Minnesota Pollution Control Agency

Toxic Air Pollutant Update

Report to the Environment & Natural Resources Policy Committee of the Minnesota Legislature

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Environment & Natural Resources Policy Committee
of the
Minnesota Legislature

Fardin Oliaei, Ph.D.
Co-author and editor

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Environmental Outcomes Division
Minnesota Pollution Control Agency
520 Lafayette Rd.
Saint Paul, MN 55155-4194

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EXECUTIVE SUMMARY

Every two years the Minnesota Pollution Control Agency (MPCA) reports on its progress in implementing the state's air toxic pollutant strategy to the Legislature. This 1999 report includes the following information:

An Overview of Air Toxic Pollutants — Air toxics are of great environmental concern because of their toxicity, persistence and bioaccumulation. Since these pollutants are known to have the potential to cause ecological and biological damages, they are worthy of control and regulations.

Like criteria pollutants (carbon monoxide, nitrogen oxide, sulfur dioxide, particulate matter, lead and ozone), air toxics are emitted from a variety of sources, including mobile, stationary and area sources. Since a national, long-term, monitoring-and-emissions-tracking program similar to that for criteria pollutants does not exist for air toxics, little is known about their emissions and ambient air concentrations. The development of comprehensive data on air toxics is complicated by several factors: the number of chemical compounds involved; the number and variety of sources emitting the compounds; the low concentration of some toxics; and the potential for secondary formation of one toxic from other, often less-toxic, compounds.

Criteria and air toxic pollutants can be emitted together. Some air toxics are emitted as particulate matter (PM) or are associated with particulates. Examples are toxic metals (mercury, arsenic, chromium, cadmium) or toxic organic compounds (dioxin, PCBs, PAHs). Air toxics may also be emitted as VOCs (benzene, acrolein, 1,3-butadiene). Thus, control efforts to reduce the ozone levels and particulate matter (PM-10) also reduce emissions of many air toxics.

Achievements and Shortfalls of the Existing Air-Toxics Strategy — The strategy is centered on three objectives: (1) smooth, fair implementation of the Clean Air Act amendments of 1990, (2) protect public health and the environment, and (3) collection of more information to make better decisions for air-toxics programs. While the three objectives have remained, the strategy has been revised every year since it was developed.

The first objective of the air-toxics strategy recognizes that the U.S. Environmental Protection Agency (EPA) has been charged with developing a national air-toxics-control program, which relies on states adopting federal regulations, monitoring compliance and taking enforcement action when necessary. Since 1990, EPA adopted a number of air-toxic-control regulations, the National Emission Standards for Hazardous Air Pollutants (NESHAP). The MPCA has adopted 22 of these standards into state rules and will continue to incorporate federal standards as they are promulgated.

Facilities affected by NESHAPs make significant changes to their process to exempt themselves from the standard. This can be done by changing to less-polluting chemicals or using less of the regulated chemical so the standard does not apply. The result of the adoption of these standards in Minnesota has been that point sources and certain area sources regulated by technology-based standards are not significantly contributing to the air-quality problems we are concerned with today.

Protect Public Health and the Environment — As part of the original air-toxics strategy, the MPCA planned to conduct health-based reviews of technology-based standards in order to ensure that they were adequately protective of public health and the environment. MPCA soon concluded that further work on this objective would be resource intensive and that generic studies of industry sectors could not accurately assess the residual risk from specific facilities. The agency continues to conduct facility-specific health reviews during environmental-assessment and air-quality-permitting activities. The review process may be affected by a number of factors, such as improvement to EPA risk-assessment methodology, industry's need and MPCA resources.

EPA is assessing the effect of toxics on human health and the environment. The assessment, called the Cumulative Exposure Project (CEP), examines exposures to toxics in the air, drinking water and food. Preliminary results released by EPA to the states, suggest that people across the country, including Minnesota, may have an elevated risk of cancer over a lifetime due to inhaling toxic air pollutants released primarily from motor vehicles. According to the CEP study, point sources account for the largest contribution of chromium, arsenic and nickel emissions in Minnesota, but toxics from cars and trucks are the largest contributors to acrolein, 1,3-butadiene, benzene and formaldehyde in the atmosphere. Overall, cars and trucks contribute about 53% of the total estimated excess cancer risk from all air toxics, area sources contribute about 25%, and point sources contribute about 22%. For this reason, it will be important to consider urban sprawl and public transportation when developing strategies for controlling and reducing air-toxics emissions.

Air Toxics Monitoring in Minnesota — Currently, four networks collect data and information on toxic air pollutants. These are (1) the MPCA Statewide Air Toxics Monitoring Study (which has two components -- ambient air toxic monitoring, described in this report, and mercury deposition monitoring); (2) MPCA Pine Bend Monitoring Network; (3) MPCA Urban Air Toxics Monitoring Network and (4) Binational Integrated Atmospheric Deposition Network.

The statewide monitoring program was designed to provide the MPCA with baseline data for ambient air concentration of selected air toxics in urban, suburban and rural locations. Preliminary data from the first two years of this study (1996-1998) are reported here. The MPCA will need to complete a comprehensive statistical analysis and compare the results with health benchmarks to fulfill the objectives of this study. Some of these data are already being used to confirm the EPA's and the MPCA's computer model analyses used to predict air pollutant concentrations. Because the CEP study has postulated that 1,3-butadiene contributes to

the estimated excess cancer rates in urban areas of Minnesota, the MPCA began analyzing air samples for this chemical in January 1999.

Ambient air monitoring needs to be conducted over time in order to determine the amount of pollution in the air. Air monitoring can also be very costly. Due to these limitations, computer modeling is often substituted for monitoring actual environmental conditions. Therefore, it is important to conduct ambient monitoring to confirm computer models' predictive abilities as well as to measure the state of the environment.

Trends in Ambient Air Monitoring — Since 1990, the MPCA has monitored a variety of volatile, toxic air pollutants in an industrialized area south of St. Paul. Similar monitoring data are collected at three urban locations in downtown Minneapolis, downtown St. Paul and in Duluth. Trends in ambient air concentration of three pollutants from these monitoring sites are reported in this report. The pollutants were selected based on levels measured relative to toxicity indices (formaldehyde and benzene) and relatively high concentrations in ambient air (toluene). The monitoring data show a steady increase in ambient air concentrations of formaldehyde. Since 1994, for all monitoring sites, the levels of formaldehyde were higher than those estimated to be protective of public health. Even though the ambient air concentrations of benzene appear to have decreased over time, its concentrations at most sites were above the levels estimated to be protective of public health. The ambient air concentrations of toluene for all sites were far below its health value. The trends of ambient air concentrations for toluene have also decreased over time. It should be noted that, over the entire monitoring period (1991-98), the highest values of these pollutants were observed at metro sites, particularly, the Minneapolis site, probably due to mobile sources.

Air Toxic Emissions in Minnesota — Air-toxic-emission inventories are fundamental to the identification, evaluation and control of air-pollution hazards associated with air toxics. A crucial first step toward reducing air-toxic emissions is to identify the sources and source categories that contribute the most to total emissions. The emission inventories information can also be used for assessing health risks due to exposure to air toxics; supporting deposition modeling and environmental fate analyses, and evaluating the possible locations of environmental monitoring sites for air toxics. Moreover, emission inventories can serve as an indicator of air-quality changes. Periodic air-toxic-emission inventories can also indicate the benefits of regulatory programs that are designed to reduce toxic emissions, such as the NESHAP program. The MPCA has made progress in developing an accurate air-toxics-emissions inventory throughout the life of the current strategy. Having an accurate air-toxics-emission inventory is becoming more important than ever, given the rising importance of area sources and cars and trucks in air-quality-protection issues. All sources of air toxics emissions need to be better characterized so that future regulatory responses are proportional and appropriate. Further, having an inventory in and of itself can motivate reductions of air toxics, as the Toxic Release Inventory (TRI) is demonstrating.

Recently, the eight Great Lakes states and Ontario, working through the Great Lakes Commission, created a Great lakes Regional Air Toxics Emission Inventory. As a consequence, a Regional Air Pollutant Inventory Development System (RAPIDS) has been developed. RAPIDS is the first-ever, multistate, pollutant-emission-inventory software that manages emission data and calculates emission estimates for point, area and mobile sources. The Great Lakes states and Ontario decided to compile a base-year emission inventory for 1996, and to update the inventory annually. The 1996 regional inventory for all sources is expected to be completed in mid-1999.

To provide the proportions of point, area and mobile source emissions in the state, PM and VOCs emission estimates from EPA are presented in this report. VOCs and PM emissions are used because limited information on individual toxic air emissions is available. Also, VOCs and PM are broad categories that include many individual toxic air pollutants. It should be noted that mobile and area source emissions, including highway vehicles, constituted about 85% of the total 1997 VOC emissions. The major point and fugitive process sources of PM-10 in Minnesota are fuel combustion, metal processing and other industrial processes. Area sources and transportation (highway and off-highway) sources contribute about one-fourth of all PM-10 emissions.

The statewide point source emissions for 37 chemicals that are included in both Minnesota's air-toxic-emission inventory and the TRI are reported here. Emissions of mercury, a common pollutant in both inventories, are discussed in a separate section of this report. With regard to mass emissions, the top air pollutants are VOC air toxics. The highest emissions from point sources were reported for toluene (2.9 million lb per year). This is about 50% higher than xylene emissions; the second-most-emitted toxic. Styrene has the third highest emission levels.

More detail is provided on the source categories that emit the pollutants with the top five mass emissions. Overall, the manufacturing industries dominate the emissions. Although mass emissions provide a quantitative estimate of toxic air pollutants emitted in Minnesota, this is not enough to address the potential health effects from these emissions. The human health and environmental impact of a pollutant is not only determined by the quantity of its emissions but also its potential toxicity and environmental persistence. To take the toxicity and environmental persistence of a pollutant into account, MPCA staff developed an indexing system that assigns numerical values ("indexing values") to pollutants according to their hazard potential. The estimated emissions based on the available indexing values for each chemical (weighted emissions) show that seven of the top 10 pollutants of concern are metals. Electric Services and Metal Mining, Iron Ores, dominate the mass emissions of lead, nickel, arsenic and cadmium. For cadmium and arsenic, almost 100% of mass emissions are from these two industrial sectors. Primary Metal Industries contribute 72.9% of copper mass emissions. For chromium, 37.6% of mass emissions are from Electric Services and Metal Mining, Iron Ores; the rest is from manufacturing industries.

Trends of Air Toxics Emissions for Point Sources — The trends of air toxics emissions for point sources based on TRI data are reported for selected top 10 pollutants. Emissions of toluene and xylenes decreased with time. Styrene emissions reached their lowest in 1990, then

continuously increased until 1995, with a small drop from 1995 to 1996. The level of glycol ethers emissions, relatively stable from 1989 to 1993, increased suddenly after 1994. Formaldehyde emissions had a slow reduction trend after 1990, with a small fluctuation from 1994 to 1995. Benzene emissions tended to drop significantly after 1993 (the reduction was about 40-50% per year from 1993 to 1995), then were relatively stable from 1995 to 1996. Lead emissions decreased significantly after 1990, but rebounded after 1995. It should be noted that the TRI data cover only a portion of toxics emissions from point sources and the amounts of reported emissions have unknown accuracy.

The current air-toxics strategy is working to minimize health and environmental impacts from point sources. The strategy continues to focus its program resources on air emission releases from point sources. The success of these programs can be seen in the emissions reductions that have been achieved for a number of pollutants. Although, the MPCA has in a few instances developed regulatory policies and standards for area sources, it has not routinely dealt with small, ubiquitous sources until recently. Further, the MPCA has not traditionally taken an active role in transportation issues or land-management issues. The MPCA believes that, within a year, it will be able to give due consideration to these issues and construct a new air-toxics strategy. Future strategies need to respond to the results of ongoing ambient-air-quality monitoring, be it further monitoring, source identification efforts or even regulatory controls.

Mercury Contamination, and the Mercury Reduction Initiative — Mercury is considered separately from other air pollutants in this report because, as the subject of a special MPCA initiative, it has been studied intensively and its emissions have been quantified separately. In addition, a new law requires the MPCA to report on the mercury emissions associated with the production and retail sale of electricity in Minnesota.

Virtually all the mercury found in fish is delivered to the lake from the atmosphere. About three-quarters of the mercury in the atmosphere is a result of man-made air pollution. Reducing mercury contamination is a high priority in Minnesota, and several programs are in place to reduce the use and emission of mercury. In 1997, the MPCA began the Mercury Contamination Reduction Initiative, aimed at reducing mercury contamination of fish in Minnesota lakes. In January 1999, the initiative's Advisory Council recommended that the state adopt a goal of reducing mercury releases to Minnesota's air and water by 70% (compared to 1990 levels) by the year 2005.

Mercury Emission Inventory for Minnesota — It is important to understand the sources of mercury to the atmosphere in order to reduce air pollution, mercury deposition to lakes, and fish contamination. To that end, MPCA staff have revised estimated emissions of mercury to the air for 1990 and 1995. The three main categories of emissions are: (1) emissions that are incidental to energy production; (2) emissions that largely result from the purposeful use of mercury and (3) emissions incidental to other activities.

Trends in Mercury Emissions — Mercury emissions declined greatly (by about 45%) from 1990 to 1995, from about 8,500 lb to 4,500 lb. Virtually all of the decline can be attributed to emissions associated with the purposeful use of mercury. The major reductions were the elimination of mercury additives to latex paint, control at municipal waste incinerators, and reductions from medical waste incinerators.

How Mercury in Products Gets to the Atmosphere — An attempt to track the fate of mercury in products, from purchase to disposal, and to estimate the quantity of mercury released to air, land and water during storage and use is presented in this report. Once all possible fates of mercury-containing products are estimated, one can add all sources of mercury to air, land and surface water. MPCA staff estimate, that of the approximately 11,000 lb of mercury removed from service in 1995, 15% (1,655 lb) made its way to the atmosphere, 76% (about 8,400 lb) is on the land or in landfills, 9% was recycled and only 0.1% (17 lb) was discharged to surface water.

Mercury Emissions Associated with Electrical Production and Consumption — In 1997, a state law took effect that requires the producers and retailers of electricity to report on the amount of mercury emitted in generating electricity. The law requires the MPCA to summarize this emission information in the biennial air toxics report. This is the first such report, summarizing 1997 emissions.

For 1997, the MPCA received reports from 28 generation units in Minnesota. The major fuel for most of these units was coal, although two depended on municipal solid waste for fuel. In 1997, a total of 1,814 pounds of mercury were emitted to the atmosphere in the production of 33,721,787 megawatt-hours (MWh) of electricity.

The law also requires Minnesota retailers and wholesalers of electricity that is produced outside Minnesota to report on the mercury emissions associated with production. For 1997, the MPCA received reports totalling 865 lb of mercury emitted in neighboring states in the production of 11,169,946 MWh of electricity that were likely consumed in Minnesota.

1. Introduction - Air Toxic Pollutants in Minnesota

The Minnesota Pollution Control Agency (MPCA) is required to report to the Minnesota Legislature's Environment and Natural Resources Committees every two years on the air toxics program. Minn. Stat. §115D.15 and §116.925 requires this 1999 report to contain the following information:

- an analysis of the achievements, shortfalls and resource needs for implementing the MPCA's air toxics strategy;
- an analysis of the data collected from the MPCA's statewide monitoring and inventory program;
- an analysis of reductions in emissions of toxic air contaminants;
- an updated list prioritizing and categorizing facilities emitting toxic air contaminants; and
- the amount of mercury emitted in the generation of electricity.

The first report in 1995 presented MPCA's long-term air-toxics strategy and summarized the agency's activities in implementing the Clean Air Act Amendments (CAAA) of 1990. The report also described an indexing system that ranks chemicals with regard to their potential toxicity. The 1993 toxic-air-emission estimates for the principal sources in Minnesota and 1990 emission estimates for mercury were presented in the first report also. The 1997 report summarized the status of the various air programs in reducing emissions and implementing the CAAA, discussed improvements in estimating air emissions and Minnesota's involvement in the Great Lakes Regional Air Toxics Emissions Inventory, and presented available ambient monitoring data.

This report presents the agency's progress in implementing the air-toxics strategy, and the CAAA. The first chapter describes air-toxic pollutants — what they are; identification and regulation issues; an overview of the movement of toxics from their sources, through the environment, to living organisms; and a brief description of the U.S. Environmental Protection Agency (EPA) Cumulative Exposure Project (CEP). Achievements, shortfalls and resource needs of the current strategy are discussed and a new strategy is recommended in Chapter 2. A summary description of the air-toxics-monitoring networks in Minnesota and the trends in ambient air concentrations of selected air toxics can be found in Chapter 3. Chapter 4 includes information about emissions of air-toxics pollutants, emission inventories, and emission estimates and trends of air toxics. The EPA's statewide emissions estimate for particulate matter (PM) and volatile organic compounds (VOCs), which are closely related to air toxics, are briefly discussed in this chapter. Chapter 5 discusses mercury emissions, trends and related activities. Mercury is treated separately in this report because it has been the subject of a special reduction initiative and has been studied more intensively than other air toxics.

Chapter 4 also identifies the principal industrial sectors and the proportion they contribute to the emissions of selected pollutants. These industrial sectors either emitted the highest emissions on a mass basis or emitted the highest emissions based on toxicity and environmental persistence of the released chemicals. This method of categorizing sources of emissions replaces a list of specific facilities. MPCA staff are completing the estimates for point, area and mobile sources for the 1996

emission inventory. We anticipate that a complete air-toxic-emission inventory will be available by mid-1999.

1.1 Background - What Are Air Toxics?

Air toxics are chemicals that are known to cause, or are suspected of causing, cancer, neurological changes and reproductive problems. Air toxics may also impair immune function and/or disrupt endocrine function. In addition to human health impacts, air toxics may cause damage to natural ecosystems by negatively affecting population survival, biodiversity and sustainability of ecosystems.

Air toxics are emitted from a variety of sources, including mobile, stationary and area sources. Since a national, long-term monitoring-and-emissions-tracking program similar to that for criteria pollutants (carbon monoxide, nitrogen oxide, sulfur dioxide, particulate matter, lead and ozone) does not exist for air toxics, relatively little is known about their emissions and ambient air concentrations.

Examples of air toxics include semivolatile organic compounds (SVOCs), such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polychlorinated dibenzo-p-dioxins and furans (PCDD/PCDF); individual volatile organic compounds (VOCs); carbonyl compounds (CCs) and metals (e.g., mercury, chromium and arsenic).

The development of comprehensive data on air toxics is complicated by several factors: the number of chemical compounds involved; the number and variety of sources emitting the compounds; the low concentration of some toxics; and the potential for secondary formation of one toxic from other, often less toxic, compounds.

1.1.1 Identification and Regulation Issues

The CAAA (1990) identified 188 pollutants as hazardous air pollutants (HAPs) and targeted them for regulation in Title III, section 112(b). HAPs are a subset of air toxics identified by EPA for regulation. They are controlled and regulated differently than criteria pollutants:

- For air toxics, EPA has focused on identifying important emission-source categories and developing nationwide technology-based performance standards for those categories. The six criteria pollutants are regulated by National Ambient Air Quality Standards (NAAQS) and control strategies. There are no national ambient air standards for air toxics similar to NAAQS.
- There is no national air-quality monitoring program for air toxics similar to the nationwide network for criteria pollutants. As a result, ambient concentration data for air toxics are limited.
- Many air toxics are observed at lower ambient concentrations than criteria pollutants, often at or below detection limits of current monitoring instruments.

- Regulation of air toxics is relatively new compared to the longer-term, detailed work on criteria pollutants.

Nevertheless, criteria pollutants and air toxics are emitted together. Some air toxics are emitted in the form of particulate matter (PM) or are associated with particulates. Examples are toxic metals (mercury, arsenic, chromium, cadmium) or toxic organic compounds (dioxin, PCBs, PAHs). Air toxics may also be emitted as VOCs (benzene, acrolein, 1,3-butadiene). Control efforts to achieve NAAQS for ozone and particulate matter less than 10 microns (PM-10) also, as a side effect, reduce emissions of many air toxics mentioned above. For example, as pollution-control strategies for automobiles become more stringent, certain air-toxics emissions from motor vehicles drop. Similarly, emission requirements under the air-toxics program can also reduce emissions of criteria air pollutants (i.e., reduction of toxic volatile organic compounds helps reduce concentrations of ground-level ozone – and, therefore, smog formation). However, we should keep in mind that reducing the emissions of one pollutant may actually result in an increase in emissions of another pollutant.

1.1.2 Movement of Toxics from Their Sources, Through the Environment, to Living Organisms

It is important to understand the sources, reactions, transport, effects and fates of air toxics when they are released into the atmosphere, and migrate in and between various media of air, water, soil and living environments.

We must understand how these pollutants are going through physical, chemical and biological processes; how long they will remain in the environment; and, finally, the effects which they will have on the living organisms, including ourselves. This understanding is essential in order to assess the possible adverse ecological or human health effects from the release of toxics into the environment.

It is believed that over 60,000 chemicals are currently in commercial use, with approximately 1,000 being added each year. Of these, at least 500 are of great environmental concern because of: (1) their presence in detectable quantities in various environmental media; (2) their toxicity; (3) their tendency to bioaccumulate; and/or (4) their persistence in the environment. These pollutants are known to have the potential to cause ecological and biological damages. Thus, they are worthy of control and regulations. It should be noted that some pollutants, such as dioxins, PCBs, PAHs, petroleum and many solvents, are considered as one chemical in the list whereas, in reality, they represent hundreds of possible individual pollutants.

Nature of Multimedia Environment - It is useful to view the environment as consisting of a number of phases or compartments. Our simplest view of the environment includes atmosphere, surface water, water sediment, terrestrial soil, ground water and their related biota (plants and animals, including humans). Some compartments are adjacent. Thus, a pollutant may migrate between them

(e.g., air and water), while others are not in contact. Thus, the direct movement of toxics between them is not possible (e.g., air and ground water or sediment).

Atmosphere - The atmosphere is the point of entry to the environment for many pollutants, such as chemical vapors from industry or exhaust gases from cars. Within the atmosphere, many chemical processes can change the form and toxicity of pollutants. Some of these pollutants are gases, some are in the form of a suspension of small liquid or solid particles (called "aerosols" or "particulates") and some are dissolved in cloud vapor or raindrops.

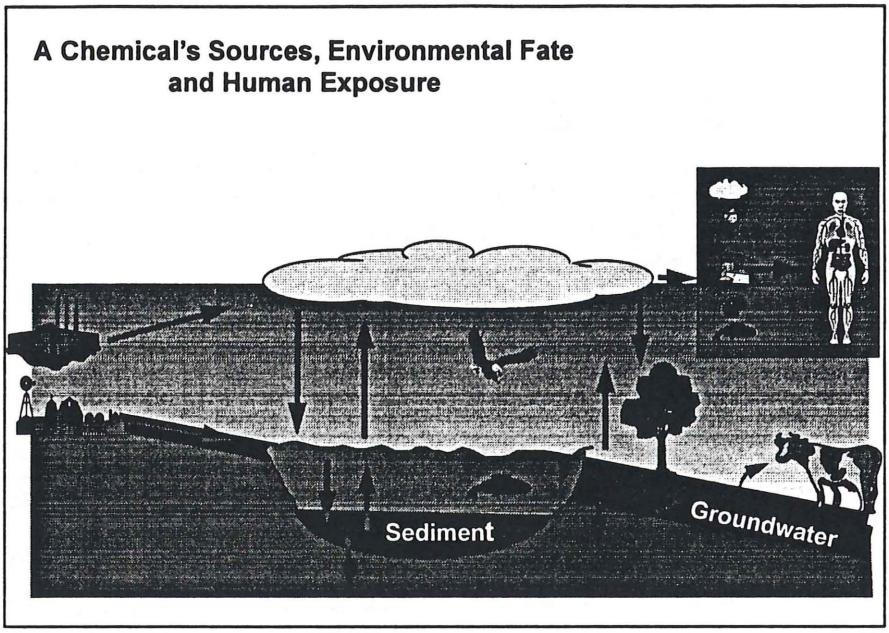
Air toxic pollutants may fall to the land or water by "dry deposition," or as the materials in the raindrops (or snowflakes), which is called "wet deposition." In this way, air pollution becomes water, ground water and soil pollution. Pollutants reach our bodies from the atmosphere either directly by inhalation or skin contact, or indirectly in food or water after the pollutant has fallen from the atmosphere to the land or water.

Water - The collection of all waters on Earth is called the "hydrosphere." Water is also an environmental media with similar capabilities to transport and transform environmental pollutants. Within the hydrosphere, water continually cycles from atmosphere as rain and snow, washes out to the water, seeps through the soil, reaches the ground water, and evaporates to the air again. Because many pollutants dissolve in water, the movement of water through the hydrosphere results in the movement of pollutants. Water can dilute pollution as well as transport it. Water may speed up chemical reactions among dissolved pollutants, which may change the toxicity of many pollutants. In summary, water, like air, is a medium in which pollutants are transported and chemically transformed. Some pollutants may pass through one additional medium, soil.

Soil - Since air toxics are generally emitted over land, they may leave the atmosphere as dry and wet deposition, entering the soil and terrestrial ecosystems. Pollutants in the soil may be transferred, transformed or taken up by plants and animals. Often pollutants in the soil will be flushed out by rain into water bodies, or seep through the soil to the ground water. They may even volatilize from the soil, back into the air. Finally, some soil pollutants, particularly certain toxic metals, may reside for hundreds of years in the soil because they are neither volatile, soluble nor accessible to living organisms.

Figure 1.1 summarizes the movement of toxic pollutants from their sources to our multimedia environment of air, water, sediment, soil and ground water. As shown in this figure, pollutants are subjected to many environmental processes. When they are released or discharged from their sources to the environment, they may disperse, dilute, and go through complex chemical, physical and biological processes, such as transportation, transformation, degradation, volatilization, dilution, partition and bioaccumulation. They may be taken up by plants or ingested by animals. They may move to another environmental media, may evaporate to the atmosphere, may break down to less or more toxic pollutants, or may return to earth by dry and wet deposition.

