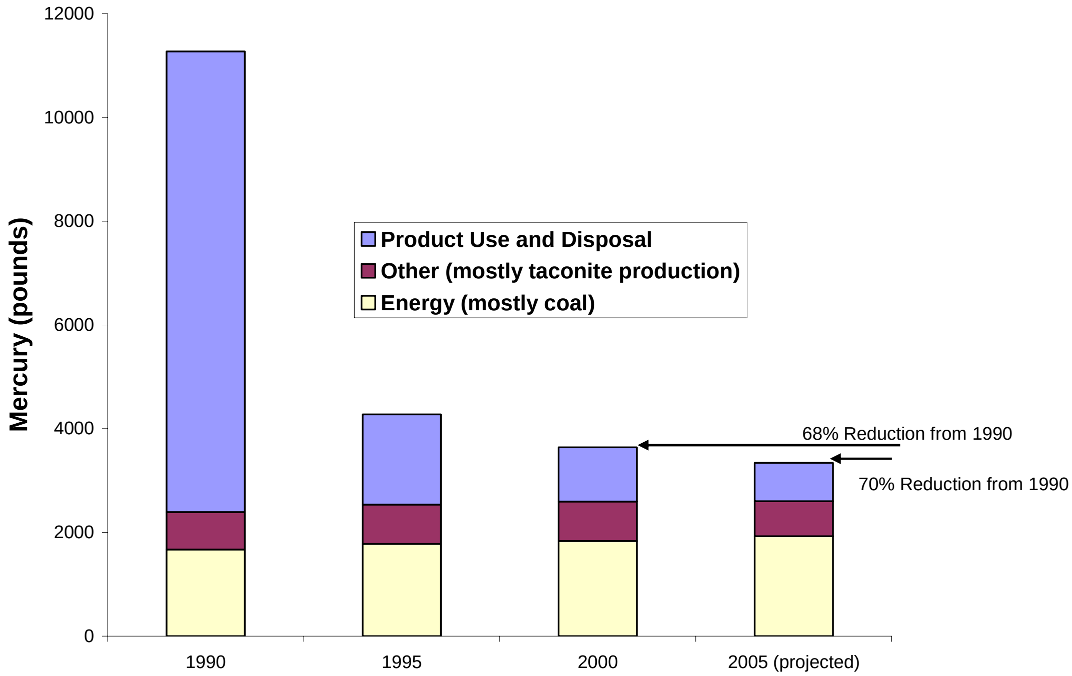
Because mercury vapor can be transported long distances by the atmosphere, most of Minnesota's emissions are deposited in other states and countries, and Minnesota receives their emissions. Minnesota emits about as much mercury as the state receives, and about 90 percent of Minnesota's emissions are 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 due to three roughly equal sources: 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 3,300 pounds, a 70% reduction from 1990 levels.

Trends in Minnesota Mercury Emissions from Human Activities, 1990-2005



Sediment core studies from lakes in Minnesota and elsewhere show slight declines in atmospheric deposition relative to a peak in the 1970s and 1980s. There is some evidence that concentrations of mercury in fish have also declined, but not to the point of eliminating concerns about fish consumption. MPCA staff estimates that in order for Minnesota to significantly reduce concerns about mercury in fish, human-caused emission sources in and out of the state would need to be reduced by about 93 percent from 1990 levels, or about 78 percent from 2000 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

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 goals in the MPCA's ongoing clean air strategic plan is to meet all environmental and human health benchmarks for toxic air pollutants. Of the 48 gaseous air toxics measured by the MPCA that have health benchmarks, only formaldehyde commonly has concentrations above its health benchmark 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 inventory for Minnesota is from 2002. This inventory is draft and there may be some changes in the future. 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 other non-road equipment, the MPCA used air toxics emissions estimations in the Draft 2002 National Emissions Inventory (NEI) except for recreational marine equipment and snowmobiles. MPCA spatially allocated NEI emissions for recreational marine equipment, and used state-specific weather data to estimate emissions for snowmobiles.

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 168 chemicals: 16 polycyclic aromatic hydrocarbon compounds (PAHs), 138 non-metal compounds (excluding 16-PAHs), and 13 metal compounds.

Table 3: 2002 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	Total (short tons)	Point Sources (%)	Area Sources (%)	On-Road Mobile (%)	Non-Road Mobile (%)
PAHs					
Acenaphthene	39	90.2%	6.7%	1.1%	2.0%
Acenaphthylene	56.7	0.3%	92.2%	3.9%	3.5%
Anthracene	7.92	5.5%	82.3%	6.5%	5.7%
Benz[a]Anthracene	8.82	0.4%	96.7%	1.4%	1.4%
Benzo[a]Pyrene	4.85	0.8%	88.8%	3.1%	7.2%
Benzo[b]Fluoranthene	2.43	2.1%	93.8%		4.1%
Benzo[g,h,i,]Perylene	2.2	0.3%	92.4%	3.8%	3.5%
Benzo[k]Fluoranthene	2.24		93.1%	3.8%	3.1%
Chrysene	6.98	0.5%	97.2%	0.9%	1.4%
Dibenzo[a,h]Anthracene	0.148	9.7%	88.6%		1.7%
Fluoranthene	11.2	1.5%	84.6%	4.7%	9.3%
Fluorene	9.85	4.3%	70.0%	8.9%	16.8%
Indeno[1,2,3-c,d]Pyrene	3.37	21.7%	73.8%	1.3%	3.2%
Naphthalene	387	6.3%	70.2%	15.8%	7.6%
Phenanthrene	29.6	2.1%	82.5%	4.9%	10.5%
Pyrene	14.1	2.3%	84.3%	5.2%	8.3%
Other PAHs not included above	29.6	8.1%	91.6%	0.3%	0.0%
PAH Total	**616**	**10.6%**	**71.6%**	**11.1%**	**6.6%**
Metal Compounds					
Antimony	1.77	98.6%	0.8%		0.7%
Arsenic	7.37	92.2%	2.2%	5.6%	
Beryllium	0.233	73.0%	16.7%		10.3%
Cadmium	1.69	86.9%	11.7%		1.5%
Chromium	8.24	89.9%	3.2%	6.6%	0.2%
Chromium VI	0.978	86.1%	1.8%	11.1%	1.0%
Cobalt	3.33	98.4%	1.2%		0.4%
Copper	13.5	95.9%	1.4%	2.7%	
Lead	44.4	70.6%	3.5%	0.1%	25.8%
Alkylated Lead Compounds	0.0011	32.2%	67.8%		
Manganese	52.5	97.3%	1.5%	1.2%	
Nickel	16.7	93.5%	2.7%	2.5%	1.2%
Selenium	4.01	89.0%	10.8%	0.2%	
Metal Total*	**155**	**87.9%**	**2.7%**	**1.6%**	**7.6%**
* mercury addressed separately					
Non-Metal Compounds (Excluding PAHs)					
Acetaldehyde	2,260	13.0%	25.4%	34.9%	26.7%
Acetamide	0.0003		100.0%		
Acetone	1,340	27.9%	46.9%	24.0%	1.3%
Acetonitrile	0.685	99.9%	0.1%		
Acetophenone	0.962	22.9%	77.1%		

