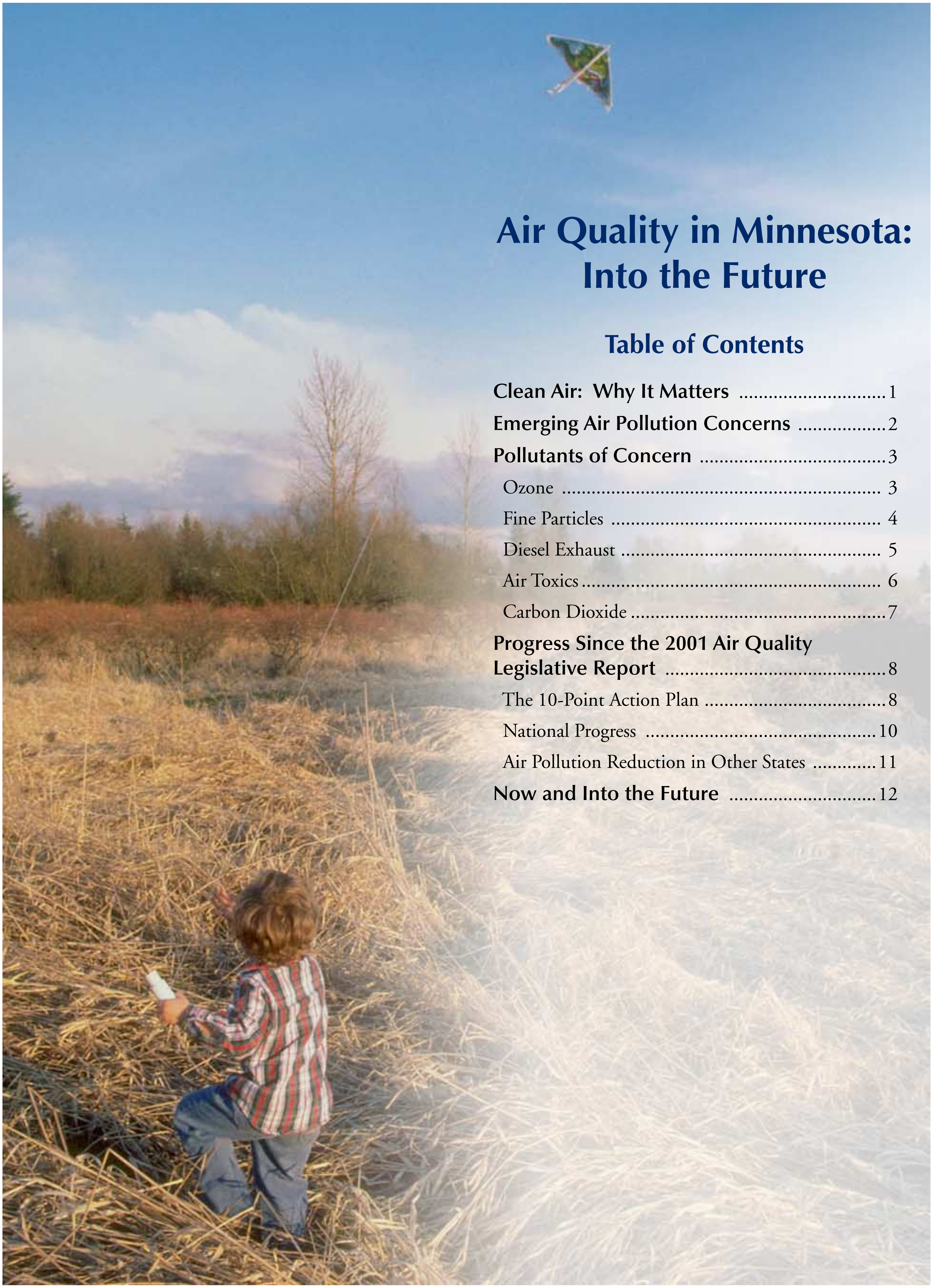
Air Quality in Minnesota: Into the Future

Report to the Legislature

Minnesota Pollution Control Agency

March 2003



Air Quality in Minnesota: Into the Future

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This report has the following purposes:

1. To respond to a January 2002 Legislative Auditor's report, which recommended that the MPCA continue to study factors that contribute to Minnesota's air pollution and that the MPCA explore low-cost options to minimize the likelihood of federal air quality violations.
2. To provide a progress report on the 10-point Action Plan introduced in the MPCA's 2001 Air Quality Legislative Report.
3. To share information about scientific developments that were unknown at the time of the MPCA's 2001 Air Quality Legislative Report.
4. 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.

Cost to prepare this report: staff time $28,000; production $500.

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Primary report contributors: Leo Raudys, David Thornton, Mary Jean Fenske, Jeff Buss
Report editor: Rebecca Helgesen
Report designers: Carol Pruchnofski

Air Quality In Minnesota: Into the Future

The January 2002 Legislative Auditor's report, Minnesota Pollution Control Agency Funding, recommended that the MPCA continue its efforts to explore low-cost options to address air quality issues in Minnesota. The report also recommended that the MPCA report to the 2003 Legislature "what, if any, additional state-level strategies would cost-effectively help the state to avoid violations of federal standards for ozone and particulate matter." While the state currently meets all applicable federal air quality standards, recent data suggests that Minnesota could be headed towards violating federal air quality standards. Prompt action may prevent this from taking place.

State and federal regulations have traditionally focused on large stationary sources of air pollution, such as power plants, refineries and factories. For a variety of reasons, stationary sources now emit a much smaller share of air pollution. A considerable share of key air pollutants — about half, on average — comes from mobile sources (cars, trucks, and buses, as well as off-road vehicles and equipment). Without understanding and reducing emissions from mobile sources, Minnesota could violate federal air quality standards, which would result in costly federal air pollution control requirements. Aside from these potential economic costs, there would be human health concerns, primarily in the elderly and children.

Clean air: why it matters

- **Clean air means healthier people.**
  Air pollution can cause breathing problems, itchy throat 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.
- **Clean air means healthier crops and forests.**
  Air pollution can stunt growth and reduce yields in crops, and lead to disease in trees and other plants.
- **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.**
  Health-related and other costs due to air pollution from transportation sources alone in the Twin Cities were estimated at nearly one billion dollars for 1998, according to a 2000 study by the Center for Transportation Studies at the University of Minnesota.[1] In addition, crops damaged or weakened by air pollution produce lower yields, harming farmers and consumers; and forests weakened by air pollution succumb more easily to pests and disease. According to a 1999 study done for the Minnesota Chamber of Commerce,[2] violating the federal ozone standard could cost Minnesota businesses and consumers between $189 and $266 million a year to meet new federal requirements (1998 dollars).

Emerging air pollution concerns

In the summer of 2001, the Twin Cities was confronted with an urban problem that is a part of daily life in cities like Los Angeles, Houston, Chicago and Atlanta. That summer, for the first time since the 1970s, ozone (smog) levels rose high enough in the Twin Cities that the MPCA was forced to issue air pollution health alerts. Health alerts were issued on three occasions in 2002, as ozone and fine particles rose to levels unhealthy for those with asthma and other respiratory conditions, as well as heart disease.

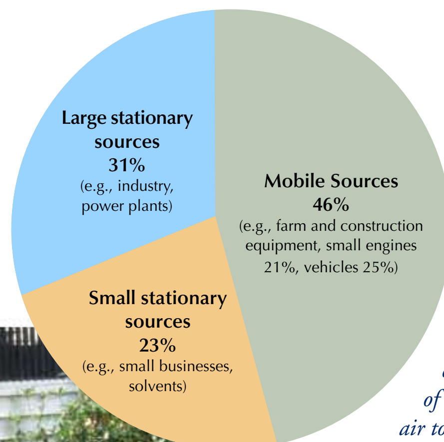
Our increasing knowledge about the harmful effects of air pollution is also raising concern to new heights. Recent health studies have linked air pollution to heart attacks and cancer, as well as respiratory ailments. Even healthy people, especially athletes — who inhale deeply during exercise — can be affected by air pollution. Scientific advances continue to find new links between public health and air quality.

Areas outside the Twin Cities are also affected. Air pollution from the Twin Cities and other states blows into other areas of Minnesota. As a result, rural areas can at times have as much ozone air pollution as urban areas.

Where does Minnesota's air pollution come from?

A majority of air pollutants arise from burning fossil fuels (coal, oil, and gasoline). In general, the facilities the MPCA regulates (mostly large stationary facilities) have achieved large emissions reductions and now account for less than a third of Minnesota's air pollution. The following figure illustrates the approximate shares of air pollution from the three main source categories: mobile sources like cars and lawnmowers; large point sources such as large factories or power plants; and small sources such as small businesses and solvent use.

Where does Minnesota's air pollution come from?



This graphic was compiled by averaging the contribution to each source category of these pollutants: air toxics (1996 MPCA toxics inventory); greenhouse gases (1998 MPCA inventory); nitrogen oxides, sulfur dioxide, and VOCs (2000 EPA AIRS data).

Pollutants of concern

Five pollutants are addressed in this report:

1. ozone (smog)
2. fine particles
3. diesel exhaust
4. air toxics
5. carbon dioxide

Ozone

Ozone, commonly called "smog," is formed by the combination of nitrogen oxides (NO_X) and volatile organic compounds (VOCs). Most of these chemicals enter the atmosphere from fossil fuel combustion and use of solvents and paints. Ozone irritates the eyes, nose, throat and lungs, and can aggravate asthma and other respiratory conditions. Although the elderly, children and those with respiratory disease are the most vulnerable, it can also cause breathing difficulties in healthy adults who exercise outdoors. Ozone also damages plants, including trees and crops.

Ozone is found in two layers in the atmosphere. It exists naturally in the upper atmosphere, where it protects us from the sun's ultraviolet rays. It also exists at ground-level, where it results from a chemical reaction in the atmosphere triggered by summer heat and sunshine. In addition, ozone often blows into Minnesota from cities hundreds of miles away.

Currently, Minnesota is in compliance with the new national air quality standard for ozone. However in the last two years, the MPCA has issued air pollution health alerts for ozone-four times in 2001, and once in 2002. These are the first alerts issued for ozone since the 1970s.

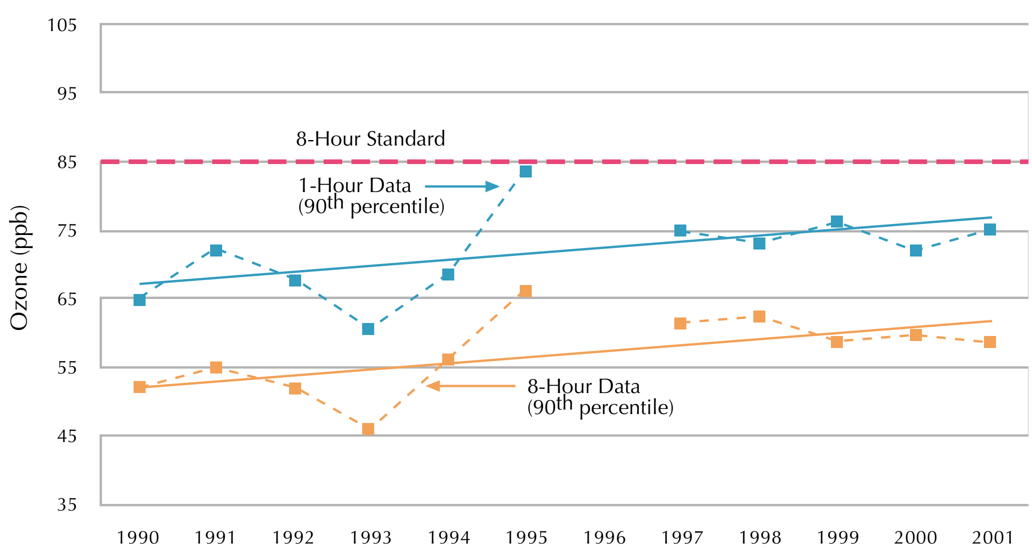
To violate the federal ozone standard, the fourth highest 8-hour average each year, when averaged over three years, must exceed the standard (0.08 parts per million). Over the past few years, the fourth highest 8-hour yearly average has ranged from 80 and 90 percent of the standard at Twin Cities area monitoring sites. Trend data suggests that ozone levels will increase. If the Twin Cities violates the ozone standard, new federal regulations will require additional pollution controls on point sources, costing businesses and consumers an estimated $189 to $266 million per year.

The MPCA, in conjunction with other interested parties, needs to conduct additional research to better understand the state's ozone pollution and to explore reasonable measures to avoid violating the ozone standard. Recently, under funding provided by a one-time EPA grant, Sonoma Technology, Inc.(STI)[3] completed a preliminary study about the state's ozone situation. Among the findings:

- Ground-level ozone levels are rising for the Twin Cities region.
- Increasing population and congestion suggest further increases.
- Both locally-generated ozone and ozone blown in from hundreds of miles away cause the high ozone levels in the area.
- Additional monitoring equipment, more comprehensive computer modeling and analysis is needed to better understand the primary sources and dispersion of locally-generated ozone and determine how best to cost-effectively control it.

