

# **Appendix D: Minnesota Toxic Emissions Inventory**

## **INTRODUCTION**

The development of the Minnesota portion of the regional air toxics emission inventory follows the instructions illustrated in the protocol document and uses the Regional Air Pollution Inventory Development System (RAPIDS) to estimate emissions. However, because Minnesota does not have air toxic emission inventory reporting requirements for industrial point sources, we have established an alternative approach for development of the Minnesota inventory that meets the protocol requirements. Using this approach, 1108 point sources were estimated to have emissions for one or more pollutants listed in the 2001 Great Lakes regional air toxics emission inventory. Also, various area sources were examined and emissions were estimated for 25 area source categories. Presented in the following sections is a detailed discussion on data acquisition, emission estimation, quality assurance and quality control plans, and uncertainties inherent in the inventory.

## **METHODOLOGY**

### **Data Acquisition**

The 2001 Minnesota portion of the air toxic emission inventory includes three principal source categories: point, area, and mobile sources. Since Minnesota focuses more on the development of a statewide emission inventory every three years, the 2001 emission inventory was taken from an updated 1999 emission inventory.

### **Point Source Emissions**

Minnesota does not have air toxic emission inventory reporting requirements for industrial point sources. However, emission data for point sources are collected for the Minnesota criteria pollutant emission inventory (MCEI). Therefore, for the purpose of the Minnesota air toxics emission inventory, point sources are identified as facilities that are required to submit their annual inventories of criteria pollutants (carbon monoxide, nitrogen oxides, particulate matter, particulate matter smaller than 10 microns, lead, sulfur dioxide, and volatile organic compounds) to the Minnesota Pollution Control Agency (MPCA). According to this definition, there were a total of 2183 point sources in Minnesota in calendar year 1999.

To estimate emissions of air toxic pollutants from Minnesota point sources, computer software, MIRROR, was developed to convert the MCEI data into the RAPIDS computing environment.

### **Area Source Emissions**

Area sources are stationary sources that are not required to submit criteria pollutant data to the MPCA. The categories of area sources have been determined by the Great Lakes States after reviewing the 1999 Base Year Nonpoint Source National Emission Inventory for Hazardous Air Pollutants (NEI), Emission Inventory Improvement Program (EIIP) documents and other available information.<sup>1,2</sup> The emission data for area sources were obtained from surveys, literature, and the submittals for the National Emission Standards for Hazardous Air Pollutants.

There are 25 categories and 53 sub-categories of area sources included in Minnesota portion of the regional emission inventory. Table D-1 lists all these categories along with activity data and information sources.

### **Mobile Source Emissions**

Mobile sources includes five subcategories: on-road sources, non-road sources, aircraft, commercial marine vessels, and locomotives. The MPCA used air toxics emissions estimations in the 1999 National Emissions Inventory (NEI) Version 3 for on-road and non-road sources.<sup>3</sup> MPCA used state-specific data to calculate emissions estimates for both aircraft and locomotives. The U.S. Environmental Protection Agency's (EPA) emissions estimates for commercial marine vessels were modified by the MPCA to correct for apparent confusion concerning the locations of ports.

## **EMISSION ESTIMATION**

### **Point Sources**

RAPIDS was used to compile Minnesota's air toxics inventory for point sources. The approach was to first separately identify each device/process at each facility, and then estimate emissions for each device/process. The following describes the available emission estimation methods and their prioritization for use in the emission inventory.

#### 1. Direct reporting values

Because Minnesota does not have a rule to mandate point sources to report air toxics emissions, in August 2000, MPCA sent a letter to the top 400 emitters based on the sum of PM and VOC emissions to request that they voluntarily provide emission information. This letter was also posted on the MPCA web site along with reporting guidance. About 35% of facilities (137) responded, including refineries and other manufacturing facilities.

Also, in March 2001, a separate letter was sent to 240 facilities holding Option D air quality permits with actual VOC emissions of more than 5 tons in 1999. These facilities use paints and primers, cleaning solvents, printing solutions, and paint thinners, and are required to track monthly HAP emissions. About 98% of these facilities (236) responded to the data request. The reported information was examined and appropriate emissions were used.

In addition, lead (Pb) emissions were provided by facilities for the criteria pollutant inventory. These values were adapted to the air toxics emission inventory in order to maintain the consistency in these two MPCA inventories.

#### 2. Emission factors

An emission factor is defined as "a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant."<sup>5</sup> Emission factors can be either source-specific or generic. In the current version of RAPIDS, the emission factors from the EPA Factor Information Retrieval (FIRE) Data System, version 6.23, are used as generic emission factors.<sup>6</sup> In most cases, these emission factors are derived from actual measurements of the emissions from representative sources/processes, and are assumed to be the long-term averages for all facilities in the source category. The source-specific emission factors are derived from source-specific emission testing, mass balance, or chemical analysis. Therefore, they are preferred for estimating emissions from a source.

