Air Quality in Minnesota

Progress and Priorities

2005 Report to the Legislature

February 2005

Minnesota Pollution Control Agency

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This report has the following purposes:

To report on progress made since the MPCA's 2003 Air Quality Legislative Report.

To share information about air quality trends in Minnesota as well as scientific developments that were unknown at the time of the MPCA's 2003 Air Quality Legislative Report.

To fulfill the statutory requirement (Minn. Stat. 115D.15 and 116.925) for the MPCA to prepare a biennial report to the legislature on a category of air pollutants known as air toxics.

Because the MPCA's authority extends to the outdoor environment only, this report does not address pollutants in indoor air.

WHY DOES CLEAN AIR MATTER?

Clean air means healthier people

Air pollution can cause breathing problems, itchy throats and burning eyes, and make asthma and bronchitis worse. It can contribute to cancer, heart attacks and other serious illnesses. Even healthy, athletic adults can be harmed by breathing air pollutants. Because of their small size and rapid breathing, children may be even more susceptible. A 2003 study by the federal Office of Management and Budget noted that the estimated value of the health benefits of cleaner air is often several times the cost of making the air pollution reductions.[1]

Clean air means cleaner water

Some air pollutants, such as mercury, settle out of the air into our lakes and rivers, contaminating aquatic ecosystems and fish and, through them, humans.

Clean air means a healthier economy

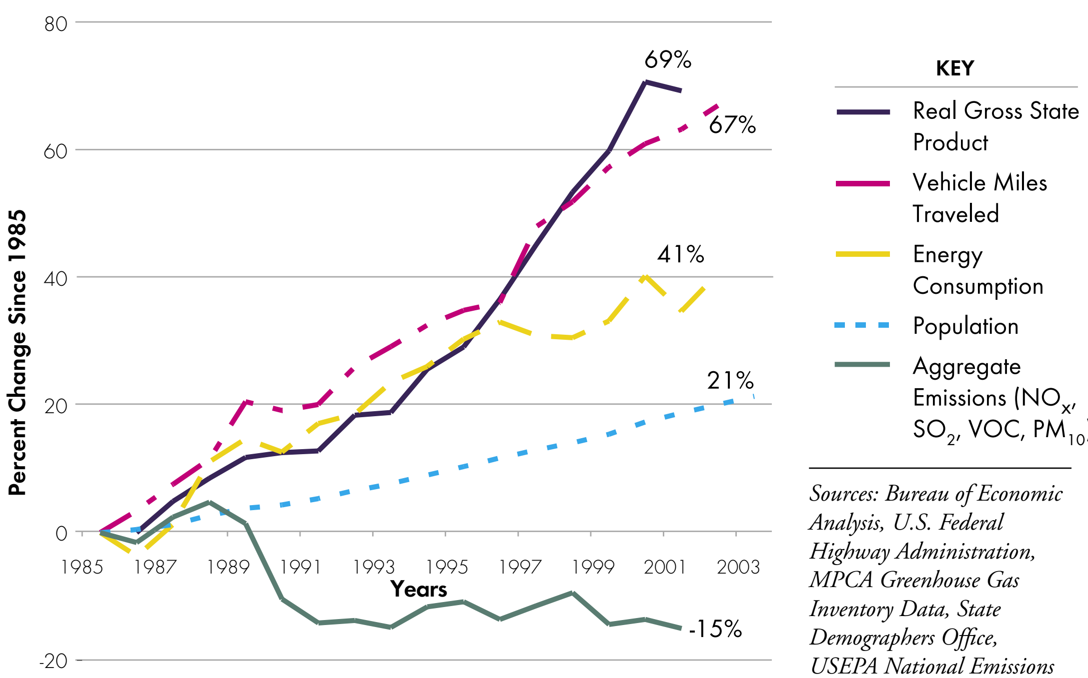
Clean air yields benefits that add to the value of a region's economy. Crops damaged or weakened by air pollution produce lower yields, and forests weakened by air pollution succumb more easily to pests and disease. Minnesota's tourism industry depends on fishable, swimmable waters; limits on fish consumption due to mercury can discourage would-be tourists. Minnesota tourism may also be affected by smoggy vistas in scenic and remote beauty spots. In addition, according to a study sponsored by the Minnesota Chamber of Commerce, should Minnesota violate the ozone standard, the regulatory requirements that would become applicable could cost Minnesota businesses and consumers almost $200 million per year.

HOW ARE WE DOING IN MINNESOTA?

Despite sizeable increases in energy use, population, vehicle miles traveled, and gross domestic product in Minnesota, emissions of regulated pollutants generally have declined since 1985.

Minnesota, however, is faced with the same challenges as other states. Population and energy/fuel use remain major factors in air pollution. When more people drive more vehicles longer distances, air pollution from vehicle exhaust increases. As population grows, so does demand for electricity, causing current power plants to operate more, and creating pressure to build new power plants. New scientific discoveries, such as those documenting the health effects of fine particles and diesel exhaust, increase the priority of these environmental problems.

Comparison of Growth Areas and Emissions in Minnesota

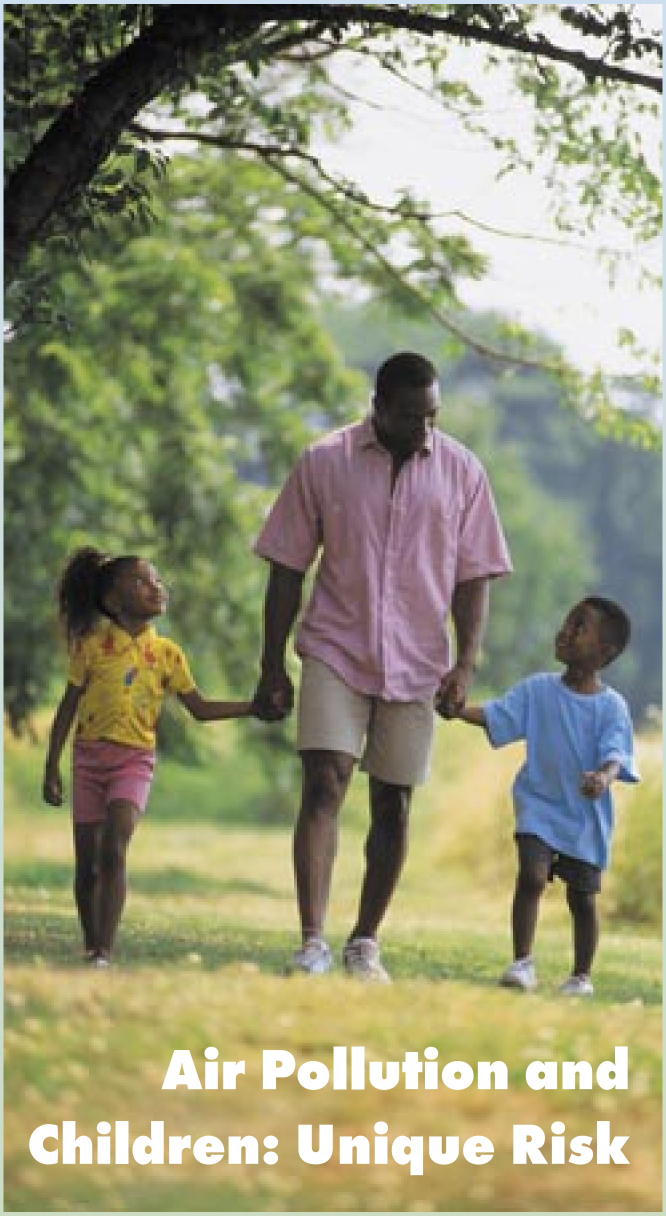


Sources: Bureau of Economic Analysis, U.S. Federal Highway Administration, MPCA Greenhouse Gas Inventory Data, State Demographers Office, USEPA National Emissions Inventory Database

Minnesota continues to meet all federal ambient air quality standards, having reduced air pollution in several areas of the state that once did not meet these standards. In 1997, a new, more stringent federal ozone standard was put into place, along with a new standard for fine particles. The federal government recently found that Minnesota meets these new, more stringent standards, making Minnesota one of only 11 states that currently meet all federal air quality standards.

Minnesota's current attainment status can not be taken for granted, however. Minnesota's ambient air is at about 80 percent of the new ozone and fine particle standards. In recent years, Minnesota has experienced a dozen days a year where ozone and fine particle levels have triggered air quality alerts. Minnesota must continue to work to reduce levels of these air pollutants. Falling out of compliance with the ozone standard would be harmful to human health and impose substantial costs on Minnesota's transportation system and business community. Fine particles are known to have health impacts at levels even below the standards. For this reason, MPCA continues to work to find collaborative, cost-effective ways to reduce emissions that contribute to ozone and fine particle formation.

Some air pollutants contribute to more than one pollution problem. For instance, some air toxics are also components of particles, and some are ozone precursors. Gases like sulfur oxides and nitrogen oxides can react with other chemicals in the atmosphere to form fine particles. While this makes air pollution more challenging to



Air Pollution and Children: Unique Risk

Because they are small, children eat, drink, and breathe more per pound of body weight than adults. This means that children take in more pollution per pound than adults. Children are also particularly sensitive to environmental contaminants because they are still developing and cannot remove toxins from the body as efficiently as adults.

Children have an entire lifetime ahead of them during which they may develop diseases caused by exposure to air pollution in youth. Scientists have found that the risk of developing cancer may be due more to exposures during childhood than total exposure throughout life.[2] Many studies have found a link between respiratory concerns in children and proximity to traffic.[3]

The California Air Resources Board just completed a landmark ten-year study of the effects of long-term exposure to outdoor air pollution in children. In the 1990s, southern California elementary school children were tested for lung function by measuring functions such as how much air their lungs can hold and how well they exhale. Over eight years, the researchers found the lungs of children living in areas with more air pollution functioned worse than those who lived and breathed the air in less-polluted communities. This decreased lung development may have permanent effects on these children as adults decades later. The study found that new cases of asthma and asthma exacerbations were associated with ambient air pollution levels, and school absences from acute respiratory illnesses followed rises in ozone levels.[4]

A National Institute of Environmental Health Sciences study of this data found that children living in the most polluted communities in Los Angeles were five times more likely to have substantially decreased lung function than children in cleaner communities.[5]

understand, it can actually make reduction strategies more effective. Strategies that address a single pollutant can often result in reductions of multiple pollutants. For example, efforts to reduce ozone and fine particles will also reduce air toxic emissions.

In the past, the MPCA has measured two air toxic pollutants, benzene and formaldehyde, at concentrations exceeding health-based benchmarks. Recent monitoring has shown that benzene concentrations are now below the health risk levels, and that formaldehyde concentrations may be showing some decline. The MPCA continues to monitor air toxic pollutants to determine whether any other air toxics exceed health-based benchmarks.

In its 2003 Air Quality Report to the legislature, the MPCA announced partnerships and voluntary initiatives to protect and improve the quality of Minnesota's air. This 2005 report describes the substantial progress made on the actions committed to in the 2003 report, the progress achieved in meeting the MPCA's strategic plan goals for air quality, and the MPCA's future priority actions to meet Minnesota's air quality challenges.

PROGRESS ON PRIORITY ACTIONS FROM 2003 AIR QUALITY REPORT

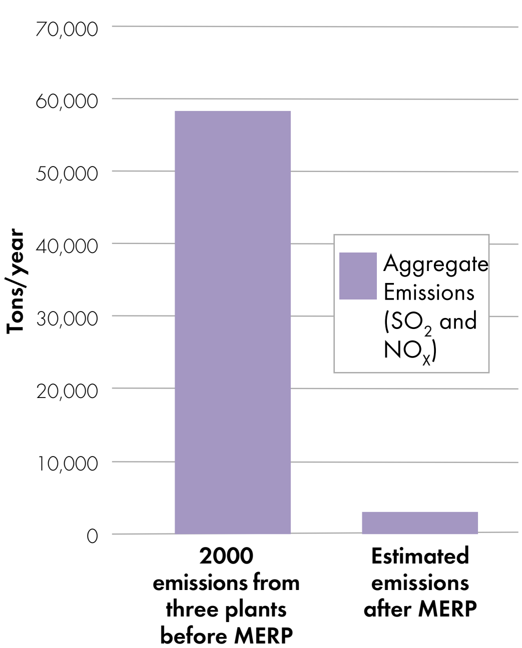
In its 2003 Air Quality Report, the MPCA listed priority actions planned to protect and improve the quality of Minnesota's air. This section describes progress in implementing these actions. Because Minnesota already attains federal air quality standards, the MPCA has focused on voluntary, partnership-based actions to improve air quality. The MPCA has promoted early adoption of clean, cost-effective technologies to reduce air emissions in the state.

Cleanup of older coal-burning power plants

In March 2004, the Minnesota Public Utilities Commission approved a proposal by Xcel Energy that will result in the single largest air emission reduction ever put into place in Minnesota.[6]

Xcel Energy will begin installing state-of-the-art pollution controls at the Allen S. King power plant in Oak Park Heights in 2005, with the renovated plant achieving much cleaner operation in 2007. By 2008 and 2009, respectively, St. Paul's High Bridge power plant and Minneapolis' Riverside power plant will both be changed from coal to natural gas. Natural gas is a cleaner fuel than coal.

Metropolitan Emissions Reduction Project (MERP)



This project, the Metropolitan Emissions Reduction Project (MERP), will achieve a projected 95 percent reduction in NO_x and SO_2 emissions from the three plants. NO_x and SO_2 contribute to the formation of fine particles in the air; NO_x is also a precursor of ozone pollution. In addition, mercury emissions from the three plants will be reduced by 81 percent, PM_{10} (larger particles) by 70 percent and CO_2 by nine percent.

The MERP was proposed under an innovative state statute called the emission reduction rider statute. This statute created a procedure for considering the environmental benefits of a proposed project at the same time impacts on electric rates and other energy system planning issues are evaluated. The statute requires the MPCA to make a technical evaluation of the control technology proposed, evaluate whether the proposed costs were reasonable for the installations proposed, assess the benefits of the project, and make a recommendation to the Public Utilities Commission on whether the project should be approved.

The MPCA, after detailed and careful evaluation, concluded that the MERP qualified under the statute: it had substantial health and environmental benefits and implemented cost-effective emission reductions. These emissions reductions will be accomplished well in advance of proposed federal utility regulations.

The MERP is the result of a collaboration of Xcel Energy, Minnesota businesses, environmental groups and state agencies. It accomplishes huge emission reductions while increasing available capacity on Xcel Energy's system to meet Minnesota's growing energy needs.

Use of new, cleaner technologies on buses, trucks, and other motor vehicles

The MPCA provides technical support and encouragement to government agencies and private partners to voluntarily retrofit their on- and off-road diesel engines with pollution control equipment. The MPCA also encourages expanded use of biodiesel and ethanol in fuel, and has worked to initiate use of ultra-low-sulfur diesel fuel (ULSD) ahead of federal requirements. ULSD has 97 percent less sulfur than diesel fuel currently used by on-road vehicles. Lower sulfur content reduces formation of sulfur oxides and particles, and improves the efficiency of pollution control equipment.

Diesel Pollution Reduction Projects in Minnesota*

In 2004, with the assistance and support of the Minnesota Department of Administration and the MPCA, the Twin Cities' Metro Transit Authority began purchasing ULSD for half of their 900 buses. By using ULSD, Metro Transit will reduce annual bus tailpipe emissions by an estimated 8.5 tons of smog-forming pollution at a price comparable to regular diesel fuel. Further, by purchasing large quantities of ULSD, Metro Transit has brought this fuel into the Twin Cities market nearly three years before it is required by federal law. As a result, ULSD is now available to other fleet owners, including school bus fleets.

Depending on the engine and the particular diesel engine retrofit, combining ULSD with diesel retrofit technology can reduce tailpipe emissions by 60 to 90 percent. Diesel retrofit technology and cleaner diesel fuel are employed statewide.

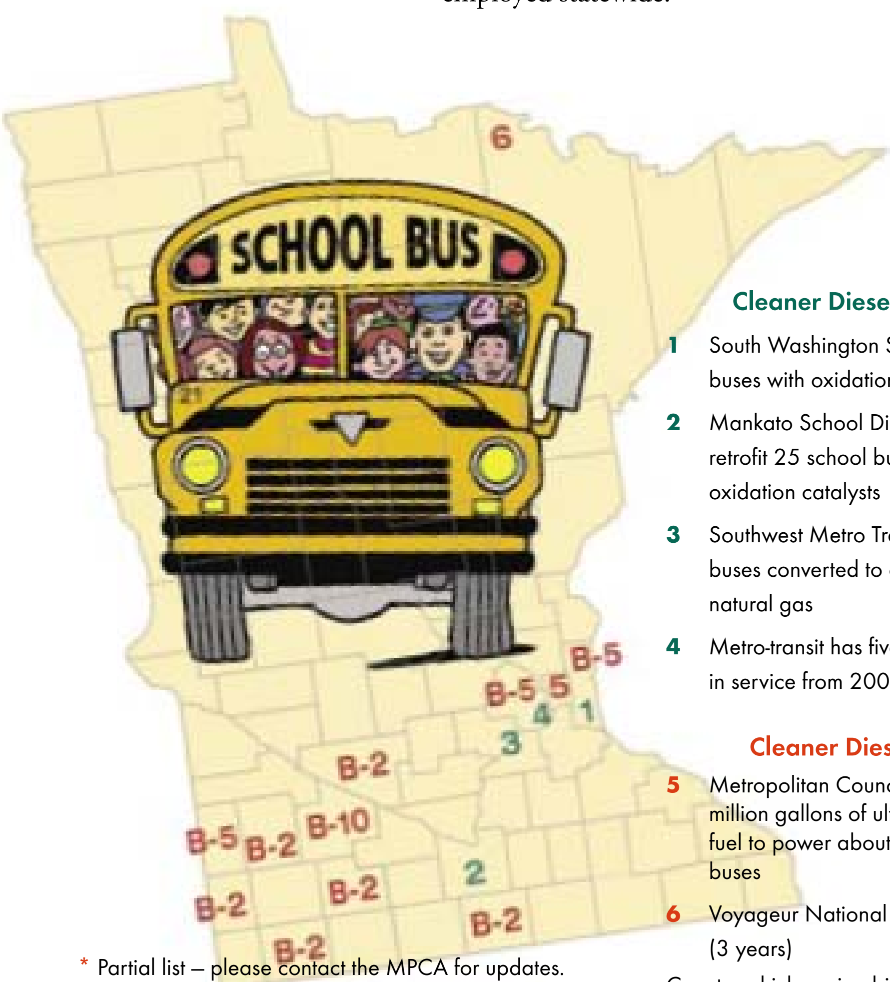
Using events such as the State Fair and Auto Show, the MPCA reaches more than 300,000 citizens each year with information about cleaner fuels, fuel efficiency and practical ways to reduce fuel consumption.

The MPCA has been a leader in efforts to improve the efficiency of the state vehicle fleet. The MPCA also continues to provide technical assistance to other diesel fleet operators with an interest in cleaner fuels and diesel retrofit technology.

Control emissions from underground gas station tanks

Reducing volatile organic compound (VOC) emissions that result when tankers refill gas station underground storage tanks is the most cost-effective way to reduce emissions of this ozone precursor. The control equipment used to make these reductions is called "Stage 1 vapor recovery," and reduces VOC emissions by 95 percent or more. The MPCA worked collaboratively with petroleum marketers between 2001 and 2003 to get Stage 1 vapor controls installed in gas stations selling 40 percent of the gasoline sold in the Twin Cities. The city of Minneapolis joined the effort, creating a Stage 1 vapor control ordinance.

This led to broad support for requiring Stage 1 vapor recovery at all Twin Cities gas stations. Minn. Statutes 116.49, subd. 3, enacted by the 2003 Minnesota legislature, requires remaining gas stations to install Stage 1 controls. By January 1, 2006, all gasoline stations in the seven-county Twin Cities metropolitan area will have "Stage 1" vapor controls. This requirement will keep about 3,000 tons of smog-forming pollutants out of the air each year.



Cleaner Diesel Technology

1 South Washington School Dist., 65 retrofit buses with oxidation catalysts

2 Mankato School Dist. plans to retrofit 25 school buses with oxidation catalysts

3 Southwest Metro Transit – five diesel buses converted to compressed natural gas

4 Metro-transit has five diesel-electric buses in service from 2003

Cleaner Diesel Fuel Use

5 Metropolitan Council – bought 3.7 million gallons of ultra-low-sulfur diesel fuel to power about half of the transit buses

6 Voyageur National Park used B-20 (3 years)

County vehicles using biodiesel blends are indicated on the map by B-2 (2% biodiesel), B-5 (5%) and B-10 (10%).

* Partial list – please contact the MPCA for updates.

Reduce ozone on peak days

The MPCA partners with Minnesota Environmental Initiative's Clean Air Minnesota (CAM) to achieve voluntary reductions of ozone-forming pollutants — especially on days when ozone levels are forecast to be high.[7] CAM is a voluntary partnership of businesses, environmental groups, government agencies and citizens. The MPCA notifies CAM partners when ozone or other pollutant levels are forecast to be high. CAM partners, in turn, notify their employees and take steps to reduce pollutants from their own daily operations.

CAM's goal is to achieve significant, measurable reductions in air pollution through voluntary actions of people and businesses in Minnesota. For example, CAM enlisted a local printer to test a new lower-polluting press-cleaning solvent. The MPCA has also supported CAM by providing information about the reduction potential of activities — from biodiesel to switching to cleaner lawnmowers. The MPCA assisted in developing a tool to calculate emissions reductions that will be available to CAM partners online.

As a CAM partner, the MPCA agreed to take steps to reduce air pollution from its own business operations. These include use of fuel-efficient vehicles, cleaner vehicle fuels, energy-saving actions in its building, use of low-VOC cleaning products, and postponing maintenance activities on air quality alert days. After initiating these actions, the MPCA developed an action plan for use by all state agencies.

More than 2,500 individuals have signed up to receive e-mail notice of air pollution alerts from the MPCA. Many of them, including school staff, businesses, government and environmental groups, forward the e-mail alerts to others. In particular, CAM partners agree to receive e-mail notice of air quality alerts and forward them to their employees. Through this employee connection, CAM estimates that almost 100,000 citizens will receive prompt notice of air quality alerts. This allows them to take individual actions to bring pollutant levels down, as well as being warned to reduce exertion on days when pollution is high.

Governor's Executive Order to State Agencies

On August 6, 2004, Governor Pawlenty issued Executive Order 04-08, requiring state departments to take actions to reduce air pollution in their daily operations. The order seeks to lead by example, encouraging other organizations and business in Minnesota to take the actions encouraged by Clean Air Minnesota.

The order requires departments to select at least two specific pollution-reducing actions, such as: buying the most fuel-efficient vehicles that meet department needs; using cleaner fuels such as E85 in flexible-fuel vehicles; purchasing office equipment that qualifies for the Energy Star for efficiency; and implementing energy-saving features in buildings after an energy audit.

On September 27, 2004, Governor Pawlenty issued Executive Order 04-10 requiring state departments to make a 25 percent reduction in gasoline use by 2010 for on-road vehicles and a 50 percent reduction by 2015. His order specifies that petroleum-based diesel fuel in state vehicles must be reduced by 10 percent by 2010 and 25 percent by 2015. These reductions are based on fuel that will be consumed in 2005.