Ozone Trend at Blaine Monitoring Site

Annual averages of peak one-hour and eight-hour ozone concentrations are increasing at all monitoring sites in the Twin Cities, including this site in Blaine. Only at sites to the far north (Ely and Mille Lacs) are ozone trends improving. Source: Sonoma Technology, Inc. 2002

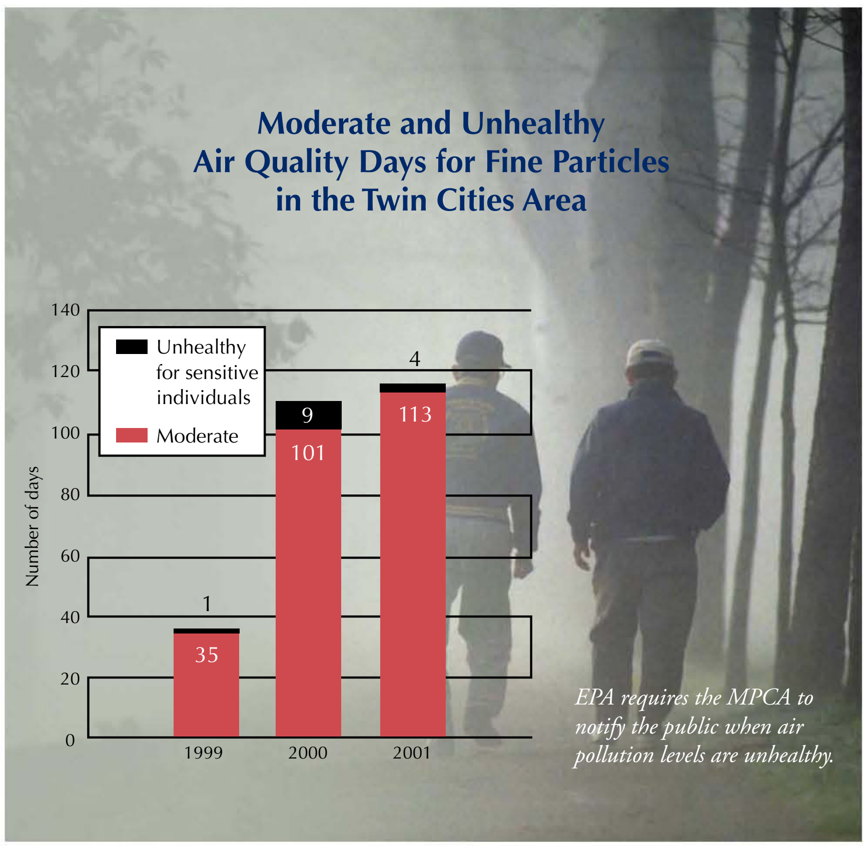


- VOC reductions would decrease ozone formation more than reducing NO_X concentrations.
- Specific voluntary actions can be taken now to reduce local ozone formation. An effective ozone-control strategy will require a combination of voluntary, individual measures plus community and business measures to produce significant reductions.

Fine particles

Particulate matter (PM) is a general term used for a complex mixture of solid and liquid particles in the air. "Coarse" particles, such as dust from roads and farm fields, have a diameter about a tenth the width of a human hair. "Fine" particles are even smaller, some so small that several thousand of them could fit on the period at the end of this sentence. Fine particles come from combustion sources like vehicle exhaust, manufacturing and power plants. Because they are so tiny and light, fine particles can travel long distances. Evidence indicates more than half the particles in Minnesota's air come from out-of-state sources.

Fine particles, which are inhaled deeply into the lungs, are linked to lung damage, heart attacks and many thousands of premature deaths nationally. They can also aggravate respiratory conditions such as asthma and bronchitis. In 1997, significant scientific advances in understanding the health effects of fine particles led to the adoption of new federal standards to protect public health. More recently, scientific studies have found health effects at concentrations even lower than the new standards. This evidence indicates that Minnesotans are likely suffering ill effects even though levels are slightly below the new national standard.



Technology now allows Minnesota and other states to monitor fine particles. On June 28 and December 13, 2002, concentrations of fine particles shown on the monitors rose into the "unhealthy for sensitive groups" range. On each occasion, the MPCA quickly called an Air Pollution Health Alert for fine particles.

In addition to having health impacts, fine particles also impair visibility, reducing our sense of well-being. Many remote areas, including national parks and wilderness areas, are now blighted by particle haze that obscures once-famous views.

Further work is needed before the MPCA can recommend effective strategies to reduce fine particle pollution. Key steps include: 1) an emission inventory to identify key sources of fine particles, 2) model development to predict ambient air conditions, and 3) control-strategy testing and selection to develop the best approaches for reducing emissions of particles.

Diesel exhaust

Across the country, there is growing concern about the familiar black smoke that comes from the tailpipes of some diesel trucks, buses and non-road equipment. This soot-filled air pollution can be harmful to breathe. The EPA recently concluded that breathing diesel exhaust over a number of years is likely to pose a lung cancer hazard. Another EPA health assessment found evidence that diesel exhaust exacerbates existing allergies and asthma symptoms.

A 2002 study[4] found that concentrations of particles inside school buses were five to 10 times higher than nearby outdoor air monitoring sites. This can be caused by bus idling, heavy traffic and the multiple effects of numbers of buses queuing outside schools.

Diesel engines are more efficient than gasoline engines and therefore use less fuel and emit less carbon dioxide (the main global warming gas). Emissions of carbon monoxide from diesels are also generally low. However, diesel engines emit more nitrogen oxides and fine particles than do gasoline engines — in fact, diesel exhaust is a significant contributor to fine particle pollution.

Fuel type, combustion conditions, emission controls, and outdoor conditions all influence the composition of diesel exhaust. Engine manufacturers have significantly lowered diesel particle emissions in recent years through engine technology and controls. In addition, strict new federal pollution controls will be required beginning in 2007. The new controls also require that diesel engines burn ultra-low-sulfur diesel fuel beginning in the second half of 2006.

While these new federal rules will reduce particle emissions in the next generation of diesels by about 95 percent, diesel engines are durable and long-lived, meaning that older, dirtier vehicles may be on the road for another 20 to 30 years. Retrofit emission-control technology can be installed on pre-2007 diesel engines, but at present such retrofits are not required. A retrofit to achieve the 2007 standards would cost about five to ten thousand dollars and, depending on the technology, might require ultra-low-sulfur diesel fuel. Ultra-low-sulfur diesel is not widely available today, although supply is growing as demand increases. An existing vehicle can also be retrofit with an oxidizing catalyst system that does not meet the 2007 standards but does reduce particle emissions by 10-30 percent. This option does not require ultra-low-sulfur fuel and costs a few thousand dollars per vehicle.

Besides the use of low-sulfur diesel fuel, biodiesel can also be used to reduce diesel emissions. Biodiesel is a renewable fuel typically made of soybean oil, although other oils and fats can be used. It does not contain sulfur and can be mixed with regular diesel fuel at various concentrations. For example, the city of Brooklyn Park uses a 20 percent biodiesel blend in all its diesel vehicles. It requires no alteration to the engine, and reduces VOC emissions.

Construction equipment emissions account for more than half of non-road emissions (farm, construction machinery, other equipment). EPA data suggests that on-road (trucks and buses) diesel emissions have decreased somewhat over the years while non-road emissions have increased. The emission standards discussed above apply only to on-road vehicles and not to non-road equipment. As the new federal standards for on-road vehicles are implemented, non-road equipment will account for a growing proportion of diesel emissions.

Nearly all diesel emissions in Minnesota come from on-road and non-road diesel engines, with very little from stationary diesel engines. However, small stationary diesel generators are increasingly being used to lower peak power demand from large centralized power plants. The growing use of diesel generators raises concerns for local health effects. These generators may also exacerbate the metropolitan ozone problem, since they are most likely to be used in summer when ozone levels may be high. In addition, small diesel generators typically have short stacks and are often located near sensitive populations. Diesel engines have much higher emission rates for nitrogen oxides and particles than other forms of electric generation. California, Texas, and a non-profit group based in the Northeast are all working on rules to limit emissions from these generators.

Air toxics

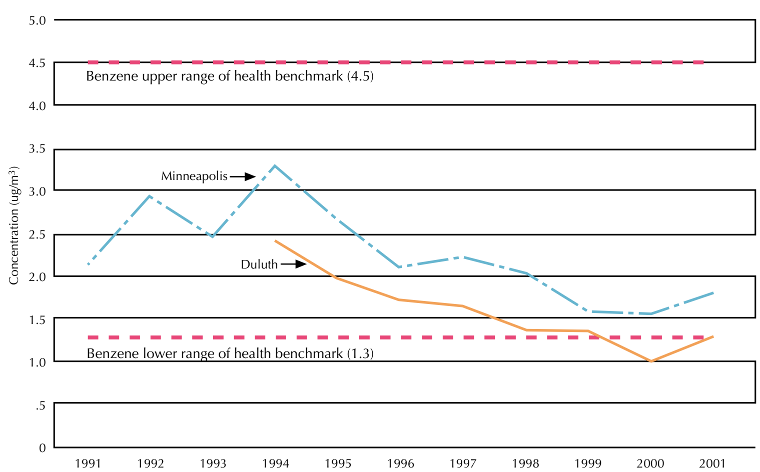
Air toxics are a group of hundreds of chemicals that, at high enough concentrations, cause or are suspected of causing cancer or other serious health problems. Hundreds of other air pollutants, some of which are little known to science, are also present in the air. Taken together, this mixture of air toxics may pose health threats. Scientists and health experts are just beginning to understand some of these mixtures and their potential health effects.

Breathing outside or ambient air is only one way in which people are exposed to air toxics. Some air toxics, such as mercury and other metals, can accumulate in the environment and cause damage to humans and wildlife through food and water. (Appendix A contains information about mercury emissions.)

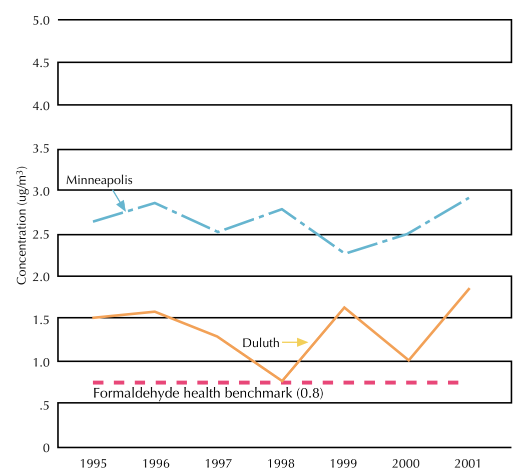
The MPCA's air monitoring efforts have confirmed that two air toxics, benzene and formaldehyde, are frequently found above health benchmarks in the Twin Cities. (A health benchmark is a point below which there is little appreciable risk of harm to humans. In some cases, a health benchmark is not a point but a range. Health benchmarks are not enforceable regulatory standards.) At high concentrations, benzene is a known human carcinogen; formaldehyde is considered a likely carcinogen.

The MPCA has monitored benzene and formaldehyde in the Twin Cities and Duluth for many years. Benzene concentrations have gradually decreased at all five monitoring locations since 1994. Currently, concentrations hover near the health benchmark. On the other hand, formaldehyde concentrations have remained steady or slightly increased since 1995. Formaldehyde is well above health benchmarks at all monitoring sites. The majority of benzene and formaldehyde comes from vehicles. (Appendix B describes emission sources of more than 100 different air toxics.)

Average Benzene Concentration Trends (1991-2001)



Average Formaldehyde Concentration Trends (1995-2001)



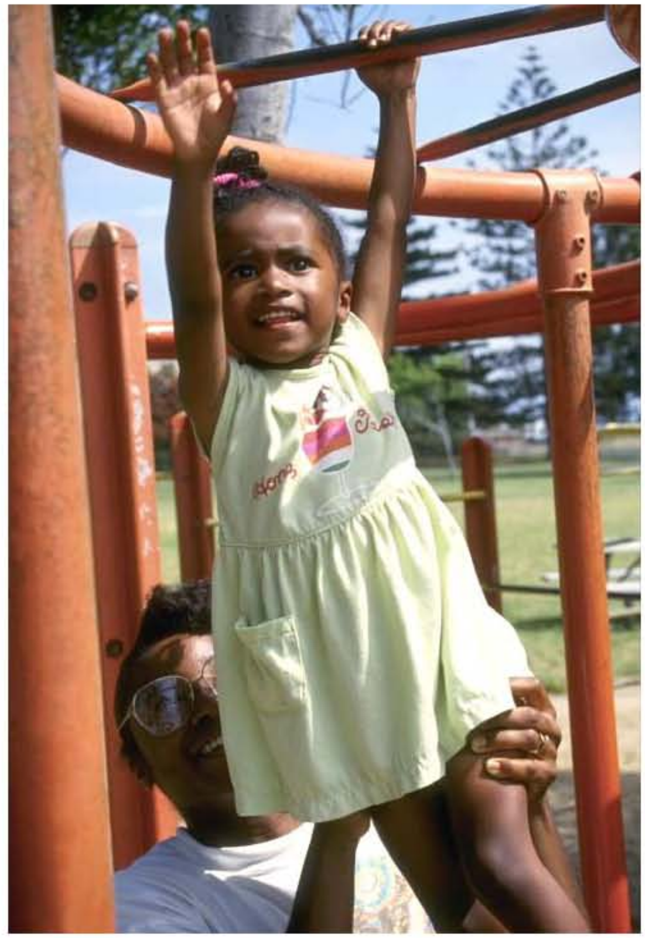
Efforts to reduce emissions of air toxics are underway at the national level. The EPA is nearing the end of a process that will result in emission standards for point sources of toxic air pollutants. These standards are known as National Emission Standards for Hazardous Air Pollutants (NESHAPs). Standards are issued for categories of point sources known to emit the largest quantities of air toxics, as well as those that might pose local risks. Standards apply to new and existing sources and, occasionally, to small point sources such as dry-cleaning establishments and wood-finishing operations.