The MPCA has focused on developing source-specific emission factors. Some source-specific emission factors were developed based on the information in facility permit applications and stack testing reports. Metal Mining/Iron Ores Process and Electric Services/Coal Burning facilities were selected for this special effort. These two industrial sectors are not covered by the Toxics Release Inventory (TRI) report but contributed almost 50% of PM emissions from point sources in 1999. A detailed discussion on the development of emission factors and the emission inventory for these two industrial sectors was presented in two papers.<sup>7,8</sup>

In addition, we also developed source-specific emission factors for municipal solid waste incinerators, chromium electroplating facilities, some paper mills, and some facilities manufacturing wood products.

We have noticed that a number of measurements from stack tests or chemical analyses are lower than detection limits. In these situations, the detection limits were used in place of the measurements.

### 3. TRI data

The TRI is compiled by the Minnesota Department of Public Safety for manufacturing point sources with certain reporting thresholds. The emission data are facility-based and of unknown accuracy. For many facilities reporting to the TRI, the emission estimates appear to be incomplete in terms of the number of pollutants included. However, when the source-specific or generic emission factors were not available, TRI emissions were used for some facilities. For the MN inventory, we incorporated TRI emissions for 162 facilities.

### 4. 1999 NEI data

The final 1999 NEI version 3 data for point sources were evaluated.<sup>4</sup> Reasonable values were used to adjust the state emission inventory for about a dozen facilities.

## **Area Source Emissions**

Source-specific emission factors and speciation profiles were developed for each area source category. Then, the county-level activity data were imported to RAPIDS and emission estimates were calculated by using the emission factor method and speciation method. In the speciation method, emissions of particulate matter (PM) or total organic gases (TOG) were speciated to individual air toxic compounds using speciation profiles.

### ***Activity Data Pre-Treatment***

There are different levels of source activity data available for different categories of area sources. Source activities are any parameters associated with the source that are surrogates for emissions, for example, fuel throughput, solvent usage, or population. Some source categories, such as Dry Cleaning, Chromium Electroplating, Halogenated Solvent Cleaners, need to comply with NESHAPs and the source-level or process-level activity data are available from the initial notification forms. In this case, spreadsheets were used to aggregate emission data for all similar or identical device/processes within each county. For example, for dry cleaners, county total tetrachloroethylene consumption values were calculated for all dry-to-dry machines with control, all dry-to-dry machines without control, all transfer machines with control, and all transfer machines without control, using tetrachloroethylene consumption data from each individual dry cleaner within the county.

However, for some area sources direct activity data are not available at the county level. In these cases, statewide activity data were apportioned to each county based on appropriate activity indicators. For example, fuel consumption data for Residential Fuel Combustion were calculated from the state fuel consumption by using population data. If state-level activity data were not available, appropriate surrogate activity data were used. For example, county-based population data were used as the most appropriate or applicable activity data for commercial and consumer solvent products and architectural surface coating.

### **Source-Specific Emission Factors and Speciation Profiles**

Since FIRE version 6.23 and SPECIATE version 3.0 contain few emission factors and speciation profiles for area sources, source-specific emission factors and speciation profiles were developed for the area sources included in the Minnesota portion of the regional emission inventory.<sup>6,9</sup> These emission factors and speciation profiles were compiled from a review of available literature. Given first preference were EPA publications or studies, such as the 1999 NEI documents and Emission Inventory Improvement Program (EIIP) documents.<sup>2,1</sup> Information from the California Air Resource Board and other resources were also incorporated. If information was not available for a source category, emission factors for similar processes or sources were used as surrogates such as the use of emission factors for commercial/institution combustion to estimate emissions from residential fuel combustion. The resulting approaches and methodologies have been documented in the emission estimation protocols for Minnesota area sources.<sup>10</sup>

### **On-Road Sources**

Minnesota's 2001 statewide air toxics emissions inventory used the 1999 NEI emissions based on MOBILE6 Vehicle Emission Modeling Software.<sup>3,11</sup> MPCA added calculations for copper emissions by speciation from PM10.