These executive orders are an example to other fleets, including private fleets, across Minnesota. The MPCA has played an instrumental role in supporting these executive orders and has been working to improve its own vehicle fleet since 2001.

Expanded air quality public information system

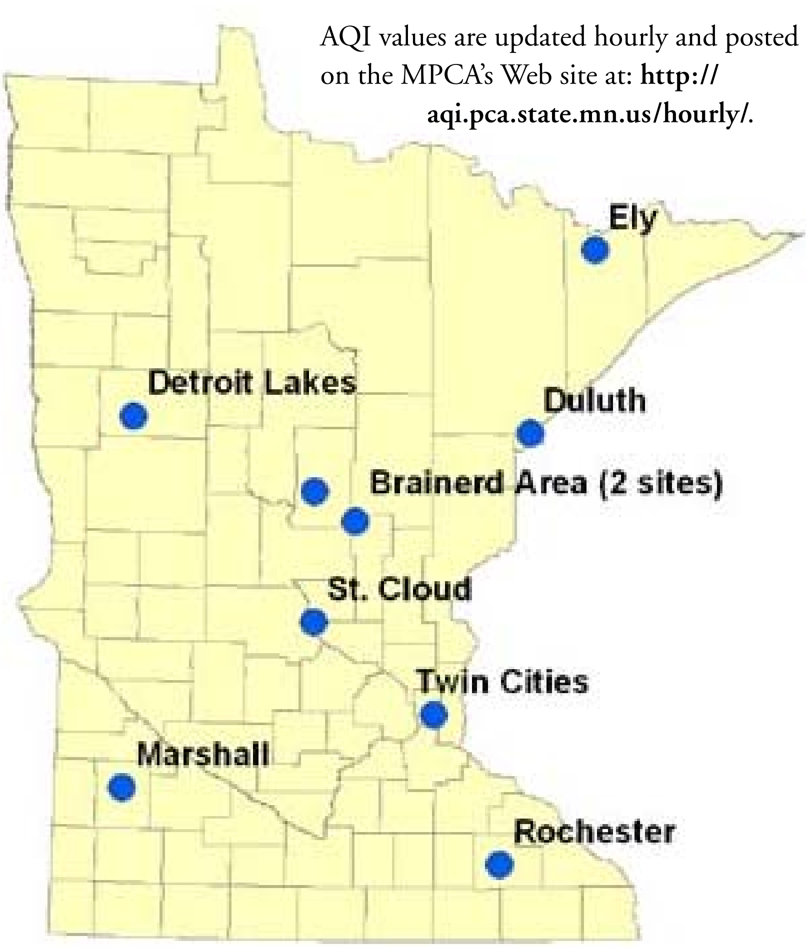
The MPCA has implemented several projects designed to improve timely citizen access to and understanding of air pollution levels in Minnesota. The MPCA has broadened the coverage of its air quality monitoring network, increased access to real-time air quality information, and improved access to information on the permit limits and emissions from regulated air facilities in Minnesota. These efforts are described below.

◆ Expanded Air Quality Index monitoring

Historically, the MPCA had Air Quality Index (AQI) monitors only in the Twin Cities. In 2003, the MPCA expanded AQI coverage to include Rochester, St. Cloud and Duluth. By early 2005, the MPCA will have monitoring and data reporting capabilities that can produce an AQI for eight Minnesota cities. This will allow citizens across the state to be able to know the quality of the air any day of the year.

AQI values are updated hourly and posted on the MPCA's Web site at: **http://aqi.pca.state.mn.us/hourly/**.

Map of AQI Locations



An AQI number is determined by measuring four pollutants: ozone, sulfur dioxide, fine particles and carbon monoxide. (Ozone monitoring takes place only from April through September, because ozone formation occurs primarily in warm weather.)

◆ Air pollution health alerts

If monitoring data shows elevated levels of one of the four pollutants (most commonly fine particles or ozone), or if a forecast shows the possibility of poor air quality, the MPCA issues an Air Pollution Health Alert to the media and to the 2,500 individuals who have signed up to receive e-mail alerts. The MPCA adopted the Air Pollution Health Alert system two years ago. Alerts allow the public to be proactive about protecting their health and about reducing their own contributions to emissions.

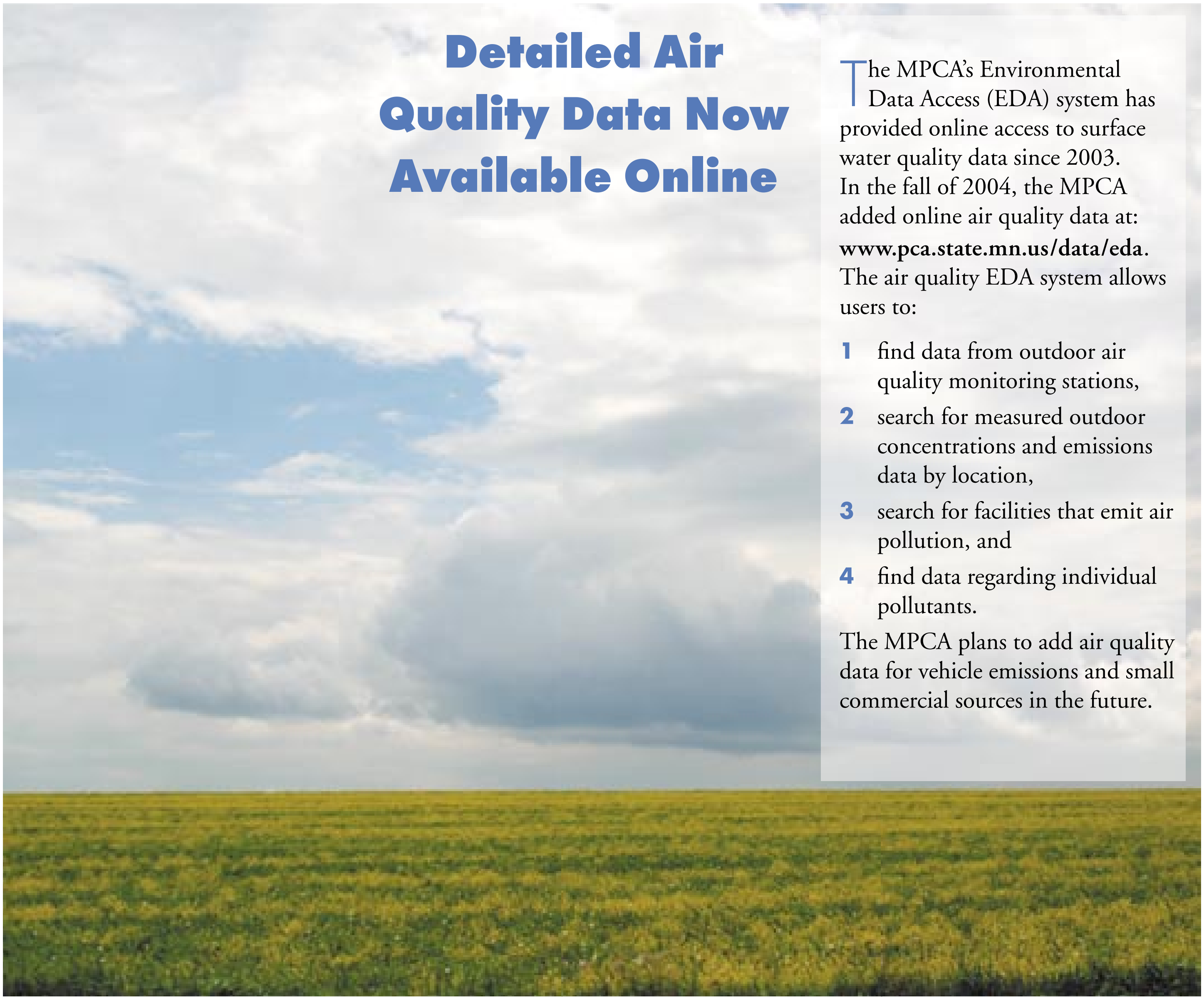
◆ Hazecam

Individuals can monitor visibility in the Twin Cities, thanks to a live internet camera in St. Paul. The camera went on-line in June 2003, as part of the Midwest Hazecam network.[8] Long recognized as a blight that obscures scenic vistas in national parks and other remote areas, haze also reduces visibility in urban areas. Haze may also indicate that concentrations of particles are near or at unhealthy levels. Hazecam images can be seen at: **www.mwhazecam.net/**

◆ Air quality permits and regulatory information online

For easy access to citizens to find out what air emission limits apply to various Minnesota point or stationery sources, the MPCA posts air permits on the web at: **www.pca.state.mn.us/air/permits/issued/index.html**.

In the fall of 2004, the MPCA formed a new air technical information e-mail listserv to quickly convey new air quality information on permitting, modeling, rulemaking, and air toxics. This service is intended particularly for large industrial sources which need to keep up with regulatory developments. For more information, see: **www.pca.state.mn.us/air/air-techinfo.html**.



Detailed Air Quality Data Now Available Online

The MPCA's Environmental Data Access (EDA) system has provided online access to surface water quality data since 2003. In the fall of 2004, the MPCA added online air quality data at: **www.pca.state.mn.us/data/eda**. The air quality EDA system allows users to:

1. find data from outdoor air quality monitoring stations,
2. search for measured outdoor concentrations and emissions data by location,
3. search for facilities that emit air pollution, and
4. find data regarding individual pollutants.

The MPCA plans to add air quality data for vehicle emissions and small commercial sources in the future.

STATUS OF ACHIEVEMENT OF OBJECTIVES IN MPCA AIR QUALITY STRATEGIC PLAN

The MPCA's ongoing clean air strategic plan goals are:

1. Meet all state and federal ambient air quality standards.
2. Meet all environmental and human health benchmarks for toxic air pollutants.
3. Reduce Minnesota's emissions of pollutants that contribute to regional, national and global air quality problems.

The MPCA develops its specific short-term action plans based on these longer-term objectives. In this section, the current status of MPCA's achievement of these objectives is provided, including a description of the various individual projects and federal regulatory developments that contribute to or are needed to achieve these goals.

Goal 1: Meet all state and federal ambient air quality standards

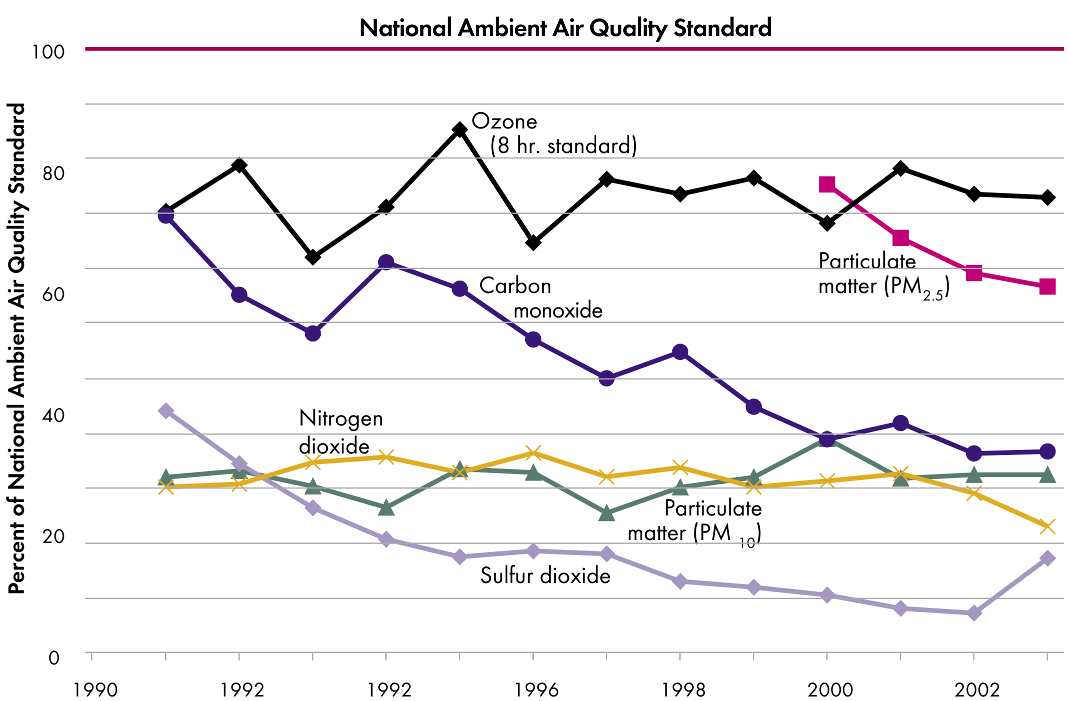
The first objective under this goal reflects the requirement to meet ambient air quality standards on an ongoing basis. Achieving the second objective under this goal will help assure that Minnesota stays in compliance with the new federal ozone standard by reducing its emissions of precursor pollutants. Achieving the third objective will help assure that Minnesota stays in compliance with the new fine particle standard, even in the event that the standard is made more stringent due to new evidence of health effects at air pollution levels that comply with the current standard.

◆ Reduce risk to humans by continuing to meet all federal and state ambient air quality standards

The EPA sets National Ambient Air Quality Standards for certain air pollutants to protect public health and the environment. These air pollutants, commonly called "criteria" air pollutants are: ground-level ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), carbon monoxide (CO) and particles or soot (PM). There are separate standards for all particles smaller than 10 microns (PM_{10}) and particles smaller than 2.5 microns ($PM_{2.5}$ or fine particles). Scientists believe fine particles are more harmful.

Minnesota currently meets all the above standards.[12] SO_2, NO_2, CO and PM_{10} ambient levels are less than 40 percent of their standards.[13] Ozone and $PM_{2.5}$ levels are at about 80 percent of their respective standards, meaning

Trends in Criteria Air Pollutants in the Twin Cities Area



Source: MPCA monitoring data

that although Minnesota is not yet in danger of violating these standards, there is not much room.

The Air Quality Index (AQI) is a tool used to describe daily levels of criteria pollutants. In 2003, the AQI reached and exceeded the minimum level for an air pollution alert (an AQI of 100-150) nine times for $PM_{2.5}$ and four times for ozone. This does not mean that Minnesota violated federal air quality standards, however, in part because violating standards involves more than one year's data.

There were no air pollution alerts for ozone in the summer of 2004, probably because 2004 was one of the coldest summers on record in Minnesota (heat accelerates formation of ground-level ozone). A 2002 report written for the MPCA concluded, however, that ozone levels in the Twin Cites generally appear to be rising over time.[14] There is not yet enough data on $PM_{2.5}$ to determine if there is a trend in Minnesota; however, an EPA analysis of recent data shows an apparent decreasing national trend in concentrations of $PM_{2.5}$.[15]

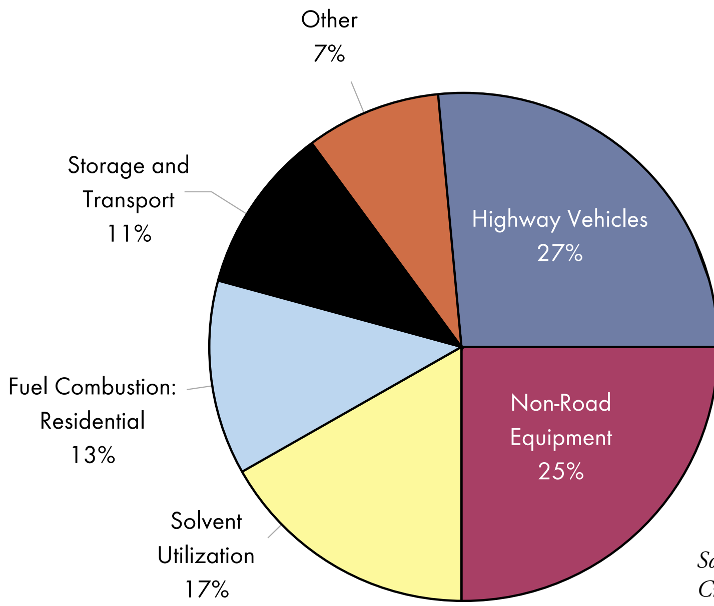
◆ By December 31, 2010, reduce emissions of pollutants that contribute to ozone formation by 30 percent from 2000 levels

Ozone, the major component of smog, is both a lung irritant and harmful to crops and trees. The primary pollutants that contribute to ground-level ozone formation are nitrogen oxides (NO_X) and volatile organic compounds (VOCs).

Almost all NO_X emissions in Minnesota are the result of burning fuels, and are therefore human-generated. However, VOCs are also produced by background sources, such as trees during the growing season.[16]

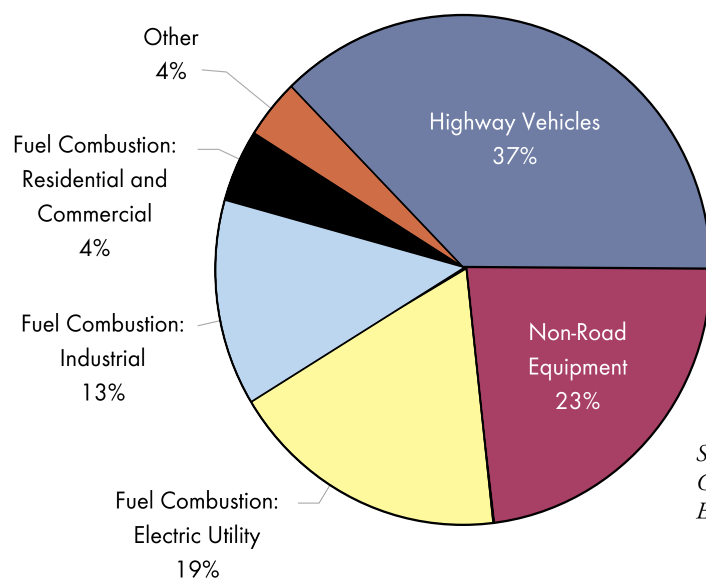
Taking into account the expected impact of federal requirements that will be implemented by 2010, growth projections, and voluntary reductions by Xcel Energy MERP, NO_X emissions are expected to decrease by about 25 percent by 2010.[17]

Sources of VOCs from Human Activities in Minnesota, 1999



Source: Minnesota Criteria Pollutant Emission Inventory

Sources of NO_X from Human Activities in Minnesota, 1999



Source: Minnesota Criteria Pollutant Emission Inventory

Because there may soon be federal legislation limiting NO_X emissions from power plants, or because Minnesota will potentially be covered by the EPA's proposed Clean Air Interstate Rule to limit NO_X from power plants, the MPCA predicts that further NO_X reductions that could help reach the reduction objective are probable, although likely to be implemented after 2010.

VOC emissions are expected to decrease by about 15 percent by 2010, primarily due to federally-required controls for on-road vehicles.[18] To meet the objective of a 30 percent reduction, additional projects will be needed for VOCs. Further analysis of the mechanics of ozone formation is already underway and is necessary to fine-tune reduction needs.

The MPCA is doing extensive modeling of ozone formation in Minnesota to learn what air pollution is transported into Minnesota from other states and how much is locally generated. This study will also help point to the types of additional emission reductions that might be the most beneficial. It is important to look for reduction projects that are both beneficial and cost-effective, because the reduction goal is meant to provide a buffer against violating the federal standard, but is not required by current regulations.

- **By December 31, 2010, reduce emissions of pollutants that contribute to fine particle formation by 30 percent from 2000 levels**

NO_X and SO_2 contribute to the formation of particles in the air, along with other pollutants. NO_X reductions to reduce ozone formation will also reduce particle formation. The status of NO_X reductions in Minnesota is discussed in the ozone objective above, and will not be repeated here.

Like the ozone objective above, this objective seeks to provide a buffer against violation of the federal fine particle standard, even if it is lowered to reflect new data on health impacts. Meeting this objective is also important to public health, because recent evidence indicates that particle levels below the standard, like Minnesota's, may still be a threat to public health. The combination of federally-required emissions reductions and voluntary reductions at three

Mobile Sources Are Getting Cleaner

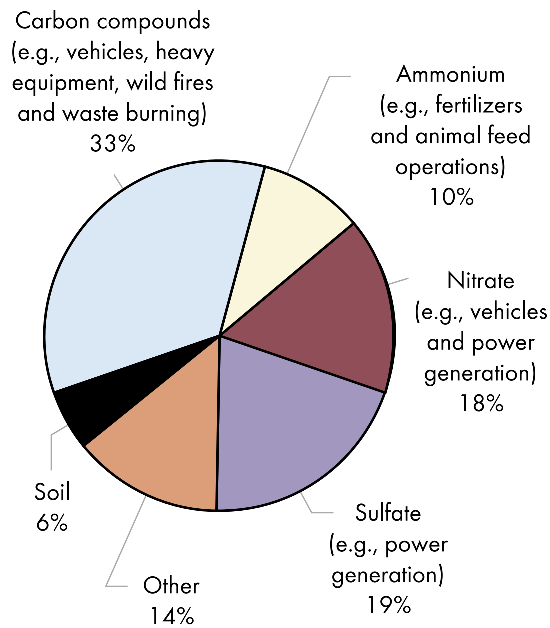
A powerful suite of new federal mobile source regulations are taking effect over the next few years:

- **Cleaner gasoline-powered vehicles.** Beginning in 2004, federal standards for new cars and trucks will reduce tailpipe emissions between 77 and 95 percent, depending on the type of vehicle. These reductions are possible by requiring a 97 percent reduction in the sulfur content of gasoline. In addition, new standards taking effect in 2005 will reduce emissions of heavy-duty gasoline-powered trucks by 78 percent. Off-road gasoline-powered vehicles will get cleaner as well: new emissions standards for motorcycles and all-terrain vehicles take effect in 2006, and for other recreational engines in 2007.
- **Cleaner diesel trucks and engines.** By the end of 2006, new federal standards for on-road diesel fuel will reduce its sulfur content by 97 percent. This fuel, called "ultra-low sulfur diesel" (ULSD), makes it possible to use more robust emission control equipment for on-road diesel engines, which will be used to meet tighter emission standards beginning with the 2007 model year. Cleaner diesel fuel means that diesel trucks manufactured after 2007 will emit 90 percent less pollution than current trucks. For off-road diesel engines, the EPA proposes a ULSD requirement beginning in 2010. Older diesel vehicles can be retrofitted with new emission control equipment which, in combination with ULSD, achieves remarkable reductions in tailpipe emissions.
- **Marine vessels.** In 2004, the EPA finalized its requirement to reduce the sulfur content of diesel fuel used by marine vessels by 99 percent. Similar to gasoline and other types of diesel engines, the EPA is proposing tighter emission standards for new commercial, recreational and auxilary marine diesel engines. These standards would be phased in between 2011 and 2013.

Xcel Energy plants is expected to reduce SO_2 emissions by about 35 percent by 2010.[19] The Xcel Energy MERP alone will reduce SO_2 emissions in the state by 17 percent from 2000 levels.

To ensure emissions reductions are effective, further analysis will be necessary to understand the composition and contributing sources of Minnesota's fine particles. This chart is a preliminary look at the composition of fine particles in Minnesota.

Composition of Fine Particles in Minnesota



Source: MPCA Speciation data from October 2001 to October 2002

Air Pollution and Heart Disease

Will the EPA change the fine particle standard?

"The increase in relative risk for cardiovascular disease due to air pollution for an individual is small compared with the impact of the established cardiovascular risk factors. However, because of the enormous number of people affected, even conservative risk estimates translate into a substantial increase in total mortality within the population. The impact on cardiovascular disease therefore represents a serious public health problem."