Carbon dioxide

According to the National Academy of Sciences' 2001 report to President Bush, "The [global temperature] changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability. Human-induced warming and associated sea level rises are expected to continue through the 21st century."

This warming is known as the greenhouse effect. The principal greenhouse gas is carbon dioxide (CO_2), and fossil fuel combustion is the largest source of CO_2 emissions. Minnesota's CO_2 emissions have grown 38 percent since 1970.

Improvements in energy efficiency and decreased reliance on fossil fuels can result in both cost savings and reduction of carbon dioxide and other pollutants. Several local governments in Minnesota have taken their own steps to reduce carbon dioxide emissions. Duluth, Minneapolis and St. Paul, as well as Hennepin and Ramsey counties, have pledged to reduce emissions. By increasing energy efficiency, these cities have already achieved some reductions and realized substantial cost savings as well. Minneapolis estimates its projects result in savings of over $5 million annually.



Voluntary efforts can also save money in school buildings. For example, the U.S. Department of Energy reports that schools can reduce energy costs by 10 to 20 percent simply through efficient operation and proper maintenance of a building's existing systems[5], at little or no cost.

Continuing voluntary efforts to encourage energy-efficiency can reduce CO_2 emissions. A side benefit of air pollution control strategies to address ozone, particles and air toxics can be CO_2 emission reductions, as well.

Progress since the 2001 Air Quality Legislative Report

The 10-point action plan

The MPCA's 2001 Air Quality Legislative Report centered on a 10-point Action Plan. The plan outlined three approaches that would have the greatest effect on emissions of all pollutants.

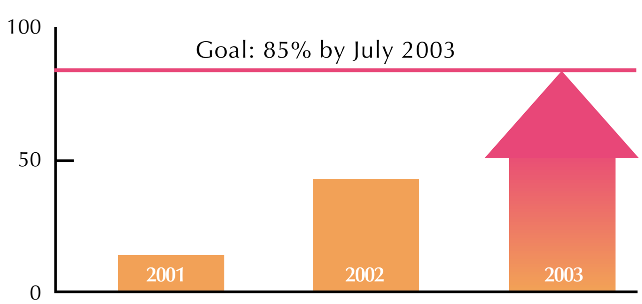
- **Actions to reduce fuel and energy consumption**
- **Actions to substitute cleaner fuels for existing ones**
- **Actions to increase the use of technologies that reduce air pollution**

The following 10 action steps have been undertaken by the MPCA with existing resources and staff. These action steps have produced substantial progress.

1. Reduce emissions at gas stations.

The MPCA is halfway to meeting its July 2003 goal of having 85 percent of gasoline sold in urban areas coming from stations operating stage one vapor controls. (Stage one controls prevent benzene — filled and smog-producing vapor from entering the air out of underground gas station storage tanks.) Three large petroleum marketers-Holiday, BP Amoco and SuperAmerica — totaling more than 40 percent of gasoline sold, installed stage one controls at their corporate-owned gas stations in 2001 and 2002. The MPCA is now working with locally-owned franchises and corporations with smaller market shares. The Minneapolis city council recently approved an ordinance that requires all 95 service stations within city limits to install and operate stage one vapor controls by January 1, 2007.

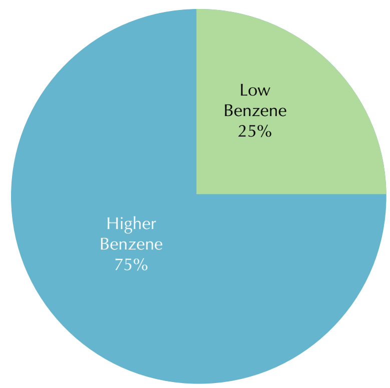
Estimated Percentage of Gas Stations with Stage 1 Vapor Controls



2. Reduce benzene content in gasoline.

MPCA's goal was to work with gasoline producers so that by December, 2001, 25 percent of gasoline sold in Minnesota would be low-benzene gasoline. Due to the efforts of Minnesota's two refineries, Flint Hills Resources LP and Marathon Ashland Petroleum LLC, that goal was met. The MPCA is continuing to pursue similar voluntary agreements with other suppliers.

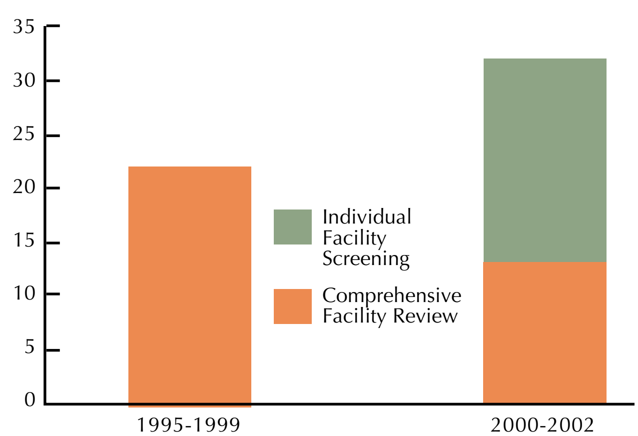
Gasolines Available in Minnesota Currently (by benzene content)



3. Use toxics evaluation guidance for air emissions permits.

In the last three years, the MPCA has evaluated health risks of toxic emissions from more facilities than the

Number of Facility Air Toxics Emissions Reviews



previous five years combined. This was due to piloting the use of a new screening tool to quickly access outdoor levels of toxic releases for facilities applying for air emissions permits, allowing the evaluation of many more facilities on a case-by-case basis with existing staff resources. The MPCA plans to analyze the results of this pilot to develop new strategies for evaluating air toxics.

4. Promote use and distribution of alternative fuels.

As an environmental agency and member of the Twin Cities Clean Cities Coalition, the MPCA models environmental leadership in its business decisions. Almost half the MPCA's own vehicle fleet is composed of alternative-fuel vehicles; two are hybrid electric cars. The MPCA encourages all state agencies to purchase vehicles that use the alternative fuel E85 (85 percent ethanol) and biodiesel. According to the U.S. Department of Energy, E85 fuel produces 25 percent less ozone-forming pollution than the cleanest gasolines sold in the nation. Due to the efforts of organizations such as the American Lung Association of Minnesota, the state is well-positioned to make use of E85, since about half of all E85 stations in the United States are located in Minnesota.

Number of Minnesota E85 Fueling Sites

5. Promote fuel-efficient vehicles and good maintenance.

The MPCA educates the public about the benefits of fuel-efficient vehicles and highlights alternative technologies. A quarter million people learned about the potential of fuels cells through a fuel cell tractor display at the MPCA's 2002 Minnesota State Fair booth. Another hundred thousand visitors came to the MPCA's hybrid electric vehicle display at the Twin Cities Auto Show. The Office of Environmental Assistance (OEA) has taken an active role in publicizing the school bus no-idling law.

6. Increase use of clean-burning woodstoves.

Woodburning contributes to the concentration of unhealthy particles in the air. As part of the Great Woodstove and Fireplace Changeout the winter of 2000-2001, 356 older woodstoves were traded in for cleaner-burning models. Working with the MPCA and OEA, Hearth Products Association dealers offered rebates of 10-15 percent on clean-burning stoves and fireplaces for those who traded in older, more polluting equipment. This single winter's project reduced total woodstove emissions in the state by 1.5 percent.

7. Increase availability and use of transit in the metro area.

MPCA staff continue to work with Metropolitan Council transit staff to expand transit services, and with Metro Commuter Services to encourage rideshare and other employer-based programs that reduce single-occupancy automobile commuting. On the other hand, last year saw an increase in metro bus fares, as well as the repeal of a vehicle surcharge used to provide commuter services and promote carpooling at the state Capitol complex.

8. Re-examine goals for indirect source permitting (e.g., large parking lots).

While indirect source permits were a useful tool for controlling carbon monoxide, they are no longer necessary to keep this pollutant in check. The Legislature eliminated this program in 2002 at the MPCA's request.

9. Join the multi-state diesel initiative.

In October 2001, Minnesota joined California and eleven other states in proposing a rule to bridge a regulatory gap in emissions controls that will exist for heavy-duty diesel engines manufactured in model years 2005 and 2006. In addition, new federal diesel requirements apply only to new vehicles and engines. It will take many more years before most diesel engines will meet the new standards. Retrofitting existing diesel engines is being encouraged, since it is an economical way to cut diesel particle emissions by up to 90 percent.

Metopolitan Emissions Reduction Proposal

In July, 2002, Xcel Energy presented a plan to reduce emissions from three metro-area coal-burning power plants. Called the Metropolitan Emission Reduction Proposal, the plan calls for re-powering the Riverside (Minneapolis) and High Bridge (St. Paul) plants to natural gas and updating the Allen S. King plant in Oak Park Heights by adding new pollution control equipment. The entire project would be completed by 2010.

If approved by the Minnesota Public Utilities Commission, the project as proposed would reduce total sulfur dioxide emissions from these three plants by 93 percent, nitrogen oxide emissions by 91 percent, direct particle emissions by 64 percent, mercury emissions by 76 percent, and carbon dioxide emissions by 21 percent. These reductions would lower total state emissions of SO_2 by 16.8 percent, NO_x by 3.1 percent and mercury by 4.9 percent.

10. Shift other MPCA resources to air pollution to strengthen implementation of federal air toxics standards, study Minnesota's ozone problem, and develop and implement an air quality communications plan.

The 2001 Legislature chose not to reallocate three MPCA staff positions from lower-priority environmental activities to these higher-priority air quality activities. Therefore, the MPCA was unable to accomplish this item in FY 02-03. The MPCA was able to use a one-time federal grant from EPA to conduct a preliminary study of ozone in the Twin Cities (the October 2002 study by Sonoma Technology, Inc.)

National progress

Power plant regulation

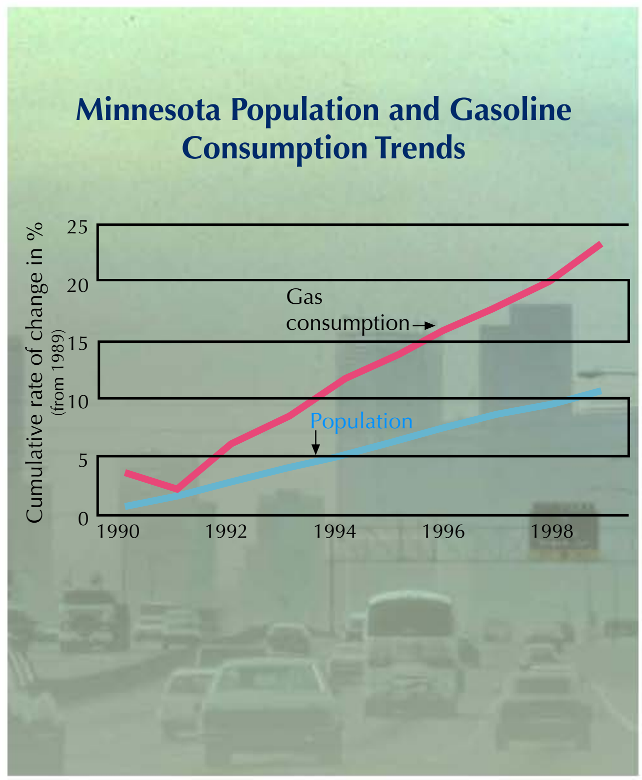
Early in 2002, President Bush announced the "Clear Skies Initiative," a proposal for legislation establishing a national cap and trade system for regulation of sulfur dioxide, nitrogen oxides, and mercury from utilities. By 2018, the Clear Skies Initiative would reduce SO_2 by 73 percent, NO_X by 67 percent and mercury by 69 percent nationally. Because these pollutants travel long distances, nationwide emissions reductions are key. The MPCA supports the adoption of a national program at least as stringent as the Clear Skies Initiative.

Mobile sources

Stricter EPA regulations will reduce emissions from cars and light trucks beginning in 2004. These new standards require passenger vehicles to be 77 to 95 percent cleaner than those on the road today, and reduce the sulfur content of gasoline by up to 90 percent.

Since 1970, however, vehicle travel and gasoline consumption have increased at a greater rate than the population. This trend reduces the air quality gains made through cleaner vehicles and fuels.

New federal emissions standards for diesel trucks will take effect in 2006 and other engines in 2008. Because diesel vehicles such as trucks and buses remain on the road for 20-30 years, however, it will take a long time for the nation's truck and bus fleets to change over to cleaner engines.