County air toxics emissions estimates are the sum of the emissions estimates for twelve vehicle types and up to twelve roadway types. The twelve vehicle types included are:

- 2B Heavy Duty Diesel Vehicles (2BHDDV)
- Buses Heavy Duty Diesel Vehicles (BHDDV)
- Heavy Duty Gasoline Vehicles (HDGV)
- Heavy Heavy Duty Diesel Vehicles (HHDDV)
- Light Duty Diesel Trucks (LDDT)
- Light Duty Diesel Vehicles (LDDV)
- Light Duty Gasoline Trucks 1 (LDGT1)
- Light Duty Gasoline Trucks 2 (LDGT2)
- Light Duty Gasoline Vehicles (LDGV)
- Light Heavy Duty Diesel Vehicles (LHDDV)
- Medium Heavy Duty Diesel Vehicles (MHDDV)
- Motorcycles (MC)

The twelve roadway types included are:

- Rural Interstate

- Rural Local
- Rural Major Collector
- Rural Minor Arterial
- Rural Minor Collector
- Rural Other Principal Arterial
- Urban Collector
- Urban Interstate
- Urban Local
- Urban Minor Arterial
- Urban Other Freeways and expressway
- Urban Other Principal Arterial

### **Non-Road Sources**

Minnesota’s 2001 statewide air toxics emissions inventory used the 1999 NEI emissions based on the NONROAD model.<sup>12</sup> The “Lockdown (May 2002)” version of the NONROAD model was used to generate the U.S. EPA’s estimates of VOC and PM for non-road sources which were speciated to calculate air toxics emissions.<sup>13</sup>

County air toxics emissions estimates are the sum of the emissions estimates for 163 equipment types in ten categories. The equipment categories included are:

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

Aircraft auxiliary power units, however, were treated differently. Emissions estimates for auxiliary power units were speciated from criteria pollutant estimates generated by the Emissions and Dispersion Modeling System (EDMS) version 4.1<sup>7</sup> produced by the Federal Aviation Administration and commercial aircraft activity data received from the Bureau of Transportation Statistics.<sup>8</sup> The NEI speciation factors for commercial aircraft<sup>9</sup> were used for auxiliary power units.

### **Aircraft**

#### ***Commercial Aircraft***

MPCA used detailed Bureau of Transportation Statistics landing and takeoff (LTO) data and the Emissions and Dispersion Modeling System (EDMS) version 4.1 software to estimate hydrocarbon emissions.<sup>14,15</sup> Hydrocarbon emissions were converted to VOC and TOG using NEI conversion factors.<sup>16</sup> Air toxics emissions were estimated by speciating VOC or TOG emissions with NEI speciation factors.<sup>16</sup>

### **Air Taxis and General Aviation**

MPCA used two sources of activity data to calculate Air Taxis and General Aviation air toxics emissions estimates. One source of data was the Air Traffic Activity Data System (ATADS).<sup>17</sup> ATADS provides the actual number of aircraft operations for a limited number of airports. Since landing and taking off are both counted as aircraft operations, the number of LTOs is one half of the number of operations. MPCA also used information from the Terminal Area Forecast System (TAF).<sup>18</sup> TAF provides estimates of the number of aircraft operations for a large number of airports. For airports that were included in both ATADS and TAF, the ATADS data was used instead of the TAF activity estimate.

While there is some concern over using the TAF activity estimates, it is reasonable to use the TAF estimates for calculating air toxics emissions estimates for the following reasons:

- TAF is the official aviation activity forecast of the Federal Aviation Administration and is intended to be used by state authorities for planning purposes.
- TAF estimates are very similar to ATADS data for the Minnesota airports that are included in both data sets.
- Contact with airport managers in Minnesota indicated that TAF estimates are usually reasonable.
- Excluding the TAF estimates would underestimate the air taxi and general aviation activity in Minnesota because few airports are included in ATADS.

MPCA converted aircraft operations to LTOs, then applied NEI emission and speciation factors to estimate air toxics emissions for air taxis and general aviation.<sup>19</sup> MPCA multiplied the ratio of lead to PM10 in the U.S. EPA's estimates times the PM10 in the MPCA's estimates in order to calculate lead emissions for general aviation.<sup>12</sup>

### **Commercial Marine Vessels**

Commercial marine vessel emissions are divided into *underway* and *in port* emissions. Minnesota's 2001 statewide air toxics emissions inventory modified the 1999 NEI estimates.<sup>12</sup> MPCA made two modifications to the distribution of *in port* emissions. These modifications did not affect the total emissions for the state.

The first modification involved relocating *in port* emissions from Itasca County to Cook County. The *in port* emissions were probably mistakenly assigned to Itasca county because of a misunderstanding concerning the location of a port. The port of Taconite Harbor, MN, is a major port on Lake Superior and is located in Cook County. Some publications of the U.S. Army Corps of Engineers refer to this port as "Taconite, MN." Taconite, MN, is not a major port and is located in Itasca County.<sup>20</sup>

The second modification involved splitting the *in port* emissions assigned to Washington County into both Washington and Ramsey counties. The U.S. EPA air toxics emissions estimates assigned *in port* emissions to Washington County, but did not assign any *in port* emissions to Ramsey County.<sup>12</sup> The port of St. Paul, MN, is a major port. MPCA contacted the U.S. Army Corps of Engineers and was informed that commercial marine traffic assigned to the port of St. Paul can be in either Ramsey county or Washington county. The U.S. Army Corps of Engineers did not indicate which county received the majority of the commercial marine traffic.