"Air Pollution and Cardiovascular Disease: A Statement for Healthcare Professionals from the Expert Panel on Population and Prevention Science of the American Heart Association," June 1, 2004

The American Heart Association (AHA) recently reviewed air pollution health research and concluded that current levels of outdoor air pollution in America, most notably particles, are already leading to serious cardiovascular public health effects. The AHA called for the EPA to consider lowering the federal standards for fine particles.

The Clean Air Act requires the EPA to review the newest air quality scientific evidence every five years. In 1996, the EPA completed such a review and, as a result, finalized a new $PM_{2.5}$ standard that was more protective of health. Despite lawsuits brought by the American Trucking Association and others, this $PM_{2.5}$ standard was ultimately upheld by the United States Supreme Court in 2002.

Minnesota meets that standard. However, in response to court rulings, the EPA is considering modifying the standard again to be more protective of health than today's standard. The EPA plans to finalize a new standard by the end of 2006.

Goal 2: Minnesota's outdoor air quality will meet environmental and health benchmarks for toxic and other air pollutants

- **By December 31, 2010, reduce measured ambient concentrations of air toxics to levels below health benchmarks**

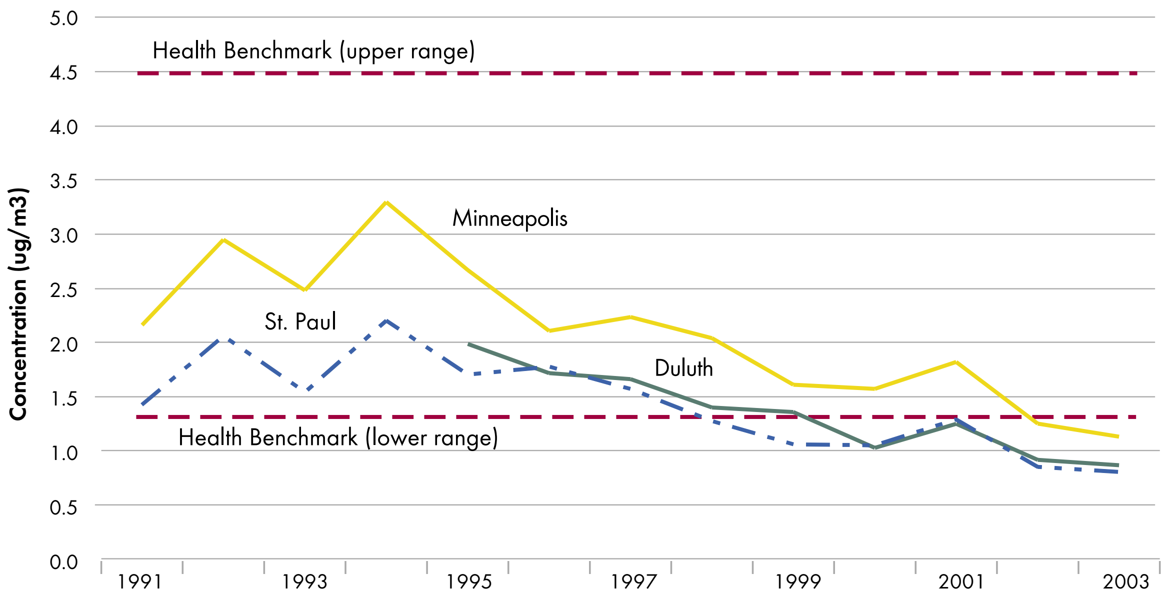
"Air toxics" is the name of a category of hundreds of chemicals that, at high enough concentrations, cause or are suspected of causing cancer or other serious health problems. Many are difficult to measure; others rapidly change or combine in the air.

The MPCA compares concentrations of air toxics in the ambient air to inhalation health benchmarks to determine at what concentrations toxics may cause health concerns. An "inhalation health benchmark" is a point or range below which there is little appreciable risk of harm to humans. Unlike the federal ambient air quality standards, they are guidelines rather than enforceable regulatory standards.

Out of the 45 gaseous air toxics measured by the MPCA that have health benchmarks, the MPCA's 2003 air quality legislative report identified two that were above health benchmarks: benzene and formaldehyde.

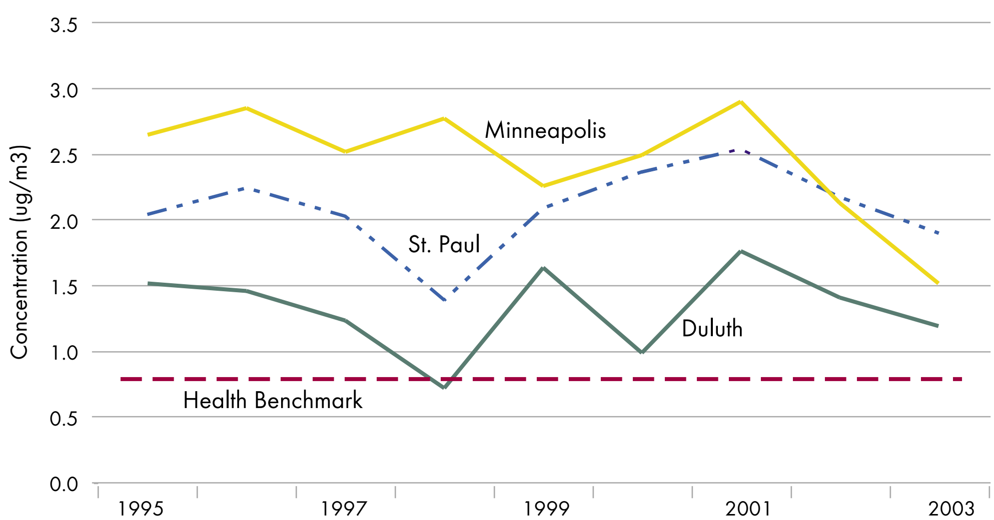
Benzene concentrations have been declining since 1996 and current levels are now below inhalation health benchmarks. The decline in benzene concentrations is attributed to efforts made by the EPA, MPCA, and partners in Minnesota to reduce emissions from automobiles, gas station fueling operations, and industrial facilities (implementing federal air toxics control

Benzene Trends at Certain Monitoring Sites



Source: MPCA monitoring data

Formaldehyde Trends at Certain Monitoring Sites



Source: MPCA monitoring data

standards), and to lower the benzene content of gasoline. Currently, about a quarter of the gasoline sold in the Twin Cities area is "low-benzene" gasoline, largely because of the voluntary efforts of Flint Hills Resources refinery. Initial MPCA modeling indicates that emissions from automobiles should continue to decrease, and that 2010 levels of benzene are expected to continue to remain below inhalation health benchmarks.

Measurements of formaldehyde are above its inhalation health benchmark in Minneapolis, St. Paul, and Duluth, as well as in most other Minnesota cities with monitors.[20] Formaldehyde concentrations in Minnesota have been relatively flat since 1995. However, the last two years have shown decreasing levels, especially in downtown Minneapolis. More monitoring is needed to see if this trend continues.

Formaldehyde comes from a variety of sources. It is directly emitted from wood-burning and from fuel-burning vehicles, as well as industrial processes. A significant amount of formaldehyde also comes from the breakdown of other air toxics and from natural sources. These disparate sources make it difficult to control formaldehyde emissions. However, decreasing emissions of other air toxics should also lower formaldehyde concentrations.[21]

◆ Reduce risks to humans by continuing to meet all federal and state air toxics control technology standards

The EPA has written technology-based rules that limit air toxics emissions from more than 100 different types of industrial activities.[22] In Minnesota, more than 600 facilities are subject to these rules, which have resulted in the installation of additional pollution control equipment in many facilities.

The MPCA tracks the percent of major facilities that meet these rules. The target, which is currently being met, is to ensure that 95 percent of major facilities meet these rules with no significant compliance issues.

Goal 3: Take responsibility for reducing Minnesota's share of air pollutants having regional, national and global impacts

This strategic plan goal is designed to address air pollution caused by emissions traveling over large geographic areas. The pollutants targeted under this goal are: regional haze, greenhouse gases and mercury. Because these are regional and global pollution problems, they cannot be solved without national and international pollution reduction programs.

◆ By December 31, 2014, cut visibility impairment by 20 percent in Voyageurs National Park and the Boundary Waters Canoe Area Wilderness

Air pollution impairs visibility not only in the Twin Cities, but even in the most pristine and remote parts of our state, the Boundary Waters and Voyageurs National Park. The Clean Air Act requires states to work toward improving visibility in these areas, known as Class I air quality areas.

Along with nine states and tribes in those states, the MPCA belongs to the Central States Regional Air Partnership, which is working toward this regional objective. The MPCA also partners with the Midwest Regional

Sequenced pictures of progressively higher PM levels from Twin Cities haze

(Hourly averages July 4-5,2003)

$PM_{2.5}$ less than 1 μg/m³ hourly average

$PM_{2.5}$ = 28 μg/m³ hourly average

$PM_{2.5}$ = 92 μg/m³ hourly average

Source: Twin Cities Haze Cam photos taken on July 4-5, 2003

Planning Organization and the Western Regional Air Partnership.

Efforts are on schedule to develop state plans to meet the regional objective; these plans are due in 2008. A main feature of the plans will be to determine what control technology qualifies as "best available retrofit technology" (BART). The facilities in Minnesota that will need to perform a BART analysis, which could lead to installation of further emission controls, include emission units at power plants, taconite facilities and paper mills that were built between 1962 to 1977. In 2005, facilities must notify the MPCA of any "BART-eligible" units.

Minnesota Greenhouse Gases and Emissions per Dollar of Gross State Product

◆ **By December 31, 2010, help reduce the greenhouse gas intensity of the U.S. economy by 18 percent from the 2000 value**

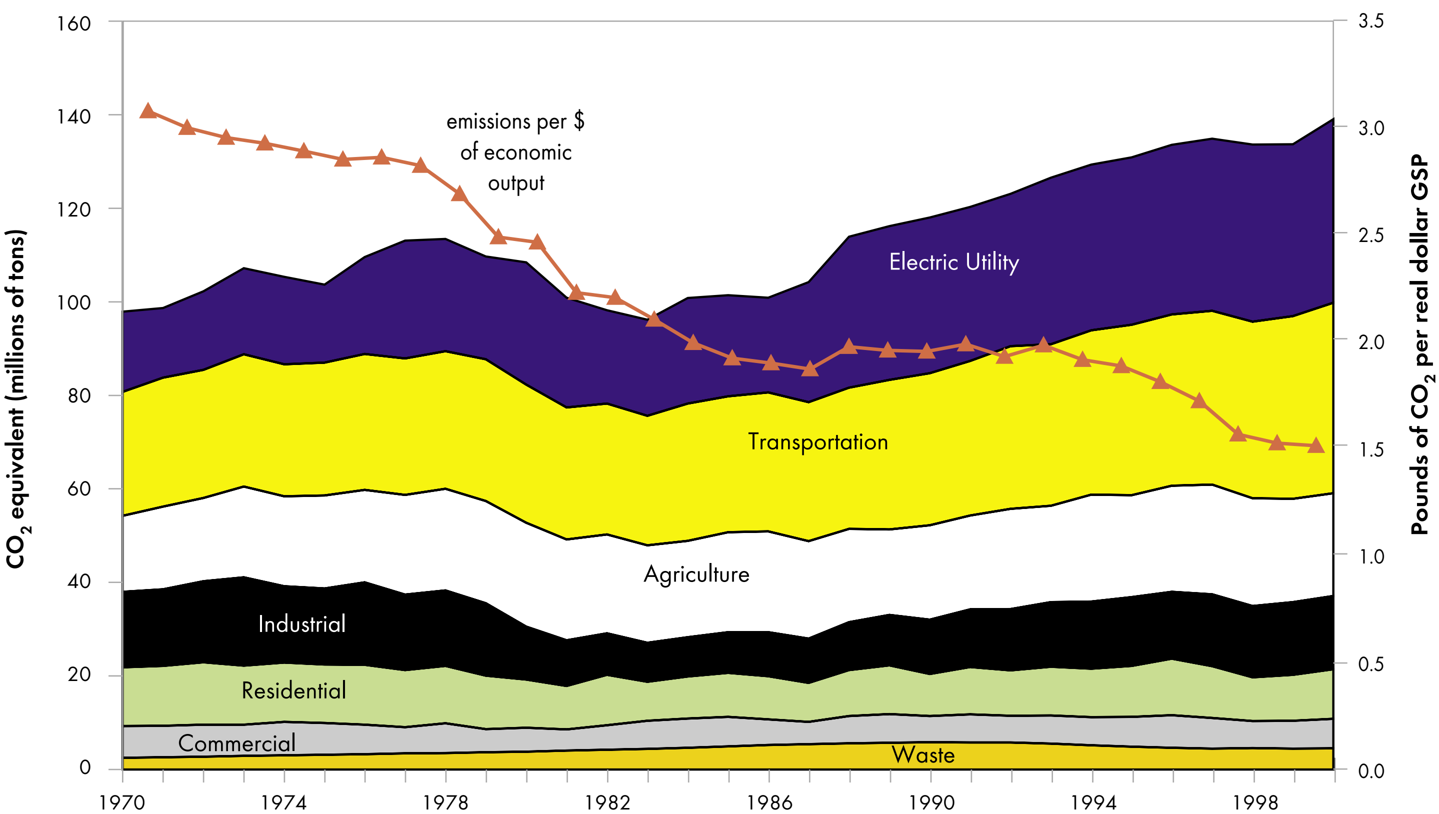
According to a report by the Bush administration, the majority of surface warming experienced in North America since 1950 can only be explained by human influence intensifying the greenhouse effect.[23] The MPCA is in the process of implementing the President's greenhouse gas intensity goal. Because there is a one- to three-year lag in available data, MPCA will begin to evaluate progress in 2005.

From 1970 to 2000, Minnesota reduced greenhouse gas emissions per unit of real state gross domestic product by about 50 percent.[24] Despite this efficiency improvement, emissions of carbon dioxide, the principal greenhouse gas, increased 37 percent from 1985 to 2000, primarily due to emission increases from the electricity and transportation sectors.

The challenge of reducing greenhouse gases offers an opportunity to Minnesota. In its Minnesota Climate Change Action Plan, the MPCA advocates:

- a 'no-regrets' short-term strategy centered on improving efficiency of the state's economy in terms of energy and materials; and
- a long-term effort to wean the Minnesota's economy from its dependence on fossil fuels and their associated greenhouse gas emissions. [25]

Improvements in energy efficiency and less reliance on fossil fuels can result in both lower emissions and cost savings.



Source: MPCA greenhouse gas inventory data

Minnesota has made many sensible efforts in recent years to reduce its emissions of greenhouse gases that qualify as "no regrets" strategies. These include:

- extensive and successful energy conservation programs
- renewable energy mandates and objectives
- the renewable energy development fund
- the small wind power incentive program
- increasing the use of ethanol and biodiesel fuels
- adopting energy efficiency standards for buildings
- collection of methane gases from landfills.

◆ Mercury

By 2005, reduce MN sources of mercury by 70 percent from 1990 levels

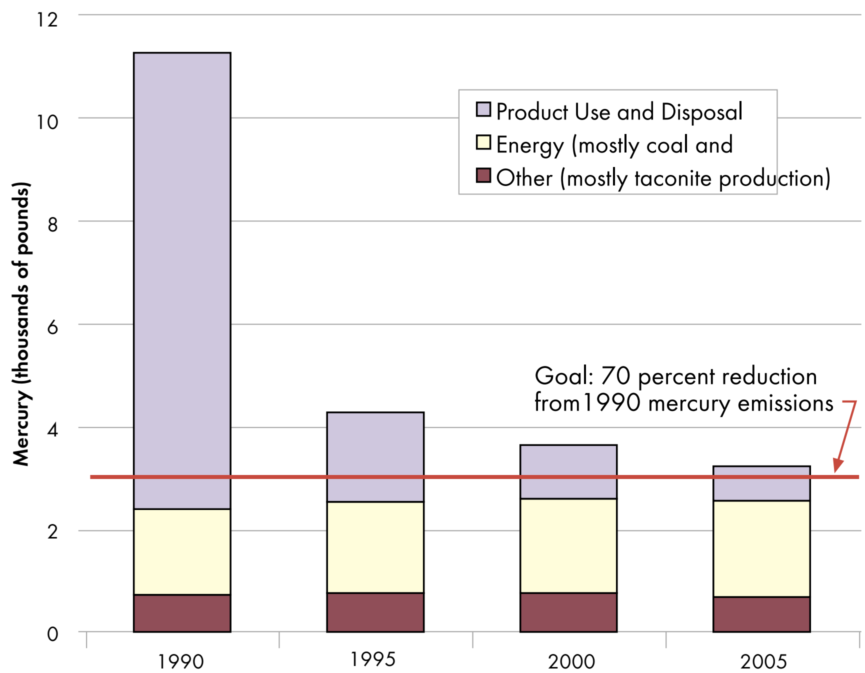
By 2010 reduce concentration of mercury in fish by 10 percent from 2000 levels.

The emission reduction goal was established by the Minnesota Legislature in the voluntary mercury reduction initiative. Data suggest that the 2005 goal of making a 70 percent emissions reduction will be met, largely through state and federal regulatory and voluntary efforts to reduce mercury in products. Minnesota is a national leader in efforts to remove mercury from products, and also in reductions of mercury from solid and medical waste incinerators.

In addition to reductions already made, Xcel Energy's MERP will result in an 81 percent reduction in three power plants' mercury emissions by 2009.

A progress report on mercury will be prepared in 2005 to correspond with (1) the MPCA's second progress report to the legislature on the mercury reduction program (due October 2005) and (2) EPA approval of the MPCA's Total Maximum Daily Load (TMDL) report on waters contaminated by mercury. The progress report will include an assessment of fish contaminant trends from 2000 to 2004 and data needs for the remainder of the decade.

Mercury Emissions in Minnesota



Source: MPCA data. Estimated in March 2004.

FUTURE DIRECTIONS AND CHALLENGES

The MPCA's primary role is to implement existing and new federal and state air regulatory programs. The MPCA will be actively involved in upcoming federal programs that address power plant emissions, regional haze and mercury. These programs have the potential to considerably reduce mercury, fine particles and ozone precursors in Minnesota.

This section describes priority actions the MPCA plans for the next two years to protect and improve the quality of Minnesota's air. These actions are expected to reduce emissions of ozone precursors and fine particles, continue to reduce power plant emissions while supporting planning for Minnesota's future energy needs, and reduce the substantial amount of regional air pollution that blows into Minnesota each day.

Reduce ozone precursor emissions

The MPCA has been studying ozone in order to understand where and how it forms in Minnesota. This study includes collaborating with other states to model the movement and formation of air pollution in the region. The MPCA hopes to learn how much air pollution is transported into the state from upwind emissions (other states) and how much is locally generated. The study is also expected to point to what kinds of emission reduction projects would be most beneficial. This study is being undertaken in conjunction with other federal efforts to reduce regional air pollution, and with the help of partner states.

The MPCA will use modeling information to help Clean Air Minnesota select projects that best reduce ozone-forming emissions (VOCs and NO_X). Efforts will continue to focus on activities that reduce VOCs on days when ozone levels are forecast to be high. The MPCA also plans to evaluate the effectiveness and cost of activities that bring about long-term, permanent reductions in ozone-forming pollutants. If ozone levels increase, further activities may be needed to keep Minnesota in attainment of federal standards.

Increase early adoption of cleaner technologies and fuels

To reduce particle emissions and ozone precursor emissions, the MPCA will continue to work to increase the availability of cleaner transportation fuels such as ultra-low-sulfur diesel fuel, biodiesel, ethanol, and low-sulfur gasoline. The MPCA will seek federal grants to fund engine retrofits, especially for school buses and public transportation. The MPCA will also seek to have future transportation projects funded with federal Congestion Mitigation Air Quality money evaluated for their impact on ozone levels, in addition to current selection factors, in its work with the Metropolitan Council's Transportation Advisory Board.

Clean Air Minnesota has identified diesel retrofit projects as a top priority, and is working with its partners to implement demonstration projects in the next year. The MPCA will provide technical support for these projects.

Retrofits that add pollution controls to older diesel engines will reduce emissions of pollutants that contribute to ozone and fine particles, and reduce diesel exhaust, which is a toxic air pollutant. These retrofits, combined with the phase-in of stringent federal standards for new diesel on- and off-road engines, and the EPA's planned performance standard for stationary diesel engines (due to be proposed this year), will substantially reduce emissions from diesel engine operations.

More Efficient Regulatory Operations

Over the past two years, the MPCA has increased the efficiency of its core regulatory program: issuing and enforcing air emission permits for facilities. The MPCA has issued air emission permits to more than 2000 facilities, called point sources. Together these point sources emit about a quarter of the total regulated pollutants statewide. In fact, just 132 facilities are responsible for about 90 percent of point source emissions, according to MPCA's 2001 criteria pollutant inventory. The MPCA expects that these efficiency improvements will better mesh environmental impact with MPCA resources.

Construction permits issued more quickly

In the fall of 2004, the MPCA began a phased plan that will result in air emission construction permits being issued more quickly, while still maintaining the environmental quality required by regulations. The goal is to issue 90 percent of construction permits in fewer than 150 days by the end of 2005. Currently about 40 percent of permits are issued in fewer than 150 days. This plan was developed by an MPCA staff team using Six Sigma, a methodology used by many Minnesota businesses to improve processes.

Permitting reform for large facilities

The EPA made changes to its New Source Review program that affect about 140 existing large facilities in Minnesota, including refineries and power plants. These changes were effective in March 2003. The MPCA has interpreted rules and conducted training to help businesses implement these changes. The MPCA will monitor the effects of the changes, which are expected to decrease the number of activities that require a federal permit.[9]

Flexible permit for mid-sized facilities

The MPCA recently completed rulemaking to create a new, flexible state permit for mid-sized facilities. A "capped" permit can be issued in less than half the time of a traditional permit, and allows a facility to make changes without need for prior agency approval. Safeguards are built into permit requirements to protect ambient air quality and to ensure the facility will not exceed federal permitting thresholds. The opportunity for public participation is preserved by creating a new state e-mail listserv, so anyone can ask to receive electronic notice of permit applications.[10]

Streamlined process to review toxic emissions

With the assistance of multiple stakeholder groups, the MPCA streamlined the process to review air toxics emissions during permitting and environmental review for certain facilities. This new process, called Air Emissions Risk Analysis, has cut the MPCA's review time by more than 50 percent and has created more certainty about permitting outcomes and timeframes for businesses conducting an air toxics risk analysis.[11]

Contracting

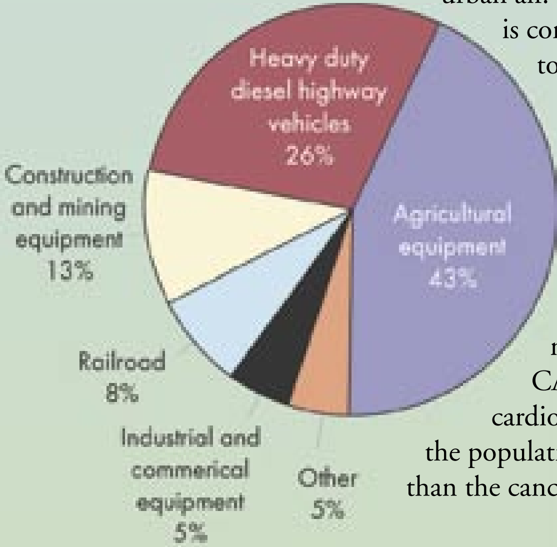
The MPCA is in the midst of a project using outside consultants to assist in writing operating permits when workload is especially heavy. These contractors had worked on about a dozen permits as of November 2004. The MPCA is exploring this approach to help meet its commitment to the EPA to issue and reissue Title V operating permits.