Table 3: 2002 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	Total (short tons)	Point Sources (%)	Area Sources (%)	On-Road Mobile (%)	Non-Road Mobile (%)
Acrolein	450	21.5%	53.4%	12.4%	12.7%
Acrylamide	0.0661	100.0%			
Acrylic Acid	7.76	99.9%	0.1%		
Acrylonitrile	3.47	32.6%	67.4%		
Aldehydes	31.1	100.0%			
Aniline	0.000004	100.0%			
Atrazine	129		100.0%		
Benzaldehyde	90.3	2.5%		85.8%	11.7%
Benzene	6,690	1.6%	29.1%	49.9%	19.4%
Benzyl Chloride	2.15	93.5%	6.5%		
Biphenyl	5.29	90.9%	9.1%		
Bromoform	0.431	98.2%	1.8%		
Methyl Bromide (Bromomethane)	518	2.1%	97.9%		
1,3-Butadiene	883	0.2%	24.4%	37.1%	38.2%
Butyraldehyde	57.6	1.4%		84.9%	13.7%
Carbon Disulfide	0.874	61.9%	38.1%		
Carbon Tetrachloride	1.21	61.9%	38.1%		
Carbonyl Sulfide	1.16	58.0%	42.0%		
Catechol	0.0611	100.0%			
Trichlorofluoromethane (CFC-11, R-11)	1.35	45.2%	54.8%		
Trichlorotrifluoromethane (CFC-113, R-113)	365	1.5%	98.5%		
Chlorine	149	17.4%	82.2%	0.4%	
Chlorobenzene	164	0.4%	99.6%		
Ethyl Chloride	27.5	14.4%	85.6%		
Chloroform	194	1.0%	99.0%		
Chloroprene	0.0011	100.0%			
2-Chloroacetophenone	0.0773	98.2%	1.8%		
Cresol/Cresylic Acid (Mixed Isomers)	1.29	100.0%			
m-Cresol	0.0251	100.0%			
o-Cresol	0.106	41.8%	58.2%		
p-Cresol	0.211	40.8%	59.2%		
Crotonaldehyde	43.4	3.4%		67.0%	29.6%
Cumene	30.9	44.9%	55.1%		
Cyanide Compounds	232	13.3%	86.7%		
2,4-D (2,4-Dichlorophenoxyacetic Acid)	27.7		100.0%		
Dibenzofuran	0.975	20.1%	79.9%		
Ethylene Dibromide (Dibromoethane)	0.546	98.1%	1.9%		
Dibutyl Phthalate	0.845	79.0%	21.0%		
Ethylene Dichloride (1,2-Dichloroethane)	2.07	41.8%	58.2%		
Dichlorvos	0.001	100.0%			

Table 3: 2002 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	Total (short tons)	Point Sources (%)	Area Sources (%)	On-Road Mobile (%)	Non-Road Mobile (%)
1,4-Dichlorobenzene	188	0.5%	99.5%		
M-Dichlorobenzene	1.01	8.8%	91.2%		
O-Dichlorobenzene	213		100.0%		
Dichlorobenzenes	0.126	29.4%	70.6%		
Ethylidene Dichloride (1,1-Dichloroethane)	0.879	22.7%	77.3%		
Cis-1,2-Dichloroethylene	0.434	100.0%			
Cis-1,3-Dichloropropene	0.0928	100.0%			
1,3-Dichloropropene	363		100.0%		
Diethyl Sulfate	0.00001	100.0%			
Diethanolamine	0.293	80.6%	19.4%		
Dimethyl Phthalate	2.66	99.5%	0.5%		
Dimethyl Sulfate	0.53	98.2%	1.8%		
N,N-Dimethylformamide	30.5	33.4%	66.6%		
Dimethylaniline(N,N-Dimethylaniline)	0.0378	100.0%			
2,4-Dinitrophenol	0.0678	99.9%	0.1%		
2,4-Dinitrotoluene	0.0269	99.8%	0.2%		
Bis(2-Ethylhexyl)Phthalate (Dehp)	3.57	99.2%	0.8%		
Di-N-Octylphthalate	0.0163	100.0%			
p-Dioxane	1.33	94.8%	5.2%		
Epichlorohydrin	0.0152	100.0%			
Ethyl Acrylate	2.14	99.9%	0.1%		
Ethylbenzene	2,070	5.3%	11.9%	51.9%	30.9%
Ethylene Glycol	125	25.2%	74.8%		
Ethylene Oxide	17.6	10.8%	89.2%		
Fine Mineral Fibers	1.81	100.0%			
Formaldehyde	4,350	11.3%	32.7%	26.6%	29.4%
Glycol Ethers	1,460	29.6%	70.4%		
Hydrogen Chloride (Hydrochloric Acid)	3,170	88.3%	11.7%		
Hexamethylene Diisocyanate	3.15	100.0%			
Hexane	4,020	21.9%	42.0%	19.4%	16.7%
Hexachlorobenzene	0.0049		100.0%		
Hydrogen Fluoride (Hydrofluoric Acid)	490	93.8%	6.2%		
Hydroquinone	8.12	41.9%	58.1%		
Isophorone	18	51.4%	48.6%		
Lindane, (All Isomers)	0.0015	100.0%			
Maleic Anhydride	0.375	100.0%			
Methyl Ethyl Ketone (2-Butanone)	2060	18.2%	81.8%		
Methylhydrazine	1.88	98.2%	1.8%		
Methyl Iodide (Iodomethane)	0.00295	100.0%			
Methyl Isobutyl Ketone (Hexone)	919	12.1%	87.9%		