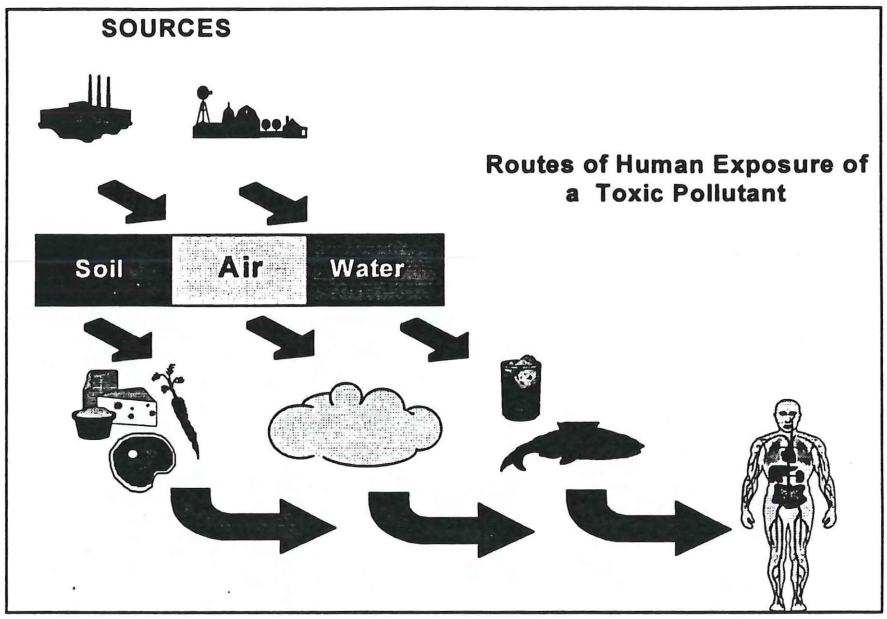
Figure 1.1 Fate and exposure pathways of toxic pollutants in the environment



1.1.3 Human health and ecological effects

Ultimately, our primary concern is the effects that air toxics may have on living organisms, particularly humans. Figure 1.2 shows the many factors that may impact human exposure to toxic pollutants.

Figure 1.2 Exposure pathways of toxic pollutants



At sufficient concentration and length of exposure, human health effects from toxic air pollutants may include cancer, poisoning and immediate acute illness. Other, less measurable effects include endocrine disruptive effects, and immunological, neurological, reproductive, developmental and respiratory problems. As shown in Figure 1.2, direct inhalation, absorption to forage plants, and bioaccumulation in plants and animals are all possible pathways of human exposure.

Air toxics may deposit onto soil or bodies of water and accumulate in vegetation or fish, ultimately finding their way into humans (via terrestrial or aquatic food chains). Bioaccumulative toxic chemicals may magnify up the food chain, each level accumulating toxics and passing them along to the next level. This is why large fish, by virtue of their position at the top of the aquatic food chain, may accumulate chemical concentrations many millions of times greater than concentrations present in the water. Recently, the EPA conducted a human health assessment of air toxics. This assessment project will be introduced and its preliminary results will be described in the following section of this report.

1.1.4 U.S. Environmental Protection Agency Cumulative Exposure Project (CEP)

The EPA is conducting an assessment of the effect on human health of toxic pollutants in the environment. The assessment, called the "Cumulative Exposure Project" (CEP), examines exposures to toxics in the air, in drinking water and food.

The MPCA is expecting that the first part of the study, estimating ambient levels of toxic air pollutants, will be completed and results potentially released by the EPA during 1999.

Preliminary results released by EPA to the states suggest that people across the country, including Minnesota, may have an elevated risk of cancer over a lifetime due to inhaling toxic air pollutants released primarily from motor vehicles.

In some areas of Minnesota, eight of the 148 pollutants studied by EPA were predicted to exist at levels higher than those estimated to be protective of public health. Seven of the eight chemicals of concern contribute to increased cancer risks, while the eighth chemical contributes to serious, noncancer health effects.

The seven pollutants that contribute to an increased cancer risk are 1,3-butadiene, arsenic, benzene, carbon tetrachloride, chromium, formaldehyde and nickel. The concentration of acrolein in Minnesota's atmosphere is above benchmark levels for noncancer health effects; that is, there is enough in the atmosphere to irritate the lungs and other mucous membranes.

The CEP study uses computer models and national emissions data to estimate air-toxics concentrations in each census tract of the country and then compares these concentrations to health-risk benchmarks. According to the CEP study, point sources account for the largest contribution of chromium, arsenic and nickel emissions in Minnesota, but toxics from cars and trucks are the largest contributors to acrolein, 1,3-butadiene, benzene and formaldehyde in the atmosphere. Overall, cars and trucks contribute about 53%, area sources contribute about 25%, and point sources contribute about 22% of the total estimated excess cancer risk from all air toxics.

A preliminary comparison of data from Minnesota's own air toxics monitoring network and other modeling studies indicates that EPA's CEP study results are realistic and may even underestimate potential concentrations. As described in Chapter 3 of this report, much of the presence of elevated concentrations of benzene and other pollutants monitored by the MPCA are a result of the use of gasoline in motor vehicles.

2. Achievements, Shortfalls and Resource Needs

According to data submitted by Minnesota companies, the amount of pollution released in Minnesota from point sources has decreased markedly over the last 10 years. Further, automobiles, also called "mobile sources," are no longer the major source of lead to the atmosphere, as leaded gasoline is no longer sold in the United States for use in automobiles.

The Minnesota Emergency Response Commission began collecting and reporting the amounts of toxics released to air, water and the land in 1987, and produces an annual Toxics Release Inventory (TRI). The amount of pollution released to the air as reported in the TRI, has decreased since 1987, the first year of the TRI, probably due to the public-reporting process. Section 4.4 discusses the trends of point emissions for selected compounds to the air.

The MPCA's current air-toxics strategy was developed in 1994. The strategy is centered on three objectives: (1) smooth, fair implementation of the Clean Air Act amendments of 1990, (2) protect public health and the environment and (3) collection of more information to make better decisions for air toxics programs (MPCA, 1994, 1995). The strategy was crafted to be flexible as new program requirements developed and as more information about toxics was gathered.

That flexibility has been important because, as federal regulations developed under the CAAA became effective, the MPCA found that the 1994 strategy was not meeting the needs of Minnesota's air quality program. While the three objectives have remained, the strategy has been revised every year since it was developed. The current strategy continues to focus on point sources for which the MPCA adopts emission limits and on sources that require air-emission permits.

In the past, environmental agencies, including the MPCA, focused most of their attention on reducing emissions of criteria pollutants from stationary sources, such as manufacturing facilities, utilities and waste incinerators. While the MPCA has known that very small air emissions sources could contribute to local air problems, the new research of the Cumulative Exposure Project, described earlier in this report, highlights the fact that cars, trucks and other very small sources are responsible for much more of the pollution than was previously believed. For this reason, urban sprawl and public transportation will be important in developing strategies for controlling and reducing air-toxics emissions.

Part 2.1 of this chapter describes the achievements and shortfalls of each part of the existing air-toxics strategy. Resource needs are addressed in part 2.1.4. The 1997 legislative report contains a description of each MPCA air-quality program element currently used to identify, measure and control air toxics releases. This information will not be repeated in this report.

2.1 Achievements and Shortfalls of the Existing Air-Toxics Strategy

2.1.1 Smooth, Fair Implementation of the Clean Air Act of 1990

This first objective of the air-toxics strategy recognizes that the EPA has been charged with developing a national air-toxics-control program that relies in great part on states adopting federal regulations, monitoring compliance and taking enforcement action where necessary. Since 1990, EPA has adopted a number of air-toxic-control regulations, termed National Emission Standards for Hazardous Air Pollutants (NESHAPs). The MPCA has adopted 22 of these standards into state rule, and will continue to incorporate federal standards as they are promulgated. No changes to this component of the strategy have been made since it was implemented in 1995.

Overall, the MPCA has encountered little difficulty in adopting federal NESHAPs. Some difficulty arises at affected facilities in complying with the federal NESHAPs after they are

adopted in the state, in part due to facilities needing to make changes to comply. Some NESHAP standards require installation of control equipment or process modifications, or have increased record-keeping and/or reporting requirements. More likely in Minnesota, an affected facility makes significant changes to its process to exempt itself from the standard altogether. This can be done by changing to less-polluting chemicals or by using less of the regulated chemical so that the standard doesn't apply. The result of the adoption of NESHAPs in Minnesota has been that point sources and certain area sources regulated by the NESHAPs are not significantly contributing to the air-quality problems we are concerned with today.

Future NESHAPs are not expected to affect cars and trucks nor area-wide emission sources. Some point sources in Minnesota may be affected by future NESHAPs, and the result of the NESHAP process may regulate pollutants other than the eight that are of concern in the CEP study.

Given our experience with facilities' efforts to comply with the new NESHAPs, the MPCA believes that for future NESHAPs, it is more cost effective to work with affected facilities to gain real reductions of emissions so they are not even subject to NESHAPs. If an emissions facility is not subject to the NESHAP, both the MPCA and the facility avoid the costs associated with permitting, control equipment, compliance monitoring, inspections and enforcement effort related to the control standard.

2.1.2 Protect Public Health and the Environment

The intent of this strategy objective was to have the MPCA conduct health-based reviews of the NESHAP standards developed by EPA since the NESHAPs are technology-based rather than health-based standards. The purpose of MPCA's review of the NESHAPs was to ensure that as Minnesota adopted NESHAPs, they were adequately protective of public health and the environment.

While this effort proved successful for the dry-cleaning-emission standard, MPCA soon realized that further work on this objective would be resource intensive and that generic studies for an industry sector could not accurately assess the residual risk from a specific facility. With this realization, MPCA discontinued work on reviewing individual NESHAPs for health protectiveness and informed the Legislature of this change in the agency's air toxics report of 1997. The MPCA continues to conduct facility-specific health reviews during environmental-assessment and air-quality-permitting activities.

During 1997 and 1998, the MPCA has completed air toxics facility reviews primarily for new and modified sources, Project XL and facilities for which MPCA has been made aware of community concerns. Currently, about 12 facilities are being evaluated for air toxics, which is a small portion of the total number of facilities receiving air permits. The review process itself has been, and continues to be, affected by a number of dynamic factors, such as improvements to EPA risk-assessment methodology, industry's needs and MPCA resources.

At times, the agency and affected facilities differ in their objectives. Industry is often limited by the time needed to acquire the permit necessary to implement operational changes, while MPCA's review process needs to meet public expectations of no significant impacts to human health and the environment. The Minnesota Department of Health (MDH) has established inhalation health risk values (HRVs) for evaluating the risk of harmful effects resulting from the inhalation of various air-toxic pollutants. HRVs are concentrations of chemicals or substances in the air that are estimated to produce no significant increased risk of harmful effects for specific lengths of exposure. When an ambient air concentration exceeds the HRV, there is less confidence that the exposure to the chemical is without risk to human health, and a closer look is justified. For some pollutants (e.g., formaldehyde), ambient air concentrations exceeded the proposed HRVs.

When using HRVs to evaluate a potential health risk, it is recommended that the agency follow the risk-assessment process formalized by the National Research Council (NRC). Risk assessments are science-based estimates of the human health risk faced by a population exposed to a particular substance. A risk assessment consists of identification of chemicals of potential concern (COPC), identification of health risk values for these chemicals, and characterization of risk faced by the exposed population.

Recently, the MDH developed health risk values for selected VOCs in ambient air for acute, subchronic or chronic inhalation exposure. The draft HRVs are available for the MPCA to use on an interim-guidance basis.

The MDH continues work on the rule-making for the HRVs. MDH is currently in the process of re-evaluating the acute HRVs and intends to move forward with the HRVs, including a subset of the acute HRVs, by this summer (1999).

The MPCA has formed, along with interested parties; a task force to evaluate how HRVs should be applied in pollution-control activities.

Although written guidance is being developed for the air-toxics-review process, MPCA and interested parties have contributed substantial time and discussion on the issues and have made limited progress toward agreement as to what procedures to follow. In spite of difficulties in conducting air toxics facility reviews and limitations of the program, past reviews have been worthwhile. These reviews have frequently resulted in changes that decrease toxic air emissions in a proposed project that otherwise might not have been considered during the permitting process.

2.1.3 Collect Information

The existing strategy calls for the MPCA to amend its rules to develop an inventory of air-toxics emissions, as well as to establish a statewide air-monitoring program for toxics.

Chapter 3 of this report describes the various monitoring programs and their results. One of these is the statewide air-toxics monitoring program. This program was designed to provide the MPCA with baseline data for ambient air concentrations of selected toxic air pollutants in urban, suburban and rural locations. Data collection began in September 1996. Tables 3.3 and 3.4 present preliminary data from the first two years of this study. The MPCA will need to complete a comprehensive statistical analysis and compare the results with health benchmarks to fulfill the objectives of this study. Some of these data are already being used to confirm EPA's and the MPCA's computer model analyses used to predict air pollutant concentrations. Because the CEP study has postulated that 1,3-butadiene contributes to the estimated excess cancer rates in urban areas of Minnesota, the MPCA began analyzing air samples for this chemical in January 1999.

Ambient air monitoring needs to be conducted over time in order to determine the amount of pollution in the air. Air monitoring can also be very costly, depending on the chemical being examined. Due to these resource limitations, computer modeling is often substituted for monitoring actual environmental conditions. Therefore, it is important to continue to conduct ambient monitoring to confirm computer models' predictive abilities, as well as to measure the state of the environment.

Ambient air data must then be examined against the current understanding of how humans and wildlife are exposed to the pollutants, and whether their exposure might result in impaired health. The MPCA is reviewing its existing resources, and is considering ways of assigning existing staff to do this work.

The MPCA has made progress in developing an accurate air-toxics-emissions inventory throughout the life of the current strategy, although progress has been slowed because of opposition from potentially regulated parties. Chapter 4 describes the existing emission inventory programs, the efforts and progress on these programs. Having accurate air-toxics-emission inventory is becoming more important than ever, given the rising importance of area sources and cars and trucks in air-quality-protection issues. All sources of air-toxics emissions need to be better characterized so that future regulatory responses are proportional and appropriate.

Further, having an inventory in and of itself can motivate reductions of air toxics, as the Toxic Release Inventory is demonstrating. Awareness of the amount of toxics released by companies has caused companies to try to eliminate air-toxic releases. For example, some companies have changed manufacturing processes, chemical use and even housekeeping practices to minimize air-toxic releases from solvents.

2.1.4 Resource Needs

Although continued work is still needed, progress has been made in understanding and addressing air-toxic problems in Minnesota using existing resources. These include a growing emission inventory, monitoring of the ambient and urban air networks and continued

implementation of NESHAPS. One of the areas where we have not been as successful is reaching a common understanding among all parties on how to assess risks for facility-specific air toxics. Also, issues regarding the cumulative impacts of air toxics and sources identified during recent court cases as well as the results of the CEP project have indicated other areas where increased work and resources are needed.

Our 2000/01 budget continues to fund the current program, focusing on continued efforts to improve the accuracy of emission estimates, collecting high-quality monitoring data, developing new ways to approach air toxic facility reviews, and beginning to address the issue of cumulative impacts. One of the results of assessing available data as well as developing new information is a need to reevaluate our strategy, priorities and where we spend our resources. This is discussed in the next section. Rather than identifying and requesting additional resources now, we believe it is beneficial to take a comprehensive look at the issue and then identify any additional resources that are needed.

2.2 A New Strategy Is Needed

The MPCA's current air-toxic strategy is working to minimize health and environmental impacts from point sources. The success of these programs can be seen in the emissions reductions that have been achieved for a number of pollutants. However, because both the CEP study and the MPCA's modeling suggest that a far larger proportion of cancer risk comes from sources not traditionally regulated by the MPCA, the MPCA should undertake an effort to revise the current strategy.

Historically, the MPCA has focused its program resources on air emission releases from point sources, in part because point sources have accounted for the release of the bulk of the pollutants for which federal and state ambient-air-quality standards were originally developed. The MPCA has in a few instances developed regulatory policies and standards for area sources, but until recently has not routinely dealt with small, ubiquitous sources. Further, the MPCA has not traditionally taken an active role in transportation and land-management issues.

Many federal programs have unfolded in the eight years since the Clean Air Act was signed into law. These programs appear to be causing reductions in the amount of air pollution released from point sources. The air-toxics strategy should be revised to account for these developments, so that the MPCA does not duplicate efforts already under way or completed at the federal level.

Because much of the information of the CEP study and the ambient monitoring is new, the MPCA is not at this point prepared to describe the specifics of how its air-toxics strategy might be revised. In order to craft an appropriate strategy, the MPCA must undertake a highly collaborative effort with other parties traditionally involved with transportation issues, land-use planning and community development. The MPCA began this process in January 1999 by forming an internal work-team. The work-team will further evaluate the results of the CEP study, the MPCA's ambient air monitoring, and other trends information to better define this

toxics problem and design a citizen-participation process. The internal work-team is expected to provide further recommendations after several months. The MPCA intends that this team's efforts will lay a foundation for developing a revised overall air-toxics strategy.

Future strategies need to respond to the results of ongoing ambient-air-quality monitoring, be it further monitoring, source identification efforts or even regulatory controls. The MPCA believes that within a year it will be able to give due consideration to these issues and construct a new air-toxics strategy. The new strategy will address the issues we know about today, provide flexibility in the strategy to allow for changes as new information is collected and include input from any Minnesotan or entity that is affected by the air-toxics problem or the solution to the problem.

2.2.1 A New Strategy Should Be Incorporated into the MPCA's Self-Assessment Process

A process for the ongoing strategizing, implementation and evaluation of air-toxics programs has been recently built into the MPCA's overall programmatic process, and should be relied on to assess the effectiveness of any air-toxics strategy.

EPA Region 5 and the MPCA entered into an Environmental Performance Partnership Agreement (EnPPA) (MPCA and U.S. EPA Region 5, 1997). This agreement addresses the roles and responsibilities of the MPCA and EPA in protecting Minnesota' environment for the period of October 1, 1997 to June 30, 1999. The agreement resulted from an initiative begun by EPA and the Environmental Council of States (ECOS) to direct scarce state and federal resources toward the most pressing environmental needs of the states. It was also designed to provide states with flexibility in how they achieve environmental results and enhance their accountability in achieving environmental progress.

This agreement attempts to describe the comprehensive collection of programs administered by the MPCA. It is not limited to those federal programs the MPCA administers on behalf of EPA with its oversight, but includes those programs initiated at the state level that do not have associated federal programs. The purpose of including the state programs is to provide a more complete picture of the environmental-protection activities occurring in Minnesota for which the MPCA has responsibility. The agreement, among a number of other measurements, includes an annual self-assessment to be submitted to EPA each fiscal year.

The EnPPA is designed to be forward-looking, and is already taking into account some of the issues raised by the new information the MPCA has collected in this last year. One part of meeting the goal of "clean, clear air" is the protection of human health and the environment from the effects of hazardous air pollutants.

Because the EnPPA is designed to be a tool to measure the effectiveness of the MPCA's programs, and because that is the intent of the statute requiring the preparation of this biennial

report, the MPCA will consider including the revised air-toxics strategy and this report requirement in its 1999 EnPPA.

3. Air-Toxics Monitoring in Minnesota

In Minnesota, as in many other states, there was a movement in the mid- to late 1980s to assess air-toxic pollutants and their potential impacts on human health and the environment. After evaluating the cost of a multi-year monitoring program, the MPCA chose to purchase its own sampling and laboratory analytical equipment. By upgrading sampling and laboratory analysis capabilities, the agency was able to establish monitoring networks in downtown Minneapolis, St. Paul and Duluth. Additional funding from industrial sources allowed the agency to expand monitoring to industrial areas of Pine Bend, St. Paul Park and Newport.

In addition to the MPCA's monitoring efforts, other studies are collecting information on air toxics in Minnesota, and these are described below. This section of the report describes the air-toxics-monitoring programs the MPCA currently conducts in Minnesota.

3. 1. Current Air-Toxics Monitoring Networks in Minnesota

Currently, four networks collect data and information on toxic air pollutants:

- MPCA Statewide Air Toxics Monitoring Study, which has two components:
  - (1) ambient air toxics monitoring, which will be described in this section, and
  - (2) mercury deposition monitoring, which is discussed in Chapter 5.
- MPCA Pine Bend Monitoring Network;
- MPCA Urban Air Toxics Monitoring Network; and
- Binational Integrated Atmospheric Deposition Network.

3.1.1 Statewide Air Toxics Monitoring Study

In 1993, the Legislature passed Minn. Stat. §116.454, authorizing the MPCA to initiate a statewide air-toxics-monitoring network. In 1995, the Legislature approved an increase in the Air Quality Division's budget to conduct the statewide program. For the first five years, the program will sample air at network sites for selected hydrocarbons (HCs), including VOCs and carbonyl compounds, as well as particulate metals. Table 3.1 lists the VOCs, carbonyl compounds and particulate metals included in the study.

This screening-level study, begun in September 1996, provides the MPCA with "baseline" ambient-air-concentration data for selected toxic-air pollutants from randomly selected rural, small town, small/medium city and large city locations. Each site is monitored for 365 days. Table 3.2 and Figure 3.1 list the sites and their geographic distribution. At the end of the five-year period, a final report will be issued.

Table 3.1 VOCs (A), carbonyl compounds (B) and particulate metals (C) included in the MPCA's Statewide Air Toxics Monitoring Study

A. Volatile organic compounds determined by EPA method TO-14.

1) benzene	13) 1,2-dichloropropane	25) 1,1,1-trichloroethane
2) bromomethane	14) cis-1,3-dichloropropene	26) 1,1,2-trichloroethane
3) carbon tetrachloride	15) trans-1,3-dichloropropene	27) trichloroethene
4) chlorobenzene	16) 1,2-dichloro-1,1,2,2 tetrafluoroethane	28) trichlorofluoromethane
5) chloroform	17) ethylbenzene	29) 1,2,4-trimethylbenzene
6) m-dichlorobenzene	18) ethylene dibromide	30) 1,3,5-trimethylbenzene
7) o-dichlorobenzene	19) freon 113	31) o-xylene
8) p-dichlorobenzene	20) hexachloro-1,3-butadiene	32) m & p-xylene
9) 1,1-dichloroethane	21) styrene	33) vinyl chloride
10) 1,2-dichloroethane	22) 1,1,2,2-tetrachloroethane	34) vinylidine chloride
11) cis-1,2-dichloroethylene	23) tetrachloroethylene	35) 1,3-butadiene
12) dichloromethane	24) toluene	

B. Carbonyl compounds determined by EPA method TO-11.

1) acetaldyhyde	3) benzaldehyde	5) crotonaldehyde	7) propionaldehyde
2) acetone	4) butyraldehyde	6) formaldehyde	

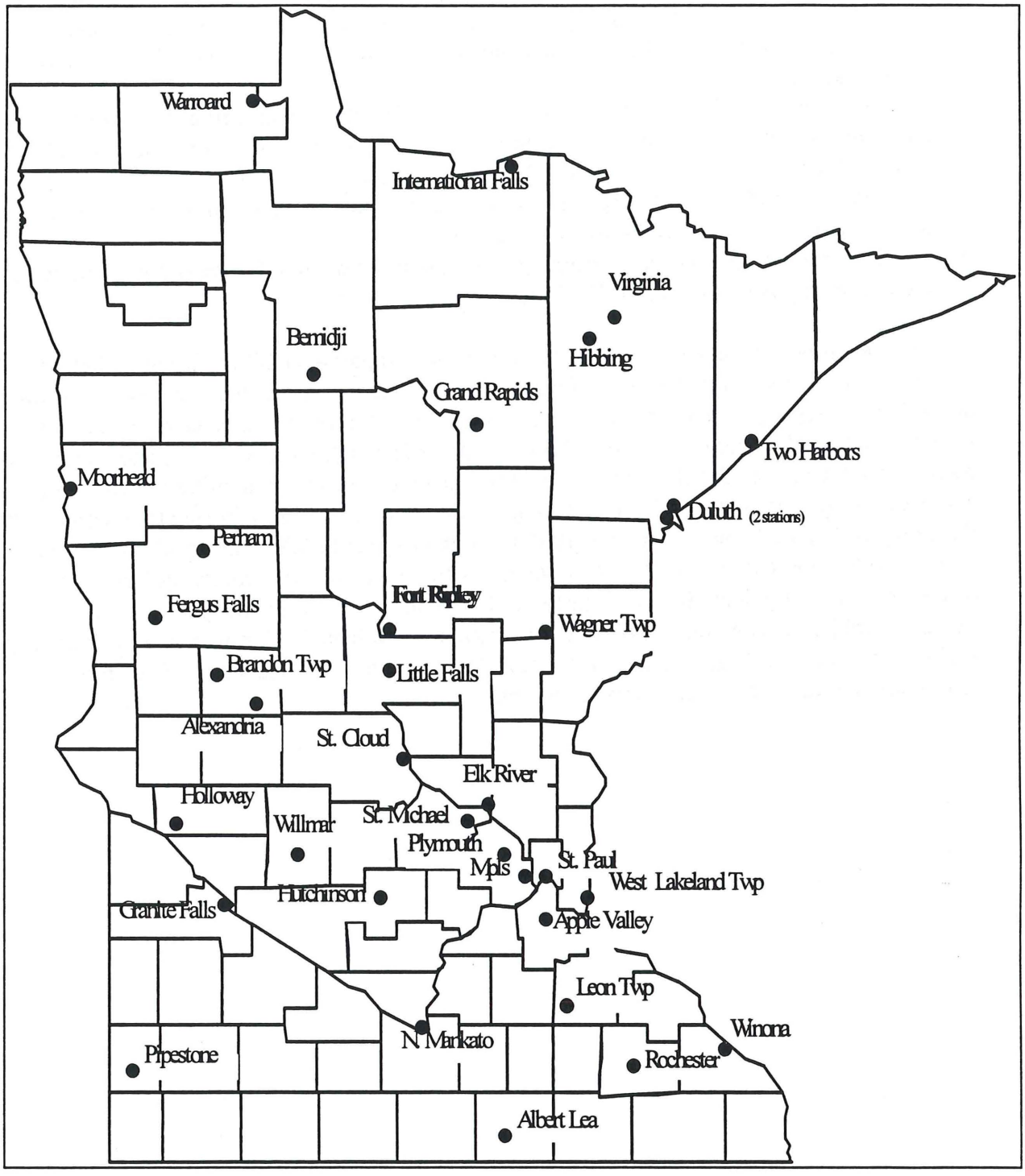
C. Particulate metals and other compounds determined by X-ray fluorescence analysis.