Diesel Emissions Health Concerns

Diesel exhaust is a complex, variable mixture of particles, gases and vapors. Health concerns are most strongly linked to particles. Health effects include:

- **Cardiopulmonary effects.** There is compelling evidence that the current level of particle air pollution is associated with cardiovascular and respiratory disease and death.[26] In particular, more people have heart attacks when particle levels rise.
- **Respiratory effects.** Diesel exhaust is a respiratory irritant. Long-term studies have documented symptoms such as cough and chronic bronchitis.[27]
- **Allergies/asthma.** Diesel particles may aggravate allergies and act with allergens to worsen symptoms of asthma.[28] Scientists are trying to better understand the role diesel plays in asthma.
- **Lung cancer.** At least six health agencies across the country have concluded that diesel exhaust is likely to cause cancer in humans.[29] The California Air Resources Board (CARB) concluded that diesel particles are a major portion of the cancer risk from breathing urban air. However, since diesel is complex and difficult to measure, most agencies (including the Minnesota Department of Health and the EPA) have not developed quantitative estimates. It is worth noting, however, that CARB estimates the cardiopulmonary impacts on the population to be much greater than the cancer impacts.

Sources of Particulate Matter from Diesel



Source: 1999 MPCA Minnesota Emissions Inventory

Reduce power plant emissions while supporting planning for Minnesota's future energy needs

The MPCA will continue to work with the Minnesota Department of Commerce, as well as the Public Utilities Commission and non-government partners, to carry out a vision for environmentally-sound, reliable and low-cost energy. Commerce's energy policy includes the following environmental goals:

◆ Encourage coal-burning facilities to convert to less-polluting fuels or install state-of-the-art emissions controls

The MPCA, working with Commerce, was a strong supporter of an agreement with Xcel Energy's MERP to clean up three older coal-fired plants by 2010, action that will significantly reduce emissions.

◆ Encourage generation of reasonably-priced, environmentally-superior energy from low-polluting or renewable fuels

Several actions are involved, including the Conservation Improvement Program, a mandate for Xcel Energy to develop wind energy, a Renewable Development Fund, the Renewable Energy Objective, and a Green Pricing Program that allows consumers to buy electricity from renewable sources at a premium.[30]

◆ Support research, development and use of new, environmentally-superior energy technologies

State government participates in the University of Minnesota's new Initiative for Renewable Energy and the Environment, Minnesota's Renewable Hydrogen Initiative, and a project researching clean coal technology with carbon sequestration.[31]

The MPCA will continue to provide key information on energy choices and their environmental impacts. The MPCA provides information on emissions of various biomass options, effectiveness of various control options, and works with neighboring states to keep their electricity generation plants from harming Minnesota's environment.

Reduce transport of pollutants into Minnesota

Many current air pollution problems are caused by pollutants that cross state and national boundaries. Ozone, fine particles, visibility, and mercury problems are caused by a combination of local and distant sources. The regional nature of the problem is shown in this figure, which compares annual average fine particle concentrations from urban and upwind rural sites for metropolitan areas in the Midwest.

Urban concentrations, represented by the total height of each bar, are dominated by sizable rural (regional) concentrations, represented by the bottom portion of each bar. Because so many cost-effective local reductions have already been made since the Clean Air Act was passed in 1970, further improvements in air quality will also require regional solutions led by the federal government.

In the past year, the EPA has proposed separate regulations intended to reduce emissions of pollutants leading to these regional and national air-pollution transport problems:

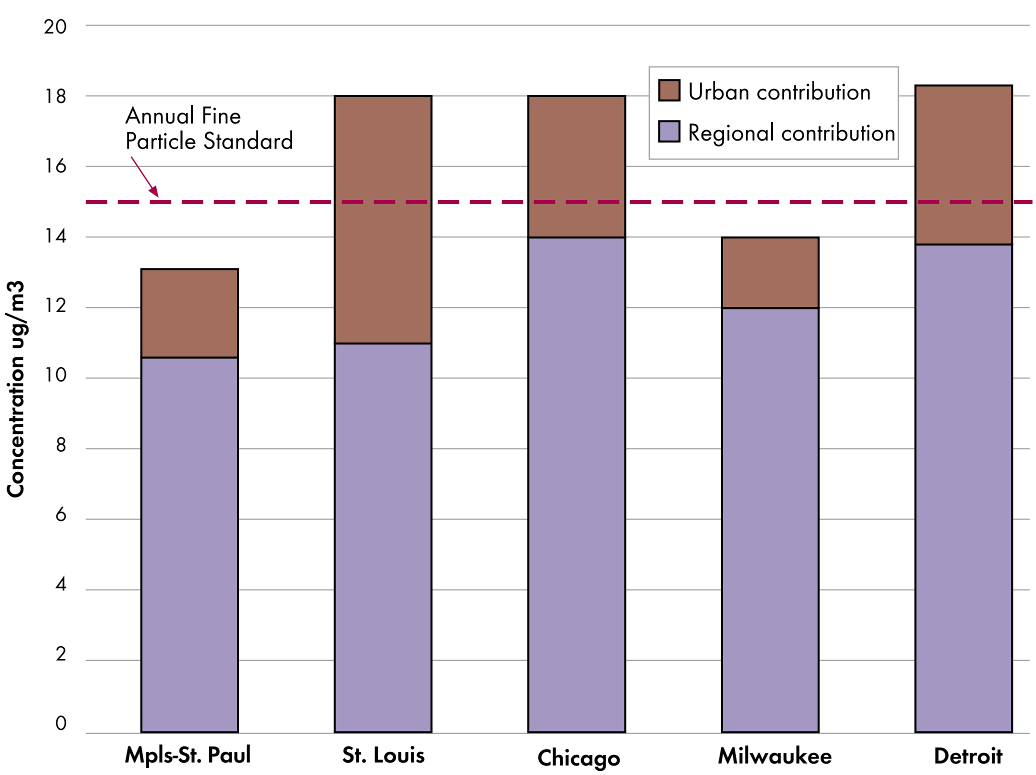
◆ Clean Air Interstate Rule

This rule proposes caps on NO_X and SO_2 emissions from power plants in 28 eastern states in order to improve air quality in the eastern U.S. Power plants would be able to buy credits to reach their allotments under the cap or sell excess emission credits. Minnesota is included as a responsible state because modeling of our air emissions shows potentially significant impacts in Chicago. The rule would likely cut NO_X emissions from several large Minnesota power plants. The rule is expected to be finalized by early 2005.

◆ Visibility improvement

Federal visibility regulations require that, by 2008, Minnesota submit a plan to improve

Estimated Urban and Regional Contributions to Annual Fine Particle Concentrations



1999-2000 data. Adapted from presentation by Michael Koerber, Lake Michigan Air Directors Consortium.

Keeping Pace with Scientific Research on Air Pollution

When scientific research identifies an issue, the process for developing a regulatory response often takes years. Sometimes regulations alone cannot address an issue. Success frequently depends on cooperation between multiple entities. For example, a number of recent studies have shown an association between adverse health effects and proximity to major roads and their vehicle exhaust.[34] The EPA is supporting more studies to better understand the risk to residents living on or near busy streets. However, response to this issue will necessarily involve individuals, government agencies, and businesses working together.

Scientists know more than ever before about air emissions and their effect on people and the environment, yet that knowledge remains limited and filled with uncertainties. There is not yet enough scientific data to develop standards for some chemicals, including air toxics. There is inadequate data to develop health benchmarks for many hundreds of other chemicals.

Air monitoring is limited by current technology, which is unable to measure some chemicals, not sensitive enough to collect data about others, or simply too costly to be practical.

Another key unknown is pollutant interactions. What are the effects of air pollutants on each other? What about when multiple pollutants are combined in the human body? Much remains unknown as yet.

Fortunately, science and technology continue to advance rapidly. The MPCA continues to follow new scientific and medical research, and uses these findings to help focus MPCA efforts.

visibility in its "Class I" areas — national parks and wilderness areas, where visibility is an important natural asset. The Boundary Waters Canoe Area and Voyageurs National Park are the only two Class I areas in Minnesota. Fine particles ($PM_{2.5}$) are responsible for visibility degradation in both areas.

◆ Mercury emissions from power plants

In 2003, the EPA proposed the Clean Air Mercury Rule, which outlined several approaches to reducing mercury emitted from power plants. The MPCA supports the EPA's approach of a national cap and trade system for mercury. However, the MPCA believes the cap should be significantly lower than that proposed by the EPA; and/or that regional budgets should be established to ensure less mercury is deposited into Minnesota lakes and streams.[32] Action on the proposed federal rule is due by March 15, 2005.

If approved, these programs would take effect some time after 2007. In addition, multi-state regional air planning groups are analyzing regional air pollution and determining reduction and control strategies.[33] Minnesota has joined the Central Regional Air Partnership for this purpose, and will continue its work with partner states to reduce regional air pollution.

END NOTES

1 The Office of Management and Budget (OMB) found that four Clean Air Act Rules issued between 1992 and 2002 to reduce air emissions from heavy duty diesel vehicles, cars and light-duty trucks, and power plants would have health benefits of up to $101 to 119 billion per year, at a cost of $8 to 8.8 billion per year. The OMB also found that EPA's proposed rule reducing air pollution from off-road diesel vehicles would be similarly beneficial. EPA has since adopted the off-road diesel rule. The full OMB study can be viewed at: www.whitehouse.gov/omb/inforeg/2003_cost-ben_final_rpt.pdf

2 In Minnesota Department of Health Website. Accessed October 2004. www.health.state.mn.us/divs/eh/children/background.html

3 Venn AJ, Lewis SA, Cooper M, Hubbard R, Britton J. (2001) Living near a main road and the risk of wheezing illness in children. Am J Respir Crit Care Med 164(12):2177-2180.

Lin S, Munsie JP, Hwang SA, Fitzgerald E, Cayo MR. (2002) "Childhood asthma hospitalization and residential exposure to state route traffic." Environ Res 88(2):73-81.

Kim, J, Smorodinsky, S, Lipsett M, Singer B, Hodgson AT, Ostro B. (2004) Traffic-related air pollution near busy roads: the East Bay children's respiratory health study. Am J Respir Crit Care Med 170: 520-526.

4 "Epidemiologic Investigation to Identify Chronic Effects of Ambient Air Pollutants in Southern California" Prepared for the California Air Resources Board and California Environmental Protection Agency. P.I. John M. Peters, May 14, 2004. Full report online at www.arb.ca.gov/research/abstracts/94-331.htm.

5 W. James Gauderman Ph.D., et al., (2004) "The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age." The New England Journal of Medicine. 351(11): p. 1057-1067.

6 Federally mandated emission reductions, such as the first round of vehicle emission reductions in the 1970s, have at times been larger.

7 For more information on Clean Air Minnesota, go to www.mn-ei.org/air/.

8 To learn more about the Twin Cities Haze Cam, go to: www.pca.state.mn.us/programs/indicators/iom-1203.html.

9 For more information about the New Source Review program in Minnesota, go to www.pca.state.mn.us/air/permits/nsr/index.html.

10 To sign up for this listserv and to learn more about the capped permit, go to www.pca.state.mn.us/air/permits/capped.html.

11 For more information about the Air Emissions Risk Analysis, go to www.pca.state.mn.us/air/aera.html

12 Violations of the state hydrogen sulfide standard continue to be measured at certain feedlots where corrective actions are pending.

13 MPCA data

14 Sonoma Technology, Inc. (October 2002) "Preliminary Assesment of Ozone Air Quality Issues in the Minneapolis/St. Paul Region."

15 EPA Air Trends report www.epa.gov/airtrends. Accessed October 2004.

16 Sonoma Technology, Inc. (October 2002) "Preliminary Assesment of Ozone Air Quality Issues in the Minneapolis/St. Paul Region."

17 Midwest Regional Planning Organization (RPO) 2010 inventory with additional adjustments. Summer weekday estimate, compared with 2001 estimated emissions.

18 Midwest RPO 2010 inventory with additional adjustments. Summer weekday estimate, compared with 2001 estimated emissions.

19 Midwest RPO 2010 inventory with additional adjustments. Summer weekday estimate, compared with 2001 estimated emissions.

20 The MPCA has measured formaldehyde concentrations in over 30 cities across Minnesota.

21 In response to public interest in data on air quality at the Minneapolis-St. Paul International Airport, the MPCA placed air monitors between two parallel runways in February 2002. The data collected shows air quality near the airport to be typical of air found throughout the Twin Cities metropolitan area. Only formaldehyde was slightly elevated at the airport monitoring site. To learn more about the airport project, go to the 2003 MPCA report Air Toxics Monitoring in the Twin Cities Metropolitan Area at: www.pca.state.mn.us/hot/legislature/reports/2003/lr-airtoxmonitoring-1sy03.pdf

22 For a listing of EPA technology-based standards, go to www.epa.gov/ttn/atw/eparules.html

23 "Our Changing Planet: The U.S. Climate Change Science Program for Fiscal Years 2004 and 2005", Climate Change Science Program and the Subcommittee on Global Change Research - A supplement to the President's Budget for fiscal years 2004 and 2005, July, 2004. www.usgcrp.gov/usgcrp/Library/ocp2004-5/ocp2004-5.pdf

24 Data from MPCA Greenhouse Gas Inventory (Ciborowski). This estimate does not take into account carbon removed from the atmosphere through forests and other sinks.

25 Minnesota Pollution Control Agency (February, 2003) "Minnesota Climate Change Action Plan: A Framework for Climate Change Action". www.pca.state.mn.us/publications/reports/mnclimate-action-plan.pdf.

26 U.S. Environmental Protection Agency (October, 2004) Air Quality Criteria for Particulate Matter, National Center for Environmental Assessment, EPA/600/P-99/002aF. http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903.

27 U.S. Environmental Protection Agency (EPA), Integrated Risk Information System, Diesel Engine Exhaust. Accessed October 2004. www.epa.gov/iris/subst/0642.htm

28 U.S. Environmental Protection Agency (EPA), May, 2002. Health assessment document for diesel engine exhaust. Prepared by the National Center for Environmental Assessment, Washington, DC, for the Office of Transportation and Air Quality; EPA/600/8-90/057F.

29 Health Effects Institute (2002) "Research Directions to Improve Estimates of Human Exposure and Risk from Diesel Exhaust." A Special Report of the Institute's Diesel Epidemiology Working Group. www.healtheffects.org/Pubs/DieselSpecialReport02.pdf

30 See Department of Commerce website for more information on these programs: www.commerce.state.mn.us

31 For more information about the Initiative for Renewable Energy: www.umn.edu/iree/about.html

32 For more information on EPA's proposed mercury rules go to: www.epa.gov/air/mercuryrule/

33 For more information on EPA's visibility programs go to: www.epa.gov/air/visibility/program.html. For more information on the regional planning organization that Minnesota participates in go to: www.cenrap.org

34 Zhu, Y., Hinds, W.C., Kim, S., Sioutas, C. (2002). "Concentration and size distribution of ultrafine particles near a major highway." Journal of Air and Waste Management Association 52:1032-1042.

Hoek, G., Brunekreef, B., Verhoeff, A., van Wijnen, J., Fischer, P. (2000). "Daily mortality and air pollution in The Netherlands." Journal of Air and Waste Management Association 50(8):1380-9.

Brunekreef, B., Janssen N.A., de Hartog, J., Harssema, H., Knape. M., et al. (1997). "Air Pollution from Truck Traffic and Lung Function in Children Living Near Motorways." Epidemiology 8: 298-303.

Appendix A: Mercury Emissions From Electricity Generation

Introduction

In accordance with Minnesota statute §116.925, this appendix reports mercury emissions associated with electricity production and consumption in Minnesota. In addition to electricity, mercury emissions are associated with a variety of other activities in Minnesota which are summarized below. The MPCA has historically considered mercury separately from other air pollutants because it is the subject of a special MPCA initiative with legislatively mandated reports in 2001 and 2005. The MPCA is in the process of preparing a more comprehensive report to the legislature on mercury emissions in Minnesota, to be delivered in October 2005.

Background

Mercury contamination of fish is a well-documented problem in Minnesota. The Minnesota Department of Health advises people to restrict their consumption of sport fish due to mercury in virtually every lake tested. Nearly all — probably about 99 percent — of the mercury in Minnesota lakes and rivers comes from the atmosphere. About 30 percent of mercury in the atmosphere is the result of the natural cycling of mercury. But 70 percent of the mercury is a result of human activities that have increased the release of mercury from the geological materials in which it had been locked up. These activities include the mining of mercury ores, the use of this mercury in products and manufacturing, and the incidental release of trace concentrations of mercury naturally present in coal, crude oil, and metal ores, such as taconite.

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 some of their emissions. In rural Minnesota, about 10 percent of mercury deposition is the result of emissions within the state.

Sources and Emissions

Mercury emitted to the atmosphere due to human activities is divided by the MPCA into three categories: (1) emissions incidental to energy production, (2) emissions due to purposeful use, and (3) emissions due to material processing. Emissions from each of these categories are estimated in Table 1.

The data show that total mercury emissions in Minnesota declined significantly from 1990 to 2000, by about 68 percent. In 1990, emissions are estimated to have been 11,272 pounds. By 2000, mostly due to discontinued use of mercury in products and mandated controls on incineration of solid waste, emissions were just 3,638 pounds. This trend in reduced emissions is most likely a national or even international trend. 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 significantly reducing concerns about fish consumption. However, it is encouraging that efforts to reduce the use and release of mercury appear to have resulted in measurable environmental improvement.

Table 1. Estimated mercury emissions, from all sources, in Minnesota (pounds per year).

Mercury Emission Inventory for Minnesota (pounds per year) Date of Estimate: March 2004	confidence level	1990 (best)	1990 Min.	1990 Max.	1995 (best)	1995 Min.	1995 Max.	2000 (best)	2000 Min.	2000 Max.
Incidental to Energy Production										
Coal combustion (total)	high	1,518.6	1,366.7	1,670.4	1,612.1	1,450.9	1,773.3	1,648.7	1,483.8	1,813.6
electric utility coal	high	1,418.3	1,276.5	1,560.2	1,512.8	1,361.5	1,664.1	1544.8	1,390.3	1,699.2
commercial/industrial coal	medium	60.8	45.6	76.0	68.5	51.3	85.6	73.4	55.0	91.7
public utility / university & college heating	medium	39.0	29.3	48.8	30.5	22.8	38.1	30.2	22.6	37.7
residential coal	medium	0.4	0.3	0.5	0.4	0.3	0.5	0.4	0.3	0.5
Petroleum Product Refining and Consumption	low	136.0	68.0	204.0	156.0	78.0	234.0	175.0	87.5	262.5
Wood combustion	high	12.5	11.3	13.8	10.5	9.4	11.5	10.0	9.0	11.0
Natural gas combustion	low	0.2	0.1	0.5	0.3	0.1	0.6	0.3	0.1	0.6
Subtotal incidental with energy production		1,667.4	1,446.1	1,888.7	1,778.9	1,538.5	2,019.4	1,834.0	1,580.5	2,087.6
% of total state emissions		15%			42%			50%		
Largely Resulting from the Purposeful Use of Mercury										
Latex paint volatilization	medium	2850.0	2137.5	3562.5	2.8	2.1	3.5	0.0	0.0	0.0
Municipal solid waste combustion	high	1806.4	1625.8	1987.0	633.9	570.5	697.2	168.6	151.7	185.4
On-site household waste incineration	low	402.0	201.0	603.0	93.0	46.5	139.5	60.0	30.0	90.0
Medical waste incineration	high	516.0	464.4	567.6	36.0	32.4	39.6	6.1	5.5	6.7
Sewage sludge incineration	med.	247.0	185.3	308.8	160.0	120.0	200.0	112.0	84.0	140.0
Fluorescent lamp breakage	low	272.3	136.2	408.5	59.4	29.7	89.1	32.2	16.1	48.3
Class IV incinerators	low	55.2	27.6	82.8	28.0	14.0	42.0	0.0	0.0	0.0
Crematories	low	30.8	15.4	46.2	49.5	24.8	74.3	68.2	34.1	102.3
General laboratory use	low	44.0	22.0	66.0	44.0	22.0	66.0	22.0	11.0	33.0
Dental preparations	low	103.0	51.5	154.5	99.0	49.5	148.5	95.0	47.5	142.5
Hazardous waste incineration	medium	5.0	3.8	6.3	5.0	3.8	6.3	5.0	3.8	6.3
Landfill volatilization	low	5.9	2.9	8.8	2.2	1.1	3.3	2.4	1.2	3.6
Recycling mercury from products within MN	medium	3.5	2.6	4.4	35.0	26.3	43.8	50.0	37.5	62.5
Minimills that recycle cars and appliances	medium	186.0	139.5	232.5	186.0	139.5	232.5	176.0	132.0	220.0
Volatilization from dissipative use	low	0.8	0.4	1.2	0.8	0.4	1.2	0.8	0.4	1.2
Golf course fungicide volatilization	low	1487.0	743.5	2230.5	1.0	0.5	1.5	1.0	0.5	1.5
Volatilization from spills and land dumping	low	54.7	27.3	82.0	48.0	24.0	72.0	48.0	24.0	72.0
Volatilization during solid waste collection & processing	low	805.5	402.7	1208.2	251.5	125.8	377.3	195.9	98.0	293.9
Volatilization: land application of compost	low	2.2	1.1	3.3	1.3	0.7	2.0	0.3	0.1	0.4
Volatilization: land application of sludge	low	3.6	1.8	5.4	1.8	0.9	2.7	1.4	0.7	2.1
Subtotal associated with purposeful use of mercury		8,880.8	6,192.2	11,569.3	1,738.2	1,234.3	2,242.2	1,044.8	678.0	1,411.6
% of total state emissions		79%			41%			29%		
Emissions Incidental to Material Processing										
Taconite processing	high	710.5	639.5	781.6	742.3	668.1	816.5	745.4	670.8	819.9
Pulp and paper manufacturing	low	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soil roasting	low	13.3	6.7	26.6	13.3	6.7	26.6	13.3	6.7	26.6
Subtotal emissions incidental to material processing		723.8	646.1	808.2	755.6	674.7	843.1	758.7	677.5	846.5
% of total state emissions		6%			18%			21%		
GRAND TOTAL =		11,272.0	8,284.5	14,266.2	4,272.7	3,447.5	5,104.8	3,637.5	2,936.0	4,345.7
Percent Reduction since 1990					**62%**			**68%**		

A more detailed version of this inventory, including explanations of each subcategory listed in the table below, is available on the MPCA's web site at http://www.pca.state.mn.us/air/mercury.html#reports.

Mercury Emissions from Electricity Generation

Minnesota statutes section 116.925 requires producers and retailers of electricity to report the amount of mercury emitted through the generation of electricity. This law also requires the MPCA to summarize this information in this biennial report to the legislature. Emissions from 2002 and 2003 are summarized in Tables 2 and 3.