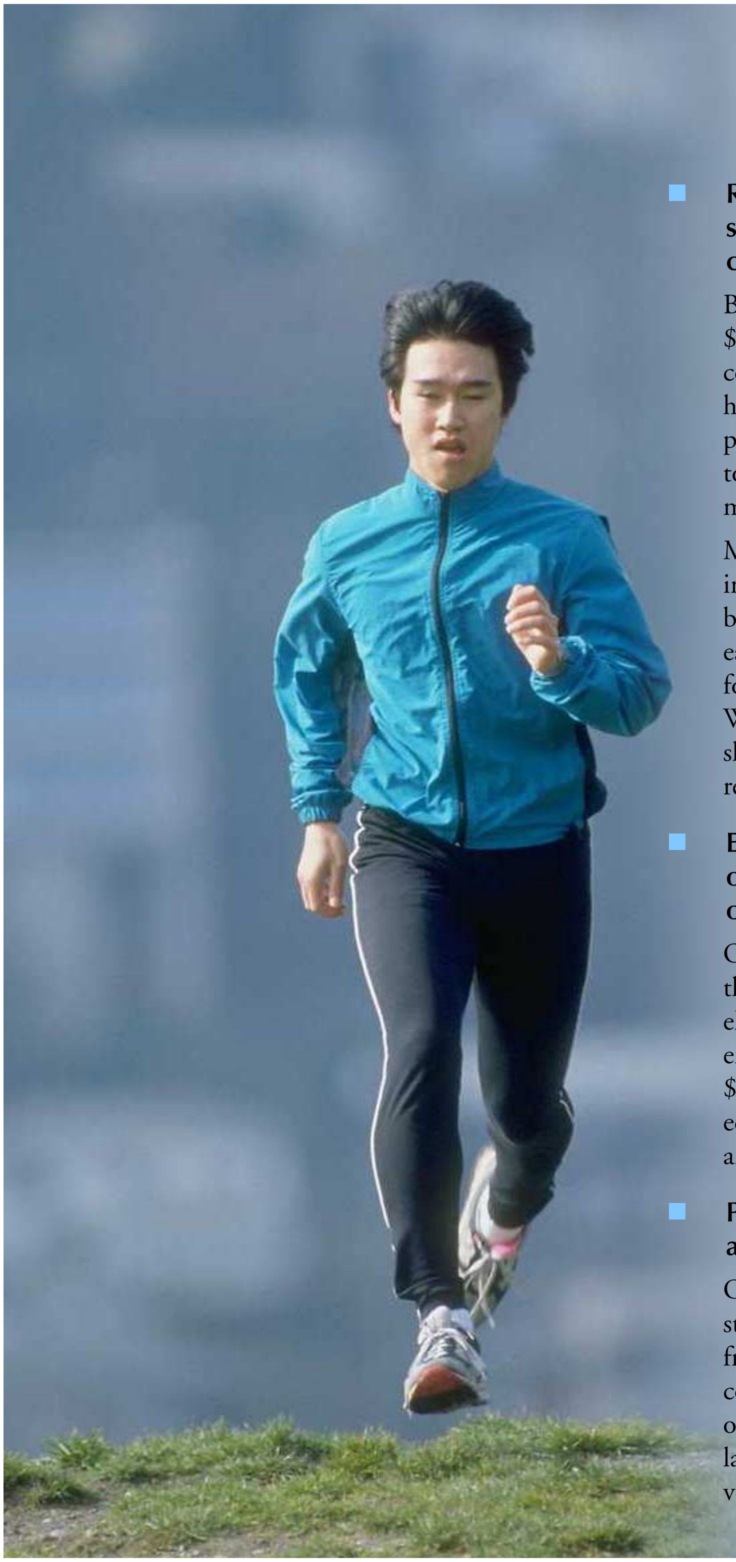


Regional haze

Air pollution has impaired visibility in even the most pristine and remote parts of the nation. In 1999, EPA promulgated a rule to improve visibility in national parks and wilderness areas. Since long-range transport of particle pollutants is largely responsible, regional planning organizations were established to analyze the problem and develop solutions. Minnesota is part of the Central States Regional Air Planning Association, which represents nine states in the center of the country from Texas north to the Canadian border. A regional plan to implement the visibility regulations is due in 2008. Since fine particles are a major contributor to haze, implementation of these plans should also help reduce fine particle pollution.

Air toxics

EPA has nearly completed writing technology-based rules to limit air toxics emissions from more than 100 different types of industrial activities. In Minnesota, more than 600 facilities will be subject to these rules.



Air pollution reduction in other states

- **Retrofitting or replacing diesel school buses, trucks and construction equipment.**

  Boston's Clean Air Construction Project spent $770,000 to add emission control devices to 70 construction vehicles used in Boston's "Big Dig" highway project. The project reduced emissions of particles, hydrocarbons, carbon monoxide and air toxics such as benzene and formaldehyde by as much as 70 percent.

  Many school districts across the country have installed pollution-control equipment on existing buses at a cost of two to eight thousand dollars each, significantly reducing particle and ozone-forming pollution. Pilot projects in Everett, Washington and Beaverton, Oregon are expected to show 95 percent reductions in air emissions from retrofitted school buses.

- **Establishing buy-back programs for older vehicles, lawnmowers and outboard motors.**

  Oregon piloted a lawn mower buy-back program that offers citizens rebates for the purchase of electric or push mowers. This effort reduced VOC emissions by an estimated 85 tons, at a cost of $40,000. This program was part of a larger public education program about ozone in the Portland area.

- **Providing alternatives to the public on air pollution alert or ozone alert days.**

  On days when ozone levels exceed the federal standard, the city of Tulsa, Oklahoma, provides free transit service as part of its "ozone alert" commitments. This subsidy has increased ridership on ozone action days by 30 percent, meaning that large numbers of citizens have chosen to keep their vehicles' pollution out of the air that day.

Now and into the future

Through research and targeted projects, the MPCA is continuing to work to improve air quality and reduce air pollution's ill effects.

Air quality forecasts and air pollution health alerts.

For the last two summers, the MPCA has been tracking ozone and attempting to forecast future air pollution episodes. Although Minnesota's rapid weather changes make it more difficult to predict ozone here than in other parts of the country, the MPCA continues to work with experts to improve the accuracy of forecasts. The MPCA, along with environmental agencies from other states, is currently cooperating with the EPA to develop a similar system for forecasting fine particle pollution.

In the summer of 2002, the MPCA introduced a new Air Pollution Health Alert system for the public and media. The system is based on the Air Quality Index (AQI), a tool used nationwide to inform the public about air quality. Although the AQI is a compilation of four different pollutants (sulfur dioxide, carbon monoxide, ozone and particles), a higher AQI in the Twin Cities usually signals ozone or fine particle problems.

When an Air Pollution Health Alert is called due to either ozone or particles, the MPCA contacts news and weather media to broadcast tips and information regarding the day's air quality, as well as tips for how to reduce emissions leading to poor air quality. As part of the Air Pollution Health Alert system, the MPCA introduced e-mail air pollution alerts, so business, media, schools and citizens can receive an immediate e-mail message when an air quality problem develops.

Assessment of ozone air quality in the Twin Cities area.

Using one-time EPA study funds, the MPCA hired consultant Sonoma Technology, Inc. (STI) to provide a preliminary assessment of ground-level ozone air quality in the Twin Cities area. STI's report (see endnote 3) noted that ozone concentrations have increased over the past decade, and that local ozone problems might best be controlled by reducing VOCs. The study identified MPCA needs for ongoing research into the nature of the ozone problem. The study also suggested a menu of voluntary controls that might be effective in reducing ozone.

Identification of sources of fine particles ($PM_{2.5}$).

The MPCA currently has 17 air monitors that measure the concentration of fine particles in the outdoor air. Three of these monitors, funded by the EPA, are specially designed to help determine the sources of particles-e.g., how much comes from diesel combustion, other mobile sources, power plants and more. These monitors have been in operation only since late 2001. More data are needed before full analysis can begin.

Potential "hot spots" monitoring.

The MPCA began monitoring air toxics and fine particles at the Minneapolis/St. Paul International Airport in February 2002. Results so far are not significantly different from other urban locations. The MPCA has also monitored, and reported to the Legislature on, air toxics in northeast Minneapolis.[6]

Environmental analysis of state energy/ electricity planning.

As directed in the 2001 Energy Bill, the MPCA worked with the Department of Commerce on the February 2002 Energy Planning Report, identifying environmental effects, emissions trends, and costs of reducing emissions. The report recommends that, in meeting the state's future energy needs, Minnesota reduce overall air emissions from electricity generation, pursue voluntary emissions reduction projects, and focus on conservation.

Environmental analysis of transportation fuel consumption and alternative fuels.

MPCA staff provide technical support on alternative fuels, with an emphasis on biodiesel and ethanol.

Environmental analysis of state land-use and transportation planning.

The MPCA supports this effort as a member of two technical advisory panels on projects coordinated by the Center for Transportation Studies at the University of Minnesota.

Future MPCA priority activities

The Legislative Auditor's report recommended that the MPCA pursue low-cost options for reducing air pollution within its current resources. The actions being undertaken by the MPCA and its partners are an important sign of progress and should be continued. While efforts to ensure compliance with the ozone standard should take precedence, these efforts also offer opportunities to reduce other important pollutants as well.

At the present time, the MPCA has a general understanding of Minnesota's air quality problems; a more detailed and specific understanding will allow the agency to recommend reduction measures that will provide the greatest benefit at lowest cost.

The MPCA has three short-term priority activities:

- **Control emissions from underground gas station tanks.** The MPCA will intensify its efforts to promote the installation of Stage 1 vapor recovery equipment to reduce air pollution from gasoline stations in the Twin Cities metropolitan area. Stage 1 vapor recovery reduces by 95 percent or more the VOC emissions from refilling underground tanks. It is by far the most cost-effective approach to reducing VOC emissions, which contribute to ozone formation. In addition, this technology effectively reduces emissions of benzene, an air toxic. The MPCA and its partners have made significant progress in promoting the use of this technology, yet much work remains. While at least 40 percent of the gasoline sold in the Twin Cities now comes from stations using this technology, increasing that figure by 10 percent will provide additional VOC reductions of nearly 600 tons per year.
- **Reduce ozone levels on peak days.** The MPCA will work in partnership with Clean Air Minnesota (a coalition of business, nonprofit and government organizations) to achieve voluntary reductions of ozone-forming pollutants. In particular, efforts will focus on activities that will reduce VOCs on those days that ozone levels are forecast to be high, to help protect public health and avoid violating the federal ozone standard. These activities may include: reducing vehicle trips, deferring lawn maintenance and painting, and refueling in the evening when cooler temperatures slow gasoline evaporation. One role for the MPCA will be to provide technical information about the reduction potential of various activities. In addition, the MPCA will continue to operate its air quality monitoring network, improve accuracy in forecasting pollution events and increase

efforts to share that information. The MPCA expects to expand its Air Quality Index (AQI) monitoring network and alert system into Rochester, St. Cloud and Duluth. The MPCA is also working with news media to include air quality forecasts in both newspaper and on television weather forecasts. The twin goals are to keep the Twin Cities from violating the ozone standard and to notify the public when air quality may become unhealthy so that they may take proactive steps.

- **Promote early adoption of cleaner technologies.** The MPCA will continue to promote early adoption of cleaner technologies as a cost-effective way to reduce harmful emissions of air pollution. Primary focus is on voluntary efforts to: 1) clean up older coal-burning power plants and 2) use new, cleaner technologies on buses, trucks and other motor vehicles. Xcel Energy has proposed to install state-of-the-art pollution control technology at their Allen S. King power plant in Bayport, and to re-power their Minneapolis and St. Paul power plants with natural gas. The projects will reduce various air pollutants by up to 93 percent. This voluntary action will modernize three of Xcel's oldest power plants in advance of federal requirements such as the Clear Skies Initiative. Similarly, voluntary efforts are underway in Minnesota and across the country to accelerate the adoption of new, cleaner technologies and fuels by buses, trucks and other motor vehicles. One new retrofit technology for existing diesel vehicles halves VOC emissions and reduces particle emissions by up to 30 percent for a one-time cost of approximately $500-$2000 per engine.

Challenges that remain

Air quality is highly complex and dynamic, with many scientific and medical unknowns. It is subject to ever-changing human, technological and weather factors. Nevertheless, despite its challenges, Minnesota must begin to take action if we are to maintain our valued quality of life.

- Mobile sources — vehicles, construction and farm equipment, and small engines — cause about half of Minnesota's air pollution. Although vehicles and fuels are getting cleaner, mobile source pollution is affected by longer commutes, more trips, more drivers and low fuel economy. Some of these trends affect not only air quality but quality of life and the economy, including traffic congestion and infrastructure costs.
- Air pollution is a regional and global matter, not local. Cities and states have little control over air pollutants that blow in from outside. To achieve cleaner air, we must work with our neighbors and with national and international interests.
- Federal air quality regulations have not kept pace with medicine and science. No standards exist for some chemicals of concern, such as air toxics and carbon dioxide.
- Because air pollution is largely invisible and undetectable by the individual on the street, it is a challenge to raise awareness among the public. It is even more challenging to educate the public about the relationship between air pollution and personal choices in vehicles, fuels, driving habits, electricity use and product purchases.

Clean Air Minnesota

The health and societal costs of violating the federal ozone standard have given rise to a new voluntary effort to reduce ozone-forming pollutants. In October 2002, the Minnesota Environmental Initiative, consisting of business, government and nonprofit organizations, launched a program to encourage voluntary reductions of the air emissions that form ozone. The group is called Clean Air Minnesota (CAM).

The goal is to work together to keep the Twin Cities from violating the ozone standard under the federal Clean Air Act. A Minnesota Chamber of Commerce study noted that if the Twin Cities violates the ozone standard, and businesses are forced to implement federally-mandated emissions-reduction activities, costs to business and consumers would be between $189 million and $266 million each year.

Minnesota businesses have pledged in excess of $150,000 to support these efforts so far, and the EPA awarded a $100,000 grant to the program. The MPCA joined the group at its founding and continues to have representation on the steering committee.