MPCA used a speciation method in order to calculate emissions some pollutants that were not included in the U.S. EPA's air toxics emissions estimates.

### **Locomotives**

MPCA requested and received a list of railroads operating in Minnesota from the Minnesota Department of Transportation. Railroads were contacted and asked to provide operational information including the number of gallons of diesel fuel consumed in line haul operation, the number of yard locomotives in use, and the counties of operation.

Line haul locomotive air toxics emissions estimation was split into three categories: Class I Railroads, Class II and Class III Railroads, and Passenger railroads. For each railroad category, MPCA distributed diesel fuel to the counties of operation using either a simple average or a weighted average for each railroad. Weighted averages were used whenever the railroad was able to provide some measure to indicate which counties had greater operations than others. The most common measure provided was the number of miles of track operated by the railroad in each county. This assumes that railroads use more fuel in counties with more track than in counties with less track. Although fuel consumption is determined by many factors, the use of weighted averages based on track length should produce more accurate distribution of air toxics emissions estimates than using simple averages. Emissions estimates were calculated using NEI emission and speciation factors as well as SPECIATE 3.2 factors.<sup>21,9</sup> The mercury emission factor used in calculations was 4.2e-7 lbs per gallon of diesel fuel consumed.<sup>22</sup>

Railroads provided the number of yard locomotives operating in each county. Diesel fuel consumption was calculated using fuel consumption factors.<sup>22</sup> Emissions estimates were calculated using NEI emission and speciation factors as well as SPECIATE 3.2 factors.<sup>21,9</sup>

## **QUALITY ASSURANCE AND QUALITY CONTROL**

To develop a reasonable and comprehensive air toxic emission inventory, procedures have been developed to provide quality assurance/quality control (QA/QC) of the data throughout the entire process of emission inventory development. Quality assurance is a planned set of external activities that are conducted by personnel not directly involved in the development of the inventory to evaluate data quality. On the other hand, quality control is a planned set of internal activities conducted by inventory development personnel to ensure data accuracy and completeness.

### **Quality Control**

The QC procedures in the inventory development include technical reviews, accuracy checks, and use of approved standardized procedures for emission calculations. The QC activities have been performed and will be performed in the following three aspects.

### **Activity Data**

For point source, the Minnesota emission inventory data for criteria pollutants were used. Using the MCEI data minimized errors in the activity data because these data are the bases for emission fees. For this reason, facilities pay close attention to the quality of these data.

For area sources, the activity data were compared with other states data. Special attention was paid to point and area source reconciliation to eliminate double counting of emissions.

This is because a given category of emissions can be comprised of both point and area sources. For example, some of the halogenated solvent cleaners are point sources and their emissions are included with the point source emissions.

### **Emission Factors**

There are many multiple generic emission factors found in FIRE 6.23. To select the appropriate emission factors, each state reviewed a section of FIRE 6.23. The generic criteria for emission factor selection were established after the review process. These selections were then reviewed and subsequently approved by the other states.

The source-specific emission factors for point sources that were developed in Minnesota were based on stack testing data, mass balance, chemical analysis results, available literature, and engineering calculations. These emission factors were reviewed by both the MPCA and the individual facilities. Most of these emission factors were derived from facility air quality permit applications.

### **Emission Results**

To assess the reasonableness of estimated emission results for point sources, the process-based emissions for each pollutant were examined. The extraordinary emission values were re-calculated. The activity data and emission factors, which led to the extraordinary emissions, were verified. For area sources, the emissions were calculated using the RAPIDS software and spreadsheets. The results from these two approaches were compared and evaluated until a perfect match was reached.

### **Quality Assurance**

The QA plan included the following activities:

- Release of the process-level emission inventories to selected facilities. Requested their voluntary validation of the emission data and estimates. The selected facilities were those having source-specific emission factors such as Metal Mining/Iron Ores Process and Electric Services/Coal Burning facilities. The information and comments in the facility responses were also incorporated into the emission inventory.
- Requested technical review at Great Lakes regional level. Minnesota emission estimates were compared with estimates from other Great Lakes States. Extraordinary values, missing pollutants, and extra pollutants were examined.

## **RESULTS AND DISCUSSIONS**

The following results represent emissions from all point, area, and mobile sources in State of Minnesota. Emissions were estimated for the 213 target compounds in the Great Lakes regional air toxics emission inventory project. However, data were only available to obtain emissions for 145 out of the 213 air toxics. Point sources emit 140 pollutants, while area sources emit 117 pollutants. Pollutants with emissions from onroad and nonroad mobile sources are 36 and 38,

respectively. The summary table (Table D-2) shows the name and the emissions of these 145 pollutants totaled by principal source category.