The statute permits combustion facilities emitting less than three pounds of mercury in a year the option of not being included in this report. Therefore, some facilities that emit less than three pounds because of excellent pollution control or the use of low-mercury fuels, such as natural gas, are not listed in Tables 2 or 3. For similar reasons, generation facilities that do not emit any mercury, such as nuclear, wind, and hydro, are not included in the tables. Some facilities in this biennial report emit more than three pounds one year and less than three pounds in the other. For the latter case, some facilities chose to report emissions even though reporting is not required for emissions of less than three pounds per year.

Minnesota law exempts certain electric generation facilities from reporting mercury emissions: 1) those that operate less than 240 hours per year, 2) combustion units less than 150 British thermal units (Btu) per hour and 3) generation units with a maximum output of less than or equal to 15 megawatts.

Submissions from about 50 generation units in Minnesota are summarized in Table 2. The major fuel for most units was coal, although some facilities depend on municipal solid waste for fuel. Some units are fueled by oil or natural gas.

The law also requires Minnesota retailers and wholesalers of electricity produced outside the state to report mercury emissions associated with production; the information is summarized in Table 3.

Included in Table 3 are about 50 Minnesota distribution cooperatives, which distribute electricity to consumers but do not generate any electricity. All retailers of electricity are required to report mercury emissions associated with the generation of the electricity they distribute. In the case of Minnesota's distribution cooperatives, most of their electricity was generated in North Dakota, South Dakota, and Wisconsin. The information is provided to the distribution cooperatives by their suppliers, Great River Energy, Dairyland Power, Minnkota Power, and East River Electric Power Cooperative. The calculated mercury emissions per megawatt-hour from each supplier (milligrams per megawatt-hour, mg/MWh) may vary because of varying amounts of electricity purchased from the grid and from the variable use of hydroelectric power by each distribution cooperative.

For 2002, facilities in Minnesota reported the emission of 1,562 pounds of mercury in the production of 34,839,053 megawatt hours (MWh) of electricity, an average release rate of 20 milligrams per megawatt hour (mg/MWh). For 2003, reported emissions increased to 1,885 pounds in the production of 37,367,580 MWh, an average emission rate of 23 milligrams per MWh. In 2003, a number of facilities reported a higher ratio of mercury emissions to MWh than in 2002. While many in-state facilities (mostly smaller producers) reported decreased ratios, an increase in ratios at several larger facilities led to an overall increase in mercury emissions per unit of electrical production.

Reports of electricity consumed in Minnesota, but produced outside of Minnesota, in 2002 totaled 16,986,351 MWh associated with mercury-emitting facilities. These facilities emitted 1,120 pounds of mercury, for an average emission rate of 30 milligrams per MWh. Reports for 2003 were similar, totaling 17,195,799 MWh and 1,272 pounds of mercury emitted. The average emission rate for 2003 was 34 milligrams per MWh. The use of lignite coal as a fuel at power-generating facilities outside the state appears to be largely responsible for the higher ratio of mercury emissions to MWh for out-of-state producers (30 to 34 mg/MWh) compared to Minnesota producers (20 to 23 mg/MWh). Lignite coal contains more mercury per Btu than other types of coal.

Summing Tables 2 and 3 yields estimates of mercury emissions associated with electricity production and consumption in Minnesota. In 2002, 2,682 pounds of mercury were reported as emitted in the production of 51,825,404 megawatt hours, an average emission rate of 23 milligrams per megawatt hour of electricity. In 2003, 3,157 pounds of mercury were reported as emitted in the production of 54,563,379 megawatt hours, an average emission rate of 26 milligrams per megawatt hour. A significant proportion of mercury emissions associated with Minnesota's electrical consumption occurred outside state borders; 42% in 2002 and 40% in 2003.

Information

For more information about Minnesota's mercury emissions inventory and other information related to mercury, visit this website:
http://www.pca.state.mn.us/air/mercury.html

For questions about mercury emissions associated with the production of electricity, contact Michael Smith at 651 282-5849 or Michael.Smith@pca.state.mn.us.

For general question about mercury in Minnesota, contact Ned Brooks at 651 296-7242 or Ned.Brooks@pca.state.mn.us.

Table 2. Reported 2002 and 2003 emissions of mercury from non-exempt electrical production facilities in Minnesota.

Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Produced (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Produced (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
Covanta Hennepin Energy Resource Co	Unit 1	MSW[a]	124,156	6.65	24	111,670	3.66	15
Covanta Hennepin Energy Resource Co	Unit 2	MSW[a]	124,156	8.46	31	exempt[g]	exempt[g]	exempt[g]
Great River Energy	Cambridge Station[c,d]	oil	384	0.00	0	359	0.00	0
Great River Energy	Elk River Station[c]	oil, gas, MSW[a]	205,474	2.31	5	207,889	2.34	5
Great River Energy	Lakefield Station[c,d]	oil, gas	193,724	0.00	0	202,281	0.00	0
Great River Energy	Maple Lake Station[c,d]	oil	419	0.00	0	347	0.00	0
Great River Energy	Pleasant Valley Station[c,d]	oil, gas	120,752	0.00	0	120,752	0.00	0
Great River Energy	Rock Lake Station[c,d]	oil	398	0.00	0	331	0.00	0
Great River Energy	St. Bonifacius Station[c,d]	oil	1,706	0.00	0	3,740	0.00	0
Interstate Power and Light Company, Sherburn, MN	Fox Lake Power Station #3[f]	oil, gas	exempt[g]	exempt[g]	exempt[g]	141,060	4.30	14
Minnesota Power(Taconite Harbor Energy Center)	Taconite Harbor Energy Center Unit 1	coal, oil	223,731	14.00	28	535,319	31.00	26
Minnesota Power(Taconite Harbor Energy Center)	Taconite Harbor Energy Center Unit 2	coal, oil	343,202	19.00	25	506,935	26.00	23
Minnesota Power (Taconite Harbor Energy Center)	Taconite Harbor Energy Center Unit 3	coal, oil	298,234	13.00	20	537,861	21.00	18
Minnesota Power	Boswell Unit 1	coal	exempt[g]	exempt[g]	exempt[g]	490,555	3.30	3
Minnesota Power	Boswell Unit 2	coal, oil	443,459	3.10	3	exempt[g]	exempt[g]	exempt[g]
Minnesota Power	Boswell unit 3	coal, oil	2,585,540	107.00	19	2,471,119	93.00	17
Minnesota Power	Boswell Unit 4[e]	coal, oil	3,850,131	184.00	22	4,506,304	195.00	20
Minnesota Power	Laskin Unit 1 & 2	coal, oil	622,581	19.00	14	713,451	20.00	13
Northshore Mining Company	Silver Bay Power Plant PB 1[c]	coal, oil, gas	263,153	1.46	3	283,164	0.90	1
Northshore Mining Company	Silver Bay Power Plant PB 2[c]	coal, gas	471,706	2.35	2	443,853	1.90	2

Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Produced (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Produced (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
NSP dba Xcel Energy	AS King 1	coal, gas, petroleum coke	3,312,425	68.80	9	3,431,730	72.60	10
NSP dba Xcel Energy	Black Dog 3	coal, gas	503,445	18.20	16	589,942	28.10	22
NSP dba Xcel Energy	Black Dog 4	coal, gas	905,635	29.30	15	867,218	39.30	21
NSP dba Xcel Energy	Black Dog 5[c,d]	gas	272,977	0.60	1	245,536	0.00	0
NSP dba Xcel Energy	Blue Lake 1-4[c]	oil	2,846	0.10	16	13,443	0.09	3
NSP dba Xcel Energy	Granite City[c]	oil, gas	1,426	0.01	3	3,761	0.00	0
NSP dba Xcel Energy	High Bridge 5	coal, gas	491,580	21.00	19	640,297	30.00	21
NSP dba Xcel Energy	High Bridge 6	coal, gas	822,676	33.80	19	858,194	36.40	19
NSP dba Xcel Energy	Inver Hills[c]	oil, gas	73,100	0.30	2	112,023	0.21	1
NSP dba Xcel Energy	Key City 4-7[c,d]	gas	4,340	0.02	3	3,158	0.00	0
NSP dba Xcel Energy	Minnesota Valley 4[c]	coal, oil, gas	185	0.02	56	379	0.01	10
NSP dba Xcel Energy	Red Wing 1 Waste-to-Energy	gas, RDF[b]	58,684	4.70	36	37,601	7.10	86
NSP dba Xcel Energy	Red Wing 2 Waste-to-Energy	gas, RDF[b]	58,560	3.50	27	35,472	12.50	160
NSP dba Xcel Energy	Riverside 6/7	coal, oil, gas	933,879	50.20	24	857,531	40.90	22
NSP dba Xcel Energy	Riverside 8	coal, oil, coke	1,505,106	47.80	14	1,550,432	67.70	20
NSP dba Xcel Energy	Sherburne 1	coal, oil	4,895,847	262.00	24	4,894,323	326.40	30
NSP dba Xcel Energy	Sherburne 2	coal, oil	4,633,354	245.30	24	4,374,304	287.90	30
NSP dba Xcel Energy	Sherburne 3 (combined for 2002, Xcel owned portion for 2003)	coal, oil	5,815,447	370.60	29	3,747,019	289.70	35
NSP dba Xcel Energy	Wilmarth 1 Waste-to-Energy[c]	RDF[b], gas	65,043	1.50	10	60,478	2.70	20
NSP dba Xcel Energy	Wilmarth 2 Waste-to-Energy[c]	RDF[b], gas	66,111	0.60	4	62,996	4.30	31

Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Produced (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Produced (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
NSP dba Xcel Energy	West Faribault 1-2[c,d]	gas	384	0.00	2	239	0.00	0
Otter Tail Power	Hoot Lake #2 & 3	coal, oil	416,376	16.24	18	560,343	17.63	14
Rochester Public Utilities	Silver Lake 4	coal, gas	exempt[g]	exempt[g]	exempt[g]	227,316	5.16	10
Southern Minnesota Municipal Power Agency	Austin NE Power Plant	coal, gas	126,721	7.42	27	146,891	8.56	26
Southern Minnesota Municipal Power Agency	Sherburne 3 (combined with Xcel for 2002, SMMPA owned portion for 2003)	coal, oil	see Xcel Sherburne 3	see Xcel Sherburne 3	see Xcel Sherburne 3	2,711,751	201.59	34
Southern Minnesota Municipal Power Agency	Minnesota River Station Combustion Turbine[c,d]	oil, gas	exempt[g]	exempt[g]	exempt[g]	17,622	0.00	0
Willmar Municipal Utilities	Boiler 3	coal, natural gas	exempt[g]	exempt[g]	exempt[g]	40,591	3.70	41
		Summary of Reports	34,839,053	1,562	median = 15	37,367,580	1,885	median = 14
			Total Reported 2002 Electricity Produced (MWh)	Total Reported 2002 Mercury Emissions (lb)	Median Reported 2002 Mercury Emissions per Megawatt-hour (mg/MWh)	Total Reported 2003 Electricity Produced (MWh)	Total Reported 2003 Mercury Emissions (lb)	Median Reported 2003 Mercury Emissions per Megawatt-hour (mg/MWh)

Notes

aMSW is Municipal Solid Waste.

[b]RDF is Refuse-Derived Fuel, which is sorted and processed municipal solid waste.

[c]Facility has agreed to include for reporting mercury emissions of less than 3 pounds.

[d]Mercury emissions round to less than 0.00 pounds mercury for one or both years.

[e]148 pounds of mercury in 2002 and 39 pounds mercury in 2003 associated with electricity sold out of state.

[f]5.15% of total energy production for all facilities is sold to Minnesota customers.

[g]Exempt from reporting. (Facilities emitting under 3 pounds of mercury or less than 240 hours of operation per year.)

Table 3. Reported 2002 and 2003 emissions of mercury from electrical production facilities outside of Minnesota for which the electricity was likely consumed in Minnesota.

Company	Electrical Supplier, if not generated by the Reporting Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Consumed in Minnesota (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Consumed in Minnesota (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
Minnesota Power	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	2,320,085	182.00	36	2,285,734	294.00	58
Otter Tail Power, Fergus Falls, MN		Coyote Plant, Beulah, ND	lignite coal, oil	545,741	54.68	45	497,277	46.53	42
Otter Tail Power, Fergus Falls, MN		Big Stone Plant, Big Stone Lake, SD	sub coal, oil	799,996	63.51	36	1,016,800	51.58	23
Marshall Municipal Utilities	Heartland Power		lignite coal	403,841	NA	NA	449,109	NA	NA
Marshall Municipal Utilities	Omaha Public Power District		lignite coal	562,641	NA	NA	31,739	NA	NA
Northern Municipal Power Agency, Thief River Falls	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	183,487	17.60	44	137,573	16.80	55
Northern Municipal Power Agency, Thief River Falls	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	96,473	8.30	39	81,584	9.30	52
Northern Municipal Power Agency, Thief River Falls	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	89,852	11.50	58	69,586	6.60	43
People's Cooperative Services	Dairyland Power Cooperative	Alma 1-5	Bit/Sub Coal	28,805	1.00	16	35,811	1.09	14
People's Cooperative Services	Dairyland Power Cooperative	JP Madgett	Sub bituminous coal	88,633	3.06	16	92,981	4.49	22
People's Cooperative Services	Dairyland Power Cooperative	Genoa	Bit/Sub Coal	92,522	2.74	13	91,273	2.97	15
People's Cooperative Services	Dairyland Power Cooperative, Great River Energy/G3	Great River Energy/G3	Bit/Sub Coal	NA	NA	NA	1,569	0.05	14

Company	Electrical Supplier, if not generated by the Reporting Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Consumed in Minnesota (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Consumed in Minnesota (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
Tri-County Electric Cooperative	Dairyland Power Cooperative	Alma 1-5	Sub Coal	36,775	1.28	16	48,126	1.47	14
Tri-County Electric Cooperative	Dairyland Power Cooperative	JP Madgett	Bit/Sub coal	113,158	3.90	16	124,958	6.03	22
Tri-County Electric Cooperative	Dairyland Power Cooperative	Genoa	Bit/Sub Coal	118,123	3.49	13	122,662	3.99	15
Tri-County Electric Cooperative	Dairyland Power Cooperative	Great River Energy/G3	Bit/Sub Coal	NA	NA	NA	2,109	0.07	15
Freeborn-Mower Cooperative Services	Dairyland Power Cooperative	Alma 1-5	Bit/Sub Coal	21,641	0.75	16	26,468	0.81	14
Freeborn-Mower Cooperative Services	Dairyland Power Cooperative	JP Madgett	Sub bituminous coal	66,591	2.30	16	68,724	3.32	22
Freeborn-Mower Cooperative Services	Dairyland Power Cooperative	Genoa 3	Bit/Sub Coal	69,513	2.06	13	67,461	2.19	15
Freeborn-Mower Cooperative Services	Dairyland Power Cooperative	Great River Energy/G3	Bit/Sub Coal	NA	NA	NA	1,160	0.04	16
Agralite Electric Cooperative	Great River Energy		lignite coal	145,492	7.08	22	160,142	7.97	23
Arrowhead Electric Cooperative	Great River Energy		lignite coal	60,780	4.06	30	63,892	4.26	30
Benco Electric Cooperative	Great River Energy		lignite coal	249,888	16.94	31	250,637	16.93	31
Brown County Rural Electrical Ass'n	Great River Energy		lignite coal	119,374	6.17	23	119,035	6.05	23
Connexus Energy	Great River Energy		lignite coal	1,923,134	130.34	31	2,007,965	135.65	31
Cooperative Light and Power	Great River Energy		lignite coal	83,912	5.69	31	87,057	5.88	31
Crow Wing Power	Great River Energy		lignite coal	459,941	31.17	31	482,127	32.57	31
Dakota Electric Ass'n	Great River Energy		lignite coal	1,643,329	111.38	31	1,690,760	114.22	31

Company	Electrical Supplier, if not generated by the Reporting Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Consumed in Minnesota (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Consumed in Minnesota (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
East Central Electric Ass'n	Great River Energy		lignite coal	795,180	53.89	31	827,512	55.90	31
Federated Rural Electric	Great River Energy		lignite coal	146,109	6.88	21	155,559	7.46	22
Goodhue County Cooperative Electric Ass'n	Great River Energy		lignite coal	82,326	5.58	31	83,056	5.61	31
Head of the Lakes Electric Cooperative	Great River Energy		lignite coal	6,952	0.47	31	Combined with East Central Energy	Combined with East Central Energy	Combined with East Central Energy
Itasca-Mantrap Co-op. Electrical Ass'n	Great River Energy		lignite coal	161,215	10.93	31	167,322	11.30	31
Kandiyohi Power Cooperative	Great River Energy		lignite coal	142,626	7.53	24	143,598	7.57	24
Lake Country Power	Great River Energy		lignite coal	626,767	42.48	31	648,434	43.80	31
Lake Region Electric Cooperative	Great River Energy		lignite coal	341,690	18.14	24	350,479	18.58	24
McLeod Cooperative Power Ass'n	Great River Energy		lignite coal	157,722	9.96	29	153,479	9.68	29
Meeker Cooperative Light & Power Ass'n	Great River Energy		lignite coal	145,657	8.30	26	148,879	8.56	26
Mille Lacs Electric Cooperative	Great River Energy		lignite coal	173,630	11.77	31	181,384	12.25	31
Minnesota Valley Electric Cooperative	Great River Energy		lignite coal	471,629	31.97	31	503,435	34.01	31
Nobles Electric Cooperative	Great River Energy		lignite coal	113,740	4.18	17	113,432	4.21	17
North Itasca Electric Cooperative, Inc.	Great River Energy		lignite coal	45,028	2.57	26	47,738	2.73	26
Redwood Electric Cooperative	Great River Energy		lignite coal	57,004	2.07	16	55,982	2.09	17
Runestone Electric Ass'n	Great River Energy		lignite coal	186,438	9.51	23	195,347	10.05	23
South Central Electric Ass'n	Great River Energy		lignite coal	139,001	6.79	22	136,846	6.58	22

Company	Electrical Supplier, if not generated by the Reporting Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Consumed in Minnesota (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Consumed in Minnesota (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
Stearns Electric Ass'n	Great River Energy		lignite coal	353,095	20.71	27	364,937	21.55	27
Steele-Waseca Cooperative Electric	Great River Energy		lignite coal	188,979	12.80	31	202,132	13.65	31
Todd-Wadena Electric Cooperative	Great River Energy		lignite coal	149,034	8.08	25	155,004	8.43	25
Wright-Hennepin Cooperative Electric Ass'n	Great River Energy		lignite coal	647,785	43.90	31	675,066	45.60	31
Clearwater-Polk Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	27,186	2.60	43	26,348	3.20	55
Clearwater-Polk Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	14,294	1.20	38	15,625	1.80	52
Clearwater-Polk Electric Cooperative	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	13,313	1.70	58	13,327	1.30	44
North Star Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	43,704	4.20	44	162,990	19.80	55
North Star Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	22,979	2.00	39	96,657	11.00	52
North Star Electric Cooperative	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	21,402	2.70	57	82,443	7.80	43
PKM Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	35,327	3.40	44	32,927	4.00	55
PKM Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	18,574	1.60	39	19,526	2.20	51
PKM Electric Cooperative	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	17,299	2.20	58	16,655	1.60	44
Red Lake Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	45,813	4.40	44	42,307	5.20	56
Red Lake Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	24,087	2.10	40	25,089	2.80	51

Company	Electrical Supplier, if not generated by the Reporting Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Consumed in Minnesota (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Consumed in Minnesota (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
Red Lake Electric Cooperative	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	22,434	2.90	59	21,399	2.00	42
Red River Valley Cooperative Power Ass'n	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	47,037	4.50	43	43,005	5.20	55
Red River Valley Cooperative Power Ass'n	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	24,731	2.10	39	25,050	2.90	53
Red River Valley Cooperative Power Ass'n	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	23,033	3.00	59	21,753	2.10	44
Roseau Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	63,723	6.10	43	58,216	7.10	55
Roseau Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	33,504	2.90	39	34,523	3.90	51
Roseau Electric Cooperative	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	31,205	4.00	58	29,446	2.80	43
Wild Rice Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	85,960	8.20	43	81,067	9.90	55
Wild Rice Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	45,196	3.90	39	48,074	5.50	52
Wild Rice Electric Cooperative	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	42,094	5.40	58	41,005	3.90	43
Beltrami Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #1, Center, ND	lignite coal	178,061	17.10	44	156,122	19.00	55
Beltrami Electric Cooperative	Minnkota Power Cooperative	Milton R. Young #2, Center, ND	lignite coal	93,620	8.10	39	92,584	10.50	51
Beltrami Electric Cooperative	Minnkota Power Cooperative	Coyote Station, Beulah, ND	lignite coal	87,195	11.20	58	78,969	7.50	43
Sioux Valley-Southwestern Electric Coop	L & O Electric (Purchases from Basin Elec.)		coal	62,382	3.49	25.38	93,066	5.21	25.40

Company	Electrical Supplier, if not generated by the Reporting Company	Generating Facility	Major Fuel Type(s)	2002 Electricity Consumed in Minnesota (MWh)	2002 Mercury Emissions (lb)	2002 Mercury Emissions per Megawatt-hour (mg/MWh)	2003 Electricity Consumed in Minnesota (MWh)	2003 Mercury Emissions (lb)	2003 Mercury Emissions per Megawatt-hour (mg/MWh)
Lyon-Lincoln Electric Cooperative	East River Electric Power Cooperative		lignite coal	53,459	2.57	22	53,928	2.59	22
Minnesota Valley Coop. Light & Power Ass'n	Basin Electric		lignite coal	99,642	5.58	25	101,453	5.60	25
Traverse Electric Cooperative	Basin Electric		lignite coal	27,236	1.31	22	25,440	1.22	22
Wright-Hennepin Cooperative Electric Ass'n	Basin Electric		lignite coal	8,760	0.59	31	8,795	0.42	22
Renville Sibley Cooperative Ass'n	East River Electric Power Cooperative		lignite coal	99,375	4.76	22	101,724	4.88	22
Minnesota Valley Electric Cooperative	Utilities Plus		lignite, sub coal	43,800	1.57	16	43,669	1.61	17
Stearns Electric Association	Utilities Plus		sub coal, lignite	22,032	0.79	16	26,280	0.80	14
Wright-Hennepin Cooperative Electric Ass'n	Utilities Plus		lignite, sub coal	52,560	1.88	16	52,398	2.03	18
			Summary of Reports	**16,986,351**	**1,120**	**median = 31**	**17,195,799**	**1,272**	**median = 31**
				Total Reported 2002 Electricity Produced (MWh)	Total Reported 2002 Mercury Emissions (lb)	Median Reported 2002 Mercury Emissions per Megawatt-hour (mg/MWh)	Total Reported 2003 Electricity Produced (MWh)	Total Reported 2003 Mercury Emissions (lb)	Median Reported 2003 Mercury Emissions per Megawatt-hour (mg/MWh)

Notes

NA indicates data was either not available or not submitted to MPCA

Appendix B: Air Toxics Emissions Information

Introduction

This appendix describes the sources of air toxics emissions in Minnesota using data from the Minnesota air toxics emission inventory. The Minnesota Pollution Control Agency (MPCA) compiles an air toxics emission inventory every three years to correspond to the national emission inventory cycle. At this time, the most current air toxics emission inventory is for calendar year 1999. The 2002 emission inventory will be available in mid-2005. This report presents an updated 1999 Minnesota air toxics emission inventory compared with the 1999 inventory presented in the 2003 air quality legislative report. The adjustments were made primarily to airports, commercial marine vessels, and some individual facilities. As a result of these inventory adjustments, total emissions increased overall by 5 percent in this updated 1999 inventory.