Table 3: 2002 Minnesota Air Toxics Emissions Inventory Statewide Summary

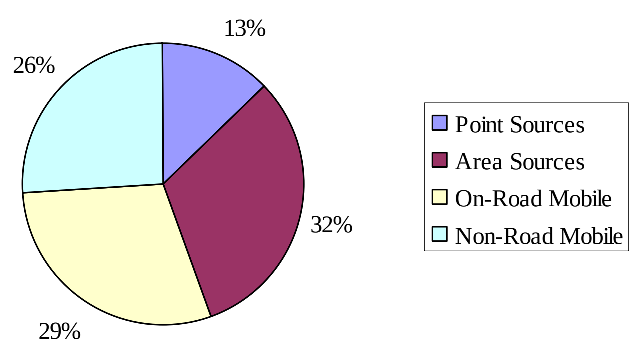
Pollutant Name	Total (short tons)	Point Sources (%)	Area Sources (%)	On-Road Mobile (%)	Non-Road Mobile (%)
Methyl Isocyanate	0.0135	100.0%			
Methyl Methacrylate	35.1	100.0%			
Methyl Tert-Butyl Ether	0.454	86.5%	13.5%		
Methanol	2,540	28.7%	71.3%		
4,4'-Methylenedianiline	0.000003	100.0%			
4,4'-Methylenediphenyl Diisocyanate (MDI)	19.8	100.0%			
Methyl Chloride (Chloromethane)	95.7	8.2%	91.8%		
Methylene Chloride (Dichloromethane)	397	22.6%	77.4%		
Nitrobenzene	0.243	100.0%			
4-Nitrophenol	0.496	59.5%	40.5%		
2-Nitropropane	0.0065	25.2%	74.8%		
Polychlorinated Biphenyls (Aroclors)	0.649	1.0%	99.0%		
Polychlorinated Dibenzodioxins, Total	0.0184	90.1%	9.8%		0.1%
Polychlorinated Dibenzo-P-Dioxins and Furans, Total	0.00007	94.6%	0.1%	5.3%	
Polychlorinated Dibenzofurans, Total	0.00031	16.8%	81.7%		1.5%
Pentachlorophenol	0.12	90.0%	10.0%		
Tetrachloroethylene (Perchloroethylene)	233	32.1%	67.9%		
Phenol	161	71.4%	28.6%		
p-Phenylenediamine	0.0633	100.0%			
Phosphine	2.24	78.3%	21.7%		
Phosphorus	1.35	97.0%	1.3%		1.6%
Phthalic Anhydride	0.74	100.0%			
Polycyclic Organic Matter	11.1	29.4%	70.6%		
Propionaldehyde	199	4.5%	1.6%	31.5%	62.3%
Propoxur	0.000000004	100.0%			
Propylene Dichloride (1,2-Dichloropropane)	0.53	71.4%	28.6%		
Propylene Oxide	0.621	100.0%			
Quinone (p-Benzoquinone)	1.11	100.0%			
Styrene	1,120	55.4%	16.7%	20.0%	7.9%
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	0.000004	29.0%	66.6%		4.3%
2,3,7,8-Tetrachlorodibenzofuran	0.00003	30.1%	68.7%		1.2%
Methyl Chloroform (1,1,1-Trichloroethane)	904	0.7%	99.3%		
1,1,2,2-Tetrachloroethane	0.869	13.8%	86.2%		
Toluene	21,400	3.6%	23.4%	33.7%	39.3%
2,4-Toluene Diisocyanate	1.28	100.0%			
o-Toluidine	0.0004	27.6%	72.4%		

Table 3: 2002 Minnesota Air Toxics Emissions Inventory Statewide Summary

Pollutant Name	Total (short tons)	Point Sources (%)	Area Sources (%)	On-Road Mobile (%)	Non-Road Mobile (%)
Trichloroethylene	210	95.5%	4.5%		
1,2,4-Trichlorobenzene	5.89	99.6%	0.4%		
1,1,2-Trichloroethane	0.266	100.0%			
2,4,6-Trichlorophenol	0.0002	97.0%	3.0%		
Triethylamine	9.66	75.5%	24.5%		
Trifluralin	19.9		100.0%		
2,2,4-Trimethylpentane	7,010	0.1%	3.2%	42.8%	53.9%
1,2,4-Trimethylbenzene	1,380	4.9%	0.8%	94.3%	
1,3,5-Trimethylbenzene	468	0.1%		99.9%	
Trimethylbenzene	30.9	5.7%	94.3%		
Vinylidene Chloride (1,1-Dichloroethylene)	1.56	15.2%	84.8%		
Vinyl Acetate	26.1	63.3%	36.7%		
Vinyl Chloride	7.99	16.3%	83.7%		
m-Xylene	5.99	63.6%	36.4%		
o-Xylene	96.5	2.9%	97.1%		
p-Xylene	0.649	100.0%			
Xylenes (Mixed Isomers)	12,600	6.2%	28.0%	32.6%	33.3%
Non-Metal Total	**82,100**	**12.6%**	**31.6%**	**29.6%**	**26.2%**
Grand Total	**82,900**	**12.7%**	**31.9%**	**29.4%**	**26.0%**

The following chart summarizes air toxics pollutant emissions in Minnesota from 2002. On-road and non-road mobile sources account for just over half of the emissions. Area sources contributed 32 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.