It was estimated that 1108 out of 2183 point sources emitted one or more pollutants listed in the summary table. We incorporated source-specific emission information from 145 large emitters, 236 facilities with Option D permits, and 165 TRI facilities. Point source emissions are from 246 distinct standard industrial classification (SIC) codes and 200 distinct source classification codes (SCC). Emissions from area sources were calculated for the 25 categories and 53 sub-categories, mentioned in the previous section, and 44 distinct SCCs.

Hydrochloric acid was estimated to have the highest emissions at 55,814,067 pounds, while TCDD, 2378 emissions are the lowest recorded at 0.0091 pounds.

## MERCURY

A special effort in the inventory development was on more complete and accurate mercury emissions.

First, area sources categories were expanded to include those associated with mercury emissions, such as fluorescent lamp breakage and fluorescent lamp recycling.

Second, we identified source categories and processes from which mercury emissions were likely, but emission factors were not available in FIRE 6.23. Six SCCs for coal, oil, and natural gas combustion were identified: 10200204, 10200217, 10300209, 10300401, 20100201, 20300202. We didn't estimate mercury emissions for these processes in this inventory but will use emission factors for similar processes in future inventories if EPA does not update FIRE emission factors for these SCCs.

Third, through regional QA/QC activities, we identified sources and processes associated with available mercury emission factors, from which mercury emissions were not estimated. Five SCCs for combustion, manufacture, and waste dispersal were identified: 10300222, 30400301, 30400403, 30600106, and 50300501. The problems were mainly due to a lack of appropriate activity data. Consequent investigation and correction were made to these sources and processes.

Fourth, we worked collaboratively with MPCA staff who compiled an updated inventory of 1990 releases of mercury in Minnesota required under *Minnesota Statutes*. This updated inventory used an approach at a different level of details from the emission inventory compiled in this project.<sup>23</sup> We used the same methodology for certain area source categories, such as fluorescent lamp breakage and recycling, and municipal solid waste landfills. A comparison of total mercury emissions was made between the 2000 updated mercury inventory and the results presented in this report. The difference is less than 5%. However, there are discrepancies on the coverage of source categories between these two emission inventories.

Fifth, besides mercury emissions estimated from onroad vehicles and nonroad equipment in previous emission inventories, emissions from locomotive and commercial marine vessels were also calculated. The improved emission factors and speciation factors provided more mercury

emissions in 2001 than in previous inventoried years. Table D-3 shows a comparison of mercury emissions between the 2001 and 1998 inventories for mobile sources. Mercury emissions in 2001 were about 3 times over that of 1998. The exhaust of vehicles contributed about two thirds of mobile source mercury emissions while the other one third was mainly from exhaust of nonroad equipment.

The total mercury emissions in Minnesota were 5,241.53 pounds in 2001. About 67.9% of mercury emissions were from point sources. Point source mercury emissions were from 183 SIC codes and 75 distinct SCCs. Area source mercury emissions were from 4 categories including 8 sub-categories.

A summary of mercury emissions in Minnesota by source categories is shown in Table D-4. Among all source categories, electric services contributed the most, with emissions of 1,524.32 pounds (approximately 29% of the total).

## **UNCERTAINTIES**

Although QA/QC plans were established to ensure optimum results, there are uncertainties in the Minnesota portion of the Great Lakes regional air toxics emission inventory. Some uncertainties are common for all air toxics emission inventories. For example, not all pollutants are included in the inventory and some emission factors are missing or are of poor quality, resulting in unrepresentative emission estimates. These uncertainties are not discussed here. The following discussions focus on three uncertainties specifically for Minnesota.

### **Source Classification Code Assignment**

Since Minnesota does not have air toxic emission inventory reporting requirements, the emission data in MCEI were used for point sources. These emission data, including facility identification, device identification, process identification, and process activities, were submitted by the individual facilities. However, the quality of a key component, source classification codes (SCC), is in question because these codes have never been reviewed by facilities in the MCEI reporting system. SCC codes are very important for estimating air toxics emissions because all emission factors are directly tied to SCC codes. It is interesting to note that the relationship of emissions and SCC codes for criteria pollutants is not as sensitive as for air toxics. An incorrect SCC assignment may still give correct emission values for criteria pollutants but lead to significant over-estimation or under-estimation of air toxics emissions.

### **Small Point Sources**

There are 466 and 785 facilities in the MCEI with registration permit Options B and D, respectively. These facilities do not report process level throughput data and have no SCC assigned to them. Without the information, RAPIDS cannot estimate air toxics emissions for these facilities. Relying on the MCEI to convert point source emissions data to the RAPIDS computing environment caused the air toxics emission inventory to be incomplete. These sources are relative small sources, include auto body shops, small painting shops, wood furniture shops, asphalt plants, grain elevators, seed elevators, feed mills, mechanical garages, and others. Although we collected data from 236 Option D facilities and some other facilities may report to the TRI, most of these small point sources had to be treated as area sources. Since chemical

species use varied from one facility to the other, our solution was to collect material usage and composition data from these facilities. There is a plan to collect more source-specific data in the future.