METALS	METALS	CRUSTAL ELEMENTS	RARE EARTH	OTHER
Antimony (Sb)	Mercury (Hg)	Aluminum (Al)	Gallium (Ga)	Barium (Ba)
Arsenic (As)	Molybdenum (Mo)	Calcium (Ca)	Indium (In)	Boron (B)
Beryllium (Be)	Nickel (Ni)	Iron (Fe)	Lanthanum (La)	Bromine (Br)
Cadmium (Cd)	Silver (Ag)	Potassium (K)	Palladium (Pa)	Chlorine (Cl)
Chromium (Cr)	Tin (Sn)	Sodium (Na)	Rubidium (Rb)	Phosphorus (P)
Cobalt (Co)	Titanium (Ti)		Strontium (Sr)	Selenium (Se)
Copper (Cu)	Vanadium (V)		Yttrium (Y)	Sulfur (S)
Lead (Pb)	Zinc (Zn)		Zirconium (Zr)	
Manganese (Mn)				

Table 3.2 Statewide Air Toxics Monitoring Study: list of sites over the five years of monitoring

	SAMPLE YEAR				
MPCA REGION	**1**	**2**	**3**	**4**	**5**
REGION 1 DULUTH	Wagner Township, Aitkin County	Hibbing, St. Louis County	Duluth, St. Louis County	Virginia, St. Louis County	Duluth, St. Louis County
REGION 2 BRAINERD	Little Falls, Morrison County	Elk River, Sherburne County	St. Cloud, Stearns County	St. Michael, Wright County	Fort Ripley, Crow Wing County
REGION 3 DETROIT LAKES	Alexandria, Douglas County	Fergus Falls, Otter Tail County	Brandon Township, Douglas County	Perham, Otter Tail County	Moorhead, Clay County
REGION 4 MARSHALL	Pipestone, Pipestone County	Granite Falls, Yellow Medicine County	Holloway, Swift County	Hutchinson, McLeod County	Willmar, Kandiyohi County
REGION 5 ROCHESTER	Leon Township, Goodhue County	Rochester, Olmsted County	Winona, Winona County	Albert Lea, Freeborn County	North Mankato, Nicollet County
REGION 6 TWIN CITIES	Plymouth, Hennepin County	Minneapolis, Hennepin County	West Lakeland Township, Washington County	St. Paul, Ramsey County	Apple Valley, Dakota County
ADDITIONAL SITES FOR BETTER GEOGRAPHIC COVERAGE	International Falls, Koochiching County	Warroad, Roseau County	Bemidji, Beltrami County	Silver Bay, Lake County	Grand Rapids, Itasca County

Figure 3.1 MPCA Statewide Air-Toxics-Monitoring Network



The air-toxics ambient air monitoring, which is conducted in communities throughout Minnesota, has four major objectives:

1. Characterize ambient air concentrations and deposition rates of VOCs and particulate metals in rural and urban/suburban atmospheres and their seasonal variation in order to obtain baseline concentrations. The baseline concentrations will act as benchmarks for future comparisons.
2. Compare concentrations of specific VOCs and particulate metals at rural and urban/suburban sites with (a) other rural and urban/suburban areas in a similar part of the state and (b) other rural and urban/suburban areas in a different part of the state.
3. Provide a means for prioritizing future work and sampling in a more in-depth and pollutant-specific and/or source-specific basis in local areas.
4. Provide data for a preliminary screening assessment of potential health and environmental risks from exposure to selected VOCs and particulate metals.

Many toxic air pollutants are present in the atmosphere at parts-per-billion levels or below. A common assumption is that concentrations of these pollutants are less in small towns and rural areas than in metropolitan areas. Air-toxics monitoring will provide a means for testing this assumption by collecting baseline data for ambient air concentrations of VOCs and particulate metals. Tables 3.3 and 3.4 show the range of the statewide air-toxics-monitoring data (minimum and maximum) for selected pollutants during the first two years of monitoring (September 1996 through October 1997, and September 1997 through October 1998). These pollutants were selected to be reported on here, based on levels measured relative to toxicity indices, or high concentrations in ambient air. Since air toxics are monitored for only one year at each site, the trends of ambient concentrations of air toxics cannot be evaluated. The agency will statistically analyze and evaluate these data in order to fulfill the objectives of this study. Therefore, in this report only the range of the raw data is presented.

Tables 3.3 Statewide Air-Toxics-Monitoring Data (ig/m^3) for selected pollutants: 1996-1997

MONITORING SITES	Plymouth		International Fall		Wagner Township		Alexandria		Little Falls		Pipestone		Leon Township		Holman Field St. Paul		Library Minneapolis	
SELECTED AIR TOXICS (detection limit, ppb)	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
Formaldehyde (0.15)	0.136	5.967	0.132	4.132	0.170	3.923	0.102	3.855	0.152	3.154	0.211	3.696	0.166	3.494	0.678	4.672	1.237	8.188
Acetaldehyde (0.006)	0.181	2.912	0.031	2.692	0.084	1.270	0.222	2.094	0.086	1.766	0.114	1.756	0.128	1.797	0.447	3.369	0.640	3.122
Dichloromethane (0.017)	0.098	3.318	0.000	2.364	0.053	1.801	0.064	0.768	0.057	1.415	0.053	4.078	0.079	14.648	0.083	14.258	0.174	12.537
Bromomethane (0.006)	0.042	0.655	0.038	0.186	0.051	0.601	0.047	0.444	0.025	0.241	0.042	0.398	0.051	0.317	0.025	0.613	0.030	1.751
trans-1,3-dichloropropene (0.06)	0.000	0.316	0.000	1.616	0.000	0.356	0.000	0.776	0.000	0.400	0.000	0.737	0.000	0.465	0.000	0.994	0.000	0.386
cis-1,3-dichloropropene (0.02)	0.000	0.124	0.000	1.078	0.000	0.158	0.000	0.346	0.000	0.242	0.000	0.371	0.000	0.129	0.000	0.232	0.000	0.326
Benzene (0.022	0.484	6.089	0.518	7.011	0.198	1.705	0.414	3.267	0.212	2.439	0.237	2.147	0.202	1.663	0.532	5.501	0.967	6.231
Toluene (0.009)	0.550	15.510	0.640	12.838	0.259	2.192	0.570	5.372	0.562	5.241	0.636	6.382	0.443	2.245	0.532	5.501	1.995	22.668
Styrene (0.01)	0.102	0.928	0.070	0.826	0.042	0.858	0.084	0.362	0.060	26.411	0.084	13.890	0.042	0.353	0.246	2.218	0.135	1.614
Carbon tetrachloride (0.015)	0.84	1.302	0.788	1.144	0.877	1.19	0.822	1.31	0.836	1.247	0.863	1.309	0.884	1.144	0.699	1.233	0.678	1.247
Antimony (0.015)	-0.007	0.074	-0.007	0.046	-0.003	0.054	-0.007	0.039	-0.008	0.034	-0.006	0.049	-0.008	0.044	-0.008	0.066	-0.007	0.049
Arsenic (0.005)	0.000	0.002	0.000	0.003	0.000	0.003	0.000	0.004	0.000	0.004	0.000	0.004	0.000	0.006	0.000	0.011	0.000	0.006
Cadmium (0.016)	-0.004	0.011	-0.003	0.010	-0.004	0.010	-0.004	0.008	-0.003	0.017	-0.003	0.013	-0.003	0.013	-0.003	0.025	-0.003	0.001
Nickel (0.002)	-0.002	0.002	-0.001	0.001	-0.002	0.002	-0.001	0.003	-0.001	0.002	-0.002	0.002	-0.001	0.002	-0.003	0.025	-0.001	0.010
Chromium (0.002)	0.000	0.003	0.000	0.003	0.000	0.005	-0.001	0.005	-0.001	0.003	0.000	0.006	0.000	0.003	0.000	0.007	0.000	0.005

Table 3.4 Statewide Air Toxics Monitoring Study data (ig/m^3) for selected pollutants: 1997-1998

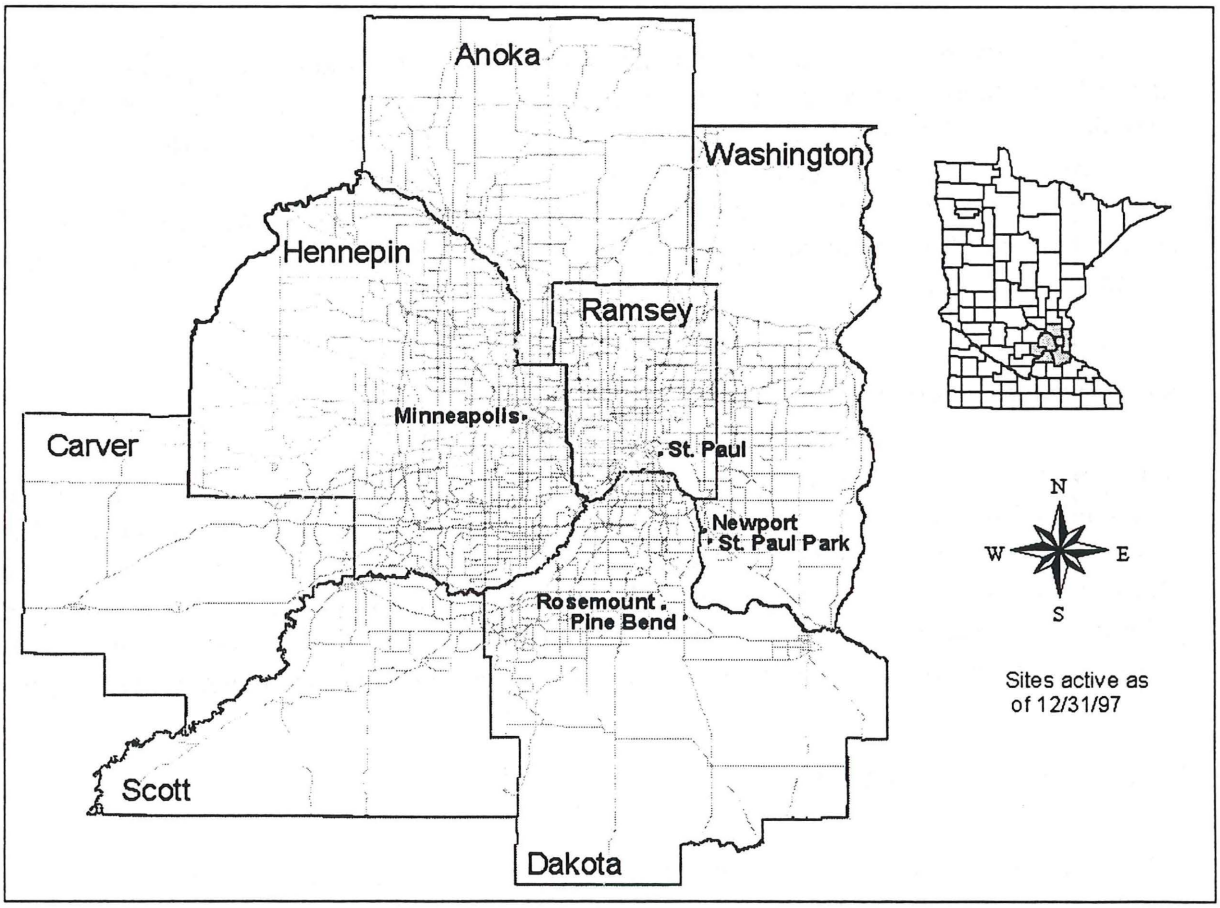
MONITORING SITES	Minnehaha Academy		Fergus Falls		Warroad		Elk River		Granite Falls		Rochester		Hibbing		Holman Field St. Paul		Minneapolis Library	
SELECTED AIR TOXICS (detection limit, ppb)	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Formaldehyde (0.15)	0.495	11.814	0.562	3.843	0.254	5.979	0.288	4.551	0.494	21.997	0.395	3.119	0.453	5.756	0.667	3.378	0.998	7.028
Acetaldehyde (0.006)	0.387	3.893	0.449	5.888	0.151	1.795	0.253	3.108	0.416	2.998	0.328	1.974	0.228	2.498	0.361	2.353	0.746	3.190
Dichloromethane (0.017)	0.095	2.266	0.000	5.066	0.030	0.496	0.061	2.304	0.068	0.897	0.076	0.613	0.042	1.025	0.057	1.343	0.098	3.348
Bromomethane (0.006)	0.000	2.254	0.000	0.123	0.000	0.106	0.000	0.161	0.000	0.338	0.013	0.123	0.000	0.106	0.000	0.199	0.000	1.294
trans-1,3-dichloropropene (0.06)	0.000	0.321	0.000	0.326	0.000	0.425	0.000	0.440	0.000	0.880	0.000	0.489	0.000	0.455	0.000	0.415	0.000	0.657
cis-1,3-dichloropropene (0.02)	0.000	0.178	0.000	0.089	0.000	0.040	0.000	0.133	0.000	0.114	0.000	0.237	0.000	0.173	0.000	0.104	0.000	0.114
Benzene (0.022	0.383	5.146	0.595	3.003	0.198	2.122	0.379	3.149	0.244	7.254	0.477	2.502	0.428	3.194	0.369	3.201	0.658	6.231
Toluene (0.009)	0.743	11.972	0.796	7.991	0.337	4.638	0.398	6.181	0.480	3.099	0.694	7.654	0.747	11.492	0.845	12.727	1.818	22.668
Styrene (0.01)	0.051	1.327	0.000	0.520	0.000	0.181	0.000	1.290	0.023	0.394	0.000	0.854	0.014	0.464	0.023	0.677	0.074	1.614
Carbon tetrachloride (0.015)	0.548	1.110	0.562	1.226	0.548	1.199	0.569	1.103	0.233	1.090	0.582	1.131	0.486	1.124	0.713	1.172	0.555	1.124
Antimony (0.015)	-0.006	0.022	-0.012	0.014	-0.013	0.078	-0.007	0.025	-0.009	0.026	-0.007	0.035	-0.012	0.010	-0.011	0.027	-0.011	0.014
Arsenic (0.005)	-0.001	0.028	0.000	0.045	-0.002	0.046	0.000	0.065	0.000	0.072	-0.001	0.075	0.001	0.118	0.001	0.051	0.000	0.905
Cadmium (0.016)	-0.031	0.024	-0.038	0.033	-0.055	0.016	-0.036	0.013	-0.036	0.096	-0.029	0.035	-0.027	0.029	-0.033	0.022	-0.041	0.022
Nickel (0.002)	0.000	0.463	-0.002	0.502	-0.001	0.748	-0.001	0.759	-0.001	1.064	-0.001	0.358	-0.002	1.547	-0.001	0.995	0.000	1.285
Chromium (0.002)	-0.001	0.002	-0.001	0.003	-0.001	0.003	-0.001	0.002	-0.001	0.001	0.000	0.001	-0.001	0.003	-0.001	0.005	0.000	0.018

3.1.2 MPCA Pine Bend Monitoring Network

The Pine Bend Monitoring Network was established in the fall of 1990 to monitor the ambient-air quality in an industrial area of Dakota County (urbanized southeastern quadrant of the Twin Cities metropolitan area). The initial objective of the network was to answer questions about the air quality near Minnesota's largest refinery. Currently, five active sites are in the network (Figure 3.2).

Each site is equipped with a sampler for monitoring selected toxic hydrocarbons (HCs), including a number of VOCs and carbonyl compounds (such as formaldehyde). The agency has issued quarterly reports since the start of this project in 1990. The reports include summaries of mean and maximum concentrations of pollutants. They also focus on identification of likely source-receptor pairs and the relative influence of nearby VOC sources on observed concentrations.

Figure 3.2 MPCA Pine Bend Monitoring Network



3.1.3 MPCA Urban Air-Toxics-Monitoring Network

The MPCA operates another monitoring network for VOCs similar to the Pine Bend Network, the Urban Air Toxics Monitoring Network. The network's locations include:

- Holman Field (airport) near downtown St. Paul (one site);
- Minneapolis Public Library, near downtown Minneapolis (one site);
- City of Duluth, harbor area (one site); and
- International Falls (one site).

Ambient-air samples are collected and analyzed for the same hydrocarbons (VOCs and carbonyl compounds) as are analyzed for Pine Bend. Data collected for this study can be compared with similar data collected from Pine Bend.

3.1.4 Binational Integrated Atmospheric Deposition Network (IADN)

The United States-Canada IADN is not funded by the MPCA, and is under the jurisdiction of the International Joint Commission (IJC). The purpose of the IADN is to evaluate the importance of the atmospheric pathway in the deposition of persistent toxic pollutants to the Great Lakes. It is designed to monitor regional deposition at rural and remote sites.

The IADN provides data to all partners on ambient air concentrations and deposition of persistent and/or bioaccumulative pollutants. As an example, a monitoring site near Finland, Minnesota, provides limited data for northeastern Minnesota. This site is maintained by the Ontario Ministry of Environment. Data collected at the Brule River site in northwestern Wisconsin could, however, be extrapolated to part of east-central Minnesota. This means that data for some persistent and/or bioaccumulative toxic air pollutants and other chlorinated compounds can be obtained through the IADN.

3.2 Trends in Ambient Air Concentrations of Selected Air Toxics

Since 1990, the MPCA has monitored a variety of volatile toxic-air pollutants in an industrialized area south of the City of St. Paul (Pine Bend Monitoring Network). Similar monitoring data are collected at three urban locations, including the Minneapolis Public Library, near downtown Minneapolis; Holman Field (airport) near downtown St. Paul; and the City of Duluth. Three pollutants were selected to be reported on here, based on levels measured relative to toxicity indices (formaldehyde and benzene) and relatively high concentrations in ambient air (toluene).

3.2.1 Formaldehyde (HCHO)

Formaldehyde and other aldehydes are major byproducts of combustion processes. Formaldehyde is used in the production of certain plastics and as a fungicide and preservative

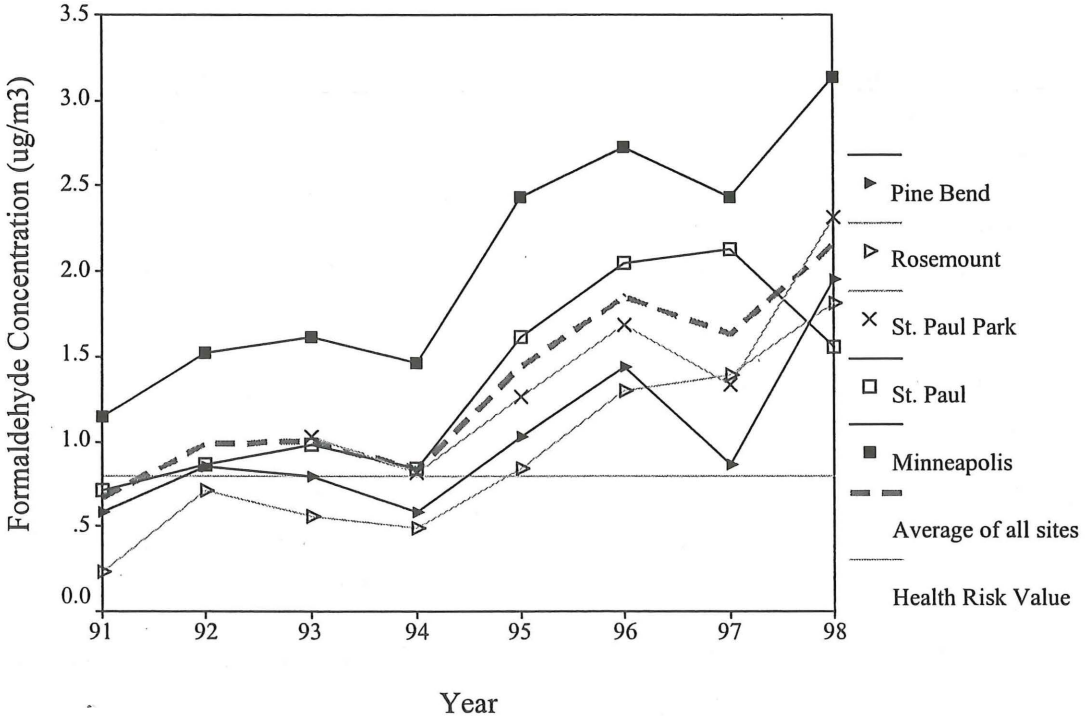
(formaline is an aqueous solution of formaldehyde). Formaldehyde is emitted in the exhaust of alcohol-fueled vehicles and has been detected in the exhaust of diesel vehicles. Ambient levels of formaldehyde are a result of these source emissions and photochemical reactions in the atmosphere.

Formaldehyde is a strong irritant to mucous membranes, causing eye irritation, runny nose, sinus congestion, shortness of breath, chest pain, headaches and more. Recently, the Minnesota Department of Health (MDH) developed health risk values (HRVs) for selected VOCs in ambient air for acute, subchronic or chronic inhalation exposure. The draft HRVs are available for the MPCA to use on an interim-guidance basis. The proposed chronic HRV for formaldehyde with potential carcinogenic effects is 0.80 $\mu g/m^3$. The proposed acute (one-hour) HRV is 60 $\mu g/m^3$.

Figure 3.3, shows the 1991-1998 annual values (median) of ambient air concentrations of formaldehyde at selected monitoring sites, including St. Paul, Minneapolis, Pine Bend, Rosemount and St. Paul Park. The average of the annual values (by year, across sites) is plotted as a dashed line. A horizontal line was added at the proposed chronic HRV of 0.8 $\mu g/m^3$ for formaldehyde. Any line crossing the horizontal line is an exceedance indicating that levels of formaldehyde are higher than levels estimated to be protective of public health.

As shown, the highest values of formaldehyde were observed at downtown Minneapolis and downtown St. Paul. For all sites (except St. Paul), the highest concentrations were observed in 1998. During the entire monitoring period, the monitoring data show a steady increase in ambient air concentrations of formaldehyde. However, because of a change in sampling method since 1995, it is difficult to accurately assess the trend.

Figure 3.3 Trends in annual values of formaldehyde concentrations in Minnesota: 1991-1997



3.2.2 Benzene (C_6H_6)

Benzene's main uses are as a constituent of gasoline (which contains up to 5% benzene by volume) and as a raw material in the chemical industry. Benzene is an effective replacement for lead in gasoline, raising the octane level of unleaded fuel. As the use of lead in gasoline is phased out, more benzene is being used and, therefore, being emitted into the atmosphere throughout the production, distribution and marketing of gasoline, as well as through operation of gasoline-powered motor vehicles and off-road equipment (lawnmowers, snowmobiles, aircraft, railroad locomotives, etc.). Smaller sources of benzene include burning coal and oil; use of industrial solvents; manufacture of detergents, plastics and resins; paints and coatings; food processing and photographic chemicals; and in coal-processing.

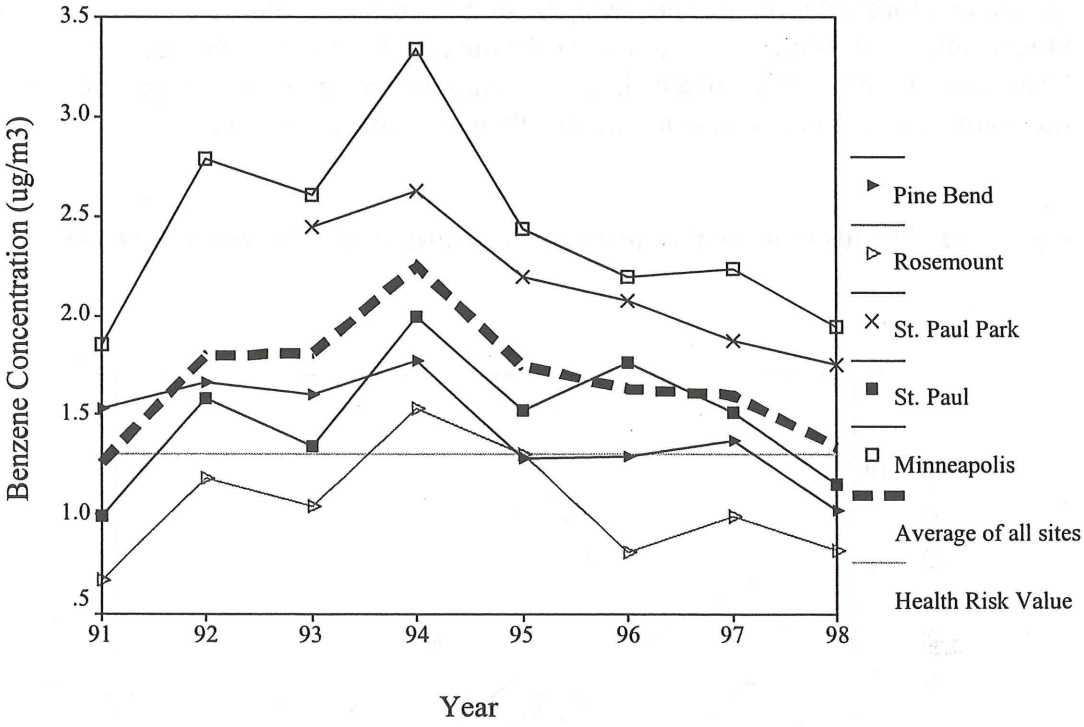
In Minnesota, the primary sources of benzene are petroleum refining, fossil fuel combustion, motor vehicles and evaporation from gasoline service stations.

Acute exposure via inhalation or ingestion of benzene affects the central nervous system, resulting in headaches, dizziness, nausea, convulsions, coma and possibly death. Chronic

exposure can result in anemia, changes in production of red and white blood cells in the bone marrow and other effects on blood.
The proposed chronic HRV for benzene with potential carcinogenic effects is 1.3-4.5 $\mu g/m^3$.

In Figure 3.4, annual median ambient air concentrations of benzene for 1991-1998 are compared with the proposed chronic HRV. The monitoring sites included are Pine Bend, Rosemount, St. Paul Park, St. Paul and Minneapolis (see Figure 3.2). The average of the annual median values at each site are connected with a dashed line. A horizontal line was added at 1.3 $\mu g/m^3$, the lower of the range of 1.3-4.5 $\mu g/m^3$.