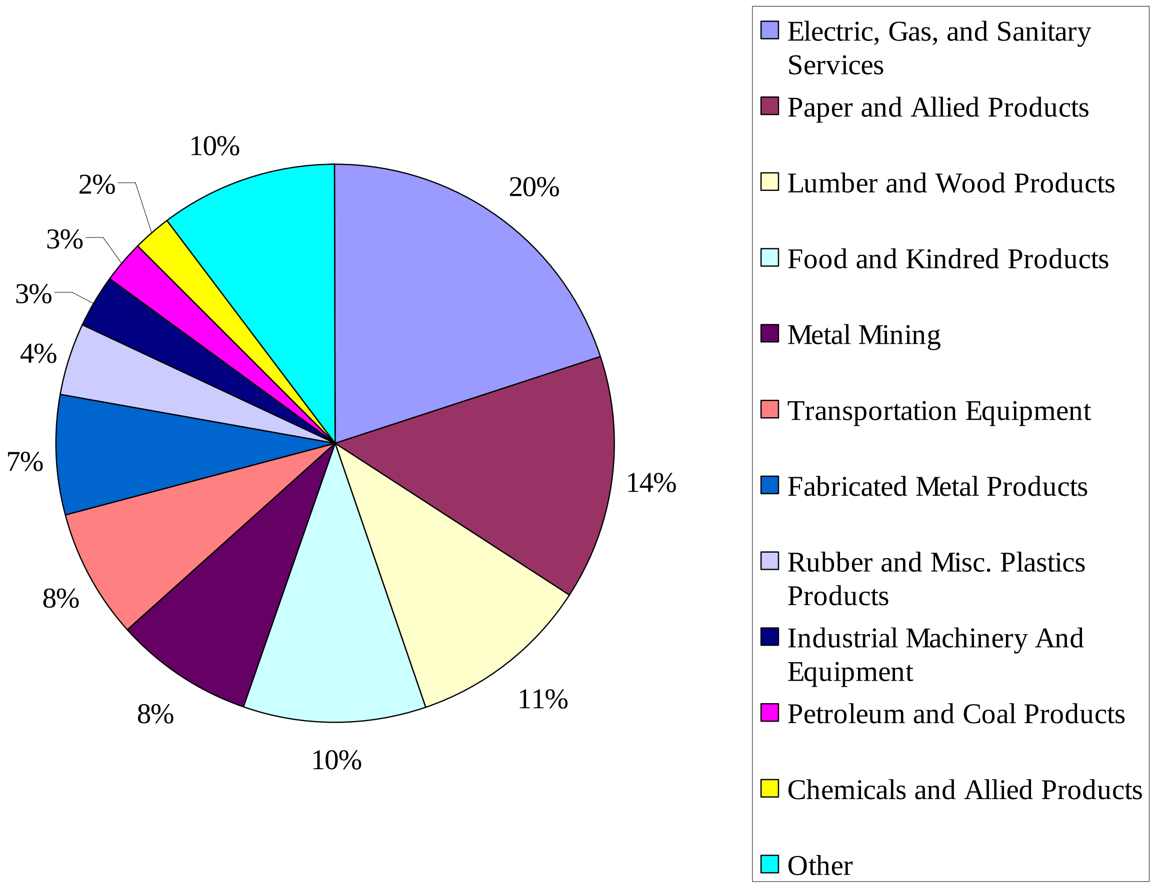
Contribution of Principal Source Categories to 2002 Air Toxics Emissions in Minnesota



Total air toxics emissions in 2002: 166,000,000 pounds or 82,900 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, Gas, and Sanitary Services which accounts for 20% of point source emissions.

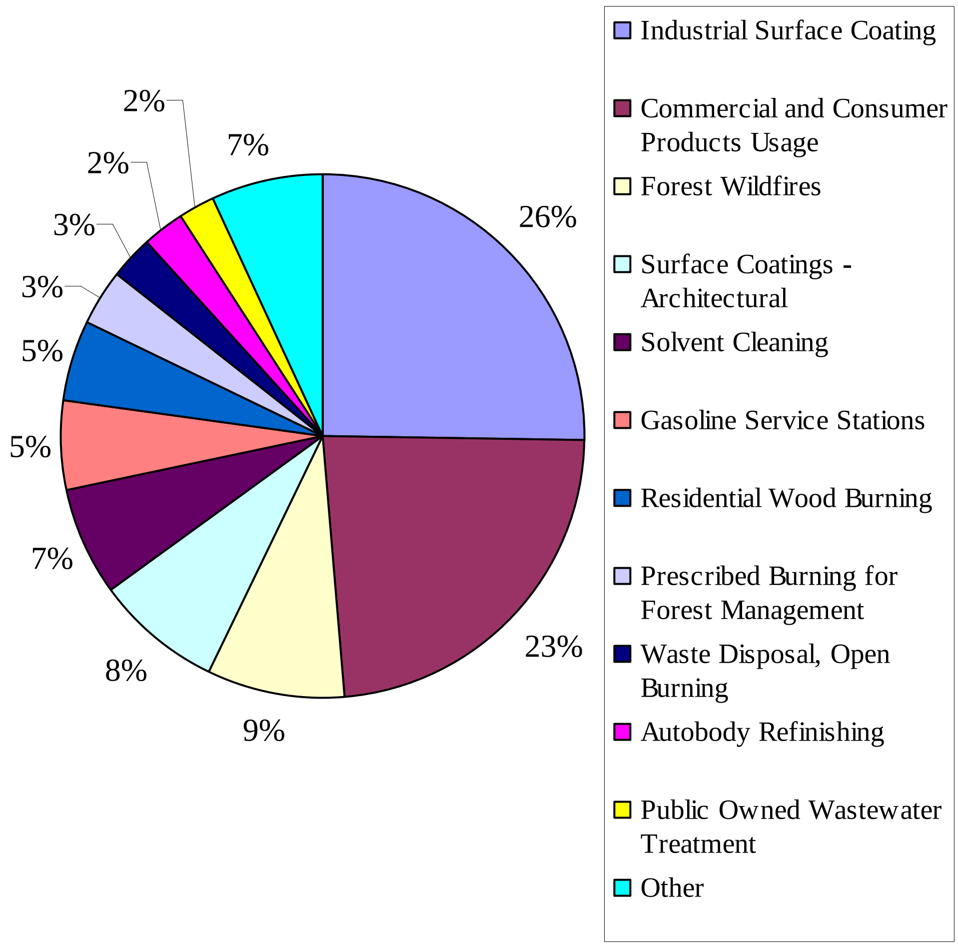
Contribution of Major Categories to 2002 Point Source Air Toxic Emissions in Minnesota



Total air toxics point source emissions in 2002: 21,100,000 pounds or 10,500 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 source categories.