Endnotes

[1] "The Full Cost of Transportation in the Twin Cities Region," Center for Transportation Studies, University of Minnesota, August 2000.

[2] "Estimated Economic Impact of Twin Cities Ozone Nonattainment," Energy and Environmental Research Center, University of North Dakota, February 1999.

[3] "Preliminary Assessment of Ozone Air Quality Issues in the Minneapolis/St. Paul Region," Sonoma Technology, Inc., October 2002. **http://www.pca.state.mn.us/air/ozonestudy.html**

[4] "Children's Exposure to Diesel Exhaust on School Buses," John Wargo Ph.D., Yale Unversity, February 2002.

[5] U.S. Department of Energy Website: **http://www.rebuild.org/solutioncenter/lowcost.asp**. Accessed December, 2002.

[6] Results of the metro area air toxics monitoring study can be found in "Air Toxics Monitoring in the Twin Cities Metropolitan Area: Preliminary Report," January 2003. **http://www.pca.state.mn.us/hot/legislature/reports/index.html**

Appendices to this report
Appendix A: Mercury Emissions from Electricity Generation
Appendix B: Air Toxics Emission Sources
are available on-line at:
http://www.pca.state.mn.us/hot/legislature/reports

For further information:

Overview and legislative

Ann Seha, Assistant Commissioner
(651)284-0382

Air Quality Lead

Jim Warner, Director, Majors and Remediation Division
(651) 296-7333

Air Quality Programs Except Mobile Sources

David Thornton, Majors and Remediation Division
(651) 296-7265

Mobile Sources

Leo Raudys, Regional Environmental Management Division
(651) 282-9884

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Appendix A: Mercury Emissions From Electricity Generation

Mercury emissions associated with electricity production and consumption in Minnesota are reported here, in accordance with Minnesota statute §116.925.

Introduction

Nearly all (98 percent) of the mercury in Minnesota lakes and streams comes from the air; very little comes from direct water discharges. Of the mercury deposited in Minnesota, about 90 percent is originally emitted by sources outside the state. A roughly equivalent amount of mercury, generated by Minnesota sources, leaves the state.

Nationally, the primary human-made sources of mercury are:

- incidental emissions from energy production (mainly from burning coal, which contains trace amounts of mercury);
- emissions from the disposal, use or manufacture of mercury-containing products or industrial wastes; and
- incidental emissions from processing mineral resources containing trace amounts of mercury (e.g., lead, iron or copper ores and limestone).

Overall, mercury emissions have declined over the past 10 to 15 years. For instance, in 1990, air emissions of mercury from human activities in Minnesota are estimated to have been about 11,000 pounds annually. About 80 percent of this mercury was from intentional use, 15 percent was incidental to energy production and 5 percent was from taconite processing. By 2000, total air emissions of mercury had decreased to 3,600 pounds a year as a result of reduced use of mercury in paint, batteries and fungicides, and decreased emissions from waste combustors. Emissions from other sources have remained relatively constant and are projected to remain constant or to increase.

In spite of its well-documented toxicity to the human central nervous system, mercury continues to be used widely. Recent studies have revealed that small amounts of atmospheric mercury pollution can lead to mercury being deposited in remote lakes. There, the mercury can concentrate in fish tissue enough to make eating the fish hazardous to humans and wildlife. As a result, the Minnesota Department of Health advises citizens, especially children and women who might become pregnant, to limit their consumption of fish from most lakes:
http://www.health.state.mn.us/divs/eh/fish/safeeating/safeeating.html

The following MPCA and EPA internet sites contain more information on mercury in the environment:

MPCA: http://www.pca.state.mn.us/air/mercury.html
EPA: http://www.epa.gov/mercury

Mercury Emissions from Electricity Generation

In 1997 a state law took effect that requires the producers and retailers of electricity to report on the amount of mercury emitted through the generation of electricity (section §116.925). The MPCA is required by the law to summarize this emission information in its biennial air toxics report to the Minnesota Legislature. Emissions from 1998 and 1999 emissions are summarized in Tables 1 and 2. Note that some data has not been submitted. For 2000 and 2001, this data has been received but has not yet been processed by MPCA staff. When available, the data will be updated on the MCPA internet site: http://www.pca.state.mn.us/hot/legislature/reports.

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

Submissions from over 20 generation units in Minnesota are summarized in Table 1. The major fuel for most units was coal, although some facilities depend on municipal solid waste for fuel.

The law also requires Minnesota retailers and wholesalers of electricity produced outside Minnesota to report mercury emissions associated with production; the information is summarized in Table 2.

About 40 Minnesota distribution cooperatives, which distribute electricity to consumers but do not generate any electricity, are required to report mercury emissions associated with the generation of the electricity that they distribute, most of which 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 normalized mercury emissions per megawatt-hour from each supplier (milligrams per megawatt-hour, mg/MWh) are variable because of varying amounts of electricity purchased from the grid and from the use of hydroelectric power.

Table 1. Reported 1998 and 1999 emissions of mercury from non-exempt electrical production facilities in Minnesota.

Company	Facility	Major Fuel Type(s)	1998 Electricity Produced (MWh)	1998 Mercury Emissions (lb)	1998 Mercury Emissions per Megawatt-hour (mg/MWh)	1999 Electricity Produced (MWh)	1999 Mercury Emissions (lb)	1999 Mercury Emissions per Megawatt-hour (mg/MWh)
Blandin Paper Company	Grand Rapids Boilers 5,6	coal, wood, ties	NA	NA	NA	NA	NA	NA
Champion International Corporation	Sartell Mill #3 boiler	coal, bark, sludge	NA	NA	NA	NA	NA	NA
Hennepin Energy Resource Corporation	Minneapolis waste-to-energy	MSW	NA	NA	NA	NA	NA	NA
LTV Steel Mining Company	Taconite Harbor Power Plant	coal	NA	NA	NA	NA	NA	NA
Minnesota Power	Boswell Unit 1	coal	323,468	18.0	25	386,085	8.0	9
Minnesota Power	Boswell Unit 2	coal	393,537	22.0	25	439,644	9.0	9
Minnesota Power	Boswell unit 3	coal	2,143,278	115.0	24	2,206,999	113.0	23
Minnesota Power	Boswell Unit 4	coal	3,556,331	197.0	25	3,140,045	178.0	26
Minnesota Power	Laskin Unit 1	coal	292,135	18.0	28	570,634	19.0	15
Minnesota Power	Laskin Unit 2	coal	285,537	18.0	29	combined with unit 1		
Northshore Mining Company	Silver Bay Power Plant	coal	NA	NA	NA	NA	NA	NA
NSP	AS King 1	coal, gas, wood	2,843,610	48.5	8	3,471,370	35.7	5
NSP	Black Dog 3	coal	519,680	17.4	15	1,493,820	45.1	14
NSP	Black Dog 4	coal	1,074,160	32.9	14	combined with unit 3		
NSP	High Bridge 5	coal, gas	573,250	23.8	19	496,989	15.7	14
NSP	High Bridge 6	coal, gas	1,061,880	40.8	17	782,899	22.9	13
NSP	Red Wing 1 Waste-to-Energy	wood, RDF	69,904	166.6	1081	69,103	160.0	1050
NSP	Red Wing 2 Waste-to-Energy	wood, RDF	70,158	159.4	1031	59,457	135.0	1030
NSP	Riverside 6/7	coal	1,110,980	55.0	22	774,869	35.0	20
NSP	Riverside 8	coal	1,636,390	47.9	13	1,539,980	45.0	13
NSP	Sherco 1	coal	4,130,940	157.2	17	4,238,380	117.5	13
NSP	Sherco 2	coal	4,780,060	185.3	18	5,104,380	146.2	13
NSP	Sherco 3 (NSP owned portion)	coal	4,092,157	191.1	21	3,507,986	56.3	7
NSP	Wilmarth 1 Waste-to-Energy	RDF, gas	71,343	15.5	99	69,884	6.7	43
NSP	Wilmarth 2 Waste-to-Energy	RDF, gas	77,658	20.5	120	exempt		
Otter Tail Power Company	Hoot Lake Plant Unit 2	coal	342,657	18.8	25	312,911	17.2	25
Otter Tail Power Company	Hoot Lake Plant Unit 3	coal	330,855	18.8	26	355,716	19.9	25
Rochester Public Utilities	Silver Lake 3	coal	NA	NA	NA	NA	NA	NA
Rochester Public Utilities	Silver Lake 4	coal	NA	NA	NA	NA	NA	NA
Southern Minnesota Municipal Power Agency	Austin NE Power Plant	coal	NA	NA	NA	NA	NA	NA
Southern Minnesota Municipal Power Agency	Sherco 3 (SMMPA-owned)	coal, oil	2,416,573	123.7	23	2,035,404	44.2	10

Notes
MSW is municipal solid waste.
RDF is refuse-derived fuel, which is sorted and processed municipal solid waste.
NA indicates that data was either not available or not submitted to the MPCA.

Table 2. Reported 1998 and 1999 emissions of mercury from electrical production facilities outside Minnesota for which the electricity was likely consumed in Minnesota. Electricity and mercury figures for each company and facility are prorated to the amount of electricity likely consumed in Minnesota.

Reporting Organization	Facility or Supplier	Major Fuel Type(s)	1998 Electricity Consumed in Minnesota (MWh)	1998 Mercury Emissions (lb)	1998 Mercury Emissions per Megawatt-hour (mg/MWh)	1999 Electricity Consumed in Minnesota (MWh)	1999 Mercury Emissions (lb)	1999 Mercury Emissions per Megawatt-hour (mg/MWh)
Interstate Power Company, Marshalltown, IA	Dubuque 1, Dubuque IA	bituminous coal	NA	NA	NA	NA	NA	NA
Interstate Power Company, Marshalltown, IA	Dubuque 5, Dubuque IA	bituminous coal	NA	NA	NA	NA	NA	NA
Interstate Power Company, Marshalltown, IA	Lansing 3, Lansing IA	bituminous coal	NA	NA	NA	NA	NA	NA
Interstate Power Company, Marshalltown, IA	Lansing 4, Lansing IA	subbituminous coal	NA	NA	NA	NA	NA	NA
Interstate Power Company, Marshalltown, IA	Louisa 1/Louisa Co. IA	subbituminous coal	NA	NA	NA	NA	NA	NA
Interstate Power Company, Marshalltown, IA	ML Kapp 2, Clinton IA	subbituminous coal	NA	NA	NA	NA	NA	NA
Interstate Power Company, Marshalltown, IA	Neal 4, Sioux City IA	subbituminous coal	NA	NA	NA	NA	NA	NA
NSP	Bay Front 1, 2, 5 (1998), 5 (1999)	coal, gas wood, RDF	343,783	11.2	15	139,019	4.1	13
NSP	French Island 1 waste-to-energy, La Crosse WI	RDF, wood	34,970	4.4	57	exempt		
NSP	French Island 2 waste-to-energy, La Crosse WI	RDF, wood	46,505	8.2	80	32,464	12.0	168
Otter Tail Power, Fergus Falls, MN	Big Stone Plant, Big Stone Lake, SD	subbituminous coal	842,738	47.8	26	966,462	24.3	11
Otter Tail Power, Fergus Falls, MN	Coyote Plant, Beulah, ND	lignite coal	516,302	60.9	54	517,163	60.4	53
People's Cooperative Power Assn.	Dairyland Power Cooperative	coal	N/A	N/A	N/A	N/A	N/A	N/A
Tri-County Electric Cooperative	Dairyland Power Cooperative	coal	N/A	N/A	N/A	N/A	N/A	N/A
Freeborn-Mower Cooperative Services	Dairyland Power Cooperative	coal	N/A	N/A	N/A	N/A	N/A	N/A
Agralite Electric Cooperative	Great River Energy	lignite coal	135,345	6.3	21	131,376	6.0	21
Arrowhead Electric Cooperative	Great River Energy	lignite coal	48,389	3.2	30	53,228	3.6	31
Benco Electric Cooperative	Great River Energy	lignite coal	NA	NA	NA	NA	NA	NA
Brown County Rural Electrical Assn.	Great River Energy	lignite coal	107,184	5.2	22	109,057	5.4	22
Connexus Energy	Great River Energy	lignite coal	1,561,431	106.2	31	1,635,474	110.5	31
Cooperative Light and Power	Great River Energy	lignite coal	74,041	1.0	6	77,672	1.0	6
Crow Wing Power	Great River Energy	lignite coal	N/A	N/A	N/A	N/A	N/A	N/A
Dakota Electric Assn.	Great River Energy	lignite coal	1,382,019	94.0	31	1,457,174	98.5	31
East Central Electric Assn.	Great River Energy	lignite coal	659,588	44.8	31	683,902	46.2	31
Federated Rural Electric	Great River Energy	lignite coal	134,413	6.0	20	133,817	5.9	20
Goodhue County Cooperative Electric Assn.	Great River Energy	lignite coal	75,708	5.2	31	76,833	5.2	31
Itasca-Mantrap Co-op. Electrical Assn.	Great River Energy	lignite coal	122,319	8.3	31	136,345	9.2	31

Table 2. Continued.