Figure 3.4 Trends in annual values of benzene concentrations in Minnesota: 1991-98



As shown in Figure 3.4, although the ambient air concentrations of benzene appear to have decreased over time, at most sites, its concentrations were above the health risk value of 1.3 $\mu g/m^3$. During the entire period, the metro sites, particularly the Minneapolis site, show the highest value for benzene, probably due to mobile sources. The Rosemount site, located primarily upwind of and further away from a refinery, has lowest concentrations of benzene. The Pine Bend site, which is close to and downwind of the refinery, shows higher concentrations for benzene than Rosemount. For all sites, the highest concentrations were observed in 1994.

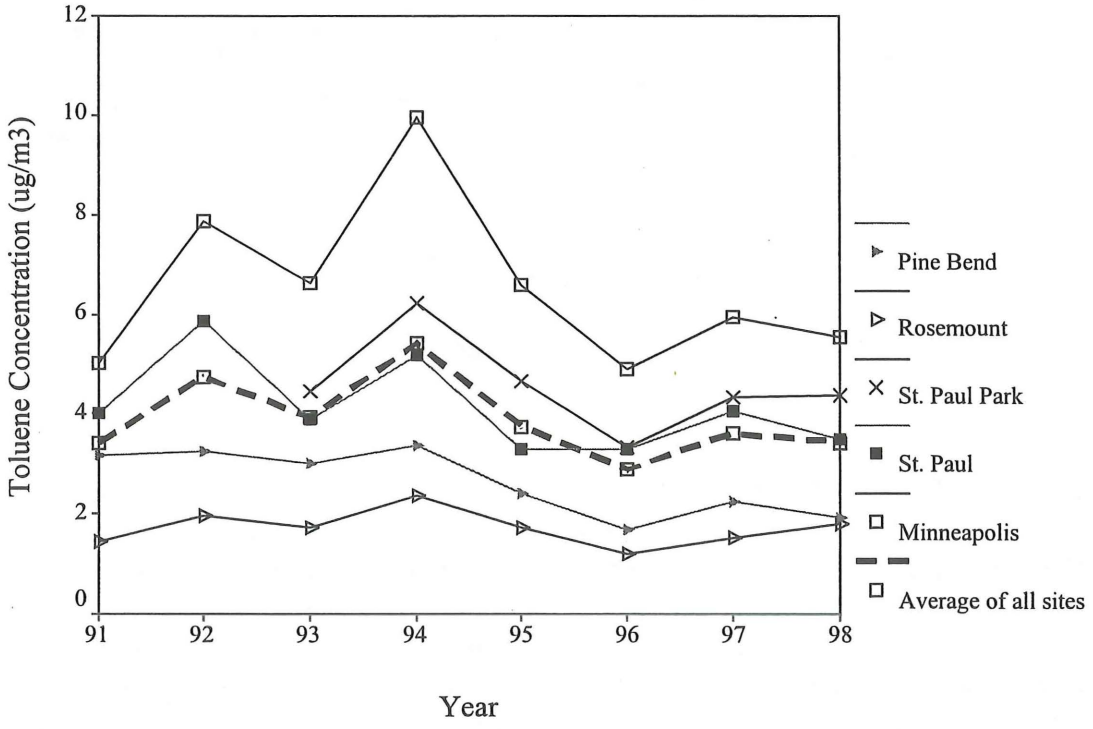
3.2.3 Toluene ($C_6H_6CH_3$)

This chemical is used as a solvent and in gasoline. Its major sources are evaporation at the gas pump and combustion of gasoline. Exposure to toluene vapors via inhalation irritates the respiratory tract, impairs the central nervous system and damages the liver and kidneys. Symptoms include fatigue, weakness, confusion, dizziness, headaches and skin irritation. The proposed chronic HRV for toluene with potential nervous and upper-respiratory-system effects is 400 $\mu g/m^3$.

Figure 3.5 shows annual median air concentrations of toluene for the period of 1991-1998 at the Pine Bend, Rosemount, St. Paul Park, St. Paul and Minneapolis monitoring sites.

The ambient air concentrations of toluene for all sites were far below its HRV (400 $\mu g/m^3$). As shown, like formaldehyde and benzene, the higher values of toluene were observed in Minneapolis, and then in St. Paul, indicating the effect of mobile sources and solvent use in the urban area. Like benzene, toluene is also a component of gasoline. In general, the industrial sites show lower concentration for toluene than the Minneapolis site.

Figure 3.5 Trends in annual toluene concentrations in Minnesota: 1991-98



In summary, although the Minnesota's air-toxics emissions of formaldehyde, benzene and toluene from manufacturing facilities included in the TRI report decreased over time (see Section 4.4), ambient-air-monitoring data for selected air toxics show little change, and for some (e.g., formaldehyde) have increased during the monitoring period. Although the ambient air concentrations of benzene appear to have decreased over time, its ambient air concentrations exceeded its health risk value. The trends of ambient air concentrations for toluene have decreased at all sites since 1994. Over the entire monitoring period (1991-1998), the ambient air concentrations of formaldehyde and benzene in Minneapolis, were above their health risk values.

It should be noted that the manufacturing sector does not emit many important toxic air pollutants in large quantities. For some toxic air pollutants (i.e., benzene, 1,3-butadiene and formaldehyde), other sources (on-road vehicles, non-road mobile sources, area sources and other industrial sectors) were much more significant. In a study conducted by the MPCA, motor vehicles and wood-burning fireplaces and stoves were the most significant sources of many cancer-causing air pollutants. Therefore, reductions of air-toxics emissions need to consider mobile sources and area sources as well as large, industrial facilities.

4. Toxic Air Pollutant Emissions

An emission inventory is a compilation of pollutant-emission estimates from sources, such as electric utilities, automobiles, industrial processes and dry cleaners. Air-toxic-emission inventories are fundamental to the identification, evaluation and control of air pollution hazards associated with air toxics. A crucial first step toward reducing air-toxic emissions is to identify the sources and source categories that contribute the most to the total emissions. Preparing an emission inventory makes this step achievable. The information provided in air-toxic-emission inventories can also be used for assessing health risks due to exposure to air toxics; supporting deposition modeling and environmental fate analyses; and evaluating the possible locations of environmental monitoring sites for air toxics. Moreover, emission inventories can serve as an indicator of air-quality changes. Periodic air-toxic-emission inventories can also indicate the benefits of regulatory programs designed to reduce toxic emissions, such as the National Emission Standards for Hazardous Pollutants (NESHAPS) program. However, an acceptable inventory requires enough time and adequate resources. Obtaining correct emission data is still a challenge for the MPCA.

In this section, the existing emission inventory programs are discussed and emission estimation results are presented and analyzed.

4.1 Great Lakes Regional Air Toxics Emission Inventory

Recently, the eight Great Lakes states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin) and the Province of Ontario, working together through the Great Lakes Commission, created a Great Lakes Regional Air Toxics Emission Inventory. This regional inventory was initiated in the 1986 Toxic Substances Control Agreement among the governors of the Great Lakes states. The 1986 agreement specified provisions for the states to "cooperate in quantifying the loading of toxic substances originating from all sources..." From this initial conceptual agreement, an Air Toxic Emission Inventory Protocol and a Regional Air Pollutant Inventory Development System (RAPIDS) have been developed. The protocol document provides instructions for developing a consistent, most complete and accurate regional inventory across all states and the province. RAPIDS is the first-ever multi-state, pollutant-emission-inventory software that manages emission data and calculates emission estimates for point, area and mobile sources.

In August 1998, the first regional emission inventory was released for 49 toxics that have been identified as significant contributors to the contamination of the Great Lakes. This inventory, based on 1993 data from point and area sources, provides the practical test of processes, procedures and systems developed to ensure the basin-wide inventories are accurate and consistent. The Great Lakes Air Toxic Emission Inventory can be found on the Internet at: *http//www.glc.org/projects/air/final93/93report.html*.

After the pilot 1993 regional inventory, the Great Lakes states and Ontario decided to compile a base year emission inventory for calendar year 1996 and to update the inventory annually. The pollutant list is expanded to 79 chemicals (Table 1, 3rd column). Emissions from mobile sources are included as well as emissions from point and area sources. The 1996 regional inventory is expected to be completed in mid-1999.

Table 4.1 List of pollutants for the 1996 Minnesota Air-Toxics-Emission Inventory

Chemical Name	CAS No.	Selection Criteria RAPIDS[1]	Selection Criteria EPA Grant[2]	Reference CAA 112(b)[3]
Non-Metal Compounds (Excluding PAHs)				
Acetaldehyde	75070	x	x	x
Acetone	67641		x	
Acrolein	107028	x	x	x
Acrylamide	79061	x		x
Acrylonitrile	107131	x		x
Atrazine	1912249	x		
Benzaldehyde	100527		x	
Benzene (including benzene from gasoline)	71432	x	x	x
1,3-Butadiene	106990	x	x	x
Butyraldehyde	123728		x	
Carbon tetrachloride	56235	x	x	x
Chlordane	57749	x		x
Chlorobenzene	108907		x	x
Chloroform	67663	x	x	x
Chloroprene	126998		x	x
Crotonaldehyde	123739		x	
1,2-Dichlorobenzene(o)	95501		x	
1,3-Dichlorobenzene(m)	541731		x	
1,4-Dichlorobenzene(para)	106467		x	x
cis-1,2-Dichloroethylene	156592		x	
cis-1,3-Dichloropropene	10061015		x	
trans-1,3-Dichloropropene	10061026		x	
1,2-Dichloro-1,1,2,2-tetrafluorethane	374072		x	
Di-n-butyl phthalate	84742	x		x
Di-n-octyl phthalate	117840	x		
Dichloroethyl ether (bis(2-chloroethyl) ether)	111444	x		x
Diethylhexyl phthalate (Bis(2-ethylhexyl) phthalate) (DEHP)	117817	x		x
Ethylbenzene	100414	x	x	x
Ethylene dibromide (Dibromoethane)	106934	x	x	x
Ethylene dichloride (1,2-Dichloroethane)	107062	x	x	x
Ethylene oxide	75218	x		x
Ethylidene dichloride (1,1-Dichloroethane)	75343		x	x
Formaldehyde	50000	x	x	x
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76131		x	
Glycol ethers		x		x
Heptachlor	76448	x		x
Hexachlorobenzene	118741	x		x
Hexachlorobutadiene	87683	x	x	x
Hexachloroethane	67721	x		x
Hydrazine	302012	x		x
m/p-Xylenes[4]	108383/106423	x	x	x
Methoxychlor	72435	x		x

		Selection Criteria		Reference
Chemical Name	CAS No.	RAPIDS[1]	EPA Grant[2]	CAA 112(b)[3]
Methyl bromide (Bromomethane)	74839		x	x
Methyl chloride	74873		x	x
Methyl chloroform (1,1,1-Trichloroethane)	71556	x	x	x
Methylene chloride (Dichloromethane)	75092	x	x	x
Methylene diphenyl diisocyanate (MDI)	101688	x		x
o-Xylenes[4]	95476	x	x	x
Parathion	56382	x		x
Pentachloronitrobenzene (quintobenzene)	82688	x		x
Pentachlorophenol	87865	x		x
Phenol	108952	x		x
Phosgene	75445	x		x
Propionaldehyde	123386		x	x
Propylene dichloride (1,2-Dichloropropane)	78875		x	x
Styrene	100425	x	x	x
Tetrachloroethylene (Perchloroethylene)	127184	x	x	x
Toluene	108883	x	x	x
2,4-Toluene diisocyanate	584849	x		x
Total polychlorinated biphenyls (PCBs)	1336363	x		x
Total polychlorinated dibenzodioxins (PCDDs)		x		
Total polychlorinated dibenzofurans (PCDFs)		x		
2,3,7,8-tetrachlorodibenzo-furan (TCDF)	51207319	x		
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	1746016	x		x
1,1,2,2-Tetrachloroethane	79345		x	x
1,1,2-Trichloroethane	79005		x	x
Trichloroethylene	79016	x	x	x
Trichlorofluoromethane (CFC-11)	75694		x	
2,4,5-Trichlorophenol	95954	x		x
2,4,6-Trichlorophenol	88062	x		x
1,2,4-Trimethylbenzene	95636		x	
1,3,5-Trimethylbenzene	108678		x	
Trifluralin	1582098	x		x
Vinyl chloride	75014	x	x	x
Vinylidene chloride (1,1-Dichloroethylene)	75354		x	x
16 PAHs (POM)				
Acenaphthene	83329	x		x
Acenaphthylene	208968	x		x
Anthracene	120127	x		x
Benz(a)anthracene	56553	x		x
Benzo(a)pyrene	50328	x		x
Benzo(b)fluoranthene	205992	x		x
Benzo(ghi))perylene	191242	x		x
Benzo(k)fluoranthene	207089	x		x
Chrysene	218019	x		x

		Selection Criteria		Reference
Chemical Name	CAS No.	RAPIDS[1]	EPA Grant[2]	CAA 112(b)[3]
Dibenz(a,h)anthracene	53703	x		x
Fluoranthene	206440	x		x
Fluorene	86737	x		x
Indeno(1,2,3-cd)pyrene	193395	x		x
Naphthalene	91203	x		x
Phenanthrene	85018	x		x
Pyrene	129000	x		x
Metal Compounds				
Antimony	7440360	x		x
Arsenic	7440382	x		x
Beryllium	7440417	x		x
Cadmium	7440439	x		x
Chromium	7440473	x		x
Chromium (6)	18540299	x		x
Cobalt	7440484	x		x
Copper	7440508	x		
Lead	7439921	x		x
Alkylated lead		x		x
Mercury	7439976	x		x
Manganese	7439965	x		x
Nickel	7440020	x		x

1. Compounds identified in the Great Lakes Regional Air Toxic Emission Inventory Project for calendar year 1996.
2. Compounds selected for environmental monitoring in the MPCA Urban Air Toxics Study granted by EPA.
3. Compounds identified in the 1990 Clean Air Act Amendments, Section 112(b).
4. In the Great Lakes Regional Air Toxic Emission Inventory Project, m/p-Xylenes and o-Xylenes are combined as Xylenes. Therefore, Xylenes (Cas No. 1330207) is also included in the state pollutant list.

4.2 Minnesota Air-Toxics-Emission Inventory

The Great Lakes Regional Emission Inventory project requires a Minnesota air-toxics-emission inventory. Minn. Stat. Ch. 115D.15 also requires that an updated list of prioritized and categorized facilities that emit toxic-air contaminants be included in this legislative report. Since the 1993 emission inventory presented in the 1995 report, the MPCA has adopted the protocol and data system used for the Great Lakes inventory, allowing for comparisons and data-sharing among the Great Lakes states and Ontario. This report provides an update based on the 1996 emission estimates.

4.2.1 Pollutants

The 1996 Minnesota air-toxics-emission inventory includes 104 chemicals (Table 4.1): 16 polycyclic aromatic hydrocarbons (PAHs), 75 non-metal compounds (excluding PAHs), and 13 metal compounds. These pollutants are selected based on two criteria: (1) the 1996 Great Lakes Regional Air Toxic Emission Inventory and (2) the MPCA Urban Air Toxics Study. The 1996 Great Lakes regional inventory includes 79 pollutants, which are the compounds identified as significant contributors to the contamination of the Great Lakes and the compounds requested by the EPA for the National Toxics Inventory. The EPA funded the MPCA Urban Air Toxics Study in February 1997.

Please note that 20 of the 104 pollutants are not in the 1990 Clean Air Act Amendment 112(b) list (Hazardous Air Pollutant list). The pollutant list with its selection criteria and reference is shown on the MPCA Internet site: *http//www.pca.state.mn.us/air/emissions.html.*

4.2.2 Source Categories

The 1996 Minnesota air-toxics-emission inventory covers three major source categories: point sources, area sources and mobile sources. For the purpose of the Minnesota air-toxics-emission inventory, point sources are defined as facilities that are required to submit their annual inventories of criteria pollutants (carbon monoxide, nitrogen oxides, particulate matter, particulate matter smaller than 10 microns, lead, sulfur dioxide, and volatile organic compounds) to the MPCA. Area sources are those stationary sources that are not required to submit criteria pollutant emission data to the MPCA. Area source categories include Architectural Surface Coatings, Automobile Refinishing, Chromium Electroplating, Consumer and Commercial Products, Dry Cleaning, Gasoline Service Stations, Graphic Arts, Halogenated Solvent Cleaners, Industrial Surface Coating, Landfills, Agricultural Pesticides, Public-Owned Treatment Works, Residential Fuel Combustion, Residential Wood Burning and Traffic Markings. Mobile sources are nonstationary sources, which are further classified as highway vehicles, nonroad mobile sources, aircraft and locomotives.

4.2.3 Data Collection

Since Minnesota does not have air-toxics-emission inventory reporting requirements for industrial point sources, emission data for point sources are mainly derived from two sources of information that already exist at the MPCA: (1) facility permit applications and (2) the 1996 Minnesota criteria pollutant emission inventory (MCEI). The information in the MCEI that is useful in estimating air-toxics emissions includes facility, device and process identifications (Source Classification Code assignments); throughput activity data; control efficiencies; and emission estimates for lead, PM and VOC. However, there are no air-toxics-emission estimates in the MCEI besides lead (Pb). Therefore, MPCA staff also review air-emission-permit applications for the purpose of finding detailed information on toxic emissions. Moreover, we consider the comments and corrections made by companies on the 1993 air-toxics-emission inventory.

Recent efforts to refine emission data have focused on two industrial sectors that are not typically covered by the Toxics Release Inventory Report: Metal Mining, Iron Ores, and Electric Services. These two industrial sectors contributed almost 50% of PM emissions form point sources in 1996. MPCA emission-inventory staff has worked very closely with permit engineers and industrial representatives. Data in permit applications, performance stack testing, and trace metal analyses are reviewed and analyzed. Source-specific emission factors are then developed. Also, facility-specific activity data, such as heat content values and control efficiencies, are collected. If one facility does not have source-specific data, the data for similar facilities are used. Finally, generic emission factors for the industrial averages in the EPA database are applied if no source-specific information is available. The estimated emissions, along with emission-estimation methods, are reviewed by industries. Corrections and adjustments are made until acceptable results are obtained. The MPCA staff and industrial representatives reached an understanding on the approach, which is believed to provide the best air-toxics-emission information at this time.

4.3 1996 Air-Toxics-Emission Estimates for Point Sources

Because the development of the RAPIDS mobile source module and the mapping of the most current version of emission factors to RAPIDS are still in process, emission data for area, mobile and point sources other than the above two industrial sectors are not available at this time. The emission estimates in this section are for point sources only. To provide the proportions of point, area and mobile source emissions in the state, PM and VOC emission estimates from EPA will be presented in the last section of this chapter. VOC and PM emissions are used because limited information on individual toxic air emissions is available and, also, VOCs and PM are broad categories that include many toxic air pollutants. A complete air-toxics-emission inventory will be available by mid-1999.

The point source emission data in this section are from two information sources:

- 1996 Minnesota air-toxics-emission inventory for Metal Mining, Iron Ores, and Electric Services; and
- 1996 Toxic Release Inventory Report (TRI) prepared by the Minnesota Department of Public Safety in December 1997.

The TRI covers point sources that meet the following requirements:

- SIC (Standard Industrial Classification) codes 20 through 39 (Minnesota has expanded to cover more SICs, see 1996 TRI.)
- 10 or more full-time-equivalent employees
- manufactures, imports, processes or in any other way uses any of the toxic chemicals listed in amounts greater than the threshold quantities. The threshold quantities have been established at 25,000 lb or 10,000 lb per chemical per year, depending on how the chemical is used at the facility.

The information from the above two inventories accounts for the facilities that contribute 85.3% of the combination of PM, and VOC emissions from point sources in 1996. The emissions from facilities are categorized by SIC Codes. Due to resource restrictions, the prioritization of emissions is also performed based on SIC codes, not facilities.

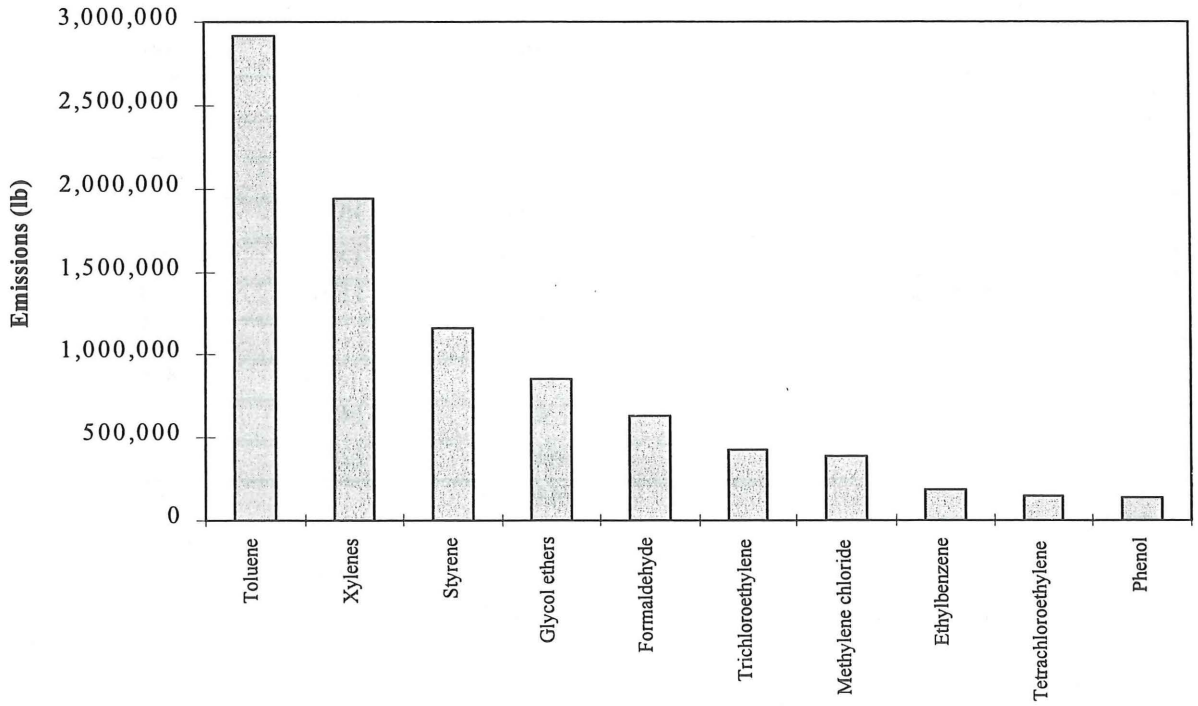
4.3.1 Prioritization and Categorization Based on Mass Emissions

Table 4.2 presents statewide point-source emissions for 37 chemicals that are included in both the Minnesota air-toxics-emission inventory and the TRI. Mercury is also a common pollutant in both inventories; its emissions are discussed in Chapter 5. Figure 4.1 shows the top 10 pollutants with regard to mass emissions. All of the top 10 pollutants are VOC air toxics. The highest emissions from point sources are toluene emissions, 2.9 million lb, which is about 50% higher than xylene emissions, the second-most-emitted toxic. Styrene is the pollutant with the third-highest emissions, about 1.2 million lb. The mass emissions from the fourth-highest are less than 1 million lb.

Table 4.2 1996 state point-source emissions by pollutant name

Chemical Name	Cas No.	Indexing Value	Emissions (lb)	Weighted Emissions
1,2,4-Trimethylbenzene	95636	8.16	130,243	13.3
1,3-Butadiene	106990	12.35	3,488	15.9
Acetaldehyde	75070	10.96	59,779	15.7
Acrylonitrile	107131	13.1	40	14.7
Anthracene	120127	4.05	41	5.7
Antimony	7440360	15.53	1,457	18.7
Arsenic	7440382	15.08	10,061	19.1
Benzene (including benzene from gasoline)	71432	11.16	73,064	16.0
Beryllium	7440417		161	
Cadmium	7440439	16	856	18.9
Chloroform	67663	14.17	8,600	18.1
Chromium	7440473	12.12	12,676	16.2
Cobalt	7440484		993	
Copper	7440508	15.06	15,537	19.3
Di-n-butyl phthalate	84742	9.97	177	12.2
Diethylhexyl phthalate (Bis(2-ethylhexyl) phthalate) (DEHP)	117817	12.42	1,513	15.6
Ethylbenzene	100414	8.95	188,581	14.2
Ethylene oxide	75218	11.67	60	13.4
Formaldehyde	50000	10.91	629,155	16.7
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76131	6.93	19,702	11.2
Glycol ethers	11		856,733	
Lead	7439921	15.55	67,367	20.4
Manganese	7439965	13.38	78,812	18.3
Methyl bromide (Bromomethane)	74839	13.5	39,429	18.1
Methyl chloride	74873	12.83	81,018	17.7
Methyl chloroform (1,1,1-Trichloroethane)	71556	11.74	104,800	16.8
Methylene chloride (Dichloromethane)	75092	12.32	387,937	17.9
Naphthalene	91203	8.48	14,965	12.7
Nickel	7440020	14.96	22,952	19.3
Phenol	108952	8.45	135,681	13.6
Styrene	100425	9.63	1,163,261	15.7
Tetrachloroethylene (Perchloroethylene)	127184	12.3	151,846	17.5
Toluene	108883	8.64	2,913,694	15.1
Total polychlorinated biphenyls (PCBs)	1336363	16.92	0.03	15.4
Trichloroethylene	79016	11.09	428,910	16.7
Trichlorofluoromethane (CFC-11)	75694		10	
Xylenes (Mixed isomers)	1330207	8.77	1,937,451	15.1

Figure 4.1 Estimated toxic-air emissions of top 10 pollutants for calendar year 1996 (based on mass emissions)



More detail is provided on the source categories that emit the pollutants with the top five mass emissions. Figures 4.2, 4.3, 4.4, 4.5 and 4.6 present pie charts of the emissions by source category. Although benzene mass emissions are ranked at fifteenth highest, the ambient air concentrations of benzene is exceeding the proposed health risk value at monitoring sites, especially in metro areas. Therefore, the analysis is also done for benzene (Figure 4.7). Overall, the Manufacturing Industries (SIC codes 20-39) dominate the emissions. The contribution of Metal Mining, Iron Ores, and Electric Services is not significant except for formaldehyde and benzene, for which Metal Mining, Iron Ores, contributes about 14.7% and 17.6%, respectively.