### **Control Efficiencies**

Most control efficiencies used in the MCEI are default values and may not reflect the operating conditions in facilities. Therefore, uncertainties are introduced for criteria pollutant emission estimates. Due to scarce information on control efficiencies for air toxics, control efficiencies for particulate matter (PM) and volatile organic compounds (VOC) were used for all air toxics in PM format and VOC format, respectively. It is recognized that the control efficiencies for individual air toxics can deviate greatly from the control efficiencies for PM or VOC. However, PM and VOC control efficiencies have to be used until better information is obtained for each individual air toxic. Therefore, it is unlikely there will be a reduction in this uncertainty for some time.

### **Detection Limits**

A number of source-specific emission factors as well as generic emission factors were developed by using detection limits when the measurements were lower than detection limits. This approach provides conservative results but tends to over-estimate emissions.

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**Table D-1: Area source categories and information sources for their activity data.**

<b>Category Name</b>	<b>Sub-Category Name</b>	<b>Emission Estimation Method</b>	<b>Activity Data Information Source</b>
Architectural Surface Coating	Water-based Paint	Apply speciation profiles to VOC. VOC emissions are obtained from population-based estimation method.	Census data
	Solvent-based Paint	Same as above	Same as above
Asphalt Paving	Asphalt Paving	Use state-specific activity data and emission factors.	Survey of asphalt suppliers
Autobody Refinishing	Autobody Refinishing	Use per capita emission factor for VOC and apply speciation profiles to VOC emissions.	Census data
Chromium Electroplating	Chromic Anodizing	Use both source-specific and generic emission factors. Activity data are source-specific.	NESHAP submittals and survey
	Decorative Hexavalent Plating	Same as above	Same as above
	Hard Chrome Plating	Same as above	Same as above
Commercial/Consumer Solvent Products	Commercial/Consumer Solvent Products	Use national per capita emission factors	Census data
Dry Cleaners	Transfer Machines with Control	Use emission factor based on solvent usage and machine type.	NESHAP submittals and survey letters
	Transfer Machines Uncontrolled	Same as above	Same as above
	Dry-Dry Machine with Control	Same as above	Same as above
	Dry-Dry Machine Uncontrolled	Same as above	Same as above
Fluorescent Lamp Breakage	Fluorescent Lamp Breakage	Apportion national numbers of discarded lamp to county values based on the population census data. Use state-specific fractions for recycling and generic emission factors.	Census data
Fluorescent Lamp Recycling	Fluorescent Lamp Recycling	Same as above	Same as above
Forest Fires	Forest Fires	Use the acreage of forest fires at a county level and emission factors.	MD of Natural Resources

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
Gasoline Service Stations	Stage I: Splash Filling of Gasoline Storage Tanks	Use EPA emission factor for VOC and some air toxics. County activity data are allocated from state fuel consumption based on population. Applied speciation profiles to VOC emissions for air toxics without emission factors.	MD of Revenue
	Stage I: Submerged Filling w/o Control of Underground Tanks	Same as above	Same as above
	Stage I: Gasoline Underground Tank Breathing	Same as above	Same as above
	Stage II: Vapor Loss from Vehicle Refueling	Same as above	Same as above
	Stage II: Spilling Loss w/o controls from vehicle refueling	Same as above	Same as above
	Stage I: Total, Aviation Gasoline	Same as above	Same as above
Gasoline Trucks in Transit	Gasoline Trucks in Transit	Use EPA emission factor for VOC. County activity data are allocated from state fuel consumption based on population. Apply speciation profiles to VOC emissions for air toxics.	MD of Revenue
Grain Elevators	Grain Elevators	Apportion state pesticide usage to a county-level based on the amount of grain harvested. Calculate with an emission factor method.	MD of Agricultural, U.S. Department of Agriculture
Graphic Arts	Graphic Arts	Apply state-specific speciation profiles to VOC. VOC emissions are obtained from population-based estimation method.	Census data
Hospital Sterilization	Hospital Sterilization	Use the 1996 NEI emission factors based on the number of beds in a hospital.	American Hospital Association, MD of Health
Human Cremation	Human Cremation	Emission factors from the 1999 NEI based on tons cremated. Assume 150 LB per body.	MD of Health
Industrial Surface Coating	General Surface Coatings	Use employee-based emission factors for VOC and apply speciation profiles to VOC emissions.	Census data
	High Performance Coatings, Solvent Based Coatings	Use per capita emission factor for VOC and apply speciation profiles to VOC emissions.	Census data
	High Performance Coatings, Water Based Coatings	Same as above	Same as above