The air toxics emissions inventory includes three principal source categories: point, area, and mobile sources. MPCA staff estimated emissions for point, area sources, and certain categories of mobile sources. The results for most mobile sources in this report were obtained from EPA's 1999 National Emission Inventory. [1] The following sections provide a brief description of source categories, emission estimation methods for point and area sources, and results for all three principal source categories.

Point Sources

Unlike some other states, Minnesota does not have comprehensive air toxic emission inventory reporting requirements for industrial sources that go beyond the Toxics Release Inventory reporting requirements. However, for the Minnesota criteria pollutant emission inventory, the MPCA collects emission data annually from facilities that can emit more than a threshold amount of a criteria pollutant. The pollutants inventoried for the criteria pollutant inventory include: carbon monoxide, nitrogen oxides, particulate matter, particulate matter smaller than 10 microns, lead, sulfur dioxide, and volatile organic compounds.

These larger stationary sources are required to obtain a permit from the MPCA and are called point sources. Therefore, for the purpose of the Minnesota air toxics emission inventory, point sources are identified as facilities that are required to submit their annual inventories of criteria pollutants to the MPCA. According to this definition, in 1999 there were a total of 2183 point sources. Examples of point sources include electric utilities, refineries, and manufacturing plants.

Three methods are used to estimate air toxics emissions from point sources: 1) direct reporting by facilities, 2) using emission factors, and 3) incorporating Toxics Release Inventory data. The MPCA received 1999 air toxics emission information reported by 373 facilities, including refineries, iron ores mining, electric services/coal burning facilities, other manufacturing facilities, and facilities holding Option D air quality permits with actual VOC emissions of more than 5 tons. (These Option D facilities are mainly smaller companies using paints and primers, cleaning solvents, printing solutions, and paint thinners, and are required to track monthly hazardous air pollutant emissions.) MPCA staff incorporated

Toxics Release Inventory emissions information for an additional 162 facilities. For facilities that did not directly report air toxics emissions, staff used throughput activity data from the Minnesota criteria emission inventory and emission factors to calculate emissions. (Combustion units were the principal processes for which emissions were calculated at these facilities.) As a result, staff was able to estimate emissions of one or more targeted pollutants from 1088 out of 2183 point sources for year 1999. The 1999 inventory includes point source emissions from 246 distinct standard industrial classification (SIC) codes and 201 distinct source classification codes (SCC).

Area Sources

Area sources are stationary sources that are not required to submit criteria pollutant data to the MPCA. They are small emission sources, but collectively can release large amounts of one or more toxic air pollutants. The categories of area sources have been determined by reviewing EPA's 1999 Base Year Nonpoint Source National Emission Inventory for Hazardous Air Pollutants, Emission Inventory Improvement Program documents and other available information. The emission data for area sources were obtained from surveys, literature, and the submittals from facilities such as dry cleaners or halogenated solvent cleaners subject to a National Emission Standard for Hazardous Air Pollutants. There are 25 categories, 53 sub-categories and 44 distinct SCCs included in the Minnesota emission inventory for area sources. Table 1 lists all these categories along with activity data and information sources.

Mobile Sources

Mobile sources typically include any kind of vehicle or equipment with an engine burning a fuel such as gasoline, diesel, or natural gas. They are further sub-categorized to twelve types of on-road vehicles (see below) and four types of nonroad sources: aircraft, locomotives, commercial marine vessels, and nonroad equipment.

Vehicle Types:

- 2B Heavy Duty Diesel Vehicles (2BHDDV) (8,501-10,000 lbs. GVWR)
- Buses Heavy Duty Diesel Vehicles (BHDDV) (Diesel School Buses and Transit Buses)
- Heavy Duty Gasoline Vehicles (HDGV) (8,501 lbs. + GVWR)
- Heavy Duty Diesel Vehicles (HHDDV) (33,001 lbs. + GVWR)
- Light Duty Diesel Trucks (LDDT) (0 - 8,500 lbs. GVWR)
- Light Duty Diesel Vehicles (LDDV) (Passenger Cars)
- Light Duty Gasoline Trucks 1 (LDGT1) (0 - 6,000 lbs. GVWR)
- Light Duty Gasoline Trucks 2 (LDGT2) (6,001 - 8,500 lbs. GVWR)
- Light Duty Gasoline Vehicles (LDGV) (Passenger Cars)
- Light Heavy Duty Diesel Vehicles (LHDDV) (10,001 - 19,500 lbs. GVWR)
- Medium Heavy Duty Diesel Vehicles (MHDDV) (19,501 - 33,000 lbs. GVWR)
- Motorcycles (MC).

There are ten types of nonroad equipment, including:

- Agricultural Equipment

- Airport Ground Support Equipment
- Commercial Equipment
- Construction and Mining Equipment
- Industrial Equipment
- Lawn and Garden Equipment
- Logging Equipment
- Pleasure Craft
- Railroad Equipment
- Recreational Equipment.

MPCA staff collected activity data and estimated emissions for locomotives, aircraft and airport ground support equipment. Since the emission estimation method for aircraft and airport ground support equipment has greatly improved, estimated 2002 emissions for these categories were used instead of the 1999 estimates in this updated inventory. For commercial marine vessels, MPCA staff estimated air toxics emissions based on PM and VOC emissions prepared by the Central States Regional Air Planning Association (CenRAP) for 2002.[2] For all other categories of onroad and nonroad mobile sources, emission data were obtained from the EPA's 1999 National Emission Inventory Version 3 for Hazardous Air Pollutants (released in October 2002).[1]

Emissions

The MPCA staff attempted to estimate emissions for more than 500 target compounds, including 188 Hazardous Air Pollutants listed by EPA, pollutants in the Great Lakes regional air toxics emission inventory project, and pollutants monitored in Minnesota's outdoor air. (For a complete list of the compounds in the 1999 inventory go to: http://www.pca.state.mn.us/air/toxics/toxics-airtoxicslist.xls.) However, emissions data were only available for 240 of the more than 500 targeted compounds. Point and area sources emitted 227 and 168 of the target pollutants, respectively, while mobile sources emitted 53 of the target pollutants. Table 2 shows a summary of emissions by principal source category. In that table, emissions are presented for pollutant groups, e.g., individual metal compounds are grouped to metal compounds. For example, chromium, strontium chromate, and zinc chromate were put into the group called chromium compounds. This grouping method is also applied to dioxin congeners, individual glycol ethers, and polycyclic organic matters. As a result, there are 156 pollutant groups that are used by the EPA and the Great Lakes Commission in many air toxics programs.

Point sources contributed more than 50% of the emissions for 78 pollutant groups, dominating emissions of metal compounds, except for cadmium compounds and copper compounds. Cadmium compounds were mainly from prescribed burning. About 50% of copper compounds were from onroad mobile sources, vehicle brake wear. Area sources contribute more than 70% emissions of individual PAHs, except for acenaphthene and dibenz(a,h)anthracene. These two PAHs are mainly from point and nonroad mobile sources, respectively. Area sources also emit a significant fraction of total emissions for 48 non-metal compounds, such as atrazine, chlorobenzene, dioxins, 1,1,1-trichloroethane, o-dichlorobenzene, 1,1-dichloroethane, methyl ethyl ketone, and trifluralin. Mobile sources are primary contributors to 17 pollutant groups such as 1,3-butadiene, acetaldehyde, benzene, ethylbenzene, formaldehyde, toluene, and xylenes.

On a mass basis, mobile sources (on-road and nonroad) contribute more than half the total air toxics emitted in Minnesota. Figure 1 shows the contribution of point, area, onroad mobile sources, and nonroad mobile sources to the state total air toxics emissions. Each principal source category is responsible for approximately a quarter of total emissions with a slightly more from nonroad mobile sources (27.9%) and slightly less from point sources (20.5%).

A more detailed categorization of total air toxics emissions is shown in Table 3. The categorization was based on the first two digits of Standard Industrial Classification (SIC) codes for point sources. Category names were used for area and mobile sources. Figure 2 shows the top ten categories that each contributed more than 2% to the total emissions. The emissions of the remaining categories that had less than 2% contributions were summed to a category called "Other". The "Other" category contributed 22% of total air toxics emissions. Among the top ten categories, light duty gasoline vehicles emitted the most, followed by recreational equipment and a category of point sources, electric, gas, and sanitary services. These three categories were each responsible for more than 10% of total emissions.

A similar categorization was conducted for two air toxics: benzene and formaldehyde. These two pollutants were further analyzed because their ambient concentrations have been observed above levels of concern at many air monitoring sites. Table 4 and Table 5 provide detailed categorization of total emissions for benzene and formaldehyde, respectively. Figures 3 and 4 show the categories that contributed more than 2% to total emissions of benzene and formaldehyde, respectively. For benzene, light duty gasoline vehicles were estimated to emit a quarter of total emissions. Light duty gasoline trucks 1 & 2, prescribed burning, and pleasure craft each contributed more than 10% of total benzene emissions. For formaldehyde, prescribed burning is the most significant source category, accounting for 30.5% of total emissions. Agricultural equipment, light duty gasoline vehicles, and residential wood burning contributed to total formaldehyde emissions in a 7% to 9% range. It is worthwhile to note that contributions of point sources to benzene and formaldehyde were insignificant, 1.1% and 6.9%, respectively. It should be noted that the emission inventory only estimated direct formaldehyde emissions from human-made sources. Formaldehyde production also occurs indirectly through the oxidation of hydrocarbons and other formaldehyde precursors. These precursors include combustion byproducts and solvent emissions. During the summer, indirect sources of formaldehyde can be greater than direct sources. Natural sources of formaldehyde such as forest fires, microbial products of biological processes and plant volatiles also significantly contribute to formaldehyde in ambient air.

Limitations and Uncertainties

Although quality assurance plans are in place to ensure the best results, there are uncertainties and limitations to consider when evaluating the Minnesota air toxics emission inventory. Some limitations are common to air toxics emission inventories in all states and some are specific to Minnesota. For example, in all inventories not all pollutants are included because some emission factors are missing or emission factors are of poor quality, resulting in unrepresentative emission estimates.

There are uncertainties specific to Minnesota. First, the primary concern in the point source inventory is a lack of source-specific emission information from many facilities holding an individual total facility permit. Since chemical species use varies from one facility to the other, the MPCA prefers to collect material usage and composition data from these facilities to estimate emissions. This is particularly important for those facilities using solvents such as in surface coating and printing processes. Facilities with individual total facility permits are usually large, representing a majority of emissions from point sources. MPCA staff sent surveys to these facilities requesting their emissions. Thirty-five percent of facilities responded to the survey for 1999. The MPCA expects higher response rates to future surveys. For example, the response rate increased to 57 % for the 2002 survey.

Second, as a key component in emission estimation, SCCs may be a source of inaccuracy because these codes have been assigned by the MPCA staff and never reviewed by facilities in the Minnesota criteria emission inventory reporting system.

Third, MPCA staff could not estimate point source air toxic emissions for facilities with certain types of registration permits. There are 466 and 785 facilities in the Minnesota criteria emission inventory with registration permits Option B and D, respectively. These facilities do not report process level throughput data and have no SCC assigned to them. Without this information, staff could not estimate air toxics emissions for these facilities. Although the MPCA collected data from 236 Option D facilities and some other facilities may report to the Toxics Release Inventory, most of these small point sources had to be treated more generally as area sources in the 1999 emission inventory. For the 2002 emission inventory, 99% of the Option D facilities (269) that emitted more than 5 tons of VOC reported their air toxics emissions. Facilities with other types of registration permits cannot as easily provide air toxics emissions data because, unlike the Option D registration permit, their permit does not require tracking of air toxics emissions.

Fourth, uncertainties are introduced due to scarce information on control efficiencies for air toxics.

Fifth, a number of emission factors were developed using detection limits or half of the detection limits when the measurements were lower than detection limits. This approach tends to over-estimate emissions.

Sixth, activity levels for some area sources and all nonroad equipment were allocated from national totals which might not represent the actual local activities.

The Minnesota air toxics emission inventory is a progressive inventory that changes over time. Its goal is to contain the most accurate emission data available at the time the inventory is compiled. A meaningful comparison of emissions between different inventory years to describe emission reduction is not possible for the following primary reasons:

1. The number of pollutants in the emission inventories has increased over the years (Figure 5),
2. The number of sources and source categories have expanded with time (Figure 6 and Figure 7), and
3. Emission estimation methods, emission factors, and activity data have changed with each inventory year.

A back-calculation using the 1999 approaches for previous inventories could provide emission trend, however, this is a resource intensive effort.

Information

For more information about Minnesota's air toxics inventory and other information related to air toxics in Minnesota, visit this website:

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

Or contact:

Ms. Chun Yi Wu at 651-282-5855 or chun.yi.wu@pca.state.mn.us
Mr. Nicholas Salkowski at 651-296-8709 or nicholas.salkowski@pca.state.mn.us

References

1. *Hazardous Air Pollutants Data - 1999 NEI Version 3*; U.S. Environmental Protection Agency, October 2002. ftp://ftp.epa.gov/EmisInventory/draftnei99ver3/haps/datafiles/onroad/statefiles/MNHAPONRD1002.zip
2. Ms. Dana Coe Sullivan, Manager, Emissions Assessment, Sonoma Technology, Inc., Personal communication via e-mail. September 2, 2004. E-mail: Dana@SonomaTech.com

Table 1. Area source categories and information sources for their activity data.

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
Architectural Surface Coating	Water-based Paint	Apply speciation profiles to VOC. VOC emissions are obtained from population-based estimation method.	Census data
	Solvent-based Paint	Same as above	Same as above
Asphalt Paving	Asphalt Paving	Use state-specific activity data and emission factors.	Survey of asphalt suppliers
Autobody Refinishing	Autobody Refinishing	Use per capita emission factor for VOC and apply speciation profiles to VOC emissions.	Census data
Chromium Electroplating	Chromic Anodizing	Use both source-specific and generic emission factors. Activity data are source-specific.	NESHAP submittals and survey
	Decorative Hexavalent plating	Same as above	Same as above
	Hard Chrome Plating	Same as above	Same as above
Commercial/Consumer Solvent Products	Commercial/Consumer Solvent Products	Use national per capita emission factors	Census data
Dry Cleaners	Transfer Machines with Control	Use emission factor based on solvent usage and machine type.	NESHAP submittals and survey letters
	Transfer Machines Uncontrolled	Same as above	Same as above
	Dry-Dry Machine with Control	Same as above	Same as above
	Dry-Dry Machine Uncontrolled	Same as above	Same as above
Fluorescent Lamp Breakage	Fluorescent Lamp Breakage	Apportion national numbers of discarded lamp to county values based on the population census data. Use state-specific fractions for recycling and generic emission factors.	Census data
Fluorescent Lamp Recycling	Fluorescent Lamp Recycling	Same as above	Same as above
Forest Fires	Forest Fires	Use the acreage of forest fires at a county level and emission factors.	MD of Natural Resources
Gasoline Service Stations	Stage I: Splash Filling of Gasoline Storage Tanks	Use EPA emission factor for VOC and some air toxics. County activity data are allocated from state fuel consumption based on population. Applied speciation profiles to VOC emissions for air toxics without emission factors.	MD of Revenue
	Stage I: Submerged Filling w/o Control of Underground Tanks	Same as above	Same as above

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
	Stage I: Gasoline Underground Tank Breathing	Same as above	Same as above
	Stage II: Vapor Loss from Vehicle Refueling	Same as above	Same as above
	Stage II: Spilling Loss w/o controls from vehicle refueling	Same as above	Same as above
	Stage I: Total, Aviation Gasoline	Same as above	Same as above
Gasoline Trucks in Transit	Gasoline Trucks in Transit	Use EPA emission factor for VOC. County activity data are allocated from state fuel consumption based on population. Apply speciation profiles to VOC emissions for air toxics.	MD of Revenue
Grain Elevators	Grain Elevators	Apportion state pesticide usage to a county-level based on the amount of grain harvested. Calculate with an emission factor method.	MD of Agricultural, U.S. Department of Agriculture
Graphic Arts	Graphic Arts	Apply state-specific speciation profiles to VOC. VOC emissions are obtained from population-based estimation method.	Census data
Hospital Sterilization	Hospital Sterilization	Use the 1996 NEI emission factors based on the number of beds in a hospital.	American Hospital Association, MD of Health
Human Cremation	Human Cremation	Emission factors from the 1999 NEI based on tons cremated. Assume 150 LB per body.	MD of Health
Industrial Surface Coating	General Surface Coatings	Use employee-based emission factors for VOC and apply speciation profiles to VOC emissions.	Census data
	High Performance Coatings, Solvent Based Coatings	Use per capita emission factor for VOC and apply speciation profiles to VOC emissions.	Census data
	High Performance Coatings, Water Based Coatings	Same as above	Same as above
Municipal Solid Waste Landfills	Non-flaring MSW Landfills	Create a model based on AP-42, Section 2.4. Most concentrations of air toxics are obtained from MPCA landfill gas study.	MPCA
	Flaring MSW Landfill gas	Use generic emission factors.	MPCA
POTW facilities	Evap. emissions assoc. with treatment	Survey to gather annual influent flowrate and chlorine consumption. Treat big facilities based on actual processes. Assume a typical plant then use emission factors for small facilities.	MPCA Water Quality Division, WWTIR

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
	Evap. emissions assoc. with chlorination	Same as above	Same as above
Pesticides - Agricultural	Herbicides, Corn	Use vapor pressure of the active ingredients to determine per acre emission factors. Consider pesticide application and formulation type. Apportion state pesticide usage to a county-level based on crop acreage.	MD of Agricultural, U.S. Department of Agriculture
	Insecticides, Corn	Same as above	Same as above
	Herbicides, Soy Beans	Same as above	Same as above
Prescribed Burning	Prescribed Burning	Apportion 'region' (6 regions in the state) level data on the acreage of prescribed burns to the county level using the proportion of forested land by county. Calculate with an emission factor method.	MD of Natural Resources
Residential Fossil Fuel Combustion	Combustion of Natural Gas	Use population-based fuel consumption and both state -specific and generic emission factors.	
	Combustion of Bituminous/Subbituminous Coal	Same as above	Same as above
	Combustion of Distillate Oil	Same as above	Same as above
	Combustion of Liquid Petroleum Gas (LPG)	Same as above	Same as above
Residential Wood Burning	Certified, Catalytic Woodstoves	Use population-based fuel consumption and emission factors.	MD of Public Service, MN energy data book
	Certified, Non-Catalytic Woodstoves	Same as above	Same as above
	Conventional Woodstoves	Same as above	Same as above
	Fireplace, Cordwood	Same as above	Same as above
	Fireplace, Firelog	Same as above	Same as above
Solvent Cleaning	Open Top Vapor Degreasing, Trichloroethylene (Misc. Control)	Use emission factors and facility-specific data on type of degreasing and solvent consumption.	NESHAP submittals and survey
	Open Top Vapor Degreasing, Trichloroethylene (Uncontrol)	Use emission factors and facility-specific data on type of degreasing and solvent consumption.	NESHAP submittals and survey
	Cold, Vapor, and In-Line Cleaning	Use employee-based emission factors for VOC and apply speciation profiles to VOC emissions.	Census data
	Solvent Cleanup	Use employee-based emission factors for VOC and apply speciation profiles to VOC emissions.	Census data

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
Structure Fires	Residential Structure Fires	Use emission factors recommended by the EIIP document based on tons of material burned. Assume the average total material burned in each fire is 1.15 ton.	MD of Public Safety
Traffic Markings	Water-based paints	Use emission factor based on pain usage. Apply Minnesota specific information from the MSDS for estimating VOC and air toxics.	MD of Transportation and venders
	Epoxy	Same as above	Same as above
Total 25	**Total 53**		

DC = Department of Climatology, University of Minnesota. It provided heating degree days for adjusting the wood consumption.
DNR = Minnesota Department of Natural Resources
MD = Minnesota Department
NESHAP = National Emission Standards for Hazardous Air Pollutants
WWTIR = Wastewater Treatment Facilities Inventory Report

Table 2. Summary of the updated 1999 Minnesota air toxics emissions.