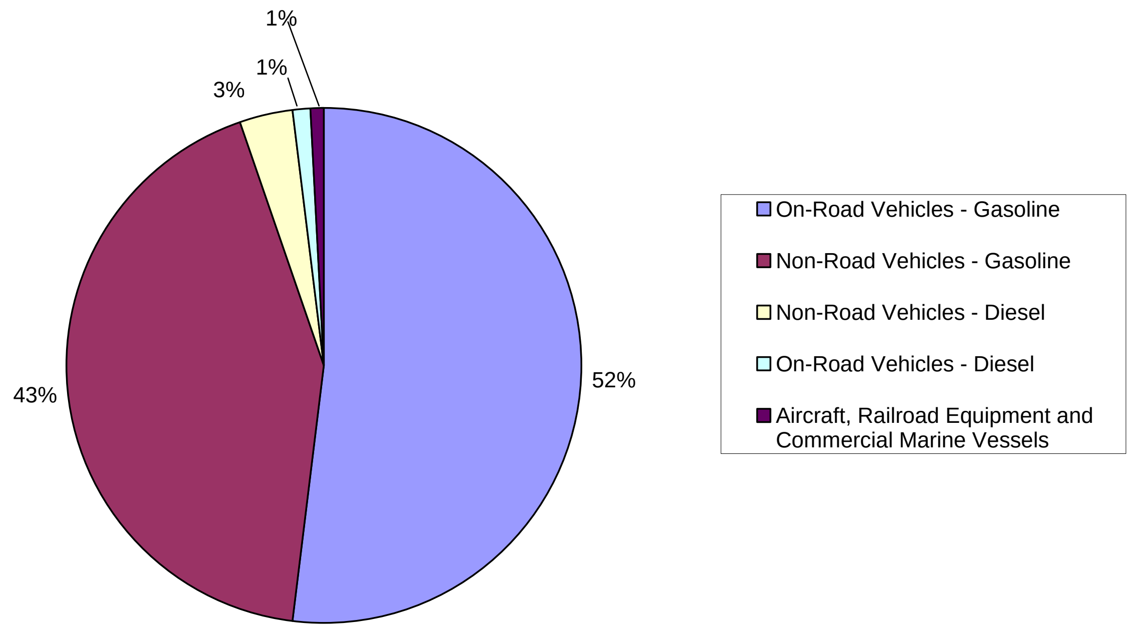
Contribution of Major Categories to 2002 Area Source Air Toxics Emissions in Minnesota



Total air toxics area source emissions in 2002: 52,700,000 pounds or 26,400 tons.

For mobile sources, the largest emission contributor is On-road Vehicles - Gasoline, which accounted for 52% of total mobile source emissions in 2002. The second largest contributor of mobile source emissions is Non-road Vehicles – Gasoline, which accounts for 43% 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: 91,900,000 pounds or 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.ht

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. The Clean Water Act requires states to publish an updated list of streams and lakes that are not meeting their designated uses because of excess pollutants every two years. The list is known as the Impaired Waters List. Additional information about the TMDL listing process and a draft copy of the 2006 Impaired Waters list can be found the following web address: http://www.pca.state.mn.us/water/tmdl/index.html#tmdl

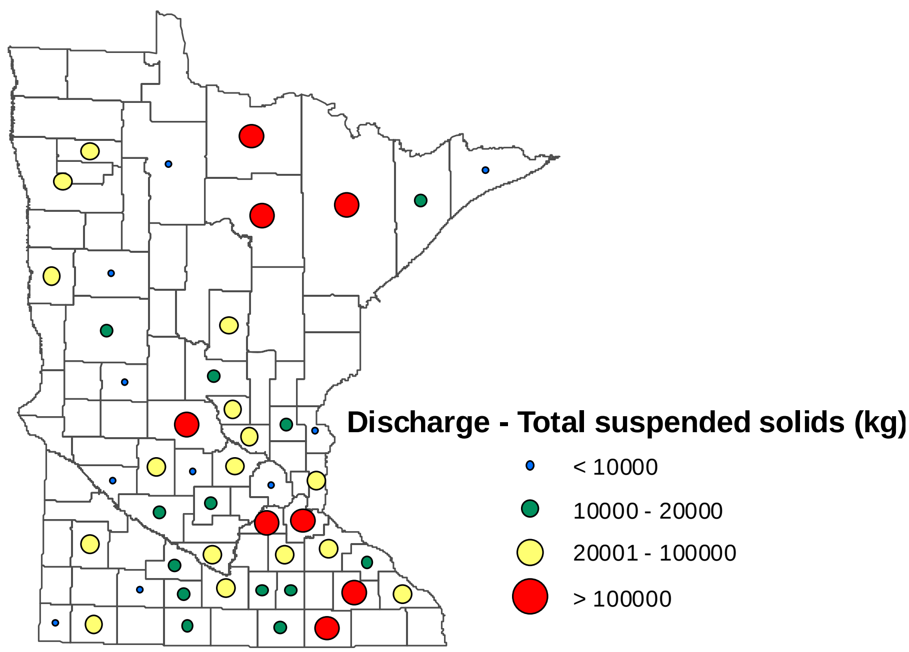
Major Water Discharge Parameters and Trends

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 2000-2004 (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 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 84 major treatment facilities, the estimated discharge of TSS to waters of the state for the year 2004 was approximately 4,600,000 kilograms, a decrease of 19.3% from that reported in 2003. In 2003 and 2004, precipitation levels returned to closer to average from the flooding conditions and persistent high flows that occurred in 2002, and suspended solids decreased accordingly. The state map below shows the 2004 TSS discharges to surface waters by major point sources of water pollutants, aggregated by county.