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
Municipal Solid Waste Landfills	Non-flaring MSW Landfills	Create a model based on AP-42, Section 2.4. Most concentrations of air toxics are obtained from MPCA landfill gas study.	MPCA
	Flaring MSW Landfill gas	Use generic emission factors.	MPCA
POTW facilities	Evap. emissions assoc. with treatment	Survey to gather annual influent flowrate and chlorine consumption. Treat big facilities based on actual processes. Assume a typical plant then use emission factors for small facilities.	MPCA Water Quality Division, WWTIR
	Evap. emissions assoc. with chlorination	Same as above	Same as above
Pesticides - Agricultural	Herbicides, Corn	Use vapor pressure of the active ingredients to determine per acre emission factors. Consider pesticide application and formulation type. Apportion state pesticide usage to a county-level based on crop acreage.	MD of Agricultural, U.S. Department of Agriculture
	Insecticides, Corn	Same as above	Same as above
	Herbicides, Soy Beans	Same as above	Same as above
Prescribed Burning	Prescribed Burning	Apportion 'region' (6 regions in the state) level data on the acreage of prescribed burns to the county level using the proportion of forested land by county. Calculate with an emission factor method.	MD of Natural Resources
Residential Fossil Fuel Combustion	Combustion of Natural Gas	Use population-based fuel consumption and both state -specific and generic emission factors.	
	Combustion of Bituminous/Subbituminous Coal	Same as above	Same as above
	Combustion of Distillate Oil	Same as above	Same as above
	Combustion of Liquid Petroleum Gas (LPG)	Same as above	Same as above
Residential Wood Burning	Certified, Catalytic Woodstoves	Use population-based fuel consumption and emission factors.	MD of Public Service, MN energy data book
	Certified, Non-Catalytic Woodstoves	Same as above	Same as above
	Conventional Woodstoves	Same as above	Same as above
	Fireplace, Cordwood	Same as above	Same as above
	Fireplace, Firelog	Same as above	Same as above
Solvent Cleaning	Open Top Vapor Degreasing, Trichloroethylene (Misc Control )	Use emission factors and facility-specific data on type of degreasing and solvent consumption.	NESHAP submittals and survey

Category Name	Sub-Category Name	Emission Estimation Method	Activity Data Information Source
	Open Top Vapor Degreasing, Trichloroethylene (Uncontrol ) Cold, Vapor, and In-Line Cleaning	Use emission factors and facility-specific data on type of degreasing and solvent consumption.	NESHAP submittals and survey
	Solvent Cleanup	Use employee-based emission factors for VOC and apply sepciation profiles to VOC emissions.	Census data
Structure Fires	Residential Structure Fires	Use emission factors recommended by the EIIP document based on tons of material burned. Assume the average total material burned in each fire is 1.15 ton.	MD of Public Safety
Traffic Markings	Water-based paints	Use emission factor based on pain usage. Apply Minnesota specific information from the MSDS for estimating VOC and air toxics.	MD of Transportation and venders
	Epoxy	Same as above	Same as above
<b>Total 25</b>	<b>Total 53</b>		

DC = Department of Climatology, University of Minnesota. It provided heating degree days for adjusting the wood consumption.