Reporting Organization	Facility or Supplier	Major Fuel Type(s)	1998 Electricity Consumed in Minnesota (MWh)	1998 Mercury Emissions (lb)	1998 Mercury Emissions per Megawatt-hour (mg/MWh)	1999 Electricity Consumed in Minnesota (MWh)	1999 Mercury Emissions (lb)	1999 Mercury Emissions per Megawatt-hour (mg/MWh)
Kandiyohi Power Cooperative	Great River Energy	lignite coal	N/A	N/A	N/A	N/A	N/A	N/A
Lake Country Power	Great River Energy	lignite coal	530,766	36.1	31	556,780	37.6	31
Lake Region Electric Cooperative	Great River Energy	lignite coal	300,259	15.2	23	307,559	15.6	23
McLeod Cooperative Power Assn.	Great River Energy	lignite coal	143,563	9.0	28	144,462	9.0	28
Meeker Cooperative Light & Power Assn.	Great River Energy	lignite coal	124,473	6.7	25	128,430	7.0	25
Mille Lacs Electric Cooperative	Great River Energy	lignite coal	8,281,585	527.2	29	8,667,605	550.7	29
Minnesota Valley Electric Cooperative	Great River Energy	lignite coal	372,022	25.3	31	397,889	26.9	31
Nobles Electric Cooperative	Great River Energy	lignite coal	106,431	3.5	15	104,782	3.4	15
North Itasca Electric Cooperative, Inc.	Great River Energy	lignite coal	32,511	1.8	25	40,068	2.7	31
Redwood Electric Cooperative	Great River Energy	lignite coal	55,055	1.7	14	54,372	1.7	14
Runestone Electric Assn.	Great River Energy	lignite coal	167,419	8.1	22	171,642	8.3	22
South Central Electric Assn.	Great River Energy	lignite coal	110,621	4.9	20	110,290	4.8	20
Stearns Electric Assn.	Great River Energy	lignite coal	NA	NA	NA	NA	NA	NA
Steele-Waseca Cooperative Electric	Great River Energy	lignite coal	165,942	11.3	31	179,424	12.1	31
Todd-Wadena Electric Cooperative	Great River Energy	lignite coal	129,478	6.7	23	133,920	6.9	23
Wright-Hennepin Cooperative Electric Assn.	Great River Energy	lignite coal	NA	NA	NA	NA	NA	NA
Clearwater-Polk Electric Cooperative	Minnkota Power Cooperative	lignite coal	NA	NA	NA	66,447	4.8	33
North Star Electric Cooperative	Minnkota Power Cooperative	lignite coal	NA	NA	NA	104,454	7.5	33
PKM Electric Cooperative	Minnkota Power Cooperative	lignite coal	NA	NA	NA	104,877	7.5	33
Red Lake Electric Cooperative	Minnkota Power Cooperative	lignite coal	NA	NA	NA	108,974	7.8	33
Red River Valley Cooperative Power Assn.	Minnkota Power Cooperative	lignite coal	NA	NA	NA	115,022	8.3	33
Roseau Electric Cooperative	Minnkota Power Cooperative	lignite coal	NA	NA	NA	NA	NA	NA
Wild Rice Electric Cooperative	Minnkota Power Cooperative	lignite coal	NA	NA	NA	203,932	14.6	33
Beltrami Electric Cooperative	Minnkota Power Cooperative	lignite coal	NA	NA	NA	395,283	28.4	33
Lyon-Lincoln Electric Cooperative	East River Electric Power Cooperative	N/A	75,507	N/A	N/A	74,570	N/A	N/A
Minnesota Valley Coop. Light & Power Assn.	East River Electric Power Cooperative	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Renville Sibley Cooperative Assn.	East River Electric Power Cooperative	N/A	94,430	N/A	N/A	112,987	N/A	N/A
Traverse Electric Cooperative	East River Electric Power Cooperative	N/A	43,996	N/A	N/A	N/A	N/A	N/A

Notes
RDF is refuse-derived fuel, which is sorted and processed municipal solid waste.
NA indicates that data was either not available or not submitted to the MPCA.
Mercury emissions per megawatt-hour calculations for the cooperatives may vary in part due to consumption of hydroelectric power

Appendix B: Air Toxics Emissions Information

This appendix describes the sources of air toxics emissions in Minnesota using data from the Minnesota air toxics emission inventory. The 1999 Minnesota air toxics emission inventory includes three principal source categories: point, area, and mobile sources. For this report, Minnesota Pollution Control Agency (MPCA) staff compiled emissions for point and area sources. The results for mobile sources in this report were obtained from EPA's 1999 National Emission Inventory Version 3 for Hazardous Air Pollutants. Since mobile emission estimates are sensitive to many factors such as local fleet mix, climate conditions, and fuel programs, EPA's estimates may not match estimates made by states. MPCA will update the 1999 inventory when state-specific estimates of mobile source become available. 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 criteria pollutants 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, 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 1999 emissions of one or more targeted pollutants from 1088 out of 2183 point sources. 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 include any kind of vehicle or equipment with a gasoline or diesel engine; airplane; or ship. They are further sub-categorized to on-road vehicles such as cars and trucks and nonroad sources, such as aircraft, locomotives, construction equipment, lawn mowers, and recreational vehicles.

Emissions

Emissions were estimated 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/pubs/atei-99-table1.pdf.) However, emissions data were only available for 240 out of the more than 500 targeted compounds. Point and area sources emit 227 and 168 of the target pollutants, respectively, while mobile sources emit 48 of the target pollutants. Table 2 shows a summary of emissions by principal source category. In that table, emissions are presented for pollutant groups. For example, individual metal compounds are grouped to metal compounds, such as chromium, strontium chromate, and zinc chromate to 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 EPA and the Great Lakes Commission in many air toxics programs.

Point sources contribute more than 50% emissions for 80 pollutant groups, particularly, dominating emissions of metal compounds, except for cadmium compounds that are mainly from Prescribed Burning. 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 sources for 11 pollutant groups such as 1,3-butadiene, acetaldehyde, benzene, ethylbenzene, formaldehyde, toluene, and xylenes.

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%) and slightly less from point sources (22%).

Figure 2 shows total emissions from major point source categories. There are 9 categories, each emitting more that 2% of total point source emissions, responsible for about 72% of total point source emissions. The most notable source category is Electric Services that account for 47.8% of point source emissions.

Figure 3 and Figure 4 show emission break down into major source categories for area and mobile sources, respectively. The major contributors of area source emissions are Industrial Surface Coating and Commercial/Consumer Solvent Products. About a half of the area source emissions are attributed to these two area source categories. For mobile sources, the largest emission contributor is Highway Vehicles – Gasoline that emitted 47% of total mobile source emissions in 1999. The second largest contributor of mobile source emissions is Off-highway Vehicle – Gasoline, mainly Recreational Equipment. Snowmobiles contribute a significant fraction (70%) of emissions from Recreational Equipment.

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, 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.

Second, 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 as area sources. 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. There is a plan to collect more source-specific data in the future. Third, uncertainties are introduced due to scarce information on control efficiencies for air toxics.

Fourth, 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.

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. However, a comparison of emissions between different inventory years to describe emission reduction is not possible due primarily to the following reasons:

1. The number of pollutants in the emission inventories has increased over the years,
2. The number of sources and source categories have expanded with time, 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 trends, 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/airtoxics.html

Or contact:

Ms. Chun Yi Wu
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155
(P) 651-282-5855
(F) 651-297-7709
(E) chun.yi.wu@pca.state.mn.us

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
	Stage I: Gasoline Underground Tank Breathing	Same as above	Same as above

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
	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
	Evap. emissions assoc. with chlorination	Same as above	Same as above

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
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
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

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
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 1999 Minnesota air toxics emissions from principal source categories.

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
POMs										
Acenaphthene	83329	7.38E+04	5.19E+03	9.52E+02	1.64E+03	8.15E+04	90.46	6.36	1.17	2.01
Acenaphthylene	208968	2.96E+02	1.09E+05	4.91E+03	3.24E+03	1.18E+05	0.25	92.81	4.18	2.76
Anthracene	120127	2.76E+02	1.57E+04	1.16E+03	7.71E+02	1.79E+04	1.54	87.66	6.49	4.31
Benz[a]Anthracene	56553	1.18E+02	2.04E+04	3.29E+02	2.99E+02	2.12E+04	0.56	96.48	1.55	1.41
Benzo[a]Pyrene	50328	1.69E+01	4.47E+03	1.84E+02	2.00E+02	4.87E+03	0.35	91.76	3.78	4.11
Benzo[b]Fluoranthene	205992	1.53E+01	3.13E+03	1.98E+02	1.45E+02	3.49E+03	0.44	89.73	5.68	4.15
Benzo[g,h,i]Perylene	191242	1.46E+00	1.04E+04	3.37E+02	6.62E+02	1.14E+04	0.01	91.22	2.95	5.81
Benzo[k]Fluoranthene	207089	1.72E+00	5.30E+03	1.98E+02	1.31E+02	5.63E+03	0.03	94.12	3.52	2.33
Chrysene	218019	1.46E+01	1.64E+04	1.53E+02	1.86E+02	1.67E+04	0.09	97.89	0.92	1.11
Dibenzo[a,h]Anthracene	53703	6.57E-01	2.90E-01	3.00E-02	4.99E+00	5.97E+00	11.00	4.86	0.50	83.64
Fluoranthene	206440	3.94E+02	2.18E+04	1.19E+03	1.93E+03	2.53E+04	1.55	86.13	4.70	7.62
Fluorene	86737	2.02E+02	1.27E+04	1.99E+03	3.20E+03	1.81E+04	1.12	70.13	11.05	17.70
Indeno[1,2,3-c,d]Pyrene	193395	8.02E-01	5.62E+03	8.98E+01	2.00E+02	5.91E+03	0.01	95.09	1.52	3.38
Naphthalene	91203	1.10E+05	6.54E+05	1.31E+05	4.17E+04	9.37E+05	11.75	69.84	13.96	4.45
Phenanthrene	85018	7.93E+02	4.96E+04	3.25E+03	6.12E+03	5.97E+04	1.33	82.98	5.45	10.24
Pyrene	129000	4.62E+02	2.80E+04	1.67E+03	2.16E+03	3.23E+04	1.43	86.71	5.18	6.68

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
POM not Included in Individual PAHs		2.68E+04	3.14E+05	0.00E+00	3.01E+00	3.41E+05	7.87	92.13	0.00	0.00
POM Total		2.13E+05	1.28E+06	1.47E+05	6.26E+04	1.70E+06	12.55	75.09	8.67	3.68
Metal Compounds										
Antimony Compounds	92	2.43E+03	4.14E+02	0.00E+00	0.00E+00	2.84E+03	85.44	14.56	0.00	0.00
Arsenic Compounds	1327533	1.69E+04	7.29E+01	8.12E+02	5.46E+02	1.83E+04	92.18	0.40	4.44	2.98
Beryllium Compounds	7440417	3.56E+02	3.50E+01	0.00E+00	2.95E+01	4.21E+02	84.69	8.31	0.00	7.00
Cadmium Compounds	125	2.03E+03	1.76E+04	0.00E+00	3.61E+01	1.96E+04	10.35	89.47	0.00	0.18
Chromium Compounds	13530659	2.76E+04	1.34E+03	3.12E+02	4.69E+01	2.93E+04	94.20	4.58	1.06	0.16
Chromium (VI)	18540299	3.15E+02	2.17E+01	2.07E+02	2.42E+01	5.68E+02	55.49	3.81	36.44	4.26
Cobalt Compounds	139	4.82E+03	4.85E+02	0.00E+00	0.00E+00	5.30E+03	90.85	9.15	0.00	0.00
Copper Compounds	0	2.95E+04	1.61E+03	0.00E+00	0.00E+00	3.11E+04	94.81	5.19	0.00	0.00
Lead Compounds	78002	7.91E+04	7.51E+03	0.00E+00	2.38E+04	1.10E+05	71.63	6.81	0.00	21.57
Manganese Compounds	7439965	2.06E+05	6.43E+03	1.76E+02	1.08E+02	2.13E+05	96.85	3.02	0.08	0.05
Mercury Compounds	199	3.56E+03	2.74E+02	9.15E+02	4.75E+02	5.23E+03	68.15	5.25	17.51	9.09
Nickel Compounds	226	4.80E+04	1.04E+04	3.94E+02	1.63E+03	6.05E+04	79.38	17.28	0.65	2.69
Selenium Compounds	253	3.88E+03	1.76E+02	0.00E+00	1.25E+01	4.07E+03	95.38	4.32	0.00	0.31
Metal Compound Total		4.25E+05	4.64E+04	2.82E+03	2.67E+04	5.01E+05	84.84	9.26	0.56	5.33
Non-Metal Compounds (Excluding PAHs)										
1,1,2,2-Tetrachloroethane	79345	7.21E+01	1.06E+03	0.00E+00	0.00E+00	1.14E+03	6.35	93.65	0.00	0.00
1,1,2-Trichloroethane	79005	9.77E+01	0.00E+00	0.00E+00	0.00E+00	9.77E+01	100.00	0.00	0.00	0.00
1,2,4-Trichlorobenzene	120821	7.32E+03	0.00E+00	0.00E+00	0.00E+00	7.32E+03	100.00	0.00	0.00	0.00
1,2,4-Trimethylbenzene	95636	1.37E+05	1.89E+04	0.00E+00	0.00E+00	1.56E+05	87.89	12.11	0.00	0.00
1,3,5-Trimethylbenzene	108678	3.24E+02	0.00E+00	0.00E+00	0.00E+00	3.24E+02	100.00	0.00	0.00	0.00
1,3-Butadiene	106990	1.71E+03	6.67E+05	7.84E+05	4.39E+05	1.89E+06	0.09	35.26	41.43	23.22
1,3-Dichloropropene	542756	4.66E+01	7.64E+05	0.00E+00	0.00E+00	7.64E+05	0.01	99.99	0.00	0.00
1,4-Dichlorobenzene	106467	4.10E+02	3.72E+05	0.00E+00	0.00E+00	3.72E+05	0.11	99.89	0.00	0.00