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
PAHs										
Acenaphthene	83-32-9	7.38E+04	5.19E+03	9.52E+02	1.72E+03	8.16E+04	90.37	6.35	1.17	2.11
Acenaphthylene	208-96-8	2.97E+02	1.09E+05	4.91E+03	3.93E+03	1.18E+05	0.25	92.27	4.15	3.32
Anthracene	120-12-7	2.76E+02	1.57E+04	1.16E+03	8.65E+02	1.80E+04	1.54	87.20	6.46	4.81
Benz[a]Anthracene	56-55-3	1.18E+02	2.04E+04	3.29E+02	2.52E+02	2.11E+04	0.56	96.70	1.55	1.19
Benzo[g,h,i,]Perylene	191-24-2	1.49E+00	1.04E+04	3.37E+02	6.92E+02	1.14E+04	0.01	90.98	2.95	6.06
Benzo[a]Pyrene	50-32-8	1.69E+01	4.47E+03	1.84E+02	1.96E+02	4.86E+03	0.35	91.83	3.79	4.04
Benzo[b]Fluoranthene	205-99-2	1.53E+01	3.13E+03	1.98E+02	1.48E+02	3.49E+03	0.44	89.65	5.68	4.24
Benzo[k]Fluoranthene	207-08-9	1.74E+00	5.30E+03	1.98E+02	1.34E+02	5.63E+03	0.03	94.07	3.52	2.38
Chrysene	218-01-9	1.46E+01	1.64E+04	1.53E+02	1.92E+02	1.67E+04	0.09	97.85	0.91	1.15

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Dibenzo[a,h]Anthracene	53-70-3	6.57E-01	2.90E-01	3.00E-02	5.00E+00	5.98E+00	10.99	4.85	0.50	83.66
Fluoranthene	206-44-0	3.94E+02	2.18E+04	1.19E+03	2.06E+03	2.55E+04	1.55	85.70	4.68	8.08
Fluorene	86-73-7	2.02E+02	1.27E+04	1.99E+03	3.38E+03	1.82E+04	1.11	69.43	10.93	18.53
Indeno[1,2,3-c,d]Pyrene	193-39-5	8.10E-01	5.62E+03	8.98E+01	2.12E+02	5.92E+03	0.01	94.88	1.52	3.59
Naphthalene	91-20-3	1.10E+05	6.54E+05	1.31E+05	5.54E+04	9.51E+05	11.59	68.82	13.76	5.83
Phenanthrene	85-01-8	7.94E+02	4.96E+04	3.25E+03	6.49E+03	6.01E+04	1.32	82.46	5.41	10.80
Pyrene	129-00-0	4.62E+02	2.80E+04	1.67E+03	2.31E+03	3.24E+04	1.42	86.29	5.15	7.13
PAH		3.58E+02				3.58E+02	100.00			
16-PAH			2.51E+05		4.75E+00	2.51E+05		100.00		0.00
7-PAH		3.21E+00	4.97E+04		4.69E-02	4.97E+04	0.01	99.99		0.00
PAH Total		1.87E+05	1.26E+06	1.47E+05	7.80E+04	1.68E+06	11.16	75.39	8.80	4.65
Metal Compounds										
Antimony Compounds		2.43E+03	4.14E+02		2.46E+01	2.87E+03	84.70	14.44		0.86
Arsenic Compounds		1.69E+04	7.29E+01	8.12E+02	5.27E+02	1.83E+04	92.28	0.40	4.44	2.88
Beryllium Compounds		3.56E+02	3.50E+01		4.97E+01	4.41E+02	80.81	7.93		11.26
Cadmium Compounds		2.03E+03	1.76E+04		5.11E+01	1.96E+04	10.34	89.40		0.26
Chromium Compounds		2.76E+04	1.34E+03	3.12E+02	3.80E+01	2.92E+04	94.22	4.58	1.07	0.13
Chromium VI Compounds		3.62E+02	2.17E+01	2.07E+02	1.96E+01	6.10E+02	59.33	3.55	33.92	3.20
Cobalt Compounds		4.82E+03	4.85E+02		2.82E+01	5.33E+03	90.37	9.10		0.53
Copper Compounds		2.95E+04	1.61E+03	3.21E+04	1.52E+03	6.47E+04	45.60	2.49	49.55	2.35
Lead Compounds		6.22E+04	7.51E+03		2.30E+04	9.27E+04	67.05	8.10		24.85
Manganese Compounds		2.07E+05	6.43E+03	1.76E+02	6.41E+01	2.13E+05	96.87	3.01	0.08	0.03
Mercury Compounds		3.56E+03	2.74E+02	9.15E+02	4.53E+02	5.20E+03	68.44	5.27	17.58	8.70
Nickel Compounds		3.59E+04	1.45E+03	3.94E+02	4.33E+02	3.82E+04	94.04	3.79	1.03	1.14

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Selenium Compounds		3.89E+03	1.76E+02		2.77E+00	4.06E+03	95.61	4.33		0.07
Metal Total		3.96E+05	3.74E+04	3.49E+04	2.63E+04	4.95E+05	80.08	7.56	7.05	5.31
Non-Metal Compounds (Excluding PAHs)										
1,1,2,2-Tetrachloroethane	79-34-5	7.21E+01	1.06E+03			1.14E+03	6.35	93.65		
1,1,2-Trichloroethane	79-00-5	9.77E+01				9.77E+01	100.00			
1,2,4-Trichlorobenzene	120-82-1	7.32E+03				7.32E+03	100.00			
1,2,4-Trimethylbenzene	95-63-6	1.48E+05	1.89E+04	3.40E+06	3.03E+06	6.60E+06	2.24	0.29	51.54	45.93
1,3,5-Trimethylbenzene	108-67-8	3.24E+02		1.16E+06	1.11E+06	2.27E+06	0.01		51.29	48.70
1,3-Butadiene	106-99-0	1.71E+03	6.67E+05	7.84E+05	4.47E+05	1.90E+06	0.09	35.12	41.27	23.52
1,3-Dichloropropene	542-75-6	4.66E+01	7.64E+05			7.64E+05	0.01	99.99		
1,4-Dichlorobenzene	106-46-7	4.10E+02	3.72E+05			3.72E+05	0.11	99.89		
2,2,4-Trimethylpentane	540-84-1	6.69E+03	4.08E+05	6.43E+06	9.80E+06	1.66E+07	0.04	2.45	38.65	58.86
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	2.62E-02	3.99E-01		4.10E-06	4.25E-01	6.17	93.83		0.00
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	1746-01-6	2.45E-03	6.69E-03		1.59E-06	9.14E-03	26.85	73.13		0.02
2,4-D (2,4-Dichlorophenoxyacetic Acid)(Inc	94-75-7		1.68E+05			1.68E+05		100.00		
2,4-Dinitrophenol	51-28-5	1.45E+02				1.45E+02	100.00			
2,4-Dinitrotoluene	121-14-2	5.20E+00	1.22E-03			5.21E+00	99.98	0.02		
2,4-Toluene Diisocyanate	584-84-9	4.89E+03	6.24E+01			4.95E+03	98.74	1.26		
2-Chloroacetophenone	532-27-4	1.30E+02	3.04E-02			1.30E+02	99.98	0.02		
2-Nitropropane	79-46-9		9.26E+00			9.26E+00		100.00		
4,4'-Methylenedianiline	101-77-9	1.51E+02				1.51E+02	100.00			
4,4'-Methylenediphenyl Diisocyanate (MDI)	101-68-8	6.33E+04	5.55E+02			6.38E+04	99.13	0.87		

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
4-Nitrophenol	100-02-7	4.27E+02				4.27E+02	100.00			
Acetaldehyde	75-07-0	1.61E+05	1.40E+06	1.88E+06	1.06E+06	4.50E+06	3.58	31.01	41.82	23.58
Acetamide	60-35-5		5.78E-01			5.78E-01		100.00		
Acetone	67-64-1	3.13E+05	1.34E+06	6.62E+05	7.04E+05	3.02E+06	10.36	44.44	21.91	23.29
Acetonitrile	75-05-8	1.22E+04	7.23E-01			1.22E+04	99.99	0.01		
Acetophenone	98-86-2	3.35E+02	1.22E+03			1.56E+03	21.53	78.47		
Acrolein	107-02-8	1.80E+04	7.16E+05	1.43E+05	1.30E+05	1.01E+06	1.79	71.04	14.23	12.94
Acrylamide	79-06-1	2.35E+02				2.35E+02	100.00			
Acrylic Acid	79-10-7	1.37E+04	1.86E+01			1.37E+04	99.86	0.14		
Acrylonitrile	107-13-1	2.00E+03	3.32E+03			5.33E+03	37.64	62.36		
Aldehydes		5.65E+04	8.34E+05			8.90E+05	6.35	93.65		
Allyl Chloride	107-05-1	7.00E+00				7.00E+00	100.00			
Aniline	62-53-3	1.10E+00				1.10E+00	100.00			
Atrazine	1912-24-9		1.79E+05			1.79E+05		100.00		
Benzaldehyde	100-52-7	1.46E+03		2.40E+05	2.86E+05	5.28E+05	0.28		45.56	54.16
Benzene	71-43-2	1.59E+05	3.85E+06	6.43E+06	3.63E+06	1.41E+07	1.13	27.38	45.72	25.78
Benzyl Chloride	100-44-7	1.21E+04	3.04E+00			1.21E+04	99.97	0.03		
Biphenyl	92-52-4	1.47E+03	8.12E+02			2.28E+03	64.45	35.55		
Bis(2-Ethylhexyl)Phthalate (Dehp)	117-81-7	9.78E+03	2.46E+01			9.80E+03	99.75	0.25		
Bromoform	75-25-2	7.25E+02	1.70E-01			7.25E+02	99.98	0.02		
Butyraldehyde	123-72-8	1.67E+02		9.13E+04	1.08E+05	2.00E+05	0.08		45.76	54.16
Carbon Disulfide	75-15-0	2.29E+03	4.37E+02			2.73E+03	83.99	16.01		
Carbon Tetrachloride	56-23-5	7.51E+02	8.58E+02			1.61E+03	46.66	53.34		
Carbonyl Sulfide	463-58-1	2.11E+05	1.17E+03			2.12E+05	99.45	0.55		

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Catechol	120-80-9	6.36E+02				6.36E+02	100.00			
Chlorine	7782-50-5	1.80E+04	5.04E+05			5.22E+05	3.45	96.55		
Chloroacetic Acid	79-11-8	2.20E-01				2.20E-01	100.00			
Chlorobenzene	108-90-7	5.94E+02	3.43E+05			3.43E+05	0.17	99.83		
Chloroform	67-66-3	4.39E+04	1.08E+04			5.47E+04	80.25	19.75		
Chloroprene	126-99-8	1.00E+00				1.00E+00	100.00			
Cresol/Cresylic Acid (Mixed Isomers)	1319-77-3	5.11E+04				5.11E+04	100.00			
Crotonaldehyde	123-73-9	1.27E+02		1.52E+05	2.19E+05	3.71E+05	0.03		40.92	59.04
Cumene	98-82-8	3.36E+04	1.33E+04			4.69E+04	71.64	28.36		
Cyanide Compounds		4.89E+04	1.43E+05			1.92E+05	25.56	74.44		
Dibenzofuran	132-64-9	3.97E+00	3.53E+01			3.93E+01	10.09	89.91		
Dibutyl Phthalate	84-74-2	2.38E+03	1.65E+02			2.54E+03	93.50	6.50		
Dichlorobenzenes	25321-22-6	6.92E+01				6.92E+01	100.00			
Diethanolamine	111-42-2	1.51E+02	3.35E+01			1.84E+02	81.82	18.18		
Diethyl Sulfate	64-67-5	6.22E+00				6.22E+00	100.00			
Dimethyl Phthalate	131-11-3	3.59E+03	2.13E+01			3.61E+03	99.41	0.59		
Dimethyl Sulfate	77-78-1	8.92E+02	2.09E-01			8.92E+02	99.98	0.02		
Di-N-Octylphthalate	117-84-0	1.04E+03				1.04E+03	100.00			
Dioxin and Furans (2,3,7,8-Tcdd Equivalent			3.29E-03	8.01E-03	2.21E-02	3.34E-02		9.85	23.96	66.18
Ethyl Acrylate	140-88-5	4.65E+03	4.34E+00			4.65E+03	99.91	0.09		
Ethyl Chloride	75-00-3	1.19E+04	4.22E+04			5.41E+04	22.05	77.95		
Ethylbenzene	100-41-4	2.51E+05	9.50E+04	2.75E+06	2.42E+06	5.51E+06	4.56	1.72	49.81	43.91
Ethylene Dibromide (Dibromoethane)	106-93-4	5.61E+02	4.63E+00			5.65E+02	99.18	0.82		

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Ethylene Dichloride (1,2-Dichloroethane)	107-06-2	1.59E+03	1.05E+03			2.64E+03	60.23	39.77		
Ethylene Glycol	107-21-1	4.61E+04	1.55E+05			2.01E+05	22.92	77.08		
Ethylene Oxide	75-21-8	1.11E+04	1.04E+05			1.15E+05	9.65	90.35		
Ethylidene Dichloride (1,1-Dichloroethane)	75-34-3	1.52E+01	9.66E+02			9.81E+02	1.55	98.45		
Formaldehyde	50-00-0	7.98E+05	5.10E+06	3.02E+06	2.68E+06	1.16E+07	6.88	43.99	26.00	23.14
Glycol Ethers		1.12E+06	2.26E+06			3.38E+06	33.07	66.93		
Hexamethylene Diisocyanate	822-06-0	3.65E+03	3.23E-01			3.65E+03	99.99	0.01		
Hexane	110-54-3	2.39E+06	3.41E+06	2.40E+06	1.73E+06	9.93E+06	24.07	34.34	24.18	17.41
Hydrazine	302-01-2	1.00E+00				1.00E+00	100.00			
Hydrochloric Acid (Hydrogen Chloride [Gas	7647-01-0	2.58E+07	6.75E+04			2.59E+07	99.74	0.26		
Hydrogen Fluoride (Hydrofluoric Acid)	7664-39-3	2.73E+06	7.21E+02			2.73E+06	99.97	0.03		
Hydroquinone	123-31-9	2.34E+03	4.23E+03			6.57E+03	35.61	64.39		
Isophorone	78-59-1	1.10E+04	1.53E+04			2.63E+04	41.79	58.21		
Lindane, (All Isomers)	58-89-9	3.00E+00				3.00E+00	100.00			
Maleic Anhydride	108-31-6	6.42E+02				6.42E+02	100.00			
M-Dichlorobenzene	541-73-1	1.01E+02	1.30E+03			1.41E+03	7.22	92.78		
Methanol	67-56-1	1.55E+06	3.48E+06			5.03E+06	30.85	69.15		
Methyl Bromide (Bromomethane)	74-83-9	1.40E+04	1.06E+06			1.07E+06	1.30	98.70		
Methyl Chloride (Chloromethane)	74-87-3	9.91E+04	2.46E+05			3.45E+05	28.68	71.32		
Methyl Chloroform (1,1,1-Trichloroethane)	71-55-6	5.64E+03	1.73E+06		1.11E+00	1.73E+06	0.33	99.67		0.00
Methyl Ethyl Ketone (2-Butanone)	78-93-3	1.19E+06	3.54E+06			4.74E+06	25.18	74.82		
Methyl Iodide (Iodomethane)	74-88-4	5.08E+00				5.08E+00	100.00			

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Methyl Isobutyl Ketone (Hexone)	108-10-1	3.55E+05	1.79E+06			2.15E+06	16.51	83.49		
Methyl Methacrylate	80-62-6	8.11E+04	1.65E+01			8.11E+04	99.98	0.02		
Methyl Tert-Butyl Ether	1634-04-4	4.53E+03	1.03E+02	1.26E+04		1.72E+04	26.34	0.60	73.06	
Methylene Chloride (Dichloromethane)	75-09-2	1.83E+05	5.74E+05			7.57E+05	24.14	75.86		
Methylhydrazine	60-34-4	3.16E+03	7.39E-01			3.16E+03	99.98	0.02		
m-Xylene	108-38-3	3.06E+02	3.10E+03			3.40E+03	9.00	91.00		
N,N-Dimethylformamide	68-12-2	1.01E+04	4.70E+04			5.71E+04	17.63	82.37		
Nitrobenzene	98-95-3	4.80E+02				4.80E+02	100.00			
o-Cresol	95-48-7	2.13E+01				2.13E+01	100.00			
O-Dichlorobenzene	95-50-1	5.23E+01	4.04E+05			4.05E+05	0.01	99.99		
o-Xylene	95-47-6	7.52E+03	2.00E+05			2.07E+05	3.63	96.37		
p-Cresol	106-44-5	1.19E+00				1.19E+00	100.00			
p-Dioxane	123-91-1	1.23E+04	7.44E+01			1.24E+04	99.40	0.60		
Pentachlorophenol	87-86-5	1.00E-02				1.00E-02	100.00			
Phenol	108-95-2	2.15E+05	3.15E+01		8.49E+01	2.16E+05	99.95	0.01		0.04
Phosphine	7803-51-2	4.40E+02	4.20E+02			8.59E+02	51.16	48.84		
Phosphorus Compounds	7723-14-0	4.25E+04	3.43E+04		4.44E+01	7.69E+04	55.27	44.67		0.06
Phthalic Anhydride	85-44-9	7.58E+02				7.58E+02	100.00			
Polychlorinated Biphenyls (Aroclors)	1336-36-3	1.14E+00	1.13E-01			1.25E+00	90.92	9.08		
Polychlorinated Dibenzodioxins, Total		2.65E-01	3.31E+00		2.70E-04	3.58E+00	7.41	92.58		0.01
Polychlorinated Dibenzofurans, Total		1.18E+00	1.40E+01		4.83E-05	1.51E+01	7.81	92.19		0.00
Polychlorinated Dibenzo-P-Dioxins and Fura		2.49E-02	6.35E-05			2.49E-02	99.75	0.25		
Polycyclic Organic Matter		2.65E+04	1.32E+04		5.63E+00	3.97E+04	66.78	33.21		0.01

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
p-Phenylenediamine	106-50-3	9.90E+01				9.90E+01	100.00			
Propionaldehyde	123-38-6	9.44E+03	1.65E+00	1.60E+05	2.62E+05	4.32E+05	2.19	0.00	37.03	60.78
Propylene Dichloride (1,2-Dichloropropane)	78-87-5	6.74E+00	2.01E+02			2.08E+02	3.24	96.76		
Propylene Oxide	75-56-9	6.45E+02				6.45E+02	100.00			
p-Xylene	106-42-3	1.33E+02				1.33E+02	100.00			
Quinoline	91-22-5	2.20E-01				2.20E-01	100.00			
Quinone (p-Benzoquinone)	106-51-4	1.87E+03				1.87E+03	100.00			
Styrene	100-42-5	2.06E+06	1.18E+03	5.57E+05	2.23E+05	2.84E+06	72.48	0.04	19.61	7.86
Tetrachloroethylene (Perchloroethylene)	127-18-4	7.60E+04	3.28E+05			4.04E+05	18.80	81.20		
Toluene	108-88-3	2.28E+06	1.03E+07	1.86E+07	2.46E+07	5.58E+07	4.08	18.52	33.37	44.03
Trichloroethylene	79-01-6	3.97E+05	2.93E+04			4.26E+05	93.12	6.88		
Trichlorofluoromethane (CFC-11, R-11)	75-69-4	3.73E+02	3.97E+04			4.00E+04	0.93	99.07		
Trichlorotrifluoromethane (CFC-113, R-113)	76-13-1		5.54E+05			5.54E+05		100.00		
Triethylamine	121-44-8	5.90E+02	4.01E+03			4.60E+03	12.84	87.16		
Trifluralin	1582-09-8		8.42E+04			8.42E+04		100.00		
Trimethylbenzene	25551-13-7	1.53E+04	7.21E+04			8.74E+04	17.54	82.46		
Vinyl Acetate	108-05-4	2.89E+04	1.25E+04			4.14E+04	69.78	30.22		
Vinyl Chloride	75-01-4	8.24E+02	1.25E+04			1.34E+04	6.16	93.84		
Vinylidene Chloride (1,1-Dichloroethylene)	75-35-4	2.14E+02	2.25E+03			2.46E+03	8.68	91.32		
Xylenes (Mixed Isomers)	1330-20-7	2.06E+06	7.07E+06	1.05E+07	1.00E+07	2.96E+07	6.93	23.85	35.32	33.90
Non-Metal Total		4.53E+07	5.47E+07	5.94E+07	6.25E+07	2.22E+08	20.44	24.65	26.76	28.16
Grand Total		**4.59E+07**	**5.60E+07**	**5.96E+07**	**6.26E+07**	**2.24E+08**	**20.50**	**24.99**	**26.59**	**27.93**

Table 3. Detail categorization of the updated 1999 Minnesota emissions for total air toxics.

Principal Category	Category	Emissions (lb)	Percent (%)
Area	Industrial Surface Coating	14,970,295	6.68
	Commercial/Consumer Solvent Products	12,139,446	5.42
	Prescribed Burning	8,092,077	3.61
	Residential Wood Burning	4,680,661	2.09
	Architectural Surface Coating	4,162,660	1.86
	Solvent Cleaning	2,729,165	1.22
	Gasoline Service Stations	2,633,598	1.18
	Forest Fires	1,602,444	0.72
	POTW facilities	1,391,224	0.62
	Autobody Refinishing	1,260,619	0.56
	Pesticides - Agricultural	705,278	0.31
	Graphic Arts	393,732	0.18
	Traffic Markings	372,369	0.17
	Residential Fossil Fuel Combustion	262,608	0.12
	Structure Fires	225,070	0.10
	Dry Cleaners	193,395	0.09
	Municipal Solid Waste Landfills	112,749	0.05
	Hospital Sterilization	31,671	0.01
	Gasoline Trucks in Transit	9,684	0.00
	Asphalt Paving	4,521	0.00
	Human Cremation	1,640	0.00
	Grain Elevators	420	0.00
	Fluorescent Lamp Breakage	27	0.00
	Chromium Electroplating	2	0.00
	Chromium Electroplating	0	0.00
	Fluorescent Lamp Recycling	0	0.00
Area Sum		55.975.355	24.99
Nonroad	Recreational Equipment	30,377,147	13.56
	Pleasure Craft	19,806,786	8.84
	Lawn & Garden Equipment	5,025,777	2.24
	Agricultural Equipment	2,710,429	1.21
	Commercial Equipment	1,761,100	0.79
	Construction & Mining Equipment	1,393,985	0.62
	Airport	639,905	0.29
	Industrial Equipment	434,058	0.19
	Locomotives	287,706	0.13
	Logging Equipment	67,561	0.03
	Commercial Marine Vessel	49,542	0.02
	Railroad Equipment	7,430	0.00
Nonroad Sum		62,561,426	27.93
Onroad	Light Duty Gasoline Vehicles (LDGV)	31,583,642	14.10
	Light Duty Gasoline Trucks 1 & 2 (LDGT1)	14,866,500	6.64
	Light Duty Gasoline Trucks 3 & 4 (LDGT2)	8,225,466	3.67

Principal Category	Category	Emissions (lb)	Percent (%)
	Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV)	2,864,551	1.28
	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B	1,253,203	0.56
	Motorcycles (MC)	305,432	0.14
	Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7	230,191	0.10
	Heavy Duty Diesel Vehicles (HDDV) Class 2B	60,608	0.03
	Heavy Duty Diesel Buses (School & Transit)	54,035	0.02
	Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5	52,688	0.02
	Light Duty Diesel Trucks 1 thru 4 (LDDT)	33,152	0.01
	Light Duty Diesel Vehicles (LDDV)	21,853	0.01
Onroad Sum		59,551,322	26.59
Point	Electric, Gas, And Sanitary Services	25,473,206	11.37
	Paper And Allied Products	2,530,261	1.13
	Food And Kindred Products	2,509,578	1.12
	Transportation Equipment	2,417,786	1.08
	Fabricated Metal Products	2,071,908	0.92
	Metal Mining	1,987,856	0.89
	Petroleum And Coal Products	1,689,446	0.75
	Rubber And Misc. Plastics Products	1,490,371	0.67
	Lumber And Wood Products	1,478,360	0.66
	Industrial Machinery And Equipment	735,835	0.33
	Chemicals And Allied Products	472,944	0.21
	Stone, Clay, And Glass Products	394,425	0.18
	Instruments And Related Products	376,752	0.17
	Wholesale Trade Nondurable Goods	340,793	0.15
	Furniture And Fixtures	287,698	0.13
	Printing And Publishing	283,050	0.13
	Electronic & Other Electric Equipment	277,207	0.12
	Primary Metal Industries	217,542	0.10
	Miscellaneous Manufacturing Industries	151,530	0.07
	Leather And Leather Products	130,300	0.06
	Educational Services	93,375	0.04
	Textile Mill Products	77,708	0.03
	Business Services	72,153	0.03
	Health Services	61,917	0.03
	Wholesale Trade Durable Goods	54,367	0.02
	Transportation By Air	49,039	0.02
	Auto Repair, Services, And Parking	46,832	0.02
	Nonmetallic Minerals, Except Fuels	38,988	0.02
	Miscellaneous Repair Services	36,798	0.02
	Special Trade Contractors	24,119	0.01
	Automotive Dealers & Service Stations	13,061	0.01
	Furniture And Homefurnishings Stores	11,157	0.00
	Engineering & Management Services	7,854	0.00
	National Security And Intl. Affairs	4,209	0.00
	Pipelines, Except Natural Gas	3,016	0.00

Principal Category	Category	Emissions (lb)	Percent (%)
	Justice, Public Order, And Safety	696	0.00
	Nondepository Institutions	460	0.00
	Food Stores	454	0.00
	Social Services	396	0.00
	Administration Of Economic Programs	285	0.00
	Amusement & Recreation Services	243	0.00
	Depository Institutions	209	0.00
	Local And Interurban Passenger Transit	202	0.00
	Museums, Botanical, Zoological Gardens	128	0.00
	Insurance Carriers	123	0.00
	Executive, Legislative, And General	117	0.00
	Personal Services	95	0.00
	Communication	71	0.00
	Water Transportation	60	0.00
	Miscellaneous Retail	55	0.00
	Trucking And Warehousing	43	0.00
	Real Estate	33	0.00
	General Merchandise Stores	26	0.00
Point Sum		45,915,136	20.50
Grand Total		224,003,239	100.00

Table 4. Detail categorization of the updated 1999 Minnesota emissions for benzene.