Total Suspended Solids Discharges from Major Point Sources, 2004

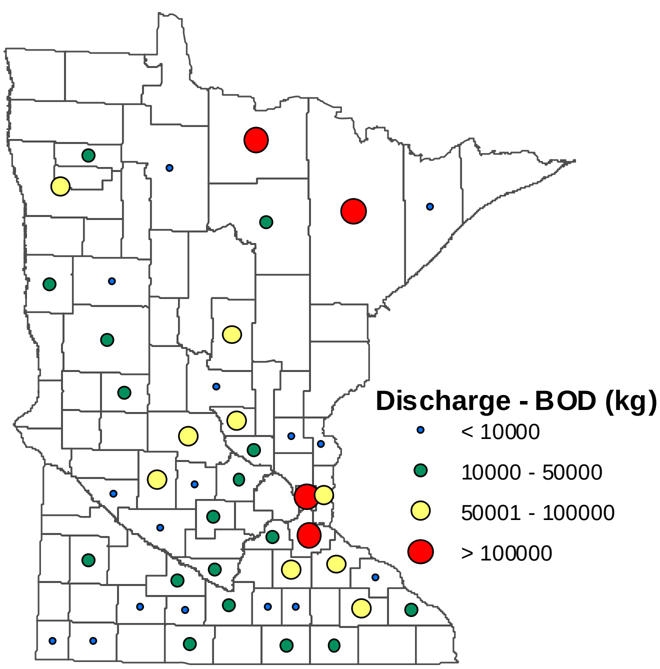


Biochemical Oxygen Demand

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 74 major treatment facilities, the estimated discharge of BOD to waters of the state for 2004 was approximately 3,000,000 kilograms, an 18.9% decrease over 2003. The combined BOD discharge to waters of the state has decreased each year since 2002, when it peaked at approximately 4,900,000 kilograms. The state map below shows the 2004 BOD discharges to surface waters by major point sources of water pollution, aggregated by county.

Biochemical Oxygen Demand Discharges from Major Point Sources, 2004

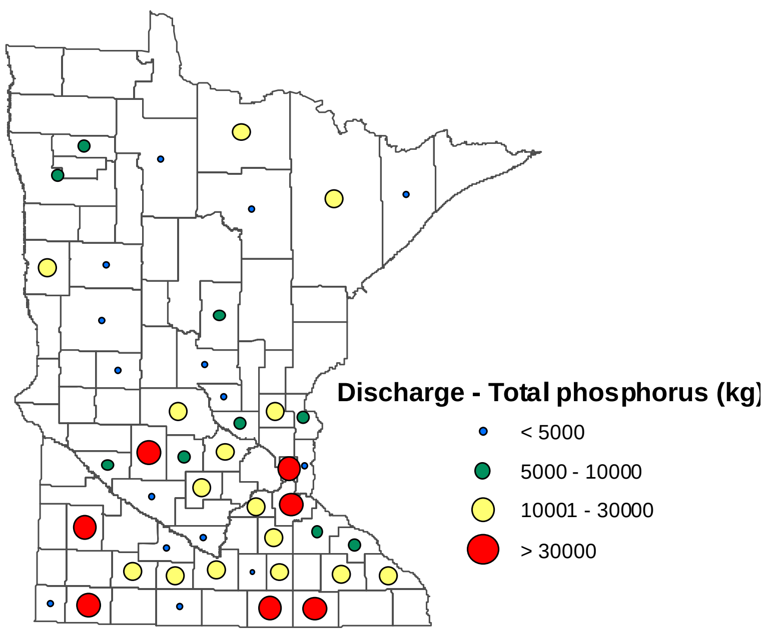


Total Phosphorus

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 64 major treatment facilities, the estimated discharge of TP to waters of the state for the year 2004 was approximately 920,000 kilograms, a decrease of 42.5% from 2003. This reverses an upward trend in TP discharges that was observed from 2002 to 2003. Many treatment plants are now using advanced treatment methods for phosphorus removal. It is encouraging to see TP discharges again decreasing because, as a headwaters state, Minnesota seeks to do its share to reduce its contribution of phosphorus to national problems like the hypoxic zone in the Gulf of Mexico. The state map below shows the 2004 TP discharges to surface waters by major point sources of water pollutants, aggregated by county.