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
2,2,4-Trimethylpentane	540841	6.69E+03	4.08E+05	6.43E+06	9.78E+06	1.66E+07	0.04	2.46	38.68	58.83
2,3,7,8-Tetrachlorodibenzo-p-Dioxin	1746016	2.45E-03	6.69E-03	0.00E+00	0.00E+00	9.14E-03	26.85	73.15	0.00	0.00
2,3,7,8-Tetrachlorodibenzofuran	51207319	2.62E-02	3.99E-01	0.00E+00	0.00E+00	4.25E-01	6.17	93.83	0.00	0.00
2,4-D (2,4-Dichlorophenoxyacetic Acid) (Including Salts)	94757	0.00E+00	1.68E+05	0.00E+00	0.00E+00	1.68E+05	0.00	100.00	0.00	0.00
2,4-Dinitrophenol	51285	1.45E+02	0.00E+00	0.00E+00	0.00E+00	1.45E+02	100.00	0.00	0.00	0.00
2,4-Dinitrotoluene	121142	5.20E+00	1.22E-03	0.00E+00	0.00E+00	5.21E+00	99.98	0.02	0.00	0.00
2,4-Toluene Diisocyanate	584849	4.89E+03	6.24E+01	0.00E+00	0.00E+00	4.95E+03	98.74	1.26	0.00	0.00
2-Chloroacetophenone	532274	1.30E+02	3.04E-02	0.00E+00	0.00E+00	1.30E+02	99.98	0.02	0.00	0.00
2-Nitropropane	79469	0.00E+00	9.26E+00	0.00E+00	0.00E+00	9.26E+00	0.00	100.00	0.00	0.00
4,4'-Methylenedianiline	101779	1.51E+02	0.00E+00	0.00E+00	0.00E+00	1.51E+02	100.00	0.00	0.00	0.00
4,4'-Methylenediphenyl Diisocyanate (MDI)	101688	6.33E+04	5.55E+02	0.00E+00	0.00E+00	6.38E+04	99.13	0.87	0.00	0.00
4-Nitrophenol	100027	4.27E+02	0.00E+00	0.00E+00	0.00E+00	4.27E+02	100.00	0.00	0.00	0.00
Acetaldehyde	75070	1.61E+05	1.40E+06	1.88E+06	1.17E+06	4.62E+06	3.49	30.26	40.81	25.43
Acetamide	60355	0.00E+00	5.78E-01	0.00E+00	0.00E+00	5.78E-01	0.00	100.00	0.00	0.00
Acetone	67641	3.13E+05	1.34E+06	0.00E+00	0.00E+00	1.66E+06	18.91	81.09	0.00	0.00
Acetonitrile	75058	1.22E+04	7.23E-01	0.00E+00	0.00E+00	1.22E+04	99.99	0.01	0.00	0.00
Acetophenone	98862	3.35E+02	1.22E+03	0.00E+00	0.00E+00	1.56E+03	21.53	78.47	0.00	0.00
Acrolein	107028	1.80E+04	7.16E+05	1.43E+05	1.38E+05	1.02E+06	1.78	70.49	14.12	13.61
Acrylamide	79061	2.35E+02	0.00E+00	0.00E+00	0.00E+00	2.35E+02	100.00	0.00	0.00	0.00
Acrylic Acid	79107	1.37E+04	1.86E+01	0.00E+00	0.00E+00	1.37E+04	99.86	0.14	0.00	0.00
Acrylonitrile	107131	2.00E+03	3.32E+03	0.00E+00	0.00E+00	5.33E+03	37.64	62.36	0.00	0.00
Aldehydes	0	5.65E+04	8.34E+05	0.00E+00	0.00E+00	8.90E+05	6.35	93.65	0.00	0.00
Allyl Chloride	107051	7.00E+00	0.00E+00	0.00E+00	0.00E+00	7.00E+00	100.00	0.00	0.00	0.00
Aniline	62533	1.10E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+00	100.00	0.00	0.00	0.00
Atrazine	1912249	0.00E+00	1.79E+05	0.00E+00	0.00E+00	1.79E+05	0.00	100.00	0.00	0.00
Benzaldehyde	100527	1.46E+03	0.00E+00	0.00E+00	0.00E+00	1.46E+03	100.00	0.00	0.00	0.00
Benzene	71432	1.59E+05	3.85E+06	6.43E+06	3.63E+06	1.41E+07	1.13	27.38	45.72	25.77

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Benzyl Chloride	100447	1.21E+04	3.04E+00	0.00E+00	0.00E+00	1.21E+04	99.97	0.03	0.00	0.00
Biphenyl	92524	1.47E+03	8.12E+02	0.00E+00	0.00E+00	2.28E+03	64.45	35.55	0.00	0.00
Bis(2-Ethylhexyl)Phthalate (Dehp)	117817	9.78E+03	2.46E+01	0.00E+00	0.00E+00	9.80E+03	99.75	0.25	0.00	0.00
Bromoform	75252	7.25E+02	1.70E-01	0.00E+00	0.00E+00	7.25E+02	99.98	0.02	0.00	0.00
Butyraldehyde	123728	1.67E+02	0.00E+00	0.00E+00	0.00E+00	1.67E+02	100.00	0.00	0.00	0.00
Carbon Disulfide	75150	2.29E+03	4.37E+02	0.00E+00	0.00E+00	2.73E+03	83.99	16.01	0.00	0.00
Carbon Tetrachloride	56235	7.51E+02	8.58E+02	0.00E+00	0.00E+00	1.61E+03	46.66	53.34	0.00	0.00
Carbonyl Sulfide	463581	2.11E+05	1.17E+03	0.00E+00	0.00E+00	2.12E+05	99.45	0.55	0.00	0.00
Catechol	120809	6.36E+02	0.00E+00	0.00E+00	0.00E+00	6.36E+02	100.00	0.00	0.00	0.00
Chlorine	7782505	1.78E+04	5.04E+05	0.00E+00	0.00E+00	5.21E+05	3.42	96.58	0.00	0.00
Chloroacetic Acid	79118	2.20E-01	0.00E+00	0.00E+00	0.00E+00	2.20E-01	100.00	0.00	0.00	0.00
Chlorobenzene	108907	5.94E+02	3.43E+05	0.00E+00	0.00E+00	3.43E+05	0.17	99.83	0.00	0.00
Chloroform	67663	4.39E+04	1.08E+04	0.00E+00	0.00E+00	5.47E+04	80.25	19.75	0.00	0.00
Chloroprene	126998	1.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	100.00	0.00	0.00	0.00
Cresol/Cresylic Acid (Mixed Isomers)	106445	5.11E+04	0.00E+00	0.00E+00	0.00E+00	5.11E+04	100.00	0.00	0.00	0.00
Crotonaldehyde	123739	1.27E+02	0.00E+00	0.00E+00	0.00E+00	1.27E+02	100.00	0.00	0.00	0.00
Cumene	98828	3.36E+04	1.33E+04	0.00E+00	0.00E+00	4.69E+04	71.64	28.36	0.00	0.00
Cyanide Compounds	74908	4.89E+04	1.43E+05	0.00E+00	0.00E+00	1.92E+05	25.56	74.44	0.00	0.00
Di-N-Octylphthalate	117840	1.04E+03	0.00E+00	0.00E+00	0.00E+00	1.04E+03	100.00	0.00	0.00	0.00
Dibenzofuran	132649	3.97E+00	3.53E+01	0.00E+00	0.00E+00	3.93E+01	10.09	89.91	0.00	0.00
Dibutyl Phthalate	84742	2.38E+03	1.65E+02	0.00E+00	0.00E+00	2.54E+03	93.50	6.50	0.00	0.00
Dichlorobenzenes	25321226	6.91E+01	0.00E+00	0.00E+00	0.00E+00	6.91E+01	100.00	0.00	0.00	0.00
Diethanolamine	111422	1.51E+02	3.35E+01	0.00E+00	0.00E+00	1.84E+02	81.82	18.18	0.00	0.00
Diethyl Sulfate	64675	6.22E+00	0.00E+00	0.00E+00	0.00E+00	6.22E+00	100.00	0.00	0.00	0.00
Dimethyl Phthalate	131113	3.59E+03	2.13E+01	0.00E+00	0.00E+00	3.61E+03	99.41	0.59	0.00	0.00
Dimethyl Sulfate	77781	8.92E+02	2.09E-01	0.00E+00	0.00E+00	8.92E+02	99.98	0.02	0.00	0.00
Ethyl Acrylate	140885	4.65E+03	4.34E+00	0.00E+00	0.00E+00	4.65E+03	99.91	0.09	0.00	0.00
Ethyl Chloride	75003	1.19E+04	4.22E+04	0.00E+00	0.00E+00	5.41E+04	22.05	77.95	0.00	0.00
Ethylbenzene	100414	2.51E+05	9.50E+04	2.75E+06	2.41E+06	5.50E+06	4.57	1.73	49.92	43.78

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Ethylene Dibromide (Dibromoethane)	106934	5.61E+02	4.63E+00	0.00E+00	0.00E+00	5.65E+02	99.18	0.82	0.00	0.00
Ethylene Dichloride (1,2-Dichloroethane)	107062	1.59E+03	1.05E+03	0.00E+00	0.00E+00	2.64E+03	60.23	39.77	0.00	0.00
Ethylene Glycol	107211	4.61E+04	1.55E+05	0.00E+00	0.00E+00	2.01E+05	22.92	77.08	0.00	0.00
Ethylene Oxide	75218	1.11E+04	1.04E+05	0.00E+00	0.00E+00	1.15E+05	9.65	90.35	0.00	0.00
Ethylidene Dichloride (1,1-Dichloroethane)	75343	1.52E+01	9.66E+02	0.00E+00	0.00E+00	9.81E+02	1.55	98.45	0.00	0.00
Formaldehyde	50000	7.98E+05	5.10E+06	3.02E+06	2.91E+06	1.18E+07	6.74	43.14	25.49	24.62
Glycol Ethers	2807309	9.63E+05	2.27E+06	0.00E+00	0.00E+00	3.23E+06	29.79	70.21	0.00	0.00
Hexamethylene Diisocyanate	822060	3.65E+03	3.23E-01	0.00E+00	0.00E+00	3.65E+03	99.99	0.01	0.00	0.00
Hexane	110543	2.39E+06	3.41E+06	2.40E+06	1.73E+06	9.93E+06	24.08	34.35	24.19	17.38
Hydrazine	302012	1.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	100.00	0.00	0.00	0.00
Hydrochloric Acid (Hydrogen Chloride [Gas Only])	7647010	2.58E+07	6.75E+04	0.00E+00	0.00E+00	2.59E+07	99.74	0.26	0.00	0.00
Hydrogen Fluoride (Hydrofluoric Acid)	7664393	2.73E+06	7.21E+02	0.00E+00	0.00E+00	2.73E+06	99.97	0.03	0.00	0.00
Hydroquinone	123319	2.34E+03	4.23E+03	0.00E+00	0.00E+00	6.57E+03	35.61	64.39	0.00	0.00
Isophorone	78591	1.10E+04	1.53E+04	0.00E+00	0.00E+00	2.63E+04	41.79	58.21	0.00	0.00
Lindane, (All Isomers)	58899	3.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E+00	100.00	0.00	0.00	0.00
M-Dichlorobenzene	541731	1.01E+02	1.30E+03	0.00E+00	0.00E+00	1.41E+03	7.22	92.78	0.00	0.00
Maleic Anhydride	108316	6.42E+02	0.00E+00	0.00E+00	0.00E+00	6.42E+02	100.00	0.00	0.00	0.00
Methanol	67561	1.55E+06	3.48E+06	0.00E+00	0.00E+00	5.03E+06	30.85	69.15	0.00	0.00
Methyl Bromide (Bromomethane)	74839	1.40E+04	1.06E+06	0.00E+00	0.00E+00	1.07E+06	1.30	98.70	0.00	0.00
Methyl Chloride (Chloromethane)	74873	9.91E+04	2.46E+05	0.00E+00	0.00E+00	3.45E+05	28.68	71.32	0.00	0.00
Methyl Chloroform (1,1,1-Trichloroethane)	71556	5.64E+03	1.73E+06	0.00E+00	0.00E+00	1.73E+06	0.33	99.67	0.00	0.00
Methyl Ethyl Ketone (2-Butanone)	78933	1.19E+06	3.54E+06	0.00E+00	0.00E+00	4.73E+06	25.16	74.84	0.00	0.00
Methyl Iodide (Iodomethane)	74884	5.08E+00	0.00E+00	0.00E+00	0.00E+00	5.08E+00	100.00	0.00	0.00	0.00
Methyl Isobutyl Ketone (Hexone)	108101	3.54E+05	1.79E+06	0.00E+00	0.00E+00	2.15E+06	16.49	83.51	0.00	0.00
Methyl Methacrylate	80626	8.11E+04	1.65E+01	0.00E+00	0.00E+00	8.11E+04	99.98	0.02	0.00	0.00
Methyl Tert-Butyl Ether	1634044	4.53E+03	1.03E+02	1.26E+04	0.00E+00	1.72E+04	26.34	0.60	73.06	0.00
Methylene Chloride (Dichloromethane)	75092	1.83E+05	5.74E+05	0.00E+00	0.00E+00	7.57E+05	24.14	75.86	0.00	0.00