Figure 4.2 1996 toluene emissions by principal source category for point sources

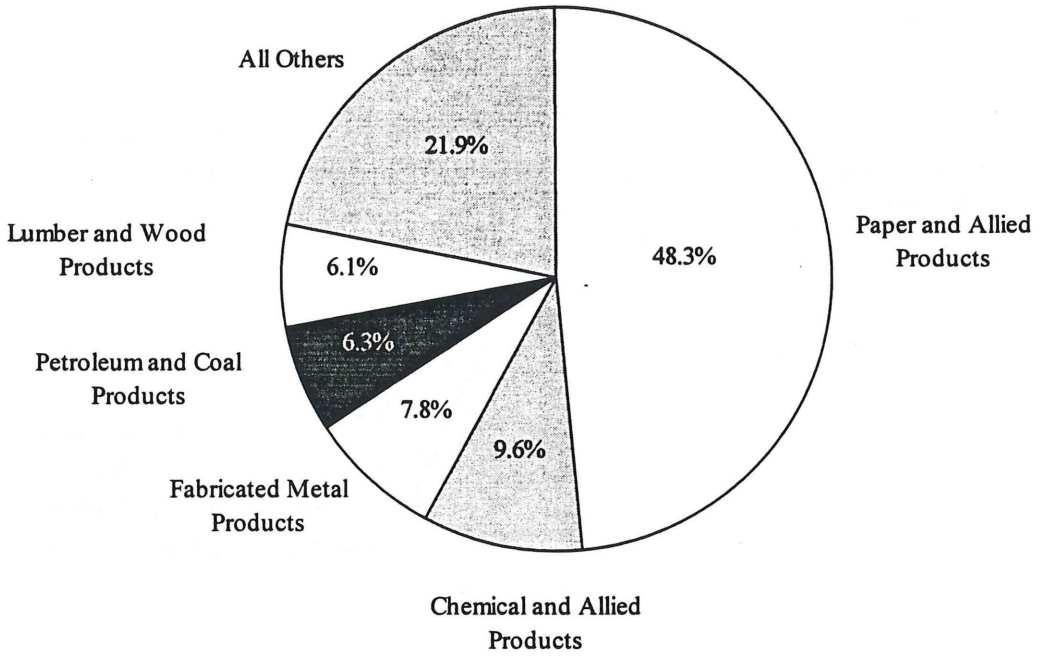


Figure 4.3 1996 xylenes emissions by principal source category for point sources

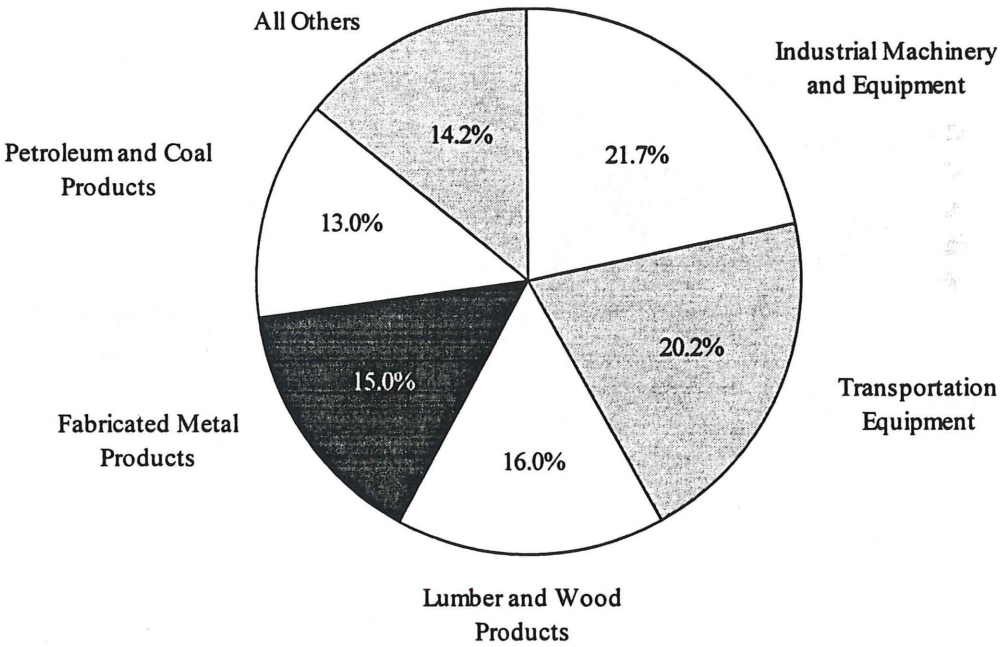


Figure 4.4 1996 styrene emissions by principal source category for point sources

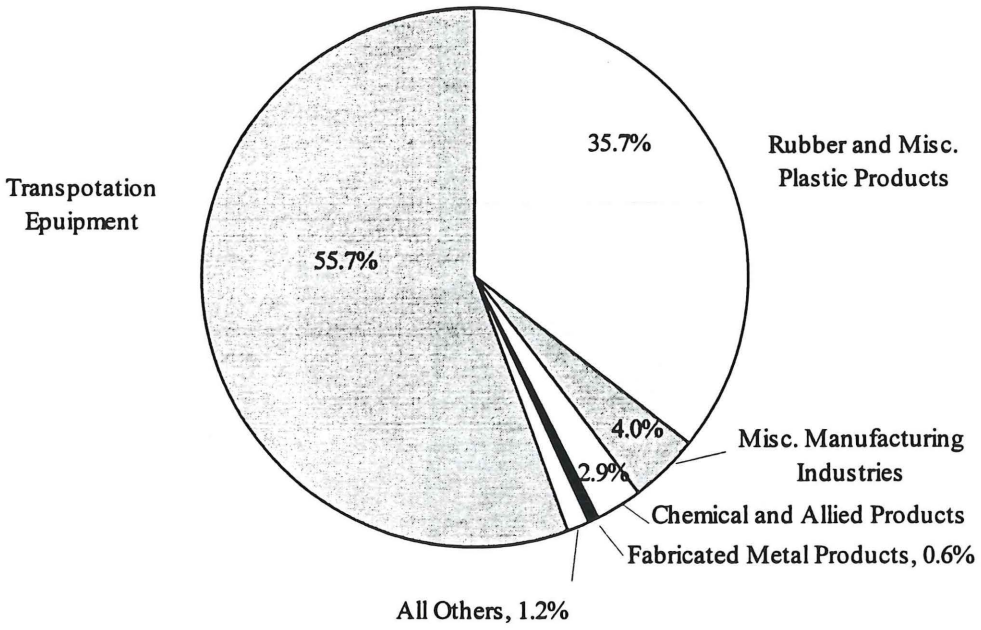


Figure 4.5 1996 glycol ethers emissions by principal source category for point sources

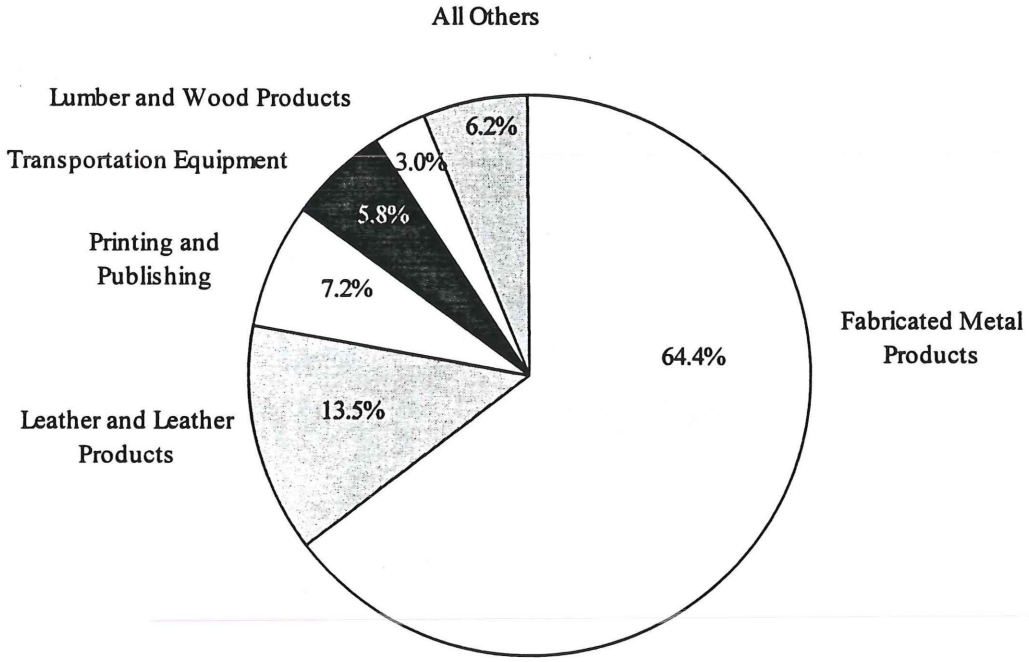


Figure 4.6 1996 formaldehyde emissions by principal source category for point sources

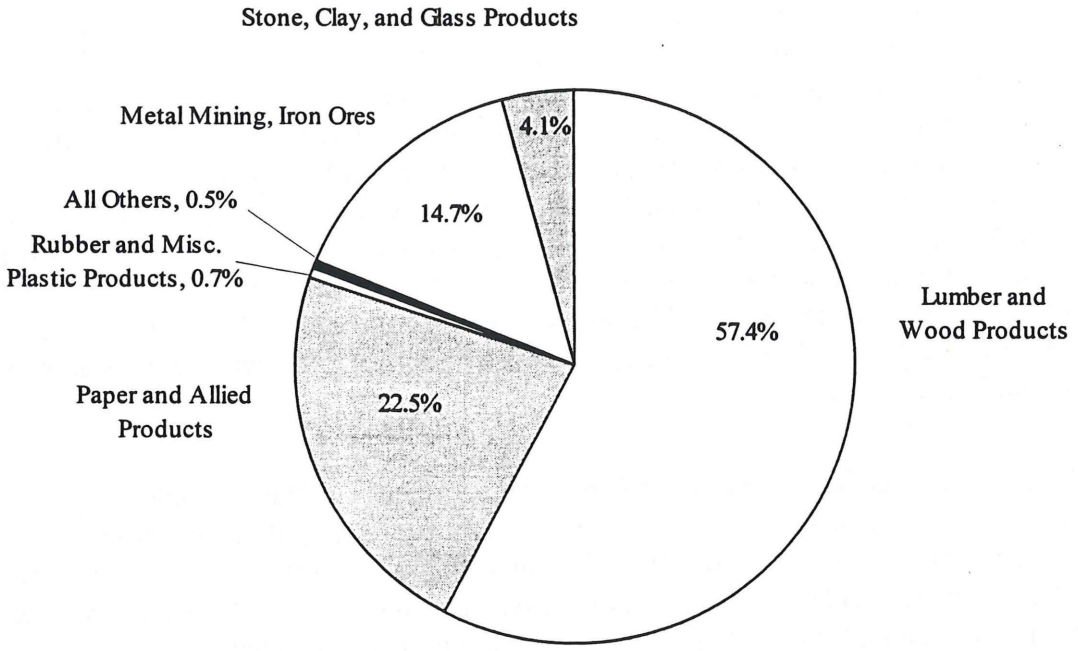
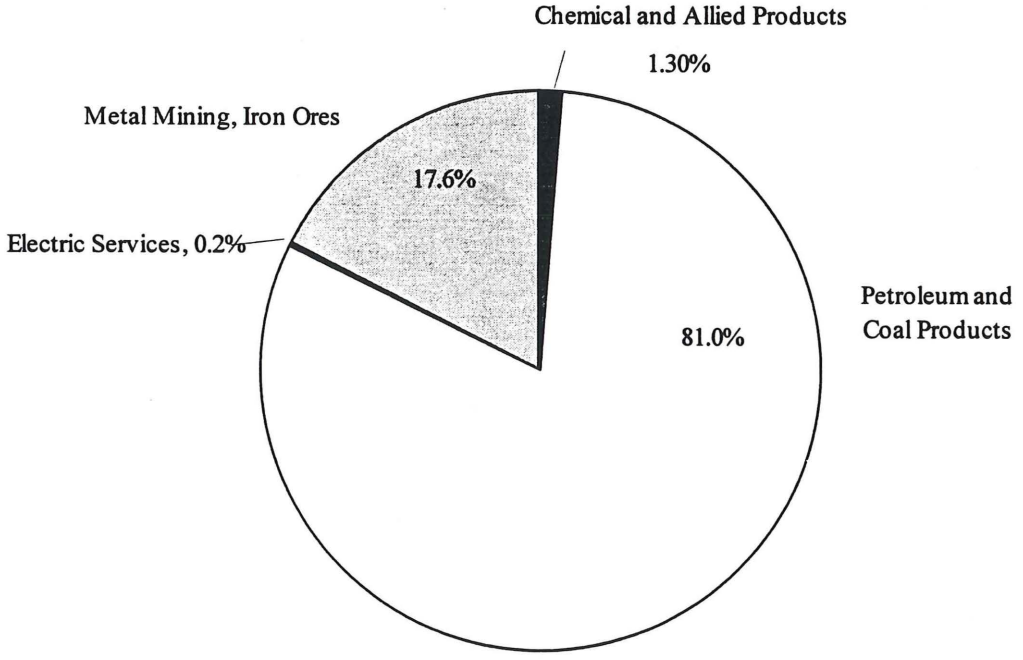


Figure 4.7 1996 benzene emissions by principal source category for point sources

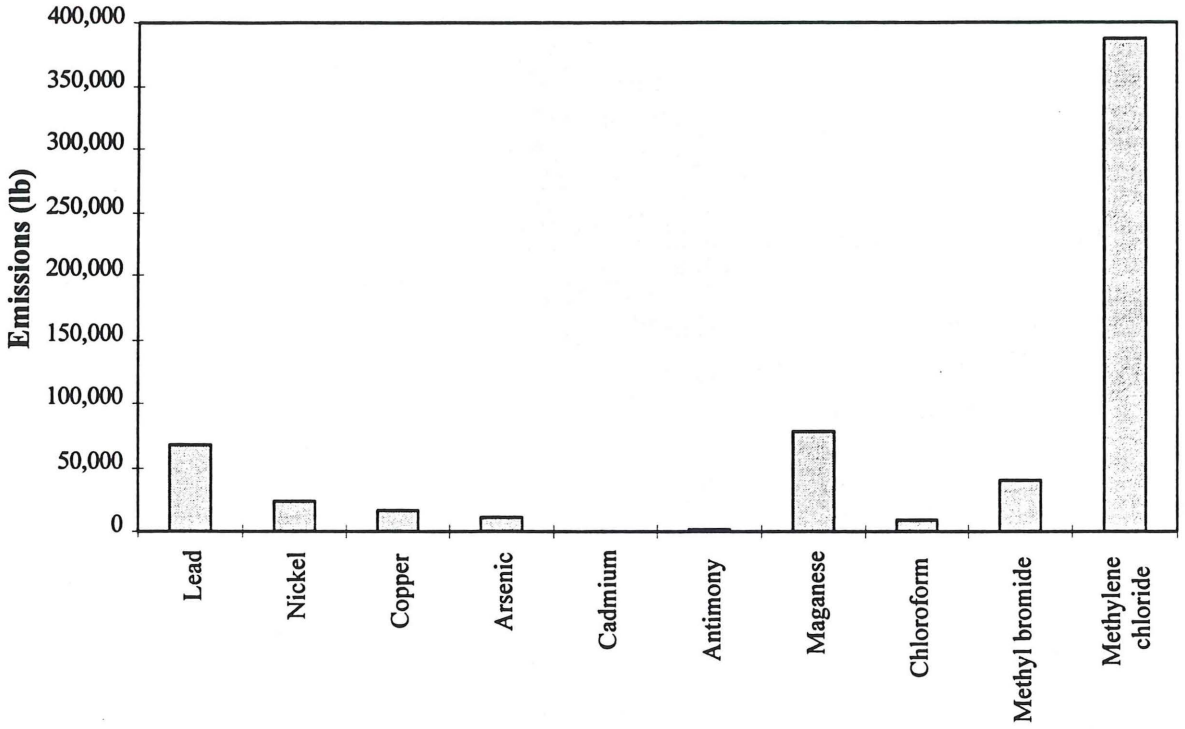


4.3.2 Prioritization and Categorization Based on Weighted Emissions

Although mass emissions provide a quantitative estimate of toxic air pollutants emitted in the State of Minnesota, this is not enough to assess the potential adverse effects from these emissions. The human health and environmental impact of a pollutant is not only determined by the quantity of its emissions but also its potential toxicity and environmental persistence. To take the toxicity and environmental persistence of a pollutant into account, MPCA staff developed an indexing system (Pratt, G.C. et al., 1993). This system assigns numerical values, so-called indexing values, to pollutants according to their hazard potential. Table 4.2, Column 3 shows the currently available indexing values for 33 chemicals. Indexing values are missing for 4 chemicals in Table 4.2 due to a lack of information on toxicity, chemical and physical property, and environmental fate. Arriving at a weighted emission for a given chemical considers its mass emissions and its indexing value.

Table 4.2 also presents the estimated weighted emissions based on the available indexing values for each chemical. Figure 4.8 shows mass emissions of the top 10 pollutants with regard to weighted emissions. Seven of the top 10 pollutants are metals, whose mass emissions are less than 0.08 million lb. Lead has the highest weighted emission value, 20.4. Although toluene is estimated to emit the highest mass emissions, 2.9 million lb, its weighted emissions are ranked in twenty-second place, with a value of 15.1. In contrast, the mass emissions of total polychlorinated biphenyls (PCBs) are only 0.03 lb, but its weighted emissions, 15.4, are ranked higher than toluene because of its high indexing value.

Figure 4.8 Estimated toxic air emissions of top 10 pollutants for calendar year 1996 (based on weighted emissions)



More detail is provided on the source categories that emit the pollutants with the top five weighted emissions. Figures 4.9 to 4.13 present pie charts of the mass emissions for these five pollutants by source category. Chromium is also considered (Figure 4.14) because using chromium III indexing value may underestimate the weighted emissions if there is highly toxic chromium VI existing in the emissions. Electric Services and Metal Mining, Iron Ores, dominate the mass emissions of lead, nickel, arsenic and cadmium. Especially for cadmium and arsenic, almost 100% of mass emissions are from these two industrial sectors. Primary Metal Industries contribute 72.9% of copper mass emissions. For chromium, 37.6% of mass emissions are from Electric Services and Metal Mining, Iron Ores, the rest part of emissions is from manufacturing industries.

Figure 4.9 1996 lead emissions by principal source category for point sources

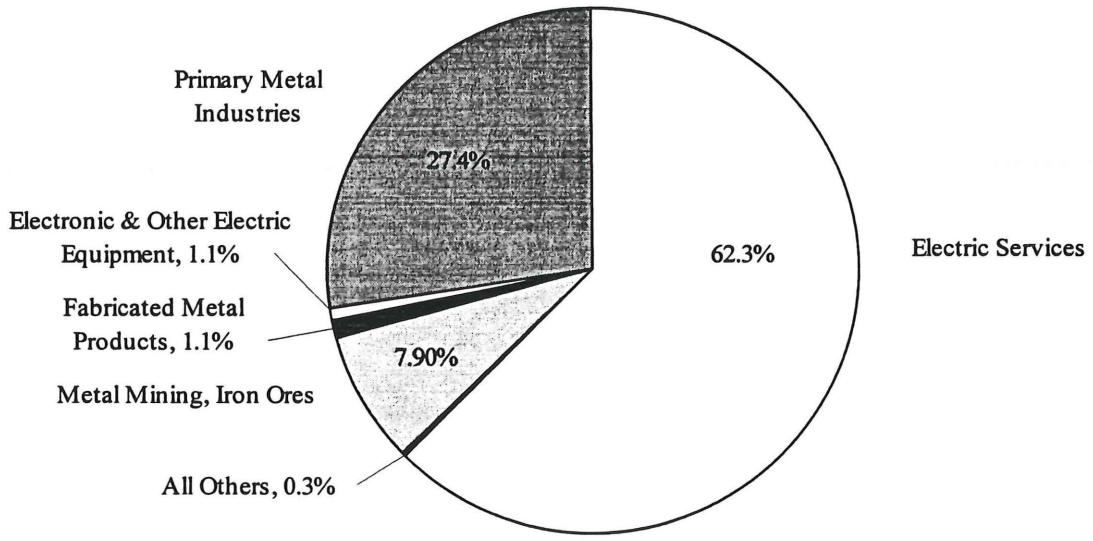


Figure 4.10 1996 nickel emissions by principal source category for point sources

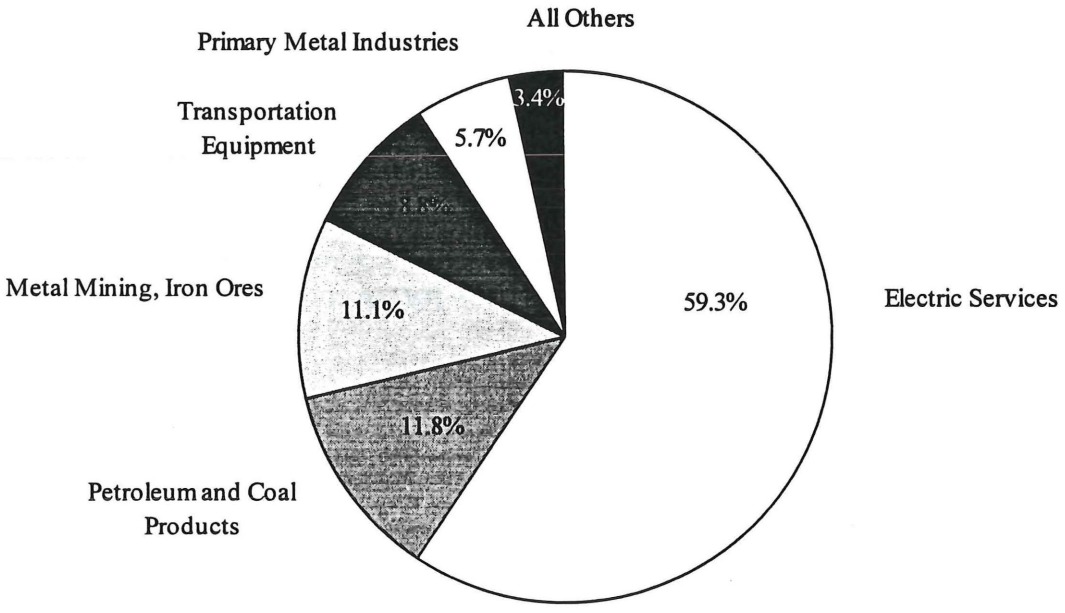


Figure 4.11 1996 copper emissions by principal source category for point sources

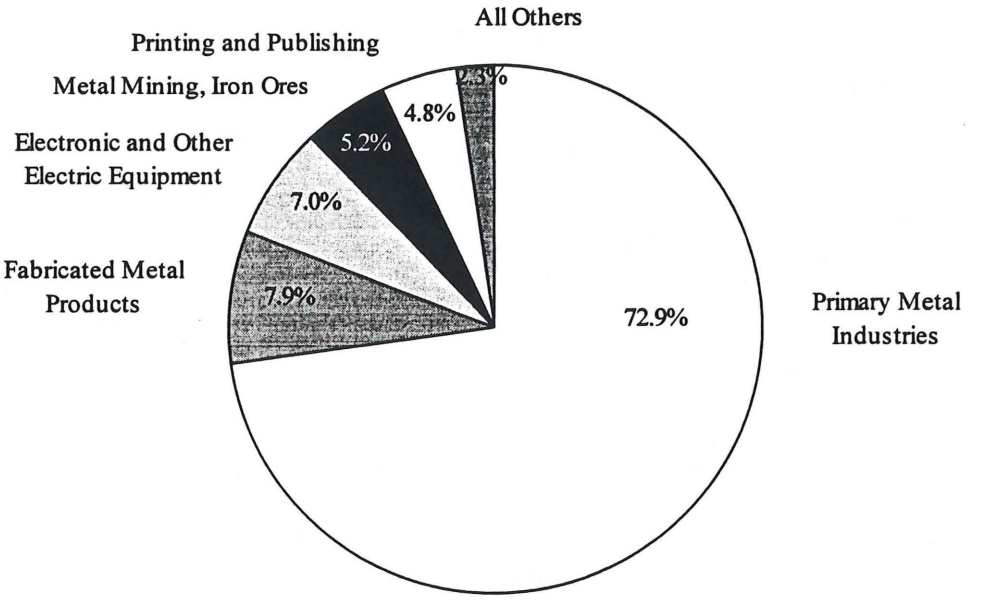


Figure 4.12 1996 arsenic emissions by principal source category for point sources

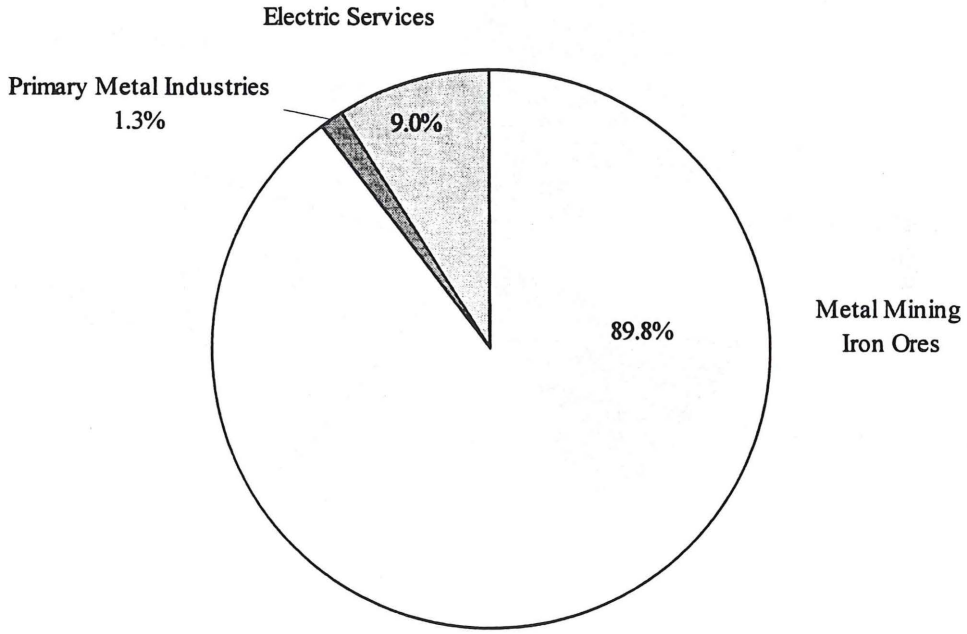


Figure 4.13 1996 cadmium emissions by principal source category for point sources