Total Phosphorus Discharges from Major Point Sources, 2004

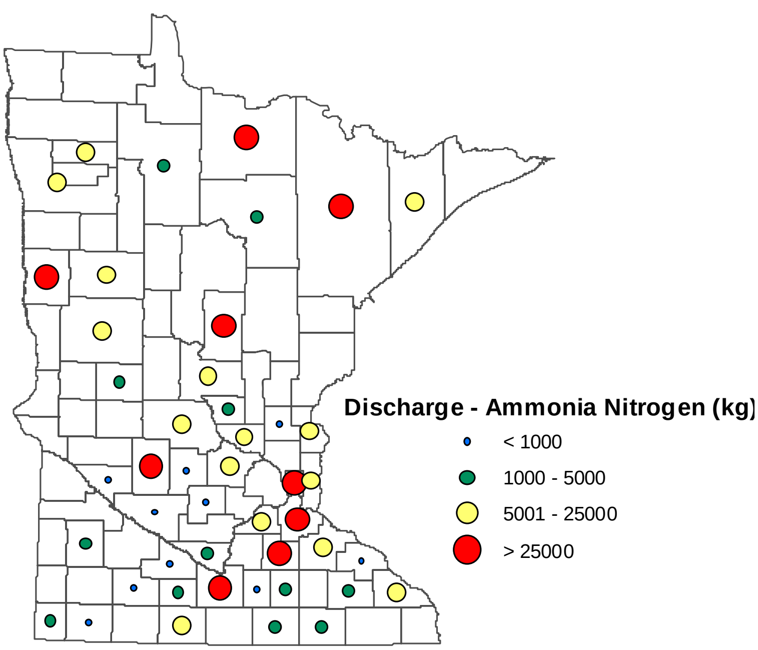


Nitrogen

Nitrogen, generally occurring as either nitrate (NO_3) or ammonia (NH_3) 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 2004 were 830,000 kilograms of ammonia, a decrease of 36.2% from 2003. Much of this decrease results from a substantial, documented decrease in NH_3-N 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 state map below shows the 2004 ammonia nitrogen discharges to surface waters by major point sources of water pollutants. A similar analysis was not attempted for nitrate (NO_3) because an insufficient number of data points were available to make a county-by-county analysis.

Ammonia Nitrogen Discharges from Major Point Sources, 2004



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 89 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 over 3,000,000 kilograms since 1997, despite significant 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 16-17 of the 2004 "Watershed Achievements" report at: http://www.pca.state.mn.us/publications/reports/wq-cwp8-04.pdf for information on pollution savings estimates associated with financial incentive programs administered by the MPCA, Clean Water Partnership and Clean Water Act Section 319 programs.

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.

Measuring the effects of solely nonpoint source pollution can be difficult and expensive. For example, the best long-term data about Minnesota streams comes from measuring six key pollutants at 80 stream locations over the past 40 years. 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. The results generally agree with those shown by point source discharges from Discharge Monitoring Reports. 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% 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% 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

Nonpoint Pollution Case Study: Road Salt in the Shingle Creek Watershed

The Shingle Creek watershed is a largely urban watershed located in the northwestern part of the Minneapolis metropolitan region. The watershed was first used as an example of a nonpoint pollution case study in the 2005 Annual Pollution Report. The creek is heavily used for stormwater management. It is approximately 11 miles long and drops approximately 66 feet from its source in northwestern Hennepin County to its mouth at the Mississippi River. The MPCA determined that waters in the Shingle Creek watershed exceed the state chloride standard for aquatic life (Class 2 water). Class 2 waters include a chronic chloride standard of 230 mg/L based on a four-day average and an acute chloride standard of 860 mg/L for a one-hour duration.

Section 303(d) of the Clean Water Act (CWA) requires the MPCA to identify waters that do not meet state water quality standards and develop Total Maximum Daily Loads (TMDLs) for those water bodies. A TMDL is the total amount of a pollutant that a water body can assimilate and still meet standards on a daily basis. Through the TMDL, pollutant loads can be distributed among the point and nonpoint sources in the watershed. Pollutant load allocations can then be used to make science-based decisions on land use management in the watershed.

In 2004, the Shingle Creek Watershed Management Association and MPCA contracted with Wenck Associates to develop a chloride TMDL for the Shingle Creek watershed. The primary objectives were to:

- Define the spatial extent, persistence and severity of chloride exceedances in the watershed,
- Identify and quantify the sources of chloride in Shingle Creek including point and nonpoint sources, and
- Allocate Shingle Creek's assimilative capacity to both point and nonpoint sources and develop safety margins protective of state water quality standards.

In order to understand chloride dynamics in an urban environment, monitoring of conductivity, chloride and discharge was conducted. In addition to obtaining grab samples biweekly and during runoff events, seven sites in the watershed were continuously monitored for flow and conductivity. An inventory of point and nonpoint sources was also conducted in the watershed. An inventory of salt storage piles and maintenance facilities as well as a compilation of salt application rates by the state (MnDOT), Hennepin County and the major cities in the watershed was done. Other potential sources of chloride in the watershed that were considered include private industrial and residential deicing, landfills, railway and airport deicing, fertilizer application, ground water discharge and natural sources (as a result of soil erosion and precipitation).

The consultant used an empirical approach to develop the chloride TMDL for Shingle Creek. The analytical data collected in the watershed was used to identify flow conditions and time of year where the most exceedances occurred. Measured loads were used to empirically develop wasteload allocations needed to meet water quality standards for chloride in Shingle Creek. Using the monitoring data, seasonal load duration curves can be developed and compared. Because chloride is largely a nonpoint source issue in the Shingle Creek watershed, the TMDL cannot be assigned a single number, but rather is a curve that represents an allowable daily load across all flow regimes. To view the complete report from which this summary was abstracted, see: http://www.shinglecreek.org/tmdl.pdf

Another conclusion of the 2004 report was that 84% of the chloride load to Shingle Creek is related to the storage and application of road salt by public entities, while the remaining 16% was attributed to commercial, residential and ground water sources. A long term goal of 75% reduction in total chloride loading was set to bring chloride concentrations down to recommended standards for Shingle Creek.

In April 2005, the Minnesota Department of Transportation (MnDOT) issued the report, *Best Available Technology: A Review of MnDOT Salt Management Practices in the Shingle Creek Watershed.* The report describes implementation of MnDOT's Salt Solutions Program, aimed at improving efficiencies in salt application and management. Actual BMPs implemented or being implemented in the Shingle Creek watershed have included:

- improving operator training and monitoring to ensure operators are meeting state guidelines;
- using an anti-icing maintenance strategy on bridges in the watershed by applying ice control chemicals just before a storm to reduce total chemical use;
- road testing alternative liquid deicing chemicals lower in chlorides such as magnesium acetate and corn salt (a mix of salt brine and a corn by-product);
- equipping trucks with pre-wetting equipment which can reduce the amount of misapplied product by up to 30% over trucks that are equipped with only ground-oriented spreaders;
- recommending that a MnDOT salt storage area in Maple Grove in the northwest part of the watershed be redesigned to include truck loading in a covered area;
- making information in MnDOT's Road Weather Information System (RWIS) available to other county and city officials in the watershed to allow them to more accurately determine application rates for deicing and anti-icing products, leading to a possible reduction in the amount of chloride used on all roads in the watershed, not just those maintained by MnDOT (see: http://rwis.dot.state.mn.us)

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 of 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 over applying fertilizer. The Minnesota Board of Water and Soil Resources (BWSR) easement projects for 1997-2001 comprised over 3,000 easements on about 200,000 acres. In several counties in southwestern Minnesota, BWSR estimates that as many as 60,000 tons of soil was saved each year as a result of implementing conservation measures on these easements (Atlas of Minnesota, 2nd Edition, University of Minnesota Extension Service, 2003).