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Methylhydrazine	60344	3.16E+03	7.39E-01	0.00E+00	0.00E+00	3.16E+03	99.98	0.02	0.00	0.00
N,N-Dimethylformamide	68122	1.01E+04	4.70E+04	0.00E+00	0.00E+00	5.71E+04	17.63	82.37	0.00	0.00
Nitrobenzene	98953	4.80E+02	0.00E+00	0.00E+00	0.00E+00	4.80E+02	100.00	0.00	0.00	0.00
O-Dichlorobenzene	95501	5.23E+01	4.04E+05	0.00E+00	0.00E+00	4.05E+05	0.01	99.99	0.00	0.00
Pentachlorophenol	87865	1.00E-02	0.00E+00	0.00E+00	0.00E+00	1.00E-02	100.00	0.00	0.00	0.00
Phenol	108952	2.15E+05	3.15E+01	0.00E+00	0.00E+00	2.16E+05	99.99	0.01	0.00	0.00
Phosphine	7803512	4.40E+02	4.20E+02	0.00E+00	0.00E+00	8.59E+02	51.16	48.84	0.00	0.00
Phosphorus Compounds	7723140	4.25E+04	3.43E+04	0.00E+00	0.00E+00	7.68E+04	55.30	44.70	0.00	0.00
Phthalic Anhydride	85449	7.58E+02	0.00E+00	0.00E+00	0.00E+00	7.58E+02	100.00	0.00	0.00	0.00
Polychlorinated Biphenyls (Aroclors)	1336363	1.14E+00	1.13E-01	0.00E+00	0.00E+00	1.25E+00	90.92	9.08	0.00	0.00
Polychlorinated Dibenzo-P-Dioxins And Furans, Total		2.49E-02	6.35E-05	0.00E+00	0.00E+00	2.49E-02	99.75	0.25	0.00	0.00
Polychlorinated Dibenzodioxins, Total		1.45E+00	1.73E+01	0.00E+00	0.00E+00	1.87E+01	7.73	92.27	0.00	0.00
Propionaldehyde	123386	9.44E+03	1.65E+00	1.60E+05	2.67E+05	4.36E+05	2.16	0.00	36.63	61.20
Propylene Dichloride (1,2-Dichloropropane)	78875	6.74E+00	2.01E+02	0.00E+00	0.00E+00	2.08E+02	3.24	96.76	0.00	0.00
Propylene Oxide	75569	6.45E+02	0.00E+00	0.00E+00	0.00E+00	6.45E+02	100.00	0.00	0.00	0.00
Quinoline	91225	2.20E-01	0.00E+00	0.00E+00	0.00E+00	2.20E-01	100.00	0.00	0.00	0.00
Quinone (p-Benzoquinone)	106514	1.87E+03	0.00E+00	0.00E+00	0.00E+00	1.87E+03	100.00	0.00	0.00	0.00
Styrene	100425	2.06E+06	1.18E+03	5.57E+05	2.20E+05	2.84E+06	72.55	0.04	19.63	7.77
Tetrachloroethylene (Perchloroethylene)	127184	7.60E+04	3.28E+05	0.00E+00	0.00E+00	4.04E+05	18.80	81.20	0.00	0.00
Toluene	108883	2.28E+06	1.03E+07	1.86E+07	2.45E+07	5.57E+07	4.09	18.54	33.40	43.97
Trichloroethylene	79016	3.97E+05	2.93E+04	0.00E+00	0.00E+00	4.26E+05	93.12	6.88	0.00	0.00
Trichlorofluoromethane (CFC-11, R-11)	75694	3.73E+02	3.97E+04	0.00E+00	0.00E+00	4.00E+04	0.93	99.07	0.00	0.00
Trichlorotrifluoromethane (CFC-113, R-113)	76131	0.00E+00	5.54E+05	0.00E+00	0.00E+00	5.54E+05	0.00	100.00	0.00	0.00
Triethylamine	121448	5.90E+02	4.01E+03	0.00E+00	0.00E+00	4.60E+03	12.84	87.16	0.00	0.00
Trifluralin	1582098	0.00E+00	8.42E+04	0.00E+00	0.00E+00	8.42E+04	0.00	100.00	0.00	0.00
Trimethylbenzene	25551137	1.53E+04	7.21E+04	0.00E+00	0.00E+00	8.74E+04	17.54	82.46	0.00	0.00
Vinyl Acetate	108054	2.89E+04	1.25E+04	0.00E+00	0.00E+00	4.14E+04	69.78	30.22	0.00	0.00

Pollutant	CAS No.	Point (lb)	Area (lb)	Onroad (lb)	Nonroad (lb)	Total (lb)	Point (%)	Area (%)	Onroad (%)	Nonroad (%)
Vinyl Chloride	75014	8.24E+02	1.25E+04	0.00E+00	0.00E+00	1.34E+04	6.16	93.84	0.00	0.00
Vinylidene Chloride (1,1-Dichloroethylene)	75354	2.14E+02	2.25E+03	0.00E+00	0.00E+00	2.46E+03	8.68	91.32	0.00	0.00
Xylenes (Mixed Isomers)	1330207	2.05E+06	7.07E+06	1.05E+07	1.00E+07	2.96E+07	6.94	23.89	35.38	33.79
m-Xylene	108383	3.06E+02	3.10E+03	0.00E+00	0.00E+00	3.40E+03	9.00	91.00	0.00	0.00
o-Xylene	95476	7.52E+03	2.00E+05	0.00E+00	0.00E+00	2.07E+05	3.63	96.37	0.00	0.00
p-Dioxane	123911	1.23E+04	7.44E+01	0.00E+00	0.00E+00	1.24E+04	99.40	0.60	0.00	0.00
p-Phenylenediamine	106503	9.90E+01	0.00E+00	0.00E+00	0.00E+00	9.90E+01	100.00	0.00	0.00	0.00
p-Xylene	106423	1.33E+02	0.00E+00	0.00E+00	0.00E+00	1.33E+02	100.00	0.00	0.00	0.00
Non-Metal Compound Total		4.51E+07	5.47E+07	5.37E+07	5.72E+07	2.11E+08	21.43	25.95	25.47	27.15
Grand Total		**4.58E+07**	**5.60E+07**	**5.38E+07**	**5.73E+07**	**2.13E+08**	**21.50**	**26.30**	**25.28**	**26.92**

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

Total emissions in 1999: 212,872,544 pounds

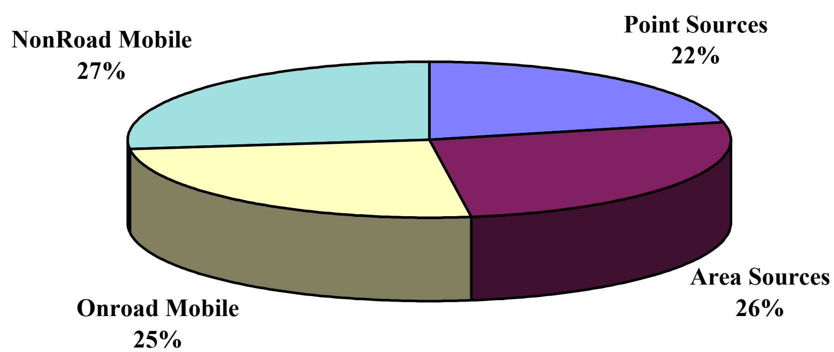


Figure 2. Contribution of major point source categories to state total emissions

Total emissions from point sources: 45,774,769 pounds

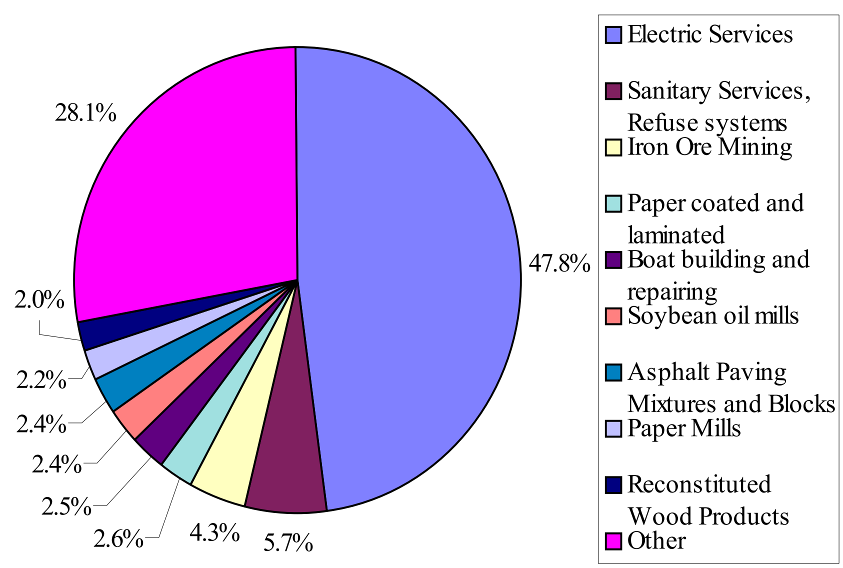


Figure 3 Contribution of major area source categories to state total emissions

Total emissions from area sources: 55,991,116.56 pounds

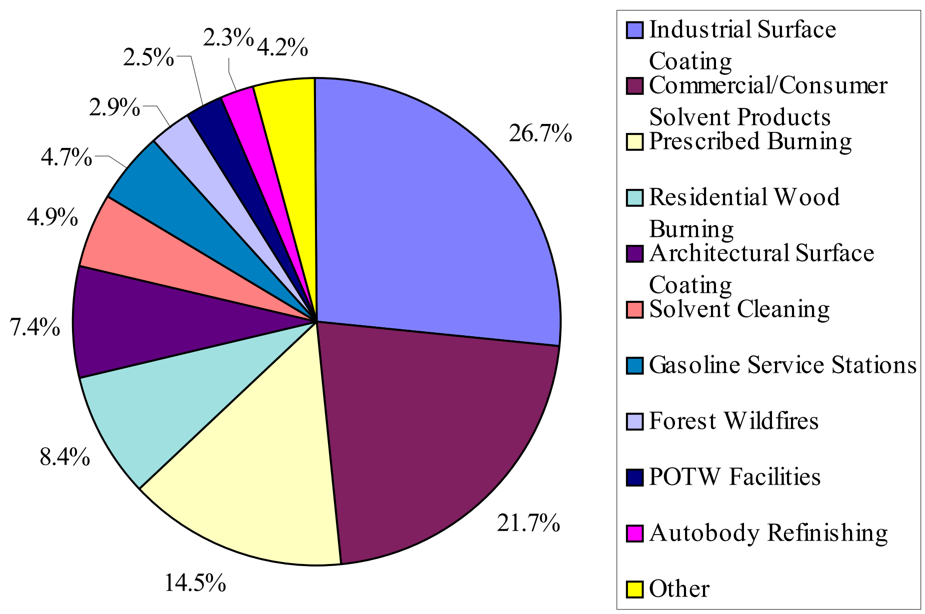
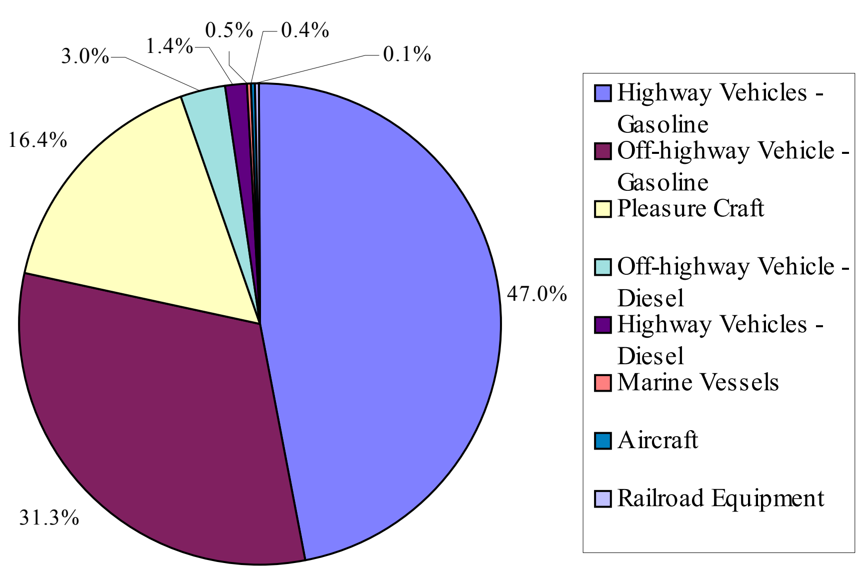


Figure 4 Contribution of major mobile source categories to state total emissions

Total emissions from mobile sources: 111,106,673.19 pounds



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Report contributors and reviewers:

Jeff Buss
Peter Ciborowski
Mary Jean Fenske
Lisa Herschberger
Anne Jackson
Chris Nelson
Kari Palmer
Greg Pratt
Leo Raudys
John Seltz
Rick Strassman
Ed Swain, author of Appendix A
David Thornton
Chun Yi Wu, author of Appendix B

Report editor: Rebecca Helgesen

Graphics design: Carol Pruchnofski