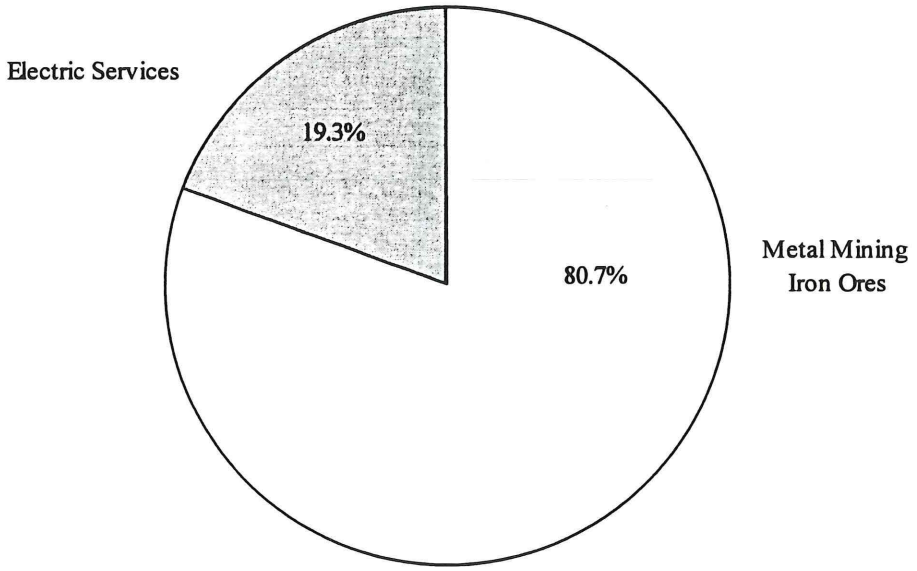
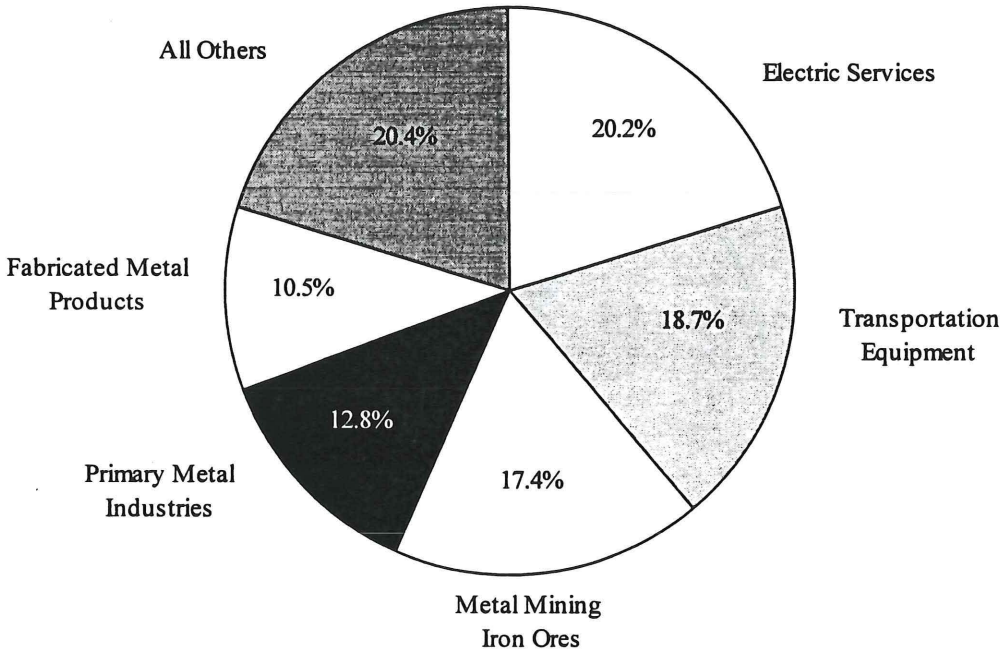


Figure 4.14 1996 chromium emissions by principal source category for point sources



4.4 Trends of Air-Toxics Emissions for Point Sources, 1989-1996

The 1989-to-1996 trends in air-toxics emissions for point sources are based on TRI data. Table 4.3 provides the emissions of the 37 pollutants for each year. Figures 4.15 to 4.26 present the trends in mass emissions for the top five pollutants with regard to 1996 mass emissions, the top five pollutants with regard to 1996 weighted emissions, benzene and chromium.

Emissions of toluene and xylenes (Figure 4.15 and 4.16) decreased with time. The 1996 toluene and xylenes emissions are 18.7% and 24.8% of 1989's values, respectively. Styrene emissions reached their lowest level in 1990, then continuously increased until 1995, with a little drop from 1995 to 1996 (Figure 4.17). The level of glycol-ethers emissions was relatively stable from 1989 to 1993 at about 0.7 million lb per year. However, it jumped to over 0.8 million lb per year after 1994 (Figure 4.18). Formaldehyde emissions (Figure 4.19) had a slow reduction trend after 1990 with a small fluctuation from 1994 to 1995. Figure 20 shows that benzene emissions declined significantly after 1993, the reduction was about 40% to 50% per year from 1993 to 1995, then leveled off in 1995 and 1996.

Lead emissions (Figure 4.21) decreased significantly after 1990, but have increased since 1995. Nickel emissions (Figure 4.22) dropped in 1991 to 1992, then remained at about 6,000 lb per year. Copper emissions (Figure 4.23) have been relatively stable compared with emissions of other metals. Emissions of arsenic and cadmium (Figures 4.24 and 4.25) remain low, but the trends in arsenic and cadmium emissions may not represent the real scenario due to the uncertainties in the TRI reporting. Chromium emissions (Figure 4.26) declined from 38,680 lb in 1989 to 7,903 lb in 1996. The most significant reduction occurred from 1993 to 1994, about 61%.

It should be noted that the TRI data cover only a portion of toxics emissions from point sources and the amounts of reported emissions have unknown accuracy.

Table 4.3 Trends of air-toxics emissions (in pounds) from point sources, 1989-96

Chemical Name	Cas No.	1989	1990	1991	1992	1993	1994	1995	1996
1,2,4-Trimethylbenzene	95636	145,252	65,952	176,426	262,649	91,432	80,632	118,108	130,243
1,3-Butadiene	106990	14,000	15,000	15,000	17,046	16,057	3,209	3,863	3,488
Acetaldehyde	75070						9,461	9,441	59,718
Acrylonitrile	107131		0	0	0	0			
Anthracene	120127	100	150	160	160	200	200	180	41
Antimony	7440360	296	571	240	212	170	186	274	481
Arsenic	7440382	389	163	113	101	66	78	178	126
Benzene (including benzene from gasoline)	71432	294,244	221,010	186,740	230,657	220,716	130,248	62,584	60,083
Beryllium	7440417	1	0	1	1	1	0		
Cadmium	7440439	49	51	515	5	5	6		
Chloroform	67663	240,000	199,964	60,400	108,100	196,316	194,100	38,602	8,600
Chromium	7440473	38,680	27,813	18,034	19,026	21,412	8,250	11,137	7,903
Cobalt	7440484	1,189	1,181	723	716	742	312	233	87
Copper	7440508	17,192	15,980	14,452	14,445	16,811	19,783	14,816	14,628
Di-n-butyl phthalate	84742					0	0		
Diethylhexyl phthalate (Bis(2-ethylhexyl) phthalate) (DEHP)	117817	2,200	1,210	1,426	1,416	4,795	4,600	4,096	1,513
Ethylbenzene	100414	479,385	575,452	565,005	513,931	397,372	361,373	272,397	188,507
Ethylene oxide	75218	100	97					63	60
Formaldehyde	50000	702,930	842,288	653,014	604,019	552,404	550,155	614,375	536,246
Freon-113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76131	2,710,161	1,948,619	1,246,667	968,468	539,782	294,779	203,893	19,702
Glycol ethers	11	737,683	728,571	738,393	696,725	691,073	880,451	799,944	856,733
Lead	7439921	33,049	33,762	20,058	16,128	12,389	12,783	23,495	20,130
Manganese	7439965	27,320	55,710	16,196	11,755	9,184	11,224	16,210	11,876
Methyl bromide (Bromomethane)	74839	16,118	37,985	25,773	46,070	46,470	47,030	52,695	39,429
Methyl chloride	74873	286,000	143,000	143,000	107,096	95,980	100,382	89,686	81,018
Methyl chloroform (1,1,1-Trichloroethane)	71556	2,697,921	3,217,842	2,822,831	2,277,332	1,163,833	462,631	324,979	104,800
Methylene chloride (Dichloromethane)	75092	2,467,918	1,479,102	946,563	812,270	734,993	805,394	507,990	387,937
Naphthalene	91203	16,340	18,943	15,540	26,464	31,721	15,649	16,250	14,916
Nickel	7440020	23,830	22,422	20,926	5,371	5,822	5,940	5,417	6,806
Phenol	108952	262,949	151,643	140,553	135,280	112,710	81,313	105,896	135,681
Styrene	100425	858,957	605,181	670,394	712,484	816,472	995,815	1,247,186	1,163,261
Tetrachloroethylene (Perchloroethylene)	127184	287,028	366,997	232,988	172,731	289,399	252,874	213,253	151,846
Toluene	108883	15,534,327	12,854,458	8,415,994	6,227,940	3,864,494	3,557,655	3,301,374	2,899,619
Total polychlorinated biphenyls (PCBs)	1336363			0.00	0.00	0.00	0.00	0.00	
Trichloroethylene	79016	903,013	832,864	1,112,980	677,228	790,200	787,293	568,648	428,910
Trichlorofluoromethane (CFC-11)	75694			51,466	31,445	44,418	12,367	755	10
Xylenes (Mixed isomers)	1330207	5,519,491	4,693,002	4,000,563	3,717,757	3,121,507	3,005,495	2,448,763	1,936,988

Figure 4.15 Trend in toluene emissions based on TRI data

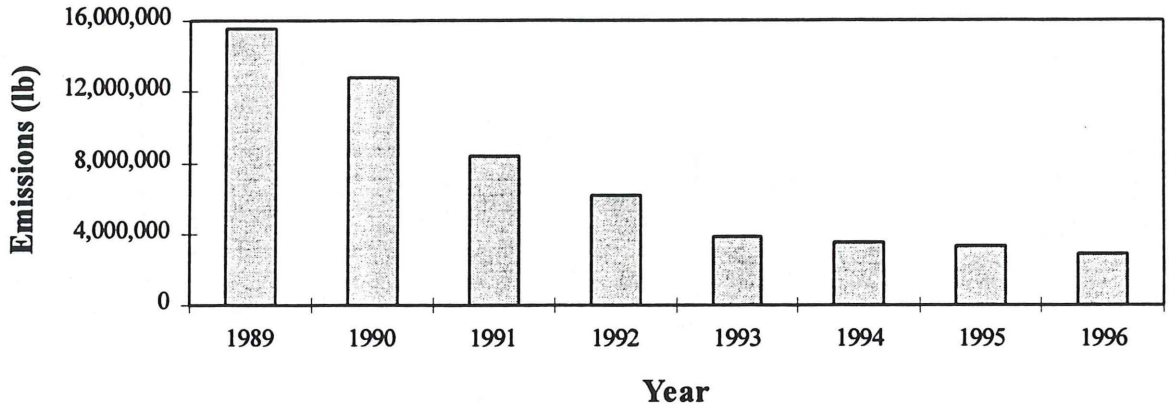


Figure 4.16 Trend in xylenes emissions based on TRI data

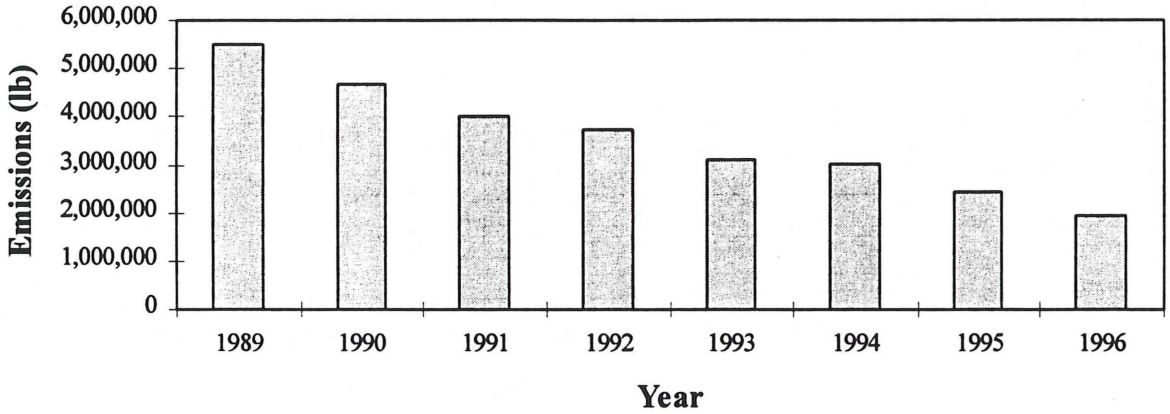


Figure 4.17 Trend in styrene emissions based on TRI data

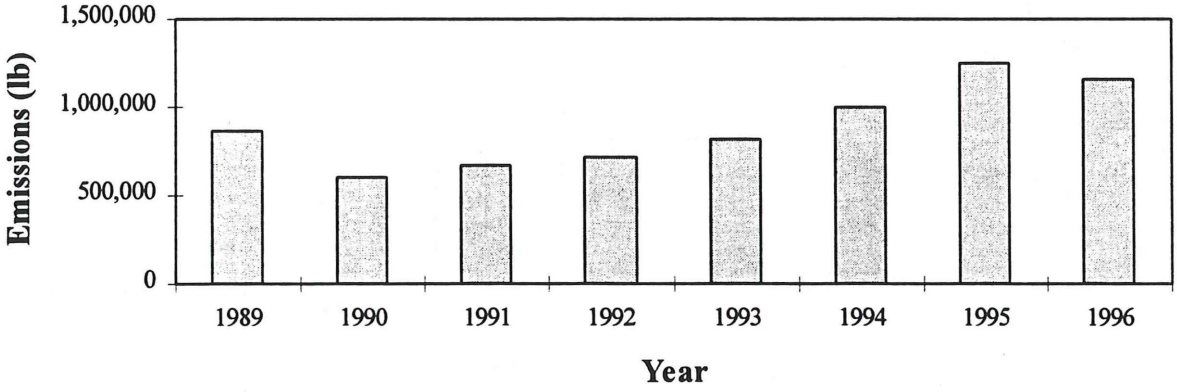


Figure 4.18 Trend in glycol ethers emissions based on TRI data

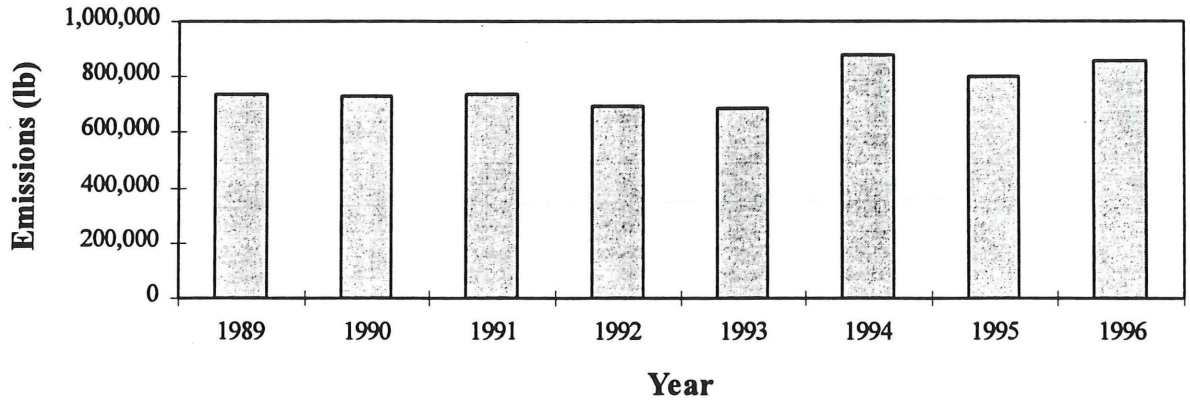


Figure 4.19 Trend in formaldehyde emissions based on TRI data

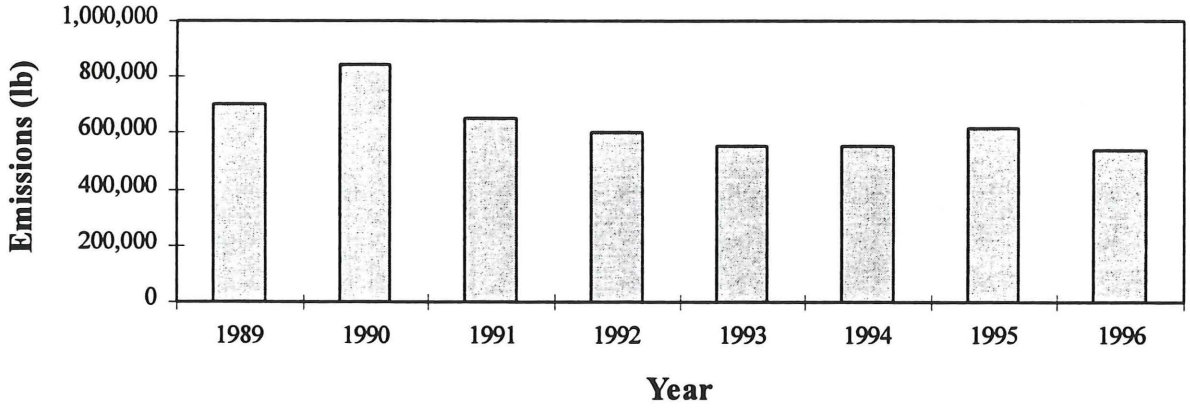


Figure 4.20 Trend in benzene emissions based on TRI data

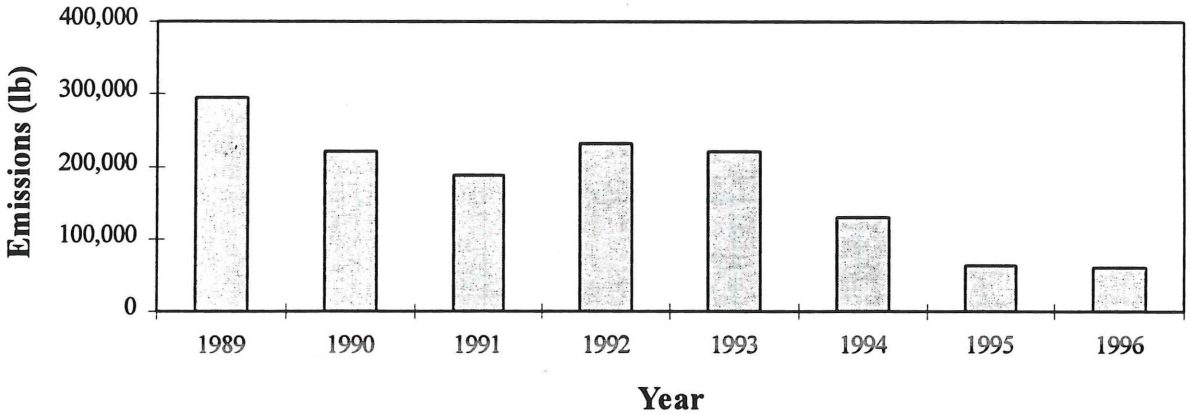


Figure 4.21 Trend in lead emissions based on TRI data

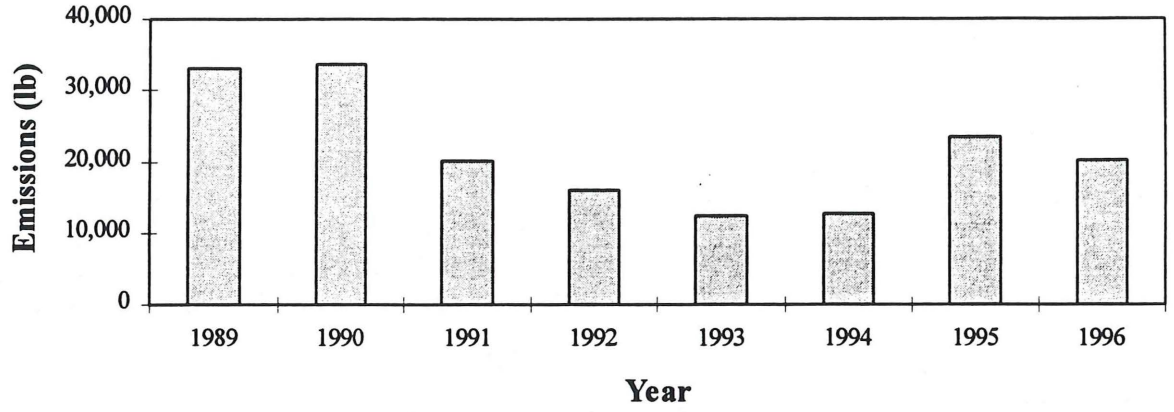


Figure 4.22 Trend in nickel emissions based on TRI data

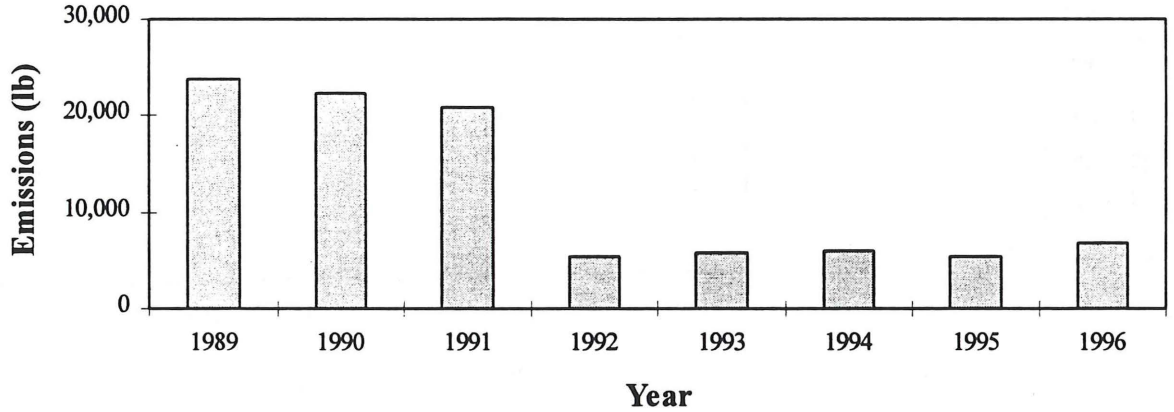


Figure 4.23 Trend in copper emissions based on TRI data

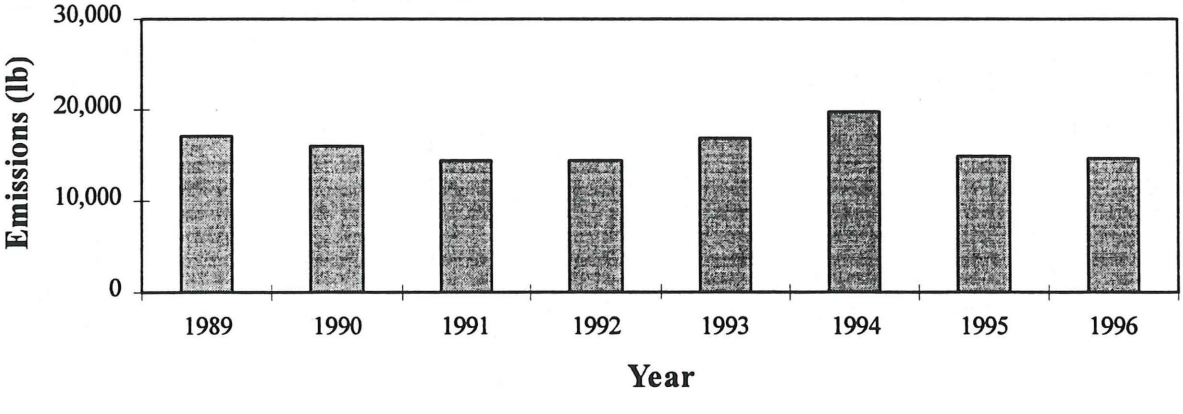


Figure 4.24 Trend in arsenic emissions based on TRI data

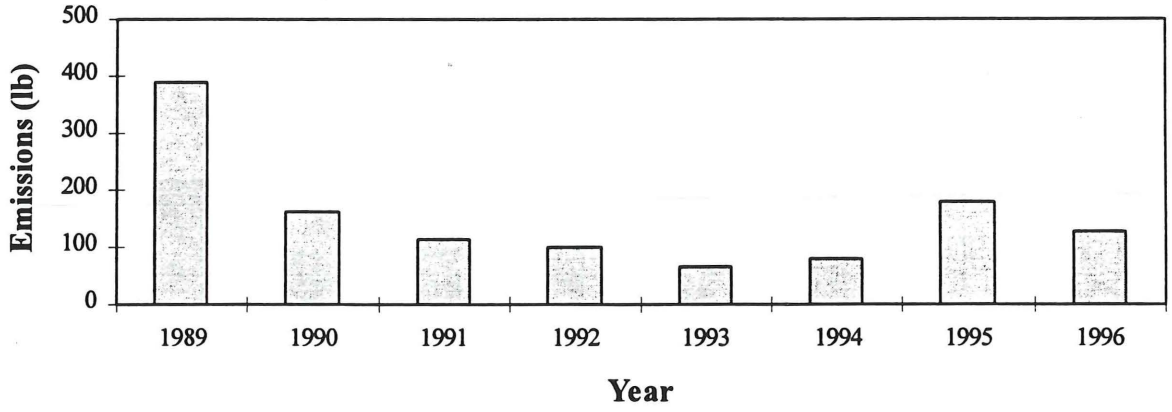


Figure 4.25 Trend in cadmium emissions based on TRI data

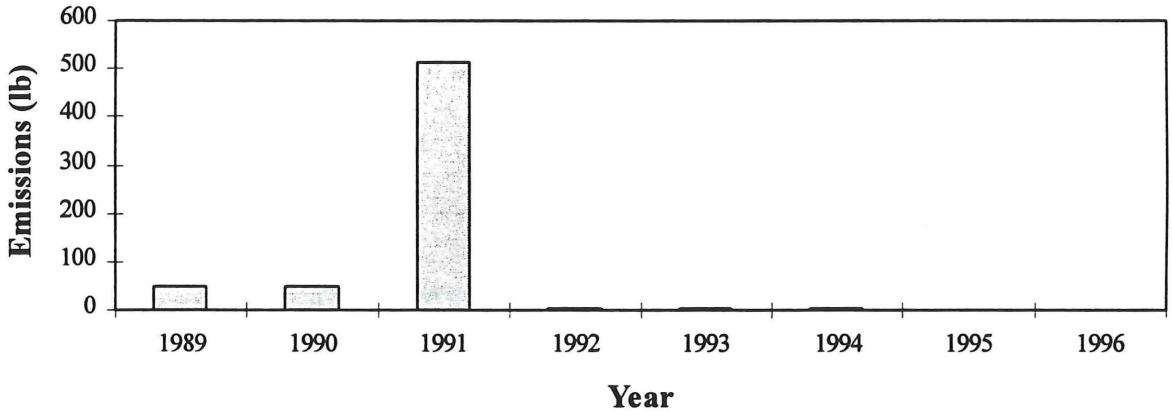
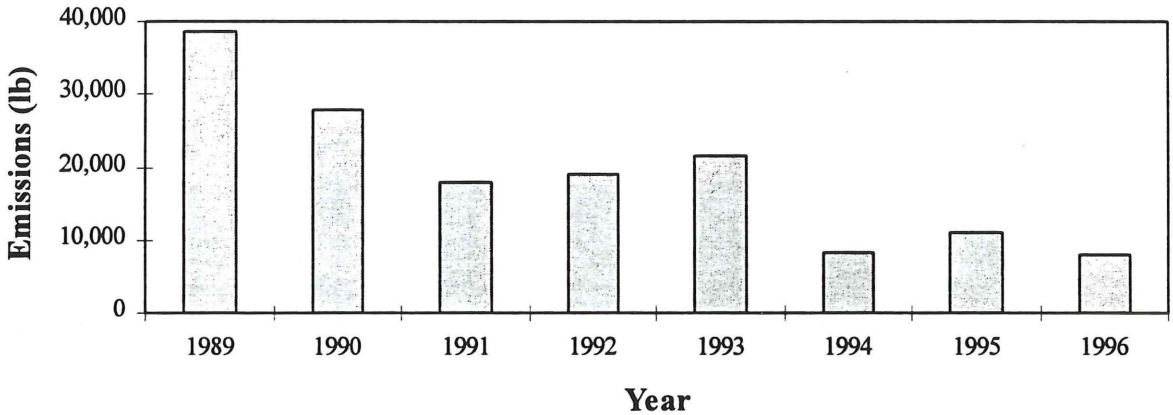