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. BWSR estimates that at least four counties in southern Minnesota saved up to 45,000 pounds of phosphorus per year from reaching surface water from the implementation of conservation practices during the period 1997-2001 (Atlas of Minnesota, 2nd Edition, University of Minnesota Extension Service, 2003).

For further information on soil loss in Minnesota and its prevention, see this fact sheet: http://www.pca.state.mn.us/programs/indicators/iom-0902.html

Other Contaminants of Concern in Minnesota's Environment

There are many newly recognized environmental contaminants (sometimes called "emerging contaminants") that are not commonly monitored but which have the potential to enter the environment and cause known or suspected adverse ecological and/or human health effects. These contaminants are commonly derived from municipal, agricultural and industrial wastewater sources and pathways. They represent a shift in traditional thinking as many are produced industrially yet are dispersed to the environment from domestic, commercial and industrial uses. In some cases, release of these contaminants to the environment has occurred for a long time, but may not have been recognized because methods to detect them had not been developed. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of emerging contaminants.

Increasing knowledge of the environmental occurrence or toxicological behavior of emerging contaminants has resulted in concern for their potential adverse environmental and human health effects. 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 evolve to speed the process of identifying and preventing problems, to ensure protection of human health and the environment.

The following kinds of substances have recently emerged and are currently being investigated as contaminants of concern in Minnesota:

- Pharmaceuticals and personal care products (PPCPs)
- Perfluorinated chemicals (PFOS and PFOA)
- Polybrominated diphenyl ethers (PDBEs)

Pharmaceuticals and personal care products (PPCPs)

PPCPs constitute a wide variety of bioactive agents including: antibiotics, hormones, detergents, disinfectants, plasticizers, fire retardants, insecticides and antioxidants. PPCPs are widely used, and are continuously released into the environment through human activities. Primary sources include sewage, manure from confined animal feedlots, landfill leachate, and veterinary clinics. A recent reconnaissance study by the U. S. Geological Survey, MPCA and the Minnesota Department of Health (MDH) showed that industrial and household use compounds and pharmaceuticals are present in streams, ground water and in some Minnesota drinking water supplies. Steroids, nonprescription drugs and insect repellent were the chemical groups most frequently detected. Detergent metabolites, steroids and plasticizers were measured in the highest concentrations. The complete report may be found at http://water.usgs.gov/pubs/sir/2004/5138/

Perfluorinated chemicals (PFOS and PFOA)

The perfluorinated chemicals (PFOS, PFOA) were manufactured for many years by 3M and other companies. They are produced synthetically or through degradation of other fluorochemical products. 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 as a processing aid to produce fluoropolymers and is found in many personal care products and textiles. 3M phased out its manufacture of PFOS and PFOA in 2002.

PFOS and PFOA are widespread and persistent in the environment, but little is known about their toxicity to humans. They have been found in animals all over the globe, and MPCA research has detected PFOS at elevated levels in blood, liver and tissue of several fish taken from the Mississippi River near the 3M Cottage Grove plant.

In animals, high concentrations of PFOS and PFOA cause harm to the liver and other organs. Exposure to high concentrations of PFOA over a long period of time also cause cancer in animals, and the EPA Science Advisory Board recently recommended that PFOA be classified as a “likely” human carcinogen. Developmental problems have been seen in the offspring of rats exposed to PFOS and PFOA while pregnant. Epidemiological studies by 3M of workers exposed during manufacture show no apparent impact on their health. There is no similar epidemiological information on the general population..

Due to limited information and the persistence of PFOS and PFOA, the MDH has set health risk limits (HRLs) of 1 ppb for PFOS and 7 ppb for PFOA in drinking water, which it characterizes as conservative (protective with an extra margin of safety). At this writing the MPCA and MDH are awaiting additional analyses of fish tissue, landfill leachates and other possible sources of PFC exposure. A complete description of all MPCA activities related to PFCs is included on the following web page: http://www.pca.state.mn.us/hot/pfc.html

Polybrominated diphenyl ethers (PDBEs)

PBDEs (polybrominated diphenyl ethers) are commonly used flame retardants found in plastics, textiles, electrical appliances and equipment, furniture, building materials and automobiles. Toxicity concerns include developmental neurotoxicity, thyroid disruption, altered behavior and learning, and dioxin formation when burned. PBDEs have been detected globally in both developed and remote environments. Monitoring studies have measured PBDEs in sediment, air, wildlife, fish, human blood and human milk. A human-milk monitoring program in Sweden showed that PBDE concentrations in breast milk nearly doubled every five years until Sweden banned PBDEs in 1997, when concentrations in breast milk dropped off rapidly. In contrast, PBDE concentrations in breast milk of North Americans, where PBDEs are still widely used, has been shown to be 10 -100 times higher than in Europe, where manufacture and usage has been phased out.

Dietary intake is assumed the primary route of PBDEs exposure in humans, although recent information suggests that inhalation and ingestion of indoor dust also may be an important exposure pathway.

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.

Additional MPCA analysis nearing completion involves measurement of PBDEs in Lake Superior water, sediment, fish tissue, zooplankton and ambient air; wastewater treatment influent, effluent and sludge; stream fish tissues and bottom sediments; and closed-landfill gases, leachate and ground water.

The European Union and five U.S. states have enacted laws banning or phasing out the manufacture and use of PBDEs over the next three years, and five other states are considering similar measures.

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/hot/legislature/reports/2005/index.html