Principal Category	Category	Emissions (lb)	Percent (%)
Area	Prescribed Burning	1,546,792	10.99
	Residential Wood Burning	1,382,538	9.82
	Gasoline Service Stations	434,314	3.09
	Forest Fires	306,306	2.18
	Solvent Cleaning	135,115	0.96
	POTW facilities	23,420	0.17
	Architectural Surface Coating	20,610	0.15
	Gasoline Trucks in Transit	1,595	0.01
	Municipal Solid Waste Landfills	894	0.01
	Residential Fossil Fuel Combustion	500	0.00
	Asphalt Paving	24	0.00
	Commercial/Consumer Solvent Products	21	0.00
Area Sum		**3,852,128**	**27.38**
Nonroad	Pleasure Craft	1,440,581	10.24
	Recreational Equipment	844,076	6.00
	Lawn & Garden Equipment	547,636	3.89
	Agricultural Equipment	264,371	1.88
	Commercial Equipment	262,445	1.87
	Construction & Mining Equipment	132,634	0.94

	Airport	62,885	0.45
	Industrial Equipment	58,773	0.42
	Locomotives	6,152	0.04
	Logging Equipment	3,888	0.03
	Commercial Marine Vessel	3,381	0.02
	Railroad Equipment	779	0.01
Nonroad Sum		**3,627,601**	**25.78**
Onroad	Light Duty Gasoline Vehicles (LDGV)	3,544,873	25.19
	Light Duty Gasoline Trucks 1 & 2 (LDGT1)	1,672,497	11.89
	Light Duty Gasoline Trucks 3 & 4 (LDGT2)	819,204	5.82
	Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV)	260,203	1.85
	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B	78,792	0.56
	Motorcycles (MC)	24,451	0.17
	Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7	14,499	0.10
	Light Duty Diesel Trucks 1 thru 4 (LDDT)	4,800	0.03
	Heavy Duty Diesel Vehicles (HDDV) Class 2B	3,819	0.03
	Heavy Duty Diesel Buses (School & Transit)	3,388	0.02
	Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5	3,317	0.02
	Light Duty Diesel Vehicles (LDDV)	3,137	0.02
Onroad Sum		**6,432,980**	**45.72**
Point	Metal Mining	33,281	0.24
	Electric, Gas, And Sanitary Services	30,616	0.22
	Petroleum And Coal Products	28,031	0.20
	Wholesale Trade Nondurable Goods	24,808	0.18
	Paper And Allied Products	13,562	0.10
	Chemicals And Allied Products	10,654	0.08
	Lumber And Wood Products	7,424	0.05
	Primary Metal Industries	4,553	0.03
	Food And Kindred Products	2,848	0.02
	Pipelines, Except Natural Gas	1,521	0.01
	Nonmetallic Minerals, Except Fuels	487	0.00
	Rubber And Misc. Plastics Products	246	0.00
	Wholesale Trade Durable Goods	186	0.00
	Stone, Clay, And Glass Products	163	0.00
	Miscellaneous Manufacturing Industries	153	0.00
	Industrial Machinery And Equipment	143	0.00
	Educational Services	73	0.00
	Health Services	65	0.00
	National Security And Intl. Affairs	46	0.00
	Furniture And Fixtures	16	0.00
	Printing And Publishing	13	0.00
	Fabricated Metal Products	7	0.00
	Transportation By Air	7	0.00
	Transportation Equipment	7	0.00
	Nondepository Institutions	6	0.00
	Food Stores	6	0.00
	Justice, Public Order, And Safety	4	0.00

	Social Services	4	0.00
	Electronic & Other Electric Equipment	3	0.00
	Amusement & Recreation Services	3	0.00
	Engineering & Management Services	3	0.00
	Depository Institutions	3	0.00
	Administration Of Economic Programs	2	0.00
	Business Services	2	0.00
	Insurance Carriers	2	0.00
	Executive, Legislative, And General	1	0.00
	Local And Interurban Passenger Transit	1	0.00
	Communication	1	0.00
	Instruments And Related Products	1	0.00
	Miscellaneous Retail	1	0.00
	Auto Repair, Services, And Parking	0	0.00
	Real Estate	0	0.00
	General Merchandise Stores	0	0.00
	Miscellaneous Repair Services	0	0.00
	Museums, Botanical, Zoological Gardens	0	0.00
	Personal Services	0	0.00
	Textile Mill Products	0	0.00
	Leather And Leather Products	0	0.00
	Trucking And Warehousing	0	0.00
	Special Trade Contractors	0	0.00
	Automotive Dealers & Service Stations	0	0.00
Point Sum		**158,952**	**1.13**
Grand Total		**14,071,662**	**100.00**

Table 5. Detail categorization of the updated 1999 Minnesota emissions for formaldehyde.

Principal Category	Subcategory	Emissions (lb)	Percent (%)
Area	Prescribed Burning	3,540,435	30.51
	Residential Wood Burning	833,523	7.18
	Forest Fires	701,099	6.04
	Residential Fossil Fuel Combustion	13,687	0.12
	Commercial/Consumer Solvent Products	6,065	0.05
	POTW facilities	5,672	0.05
	Structure Fires	4,097	0.04
	Human Cremation	0	0.00
Area Sum		**5,104,579**	**43.99**
Nonroad	Agricultural Equipment	1,053,703	9.08
	Recreational Equipment	443,933	3.83
	Construction & Mining Equipment	408,770	3.52
	Airport	152,811	1.32
	Pleasure Craft	151,181	1.30
	Lawn & Garden Equipment	136,956	1.18

	Commercial Equipment	114,730	0.99
	Locomotives	102,995	0.89
	Industrial Equipment	85,518	0.74
	Commercial Marine Vessel	24,990	0.22
	Logging Equipment	6,236	0.05
	Railroad Equipment	2,761	0.02
Nonroad Sum		**2,684,583**	**23.14**
Onroad	Light Duty Gasoline Vehicles (LDGV)	996,756	8.59
	Heavy Duty Diesel Vehicles (HDDV) Class 8A & 8B	586,820	5.06
	Light Duty Gasoline Trucks 1 & 2 (LDGT1)	579,761	5.00
	Light Duty Gasoline Trucks 3 & 4 (LDGT2)	386,448	3.33
	Heavy Duty Gasoline Vehicles 2B thru 8B & Buses (HDGV)	245,660	2.12
	Heavy Duty Diesel Vehicles (HDDV) Class 6 & 7	107,979	0.93
	Heavy Duty Diesel Vehicles (HDDV) Class 2B	28,438	0.25
	Heavy Duty Diesel Buses (School & Transit)	25,232	0.22
	Heavy Duty Diesel Vehicles (HDDV) Class 3, 4, & 5	24,704	0.21
	Motorcycles (MC)	19,301	0.17
	Light Duty Diesel Trucks 1 thru 4 (LDDT)	9,263	0.08
	Light Duty Diesel Vehicles (LDDV)	6,054	0.05
Onroad Sum		**3,016,416**	**26.00**
Point	Metal Mining	329,256	2.84
	Lumber And Wood Products	260,072	2.24
	Electric, Gas, And Sanitary Services	83,953	0.72
	Stone, Clay, And Glass Products	37,884	0.33
	Petroleum And Coal Products	29,601	0.26
	Paper And Allied Products	23,506	0.20
	Electronic & Other Electric Equipment	6,459	0.06
	Furniture And Fixtures	5,867	0.05
	Textile Mill Products	5,272	0.05
	Industrial Machinery And Equipment	2,824	0.02
	Printing And Publishing	2,467	0.02
	Chemicals And Allied Products	2,115	0.02
	Food And Kindred Products	1,983	0.02
	Fabricated Metal Products	1,542	0.01
	Primary Metal Industries	1,157	0.01
	Wholesale Trade Durable Goods	951	0.01
	Nonmetallic Minerals, Except Fuels	635	0.01
	Health Services	605	0.01
	Educational Services	489	0.00
	Pipelines, Except Natural Gas	342	0.00
	Miscellaneous Manufacturing Industries	286	0.00
	Transportation Equipment	183	0.00
	Wholesale Trade Nondurable Goods	162	0.00
	Transportation By Air	55	0.00
	Justice, Public Order, And Safety	34	0.00
	National Security And Intl. Affairs	26	0.00
	Instruments And Related Products	24	0.00
	Rubber And Misc. Plastics Products	22	0.00

	Engineering & Management Services	17	0.00
	Social Services	10	0.00
	Business Services	9	0.00
	Local And Interurban Passenger Transit	9	0.00
	Nondepository Institutions	9	0.00
	Special Trade Contractors	9	0.00
	Miscellaneous Repair Services	8	0.00
	Administration Of Economic Programs	8	0.00
	Food Stores	7	0.00
	Auto Repair, Services, And Parking	6	0.00
	Museums, Botanical, Zoological Gardens	5	0.00
	Depository Institutions	4	0.00
	Amusement & Recreation Services	4	0.00
	Personal Services	4	0.00
	Leather And Leather Products	2	0.00
	Executive, Legislative, And General	2	0.00
	Insurance Carriers	2	0.00
	Communication	1	0.00
	Furniture And Homefurnishings Stores	1	0.00
	Miscellaneous Retail	1	0.00
	Real Estate	1	0.00
	General Merchandise Stores	0	0.00
	Trucking And Warehousing	0	0.00
	Automotive Dealers & Service Stations	0	0.00
Point Sum		**797,888**	**6.88**
Grand Total		11,603,466	100.00

Figure 1. Contribution of principle source categories to total air toxics emissions

Total emissions in 1999: 224,003,239 pounds

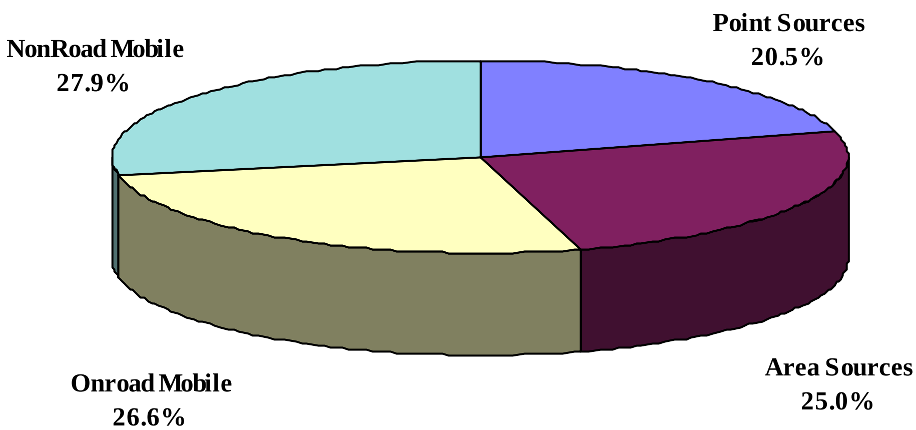


Figure 2. Contribution of top source categories to state total air toxics emissions

Total air toxics emissions: 224,003,239 pounds

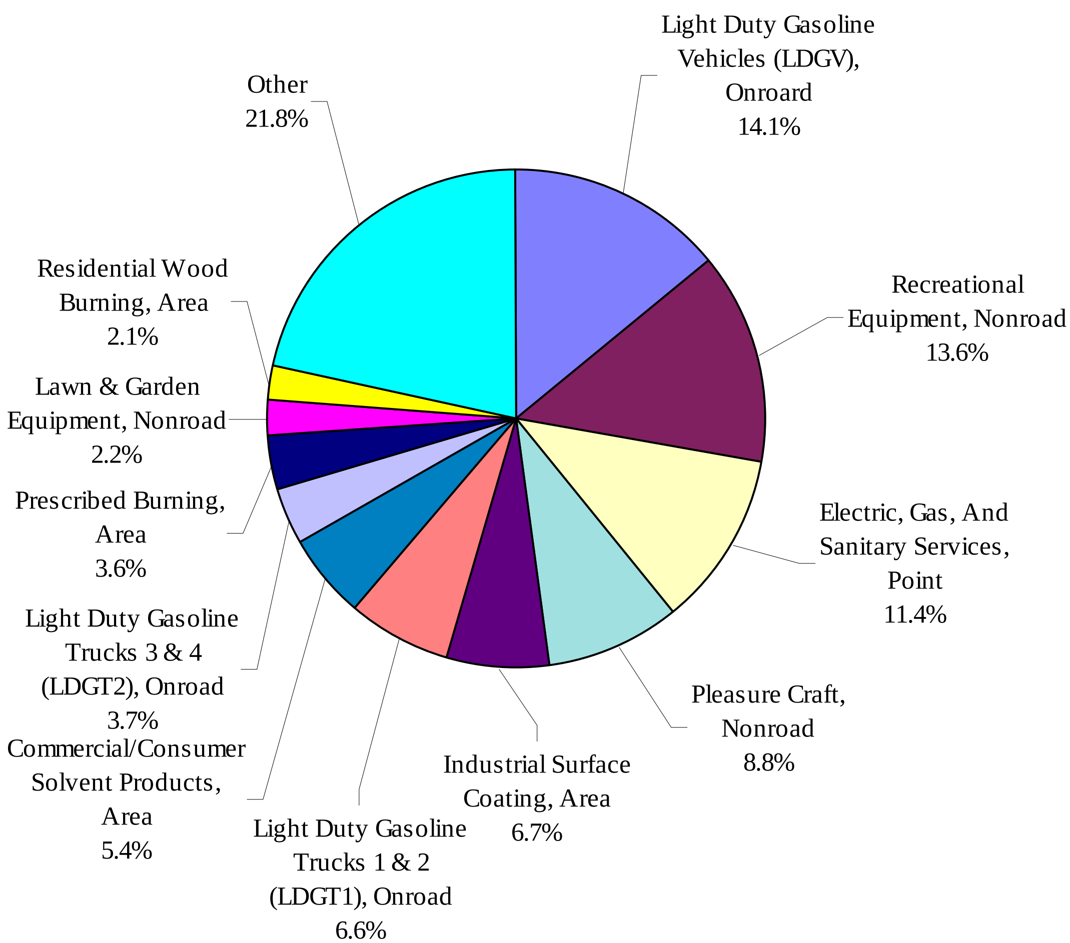


Figure 3. Contribution of top source categories to state total benzene emissions

Total air toxics emissions: 14,071,662 pounds

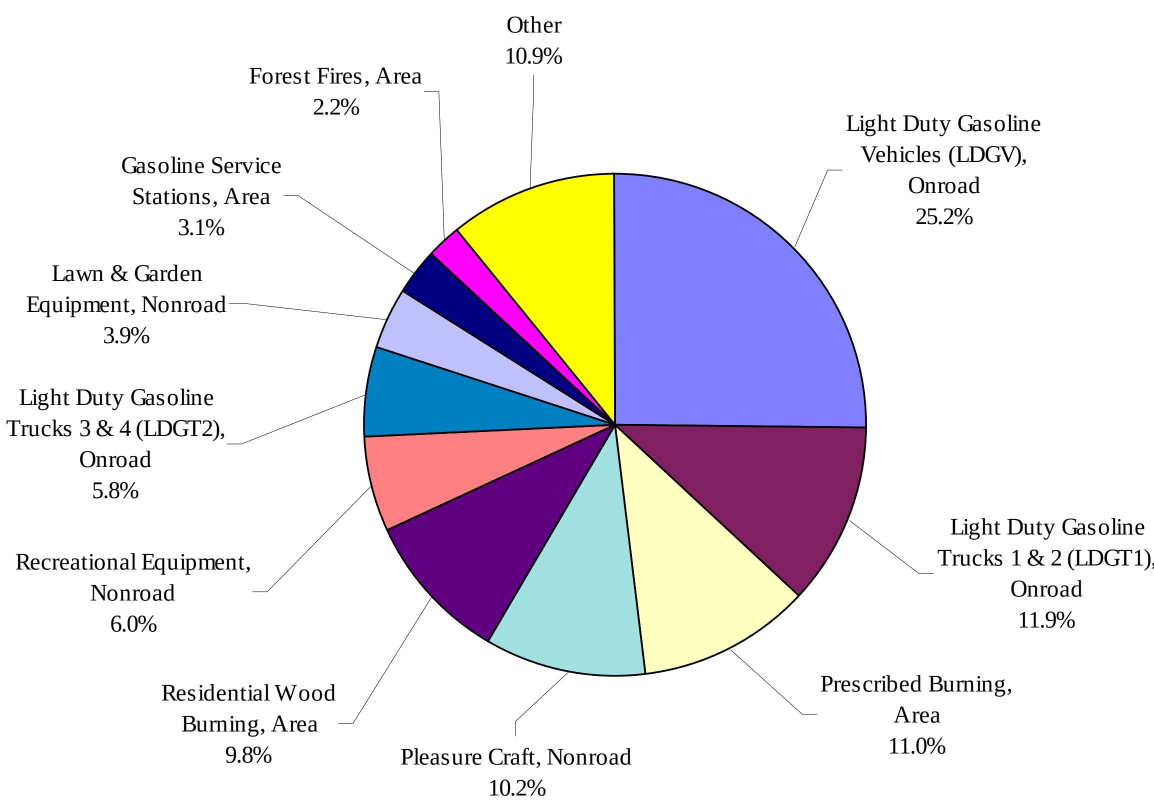


Figure 4. Contribution of top source categories to state total formaldehyde emissions

Total air toxics emissions: 11,603,466 pounds

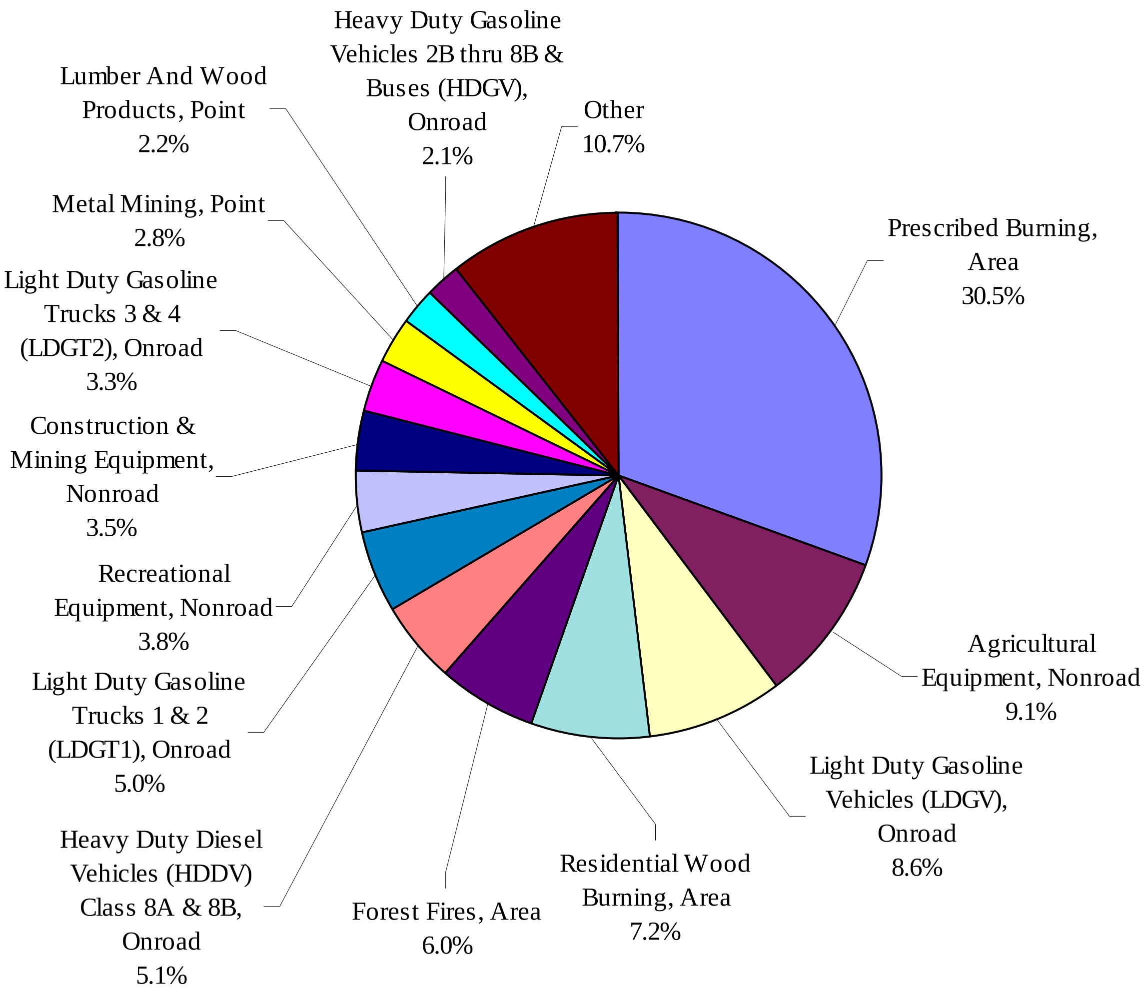


Figure 5. Number of pollutants inventoried with emission estimates.

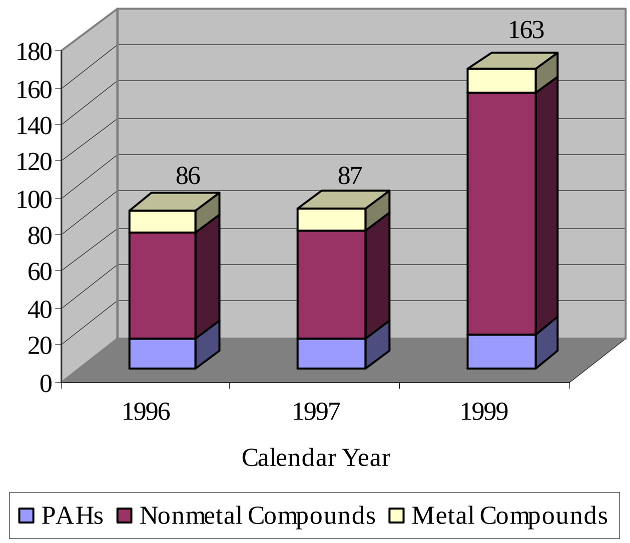


Figure 6. Number of point sources with emission estimates.

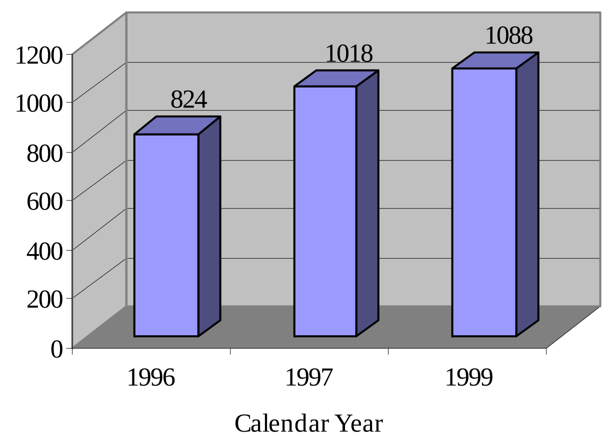


Figure 7. Number of area source categories included in inventories.