Figure 4.26 Trend in chromium emissions based on TRI data



4.5 1997 VOCs and PM-10 Statewide Emissions Estimate by Principal Source Categories

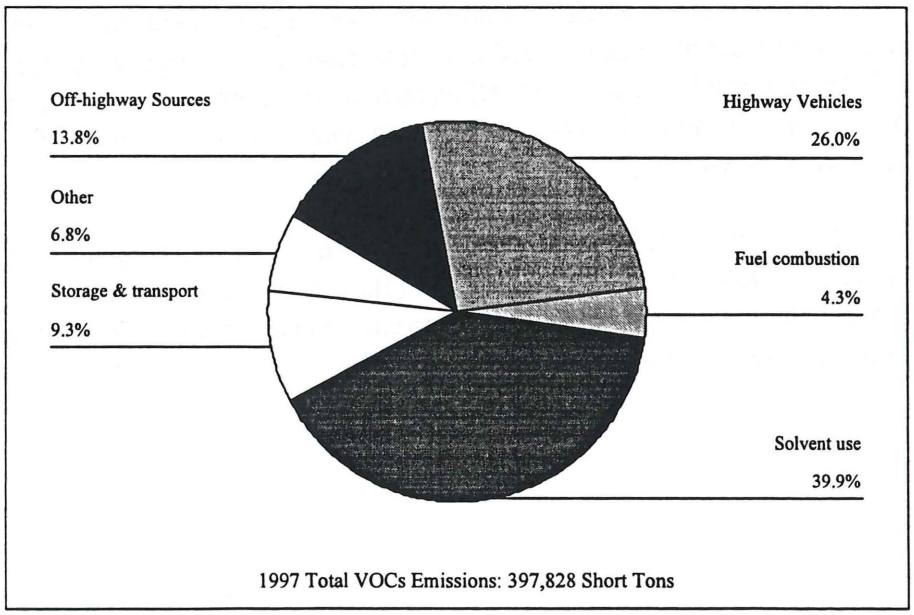
In this section of the report, contributions of statewide emissions for PM-10 and VOCs are presented as estimates of the total tonnage of each of these compounds released into Minnesota's air annually from all types of sources. These two criteria pollutants can give a general indication of sources of air toxics since they can be emitted in the form of particulate matter or as VOCs.

Though the MPCA will be completing the emission inventory of specific compounds for all types of sources in mid-1999, these estimates were obtained from EPA data. EPA estimates emissions from many factors, including the level of industrial activity, changes in technology, fuel consumption, vehicle miles traveled (VMT) and other activities that cause air pollution.

4.5.1 Volatile Organic Compound (VOC) Emissions Estimate

VOCs are a principal component in atmospheric reactions that form ozone and other photochemical oxidants. VOCs are emitted from diverse sources, including automobiles, chemical-manufacturing facilities, dry cleaners, paint shops and other commercial and residential sources that use solvent and paint. Federal rules define *volatile organic compound* (VOC) as a chemical that participates in forming ozone. Methane, a nonreactive compound, is not a VOC, nor are other organic chemicals with negligible photochemical reactivity. Figure 4.27 shows Minnesota's major sources of VOC emissions in 1997.

Figure 4.27 1997 Minnesota VOC emissions by principal source categories



As indicated, solvent use, including surface coating, degreasing, graphic arts, dry cleaning and nonindustrial applications (i.e., consumer solvent and pesticide application) contributed 38.5% of total 1997 statewide VOC emissions. Surface coating (i.e., industrial adhesives, paper, wood furniture, architectural, traffic marking, etc.), with 26 subcategories, represented 49% of solvent emissions.

The second-largest category, highway vehicles, accounted for 28.4% of total 1997 VOC emissions. Within this category, light-duty gasoline vehicles are the dominant source, contributing 39% of emissions from on-road vehicles.

Non-road sources, mainly non-road gasoline (i.e., lawn/garden, light commercial, recreational, etc.) represented 11.9% of the total.

Storage and transport, including bulk material storage, petroleum and petroleum product storage and transport as well as service stations contributed 10.7%, while fuel combustion, mainly residential wood combustion (fireplaces and wood stoves) account for 3.9% of the total.

Remaining sources, including petroleum and related industries, chemical and allied processing and waste disposal, each contributed less than 3% of the total.

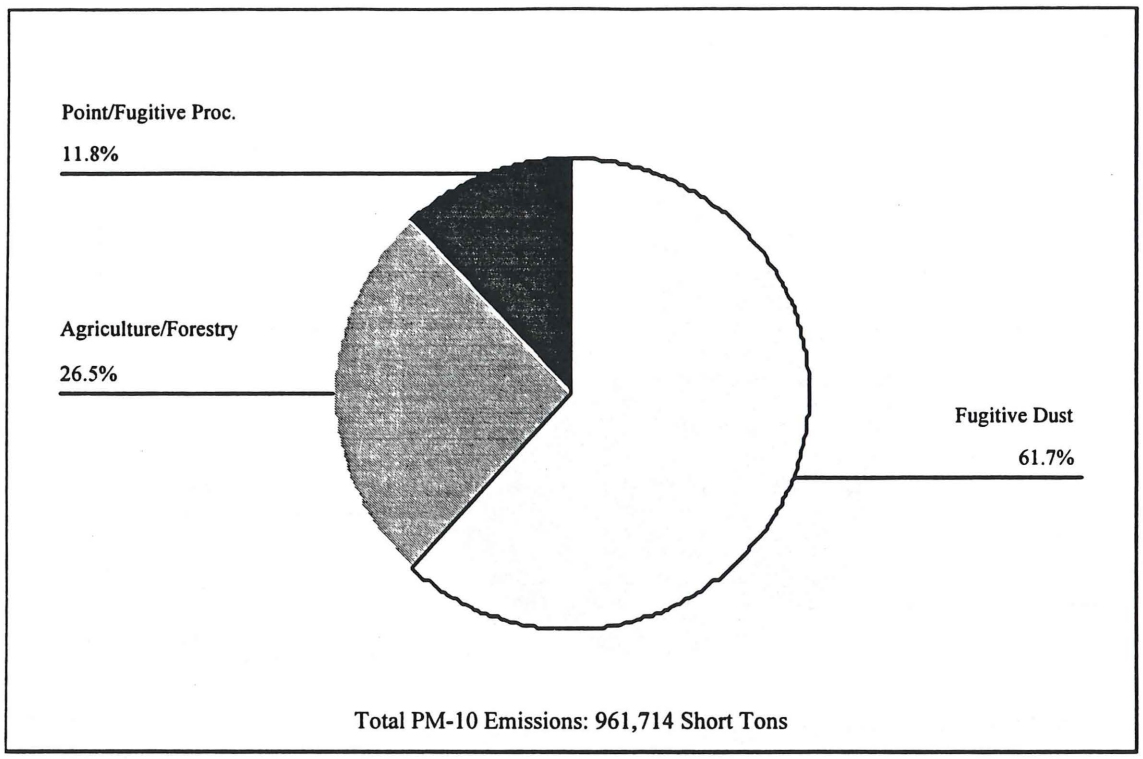
It should be noted that area source emissions, including highway vehicles, constituted about 85% of the total 1997 VOC emissions.

4.5.2 PM-10 Emissions

Because these particles originate from a variety of mobile and stationary sources, they may contain hundreds of different chemicals. Finer particles may contain substantial quantities of sulfate, ammonium, nitrate, elemental carbon and condensed organic compounds. In addition, carcinogenic PAH compounds and heavy metals, such as arsenic, selenium, cadmium and zinc, are concentrated in these particles. Larger particles, such as soil particles, fly ash and road dust, are dominated by particles of mineral origin, including silicon, aluminum, potassium, iron, calcium and other alkaline elements.

Figure 4.28 shows Minnesota's 1997 PM-10 emission sources. Total PM-10 emissions were estimated to be about 962,000 tons. The emissions in this figure include fugitive dust sources (construction, mining, paved and unpaved roads), agriculture and forestry (agricultural crops and livestock), and point and fugitive process sources.

Figure 4.28 1997 Minnesota PM-10 emissions by principal source categories



1997 PM-10 emissions were dominated by fugitive dust sources, which contributed 61.7% of all PM-10 emissions.

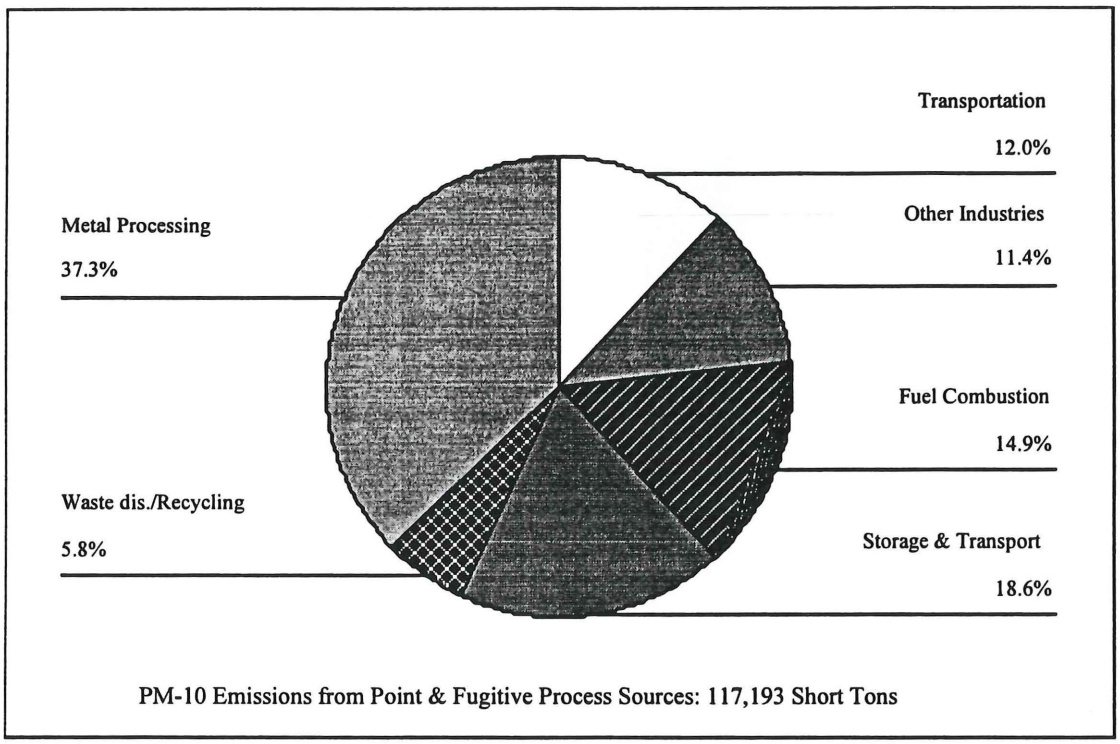
Agricultural and forestry contributed 26.5% of total PM-10 emissions.

PM-10 emissions from all major point and fugitive process sources, combined together, accounted for 11.8% of total PM-10 emissions. The major point and fugitive process sources in Minnesota are metal processing, storage and transport, fuel combustion, other industrial processes, transportation (highway vehicles and off-highway sources) and incineration.

Fugitive dust from roads and agricultural operations was by far the largest emission source. However, fugitive dust sources tend to be located away from people and fugitive dust tends to be coarser particles, which is of less concern from a health perspective. Particles emitted from apparently minor PM-10 sources, such as cars and wood stoves, are smaller, more toxic and released in populated areas, so it is appropriate to take a closer look at emission trends from combustion and industrial processes.

Figure 4.29 shows 1997 Minnesota PM-10 emissions for point and fugitive process sources exclusively. Fugitive dust and agriculture/forestry sources (which collectively contribute over 88% of total PM-10 emissions) are not included in this chart.

Figure 4.29 1997 Minnesota PM-10 emissions for point and fugitive process sources



As shown in Figure 4.29, PM-10 emissions from metal processing accounted for 37.3% of total PM-10 emissions from point and fugitive process sources.

Storage and transport (mainly bulk material storage) contributed 18.6% of the total PM-10 emissions.

Fuel combustion, mainly the burning of wood in homes, accounted for 14.9%.

Transportation (highway vehicles and off-highway sources) accounted for about 12%. Other industrial processing, including petroleum industry (refineries), accounted for 11.4% of PM-10 emissions from point and fugitive process sources.

Waste-disposal industry (incineration) contributed 5.8% to total PM-10 emissions from point and fugitive process sources.

5. Mercury

Mercury is considered separately from other air pollutants in this report because it has been the subject of a special MPCA initiative, it has been studied intensively and its emissions have been quantified separately. In addition, the MPCA is required by a new law to report on the mercury

emissions associated with electrical production and retail sales in Minnesota (see section 5.6, *Mercury Emissions Associated with Electrical Production and Consumption in Minnesota*, below).

5.1 Mercury Contamination of Fish Is Caused Largely by Air Pollution

Mercury, a pollutant toxic to the nervous system, can concentrate in fish to the point that eating the fish is hazardous. Mercury contamination of fish is a problem in Minnesota and many other states. Given Minnesota's lakes and the widespread interest in fishing and the importance of fish-eating wildlife, such as loons, mink and otter, it makes sense that Minnesota has one of the best fish-contamination-monitoring programs in the country. Managed by the Minnesota Department of Natural Resources, more than 700 lakes have been tested in the program. The Minnesota Department of Health has issued advice to limit consumption of fish from more than 90% of the tested lakes.

Virtually all of the mercury found in fish is delivered to the lake from the atmosphere. About three-quarters of the mercury in the atmosphere is a result of man-made air pollution. Reducing mercury contamination is a high priority in Minnesota, and several programs are in place to reduce the use and emission of mercury, including a comprehensive reduction effort (see *The Mercury Contamination Reduction Initiative*, below).

5.2 The Mercury Contamination Reduction Initiative

In early 1997, the MPCA began its Mercury Contamination Reduction Initiative, aimed at reducing mercury contamination of fish in Minnesota lakes. A major part of this effort is to receive advice and comments from the public regarding the goals of the initiative. The MPCA established a Mercury Advisory Council that includes representatives from government, business, and citizen and environmental groups. The advisory council met almost monthly from May 1997 to December 1998.

The advisory council's chartered goal was to devise a package of recommendations to reduce mercury contamination in the environment. In December 1998, the advisory council agreed to adopt a goal of reducing mercury releases to Minnesota's air and water by 70% (compared to 1990 levels) by the year 2005, to be established in statute in the 1999 legislative session.

The recommendations that the council voted to forward to the MPCA include:

- Encouraging voluntary commitments on the part of sources of mercury emissions (e.g., power plants, taconite facilities, sewage sludge incinerators) to reduce or work toward reducing mercury emissions.
- A package of seven strategies which the state will advance at the national level to encourage states and the federal government to act in concert to reduce national mercury releases.

- A package of strategies to persuade consumers to reduce their purchases and use of mercury-containing products and encourage counties to collect more mercury-containing waste in their household hazardous waste pickups.
- Pursue continued research on mercury sources, transport and impacts on human health and wildlife.

Recommendations for new mercury-related legislation are not contained in this report, but rather will be provided during the 1999 legislative session.

5.3 Mercury Emission Inventory for Minnesota

It is important to understand the sources of mercury to the atmosphere in order to reduce air pollution, mercury deposition to lakes and fish contamination. To that end, MPCA staff have revised estimated emissions of mercury to the air for 1990 and 1995 (Table 5.1). Table 5.1 is subdivided into three main categories of emissions: (1) emissions that are incidental to energy production (the release of trace amounts in fossil fuels), (2) emissions that largely result from the purposeful use of mercury (volatilization during product disposal and incineration) and (3) emissions incidental to other activities (e.g., processing natural resources, such as wood and iron ore). Category 3 is distinct from category 1 (even though they are both incidental emissions) in that once mercury is released during production of a material such as iron, that iron can be recycled without releasing additional mercury.

Table 5.1. Inventory of mercury emissions, in pounds, in Minnesota for the years 1990 and 1995 (The data are subject to change as better information is received.)

	confidence level	1990 (best)	1990 Min.	1990 Max.	1995 (best)	1995 Min.	1995 Max.
Incidental to Energy Production							
coal (total) (1)	medium	1,526	1,145	1,908	1,462	1,096	1,827
electric utility coal	medium	1,416	1,062	1,770	1,332	999	1,665
commercial/industrial coal	medium	110	83	138	130	97	162
residential coal		0	0	1	0	0	1
Petroleum Sector (including refining and combustion of products) (2)	low	250	125	250	250	125	250
wood (3)	medium	13	9	16	10	8	13
natural gas (4)	low	0.2	0.1	0.5	0.28	0	1
Subtotal incidental with energy production		1,792	1,281	2,179	1,725	1,230	2,095
% of total state emissions		21%			37%		
Largely Resulting from the Purposeful Use of Mercury							
Latex Paint Volatilization (5)	low	500	250	1,000	10	5	20
Municipal Solid Waste Combustion (6)	high	1,806	1,626	1,987	634	570	697
On-site Household waste incineration (7)	low	666	333	1,332	270	135	540
Medical Waste Combustion (8)	high	516	464	568	36	32	40
Sewage sludge Incineration (9)	med.	247	185	309	160	120	200
Fluorescent Lamp Breakage (10)	low	330	165	660	83	41	165
Class IV incinerators --1,000 closed by 1/96 (11)	low	55	28	110	28	14	56
Crematories (12)	low	24	12	49	35	18	71
General Laboratory Use (13)	low	44	22	88	44	22	88
Dental Preparations (14)	low	24	12	48	12	6	24
Hazardous Waste incineration (15)	medium	5	4	6	5	4	6
Landfill volatilization (16)	low	13	6	25	3	2	7
Recycling mercury from Products within MN (17)	medium	4	3	4	35	26	44
Smelters that recycle cars and appliances (18)	medium	166	125	208	166	125	208
Volatilization from Dissipative Use (19)	low	2	1	4	2	1	4
Fungicide Volatilization (20)	low	86	43	172	25	13	50
Volatilization from spills and land dumping (21)	low	55	27	109	48	24	96
Volatilization during SW collection & processing (22)	low	1,304	652	2,607	432	216	864
Volatilization: land application of compost (23)	low	2	1	3	1	0	1
Volatilization: land application of sludge (24)	low	4	2	7	2	1	3
Subtotal associated with purposeful use of mercury		5,852	3,960	9,297	2,031	1,375	3,184
% of total state emissions		69%			44%		
Emissions Incidental to other Activities:							
Taconite Processing (25)	medium	797	598	797	828	621	828
Pulp and Paper Manufacturing (26)	low	4	2	7	4	2	7
Soil Roasting (27)	low	13	7	27	13	7	27
Subtotal emissions incidental to other activities		814	606	831	845	629	862
% of total state emissions		10%	10%	7%	18%	19%	14%
GRAND TOTAL =		8,457	5,847	12,307	4,600	3,235	6,140

Abbreviations: NA = Not Applicable, NQ = Not Quantified

Confidence intervals: High, +/- 10%; Medium, +/- 25%; Low, +/- 50% (except when best estimate cannot be exceeded).

NOTES to Table 5.1

1 Based on data submitted by facilities with stack tests (NSP, MP) and extrapolated to other coal combustors.

2 Based on a preliminary analysis of crude oils delivered to Minnesota refineries. The fate of the mercury in the refinery and various products is being investigated.

3 From Pang, S.M., 1997. Mercury in wood and wood fuels. Thesis. Master of Science. University of Minnesota.

4 Assumes the EPRI emission factor of 0.0008 lb/trillion Btu.

5 Nationally, 24.2 tons of mercury was added to paint in 1990 (2% = 968 lb). Half is assumed to volatilize the first year. (Minnesota's economy is about 2% of the U.S. economy.) The addition of mercury to paint was discontinued by 1992.

6 Based on stack tests.

7 Quantity is based on Office of Environmental Assistance estimates. Municipal solid waste (MSW) is assumed to be 3.7 ppm in 1990 and 1.5 ppm in 1995.

8 Based on stack tests.

9 Based on sludge analyses and the analysis published by S. Balogh and L. Liang, 1995. Mercury pathways in municipal wastewater treatment plants. Water, Air, and Soil Pollution. 80:1181-1190.

10 Based on the proportion not recycled and industry figures on mg/lamp, assuming 25% is volatilized.

11 All of these small incinerators associated with grocery stores, etc. (about 1,000) closed by January 1996. It is assumed that they mostly burned cardboard with mercury at 0.2 ppm.

12 Assumes that each person has four amalgam fillings containing 0.5 gram of mercury each.

13 Estimate in the U.S. Environmental Protection Agency (EPA) Mercury Report to Congress.

14 Estimate in the U.S. Environmental Protection Agency (EPA) Mercury Report to Congress.

15 Estimate from Minnesota's only hazardous waste incinerator, 3M Chemolite.

16 0.1% of landfilled municipal solid waste (MSW) is assumed to volatilize to the air per year (based on studies of MSW emissions in Florida by S.E. Lindberg and J.L. Price, 1998).

17 Products within Minnesota Estimate from Brian Golob, personal communication.

18 Automobile Shredder Residue Report. MPCA, 1995. The largest scrap metal smelter in Minnesota is North Star Steel; it is assumed that 50% of mercury is emitted, and that the number of mercury switches declines with time.

19 Mercury that dissipates into the environment (excluding fungicides): ritual uses, pharmaceuticals, etc.

20 Estimate of volatilization from fungicides applied to golf courses.

21 Estimate assumes that 8% of mercury removed from service each year is spilled on the ground and that 5% of that amount volatilizes.

22 Assumes that the 5% of the mercury in solid waste is volatilized during collection, transportation and mechanical processing. Includes demolition, industrial and municipal solid waste (MSW) landfills, MSW and medical waste incineration, MSW compost, backyard burn barrels and steel-recycling facilities; fluorescent lamps calculated separately.

23 Assumes that 1.0% of mercury applied to the surface of the land volatilizes within a year.

24 Assumes that 1.0% of mercury applied to the surface of the land volatilizes within a year.

25 From Engesser et al., 1997. Mercury Emissions from Taconite Pellet Production. Univ. of Minnesota report to the MPCA.

26 From voluntary reports to the MPCA.

27 An average of 83,000 tons per year of surface soil is heated annually in Minnesota to remove organic contaminants. A background concentration of 0.08 ppm of mercury is assumed.5.3.1 Trends in mercury emissions

5.3.1 Trends in Mercury Emissions

It is clear that mercury air emissions declined greatly (by about 45%) from 1990 to 1995, from about 8,500 lb to 4,500 lb (Table 5.1). Virtually all of the decline can be attributed to emissions associated with the purposeful use of mercury. The major reductions resulted from the elimination of mercury additives to latex paint (estimated reductions of about 500 lb), source reduction and control at municipal waste incinerators (1,200 lb) and on-site incinerators (about 500 lb), and reductions from medical waste incinerators (about 500 lb). Reductions occurred at larger incinerators due to both lower levels of mercury in waste (mercury in municipal solid waste declined from about 4 ppm in 1990 to about 1.5 ppm in 1995) and control technology (e.g, the Hennepin Energy Resource Company municipal waste combustor and the Mayo Clinic medical waste incinerator installed activated-carbon-injection systems). Further reductions in mercury use and additional emissions control will likely result in lower emissions from waste incineration, from 878 lb emitted in 1995, declining to projections of about 380 lb in 2000, and 280 lb in 2005. In addition, MPCA staff calculate that about 550 fewer lb of mercury were emitted to the air in 1995 simply because there was less mercury in products to volatilize when these products were disposed of or accidentally spilled.

5.4 Mercury Deposition Monitoring

The MPCA participates in the National Atmospheric Deposition Program (NADP) to monitor mercury deposition in rain and snow. In 1996, four sites were established across Minnesota: Lamberton in southwestern Minnesota, Camp Ripley in central Minnesota, Marcell in north-central Minnesota and Ely in northeastern Minnesota. Each site is also a NADP acid-deposition monitoring site. Total mercury and acid rain parameters (major cations and anions) are monitored weekly, while methyl mercury is analyzed using four-week composite samples.

The MPCA has also obtained data on historical mercury deposition rates from sediment cores from more than 50 lakes. As sediments accumulate over time, they act as a natural archiving system for the history of contamination. By obtaining a three- to four-foot-long core of the sediment from a lake, and slicing it into thin layers for analysis, the history of the mercury contamination of that lake can be reconstructed with about a five-year resolution. From these reconstructions, the degree and timing of changes in atmospheric deposition can be calculated, including the natural level of contamination. Comparing cores from Minnesota lakes to remote Alaskan lakes also indicates the amount of contamination that has resulted from sources in the Minnesota region versus contamination from mercury that contaminates the whole globe. Results from the coring program show that (1) of the mercury deposited in northeastern Minnesota, 30% is natural, 30% is global pollution and 40% is regional, and (2) in some parts of Minnesota, the regional pollution peaked in the 1970s and has declined since then due to less emission of mercury (Engstrom and Swain, 1997).

5.5 How Mercury in Products Gets to the Atmosphere

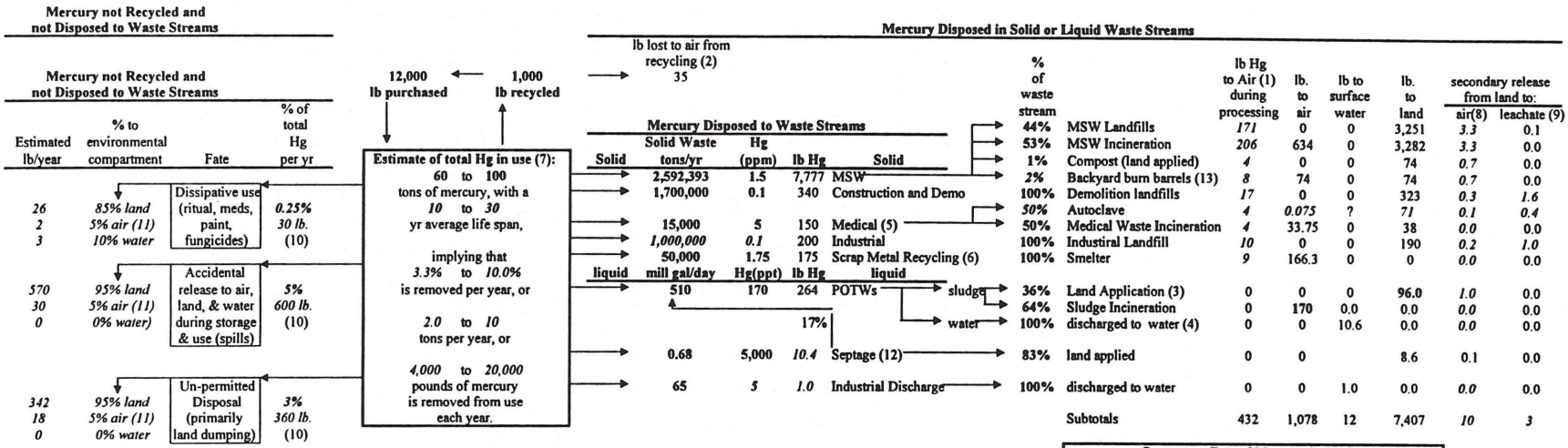
Mercury has been used in many products for many reasons. Some uses, such as pharmaceuticals and fungicides, dissipate the mercury into the environment as it is used. Such uses have a relatively short life span, and then more mercury is purchased for that use. In contrast, mercury is used in some electrical switches that have an indefinite life span (lasting 40 years or longer) and may be encapsulated until the switch is decommissioned due to equipment changes. Most of these mercury uses, such as appliance and automobile switches and medical equipment (e.g., manometers), probably have life spans between 10 and 30 years.

Figure 5.1 represents an attempt to track the fate of mercury in products from purchase to disposal and estimates the quantity of mercury released to air, land and water during storage and use. One of the primary motivating factors for the creation of Figure 5.1 was the need to understand the relative importance of reducing mercury use in products as compared to the direct release of mercury to air and water from point sources, such as coal-fired power plant stacks. Evaluation of the connection between mercury use and release indicates that for every 100 lb of mercury contained in products disposed of in 1995, 15 lb were released to the atmosphere. The remainder either was recycled, or is associated with land (via a landfill or landspreading). The 15% figure can be used as a conversion factor between mercury used in products and mercury emitted to the atmosphere. Assessment of the cost of reducing mercury releases by reducing use in products versus controlling emissions from coal-fired utilities or taconite plants showed that, in general, the cost per pound to reduce emissions is lowest by reducing mercury use in products and reducing improper disposal.

For instance, in 1995 (Figure 5.1) of the 60 to 100 tons of mercury in use in Minnesota, about 4 tons (7,777 lb) were discarded in about 2.5 million tons of solid waste. About 44% of this waste (containing about 3,420 lb of mercury) went to landfills, of which MPCA staff estimate that 5% (171 lb of mercury) was lost to the atmosphere before the waste was dumped out of the truck at the landfill (during waste collection, transportation and mechanical processing). An additional 0.1%, or 3.3 lb of mercury, is estimated to be volatilized to the air at the landfill. A greater proportion (53%) of solid waste went to combustors in 1995, where 634 lb of mercury were emitted to the air. No matter how mercury-containing products are disposed, some mercury makes its way to the atmosphere.

Once all possible fates of mercury-containing products are estimated, one can add all sources of mercury to air, land and surface water. For 1995, MPCA staff estimate that, of the approximately 11,000 lb of mercury removed from service that year, 15% (1,655 lb) made its way to the atmosphere, 76% (about 8,400 lb) is on the land or in landfills, 9% was recycled and only 0.1%, or 17 lb per year, was discharged to surface water.

Figure 1. Fate of mercury used in products in Minnesota, 1995



Notes

1. Pounds of Hg in this waste stream that is lost to air during collection, transportation, & mechanical processing, assuming that 5% is lost during those processes.
2. The Mercury Report to Congress estimates 7.4 tons per year lost to air from recycling, while USBM data indicate about 220 tons per year, about 3.5 percent.
3. Total sludge land spread in Minnesota in 1995 was 46,668 dry tons with an average mercury content of 1.83 ppm, or 171 lb (R. Wirth, pers. com.).
4. This calculation assumes that 4% of the mercury entering a POTW is discharged to surface water, and that the rest associates with sludge (Balogh and Liang 1995, Water, Air, and Soil Pollution 80: 1181-1190).
5. About 7,500 tons/year medical waste is incinerated at the two large facilities (6,900 t/yr) and 20 small units (600 t/yr) (P. Torkelson, pers. com.). The amount accepted by autoclaves is unknown.
6. Automobile Shredder Residue Report. MPCA. 1995. The largest scrap metal smelter in MN is North Star Steel; it is assumed that 50% of Hg is emitted, and that the rest is emitted when the fly ash is refined for its zinc content in another state. After 1995 North Star Steel asked suppliers to remove mercury switches before delivering scrap.
7. Based on pro-rated estimated of U.S. installed base, not counting chlor-alkali plants (S.M. Jasinski, 1995. The materials flow of mercury in the United States. Resources, Conservation, and Recycling 15:145-179.)
8. The following rates are assumed for air emissions from land: 1%/yr from surface application; 0.1%/yr from other landfilled material (0.1% is based on studies of MSW emissions in Florida by S.E. Lindberg and J.L. Price, 1998).
9. Leachate (assumed to be 0.002%/yr, based on concentration x leachate volume), is either land applied (through spray irrigation) or transported to a POTW. Median concentration is 0.7 ppb (Land Treatment of Landfill Leachate, MPCA, 1993, pg. 27).
10. Based on the mean quantity of mercury estimated to be removed from the installed base per year (in this case, the mean of 4,000 and 20,000 pounds per year, or 12,000 pounds).
11. Consistent with Note number 1, 5% of these materials is assumed to become volatilized within a year of disposal. There may be continuing release in subsequent years, which is not accounted for in this estimate.
12. Concentration from document provided by Joe Carruth.
13. It is assumed that half of the mercury burned in a back yard burn barrel is volatilized immediately, and half is buried in the land.

5.6 Mercury Emissions Associated with Electrical Production and Consumption in Minnesota.

In 1997, a new state law took effect that requires the producers and retailers of electricity to report on the amount of mercury emitted in generating electricity (Minn. Stat. §116.925). The MPCA is required by the law to summarize this emission information in its biennial air toxics report. This is the first such report, summarizing 1997 emissions.

For 1997, the MPCA received reports for 28 generation units in Minnesota (Table 5.2). The major fuel for most units was coal, although two facilities depend on municipal solid waste for fuel (Hennepin Energy Resource Company and NSP Red Wing). In 1997, a total of 1,814 lb of mercury were emitted to the atmosphere in the production of 33,721,787 megawatt-hours (MWh) of electricity. Two companies (Minnesota Power and Otter Tail Power) noted in their submissions that significant quantities of their electrical production are exported, for consumption outside Minnesota. It should be noted that electricity is also imported into Minnesota through purchases off the grid, for which it is not possible at this time to attribute mercury emissions.

The law also requires Minnesota retailers and wholesalers of electricity that is produced outside Minnesota to report on the mercury emissions associated with production. For 1997, the MPCA received reports totaling 865 lb of mercury emitted in neighboring states in the production of 11,169,946 MWh of electricity that were likely consumed in Minnesota (Table 5.2). The term "likely" is used because it is not possible to know absolutely that electrical power that is exported to Minnesota is actually consumed in the state, because electricity can be resold before it is used. Three companies that generate power outside Minnesota (Interstate Power, NSP and Otter Tail Power) reported mercury emissions associated with electrical imports into Minnesota.

Thirty-eight Minnesota distribution cooperatives, which distribute electricity to consumers but do not generate electricity, reported mercury emissions associated with the generation of the electricity, most of which was generated in North Dakota, South Dakota and Wisconsin. The information was provided to the distribution cooperatives by their suppliers, Cooperative Power, Dairyland Power, Minnkota Power and United Power (Table 5.3). The normalized mercury emissions per MWh from each supplier (milligrams per megawatt-hour, or mg/MWh) are variable because of varying amounts of electricity purchased from the grid and from hydroelectric generators. Mercury-emissions-per-megawatt-hour rates for electricity supplied by cooperatives may not be strictly comparable to rates reported by generation facilities because some of the electricity produced by coal-fired plants was counted as having zero mercury emissions (emissions neutral) due to lack of mercury data. Four Minnesota distribution cooperatives were not able to report on the mercury emissions associated with the electricity they sold because the electrical producer, Basin Electric Power Cooperative, did not supply any mercury emissions data (Table 5.3).

The law exempts certain electrical-generation facilities from reporting mercury emissions: (1) those that operate less than 240 hours per year, (2) combustion units generating less than 150 million British thermal units (Btu's) per hour, (3) generation units with a maximum output of less than or equal to 15 megawatts. Electrical-generation facilities that were exempt from reporting mercury emissions for 1997 are listed in Table 5.4.

In summary, this first attempt to report on mercury emissions associated with electrical production and consumption is a useful exercise, but has certain limitations. In particular, it is problematical to definitively quantify the electricity that is imported to Minnesota for consumption and its associated mercury emissions. As more coal-fired plants obtain mercury data, it should be possible for electrical retailers to obtain and report more mercury data associated with their wholesale purchases.

Table 5.2 Reported 1997 emissions of mercury from electrical production facilities in Minnesota

	Facility	Major Fuel Type(s)	Electricity Produced (MWh)	Mercury Emissions (lb)	Mercury Emissions (mg/MWh)
Blandin Paper Company	Grand Rapids Boilers 5,6	coal, wood, ties	121,164	4	16
Champion International Corporation	Sartell Mill #3 boiler	coal, bark, sludge	100,660	8	34
Hennepin Energy Resource Corporation	Minneapolis waste-to-energy fac.	municipal sold waste	212,797	26	55
LTV Steel Mining Company	Taconite Harbor Power Plant	coal	920,485	50	24
Minnesota Power	Boswell Unit 1	coal	355400	8	10
Minnesota Power	Boswell Unit 2	coal	335,600	7	9
Minnesota Power	Boswell unit 3	coal	1,976,200	102	23
Minnesota Power	Boswell Unit 4[1]	coal	3,661,700	201	25
Minnesota Power	Laskin Unit 1	coal	279,700	17	28
Minnesota Power	Laskin Unit 2	coal	258,200	16	28
Northshore Mining Company	Silver Bay Power Plant	coal	433,668	26	28
NSP	AS King 1	coal, gas, wood	3,670,620	68	8
NSP	Black Dog 3	coal	547,120	19	16
NSP	Black Dog 4	coal	900,520	32	16
NSP	High Bridge 5	coal, gas	302,080	15	23
NSP	High Bridge 6	coal, gas	941,000	43	21
NSP	Red Wing Waste-to-Energy	refuse-derived fuel	128,078	311	1,101
NSP	Riverside 6/7	coal	851,575	44	23
NSP	Riverside 8	coal	1,511,960	52	16
NSP	Sherco 1	coal	4,807,300	200	19
NSP	Sherco 2	coal	4,168,390	175	19
NSP	Sherco 3 (NSP owned portion)	coal	4,136,017	220	24
Otter Tail Power Company[2]	Hoot Lake Plant Unit 2	coal	302,701	12	18
Otter Tail Power Company	Hoot Lake Plant Unit 3	coal	234,539	10	19
Rochester Public Utilities	Silver Lake 3	coal	58,322	4	33
Rochester Public Utilities	Silver Lake 4	coal	150,124	10	29
Southern Minnesota Municipal Power Agency	Austin NE Power Plant	coal	119,494	4	16
Southern Minnesota Municipal Power Agency	Sherco 3(SMMPA-owned portion)	Coal	2,236,373	130	26
TOTAL			**33,721,787**	**1,814**	

[1] About 23% of electrical output from Boswell Unit 4 was exported from Minnesota.
[2] About 48% of electrical output from the Hoot Lake Plant was exported from Minnesota.

Table 5.3. Reported 1997 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.

	Facility or Supplier	Major Fuel Type(s)	Electricity Consumed in Minnesota (MWh)	Mercury Emissions (lb)	Mercury Emissions per Megawatt-hour (mg/MWh)
Interstate Power Company, Marshalltown, Iowa[1]	Dubuque 1, Dubuque, Iowa	bituminous coal	12,511	1.0	37
Interstate Power Company, Marshalltown, Iowa	Dubuque 5, Dubuque, Iowa	bituminous coal	10,236	0.8	37
Interstate Power Company, Marshalltown, Iowa	Lansing 3, Lansing, Iowa	bituminous coal	17,934	1.8	44
Interstate Power Company, Marshalltown, Iowa	Lansing 4, Lansing, Iowa	subbituminous coal	101,626	4.0	18
Interstate Power Company, Marshalltown, Iowa	Louisa 1/Louisa Co., Iowa	subbituminous coal	24,611	0.9	17
Interstate Power Company, Marshalltown, Iowa	ML Kapp 2, Clinton, Iowa	subbituminous coal	127,782	4.2	15
Interstate Power Company, Marshalltown, Iowa	Neal 4, Sioux City, Iowa	subbituminous coal	132,620	4.8	16
NSP[2]	French Island, La Crosse, Wis.	refuse-derived fuel, wood	60,584	5	36
Otter Tail Power, Fergus Falls, Minn.	Big Stone Plant, Big Stone Lake, S.D.	subbituminous coal	834,994	37	20
Otter Tail Power, Fergus Falls, Minn.	Coyote Plant, Beulah, N.D.	lignite coal	415,103	43	47
Agralite Electric Cooperative	Cooperative Power[3]	lignite coal	129,931	7	24
Benco Electric Cooperative	Cooperative Power	lignite coal	215,636	17	35
Brown County Rural Electrical Ass'n	Cooperative Power	lignite coal	106,767	6	25
Dakota Electric Ass'n	Cooperative Power	lignite coal	1,279,338	100	35
Federated Rural Electric	Cooperative Power	lignite coal	128,999	6	23
Goodhue County Cooperative Electric Ass'n	Cooperative Power	lignite coal	74,909	6	35
McLeod Cooperative Power Ass'n	Cooperative Power	lignite coal	134,341	10	32
Meeker Cooperative Light & Power Ass'n	Cooperative Power	lignite coal	124,368	8	28
Minnesota Valley Electric Cooperative	Cooperative Power	lignite coal	344,669	27	35
Nobles Electric Cooperative	Cooperative Power	lignite coal	102,256	4	17
Redwood Electric Cooperative	Cooperative Power	lignite coal	54,787	2	16
Runestone Electric Ass'n	Cooperative Power	lignite coal	167,739	9	25
South Central Electric Ass'n	Cooperative Power	lignite coal	101,862	5	22
Stearns Electric Ass'n	Cooperative Power	lignite coal	317,290	21	30
Steele-Waseca Cooperative Electric	Cooperative Power	lignite coal	158,967	12	35
Todd-Wadena Electric Cooperative	Cooperative Power	lignite coal	131,207	8	27
Freeborn-Mower Cooperative Services	Dairyland Power Cooperative[4]	coal	130,848	5	17
People's Cooperative Power Association	Dairyland Power Cooperative	coal	211,425	8	17
Tri-County Electric Cooperative	Dairyland Power Cooperative	coal	255,533	10	17
Beltrami Electric Cooperative	Minnkota Power Cooperative[5]	lignite coal	284,260	27	43
Clearwater-Polk Electric Cooperative	Minnkota Power Cooperative	lignite coal	66,042	4	28
North Star Electric Cooperative	Minnkota Power Cooperative	lignite coal	100,839	10	43
PKM Electric Cooperative	Minnkota Power Cooperative	lignite coal	102,748	6	28
Red Lake Electric Cooperative	Minnkota Power Cooperative	lignite coal	114,331	7	28

Red River Valley Cooperative Power Ass'n	Minnkota Power Cooperative	lignite coal	121,708	8	30
Roseau Electric Cooperative	Minnkota Power Cooperative	lignite coal	152,165	9	28
Wild Rice Electric Cooperative	Minnkota Power Cooperative	lignite coal	203,932	14	30
Arrowhead Electric Cooperative	United Power Association[6]	lignite coal	49,820	5	46
Connexus Energy	United Power Association	lignite coal	1,446,367	146	46
Crow Wing Power	United Power Association	lignite coal	345,358	35	46
East Central Electric Ass'n	United Power Association	lignite coal	639,097	65	46
Cooperative Light and Power	United Power Association	lignite coal	70,421	7	46
Itasca-Mantrap Co-op. Electrical Ass'n	United Power Association	lignite coal	117,996	12	46
Kandiyohi Power Cooperative	United Power Association	lignite coal	153,916	12	36
Lake Country Power	United Power Association	lignite coal	521,496	53	46
Mille Lacs Electric Cooperative	United Power Association	lignite coal	134,561	14	46
North Itasca Electric Cooperative, Inc.	United Power Association	lignite coal	38,500	4	46
Wright-Hennepin Cooperative Electric Assoc.	United Power Association	lignite coal	524,936	53	46
Lyon-Lincoln Electric Cooperative	East River Electric Power Cooperative[7]	N/A	72,580	N/A	
Renville Sibley Cooperative Association	East River Electric Power Cooperative	N/A	N/A	N/A	
Traverse Electric Cooperative	East River Electric Power Cooperative	N/A	N/A	N/A	
Minnesota Valley Coop. Light & Power Assoc.	Basin Electric Power Cooperative[8]	N/A	N/A	N/A	
TOTAL			**11,169,946**	**864**	

[1] About 13.6% of Interstate Power Company's output was exported to Minnesota.

[2] About 75% of French Island's output was exported to Minnesota.

[3] Cooperative Power (CP, Eden Prairie, Minn.) operates coal-fired generators in North Dakota that in 1997 accounted for 69% of the total electricity that CP supplied to its customers. In 1997, 31% of the electricity CP supplied was purchased from other suppliers to the electrical transmission grid (assumed to be emissions-neutral). Plus, some of the member cooperatives purchased additional power from Western Area Power Administration (WAPA), which is primarily hydroelectric.

[4] Dairyland Power Cooperative (DPC, La Crosse, Wis.) operates fossil fuel and hydroelectric generators in Wisconsin which in 1997 accounted for 70% of the total electricity that DPC supplied to its customers, with the balance purchased from the grid (assumed to be emissions-neutral).

[5] Minnkota Power Cooperative (Grand Forks, N.D.) operates coal-fired generators in North Dakota that in 1997 accounted for 66% of the total electricity that Minnkota supplied to its customers. In 1997, 22% was supplied by WAPA and 12% purchased from the grid.

[6] UPA (Elk River, Minn.) operates coal-fired generators in North Dakota and a refuse-derived fuel plant in Elk River that in 1997 together accounted for about 70% of the total electricity that UPA supplied to its customers, with the balance purchased from the grid (assumed to be emissions-neutral).

[7] East River Electric Power Cooperative (Madison, S.D.) supplies its customers with a blend of coal-fired and hydroelectric power (WAPA). The coal power is purchased from Basin Electric Power Cooperative (see footnote 8).

[8] Basin Electric Power Cooperative (Bismarck, N.D.) supplies its customers with a blend of coal-fired and hydroelectric power. Basin Electric produces electricity at coal- and oil-fired power plants in North Dakota, South Dakota, and Wyoming. The power plants include the Leland Olds Station (Stanton, ND), Antelope Valley Station (Beulah, ND), Laramie River Station (Wheatland, Wyo.), and Spirit Mound Station (Vermillion, S.D.). Basin Electric states that no mercury emissions data are available, according to submissions to the MPCA from the Minnesota distribution cooperatives.

Table 5.4 Electrical generation facilities exempt from reporting mercury emissions for 1997

Ownership	Facility	Reason for Exemption			
		< 240 hr operation	< 150x10^6 Btu/hr	< 15 Megawatt	< 3 lb/yr
Alexandria Light and Power	Units 1-3	x	x	x	
Blooming Prairie Public Utilities	Facility ID 14700001	x			
Blue Earth Light and Water Dept.	Engines No. 4, 5, 7-9			x	
Boise Cascade, International Falls	Boilers 1, 2, 3, 8, 9				x
City of Benson Public Works	Municipal Power Plant			x	
Cogentrix	LSP-Cottage Grove				x
Delano Municipal Utilities	Units 1-7	x	x	x	
Elk River Municipal Utilities	standby diesel generators	x		x	
Fairmont Public Utilities	Units 1,2,3,4,6,7		x	x	
Interstate Power Company	Dubuque 6, Dubuque, Iowa			x	
Interstate Power Company	Fox Lake 1, Sherburn, Minn.			x	
Interstate Power Company	Fox Lake 2, Sherburn, Minn.			x	
Interstate Power Company	Fox Lake 3, Sherburn, Minn.				x
Interstate Power Company	Fox Lake CT, Sherburn, Minn.	x			
Interstate Power Company	Hills Diesel 1, Hills, Minn.			x	
Interstate Power Company	Hills Diesel 2, Hills, Minn.			x	
Interstate Power Company	Lansing 1, Lansing, Iowa			x	
Interstate Power Company	Lansing 2, Lansing, Iowa			x	
Interstate Power Company	Lime Creek 1, Mason City, Iowa	x			
Interstate Power Company	Lime Creek 2, Mason City, Iowa	x			
Interstate Power Company	ML Kapp 1, Clinton, Iowa	x			
Interstate Power Company	Montgomery, Conn.	x			
Kenyon Municipal Utilities	3 Diesel Units	x	x	x	x
City of Luverne	Diesel generation			x	
Marshall Municipal Utilities	Facility ID 08300005	x			
Medelia Municipal Light & Power	Generators 2, 3, 4, 5			x	
Melrose Public Utilities	Two units	x		x	
Minnesota Methane	Edward Kraemer Landfill			x	
Minnesota Methane	Flying Cloud Landfill			x	
Minnesota Methane	State of MN – Trans. Bldg			x	
Moorhead Public Service	Gas Turbine			x	
Mountain Lake Municipal Utilities	Generating Engine No. 1-5			x	
NSP	Alliant Tech 1		x		
NSP	Black Dog Units 1 and 2	x			
NSP	Blue Lake Units 1-4	x			
NSP	Granite City Units 1-4	x			
NSP	Inver Hills Generators 1, 2		x		
NSP	Key City Units 1-4	x			
NSP	Minnesota Valley 4	x			
NSP	United Health Care 1 and 2		x		
NSP	United Hospital Units 1-3		x		
NSP	West Faribault Units 2 & 3	x			
NSP	Wilmarth 1				x
NSP	Wilmarth 2				x
Olmsted Public Works	Waste to Energy Boilers 1-4		x		
Potlatch Corporation, Cloquet	Boilers			x	x
Potlatch, Brainerd	Boilers 1-4		x		
Preston Public Utilities	Units 1-6		x	x	
New Ulm Public Utilities	Sources 1-4			x	x
Rochester Public Utilities	Silver Lake 1			x	
Rochester Public Utilities	Silver Lake 2			x	
United Power Association	Elk River Station				x
Willmar Municipal Utilities	Boilers 1-4			x	