DNR = Minnesota Department of Natural Resources

MD = Minnesota Department

NESHAP = National Emission Standards for Hazardous Air Pollutants

WWTIR = Wastewater Treatment Facilities Inventory Report

**Table D-2: Minnesota statewide summary of emissions (lb/year)**

Pollutant Code	Emissions (lb)					Percent (%)			
	Point	Area	Onroad	Nonroad	Total	Point	Area	Onroad	Nonroad
<b>PAHs</b>									
ACENAPHTHEN	73,759.42	5,186.54	952.28	1,791.58	81,689.82	90.29	6.35	1.17	2.19
ACENAPHTHYL	296.69	109,094.91	4,911.19	4,265.93	118,568.72	0.25	92.01	4.14	3.60
ANTHRACENE	276.46	15,688.71	1,161.52	990.49	18,117.17	1.53	86.60	6.41	5.47
BENZ(A)ANTHR	117.92	20,443.56	328.56	327.03	21,217.07	0.56	96.35	1.55	1.54
BENZ(GHI)PE	1.49	10,396.54	336.52	712.14	11,446.69	0.01	90.83	2.94	6.22
BENZO(A)PYRE	16.89	4,466.45	184.14	220.34	4,887.83	0.35	91.38	3.77	4.51
BENZO(B)FLUO	15.33	3,131.09	198.24	171.09	3,515.75	0.44	89.06	5.64	4.87
BENZO(K)FLUO	1.74	5,297.17	198.24	156.53	5,653.68	0.03	93.69	3.51	2.77
CHRYSENE	14.58	16,386.61	153.21	211.92	16,766.33	0.09	97.74	0.91	1.26
DIBENZAHAH	0.66	0.29	0.03	4.99	5.97	11.01	4.86	0.50	83.64
FLUORANTHENE	393.98	21,821.82	1,190.52	2,145.47	25,551.79	1.54	85.40	4.66	8.40
FLUORENE	201.94	12,663.02	1,994.37	3,562.70	18,422.03	1.10	68.74	10.83	19.34
INDN(123CDPY	0.82	5,617.35	89.79	216.55	5,924.51	0.01	94.82	1.52	3.66
NAPHTHALENE	110,175.64	654,231.68	130,796.73	63,364.65	958,568.70	11.49	68.25	13.65	6.61
PHENANTHRENE	794.00	49,557.46	3,252.86	6,939.61	60,543.93	1.31	81.85	5.37	11.46
PYRENE	462.01	27,977.89	1,671.27	2,451.53	32,562.69	1.42	85.92	5.13	7.53
<b>PAH Total</b>	<b>186,529.58</b>	<b>961,961.09</b>	<b>147,419.47</b>	<b>87,532.56</b>	<b>1,383,442.69</b>	<b>13.48</b>	<b>69.53</b>	<b>10.66</b>	<b>6.33</b>
<b>Metal Compounds</b>									
ANTIMONY	2,429.44	413.71			2,843.15	85.45	14.55		
ARSENIC	16,880.82	72.93	812.46	546.55	18,312.75	92.18	0.40	4.44	2.98
BERYLLIUM	358.21	34.99		45.83	439.03	81.59	7.97		10.44
CADMIUM	2,031.06	17,561.50		52.44	19,644.99	10.34	89.39		0.27
CHROMIUM	27,574.80	1,340.68	311.53	49.28	29,276.30	94.19	4.58	1.06	0.17
CHROMIUM VI	315.07	21.66	207.00	25.39	569.12	55.36	3.81	36.37	4.46
COBALT	4,828.94	485.46			5,314.41	90.87	9.13		
COPPER	29,528.93	1,614.66	32,074.21		63,217.79	46.71	2.55	50.74	
LEAD	62,180.06	7,513.19		103,942.40	173,635.64	35.81	4.33		59.86
MANGANESE	206,809.62	6,431.88	176.17	109.06	213,526.74	96.85	3.01	0.08	0.05
MERCURY	3,561.13	274.42	914.84	491.15	5,241.53	67.94	5.24	17.45	9.37
NICKEL	36,172.50	1,445.05	394.14	1,629.72	39,641.41	91.25	3.65	0.99	4.11

Pollutant Code	Emissions (lb)					Percent (%)			
	Point	Area	Onroad	Nonroad	Total	Point	Area	Onroad	Nonroad
SELENIUM	3,997.24	175.80		12.45	4,185.49	95.50	4.20		0.30
<b>Metal Total</b>	<b>396,667.81</b>	<b>37,385.93</b>	<b>34,890.35</b>	<b>106,904.26</b>	<b>575,848.36</b>	<b>68.88</b>	<b>6.49</b>	<b>6.06</b>	<b>18.56</b>
<b>Non-Metal Compounds (Excluding PAHs)</b>									
ACETALDEHYDE	265,550.12	1,397,090.64	1,884,013.59	1,207,185.28	4,753,839.63	5.59	29.39	39.63	25.39
ACETAMIDE		0.58			0.58		100.00		
ACETONITRILE	12,220.86	0.72			12,221.58	99.99	0.01		
ACETOPHENONE	336.66	1,220.82			1,557.48	21.62	78.38		
ACROLEIN	50,158.09	716,127.91	143,475.58	148,447.77	1,058,209.34	4.74	67.67	13.56	14.03
ACRYLAMIDE	235.00				235.00	100.00			
ACRYLIC ACID	13,708.31	18.65			13,726.96	99.86	0.14		
ACRYLONITRIL	2,004.23	3,320.88			5,325.11	37.64	62.36		
ALLYL CHLORI	7.00				7.00	100.00			
ANILINE	1.10				1.10	100.00			
ATRAZINE		179,347.95			179,347.95		100.00		
BENZENE	160,833.13	3,852,128.40	6,432,980.32	3,647,594.73	14,093,536.58	1.14	27.33	45.64	25.88
BENZYL CHLOR	12,084.88	3.04			12,087.92	99.97	0.03		
BIPHENYL	1,472.51	812.07			2,284.58	64.45	35.55		
BROMOFORM	724.88	0.17			725.05	99.98	0.02		
BROMOMETH	14,026.60	1,060,163.47			1,074,190.07	1.31	98.69		
BUTADIENE,13	1,714.20	667,115.14	783,898.88	451,090.35	1,903,818.57	0.09	35.04	41.18	23.69
CARBON DISUL	2,308.78	437.15			2,745.93	84.08	15.92		
CARBON TETRA	750.77	858.38			1,609.14	46.66	53.34		
CARBONYL SUL	211,113.40	1,170.65			212,284.05	99.45	0.55		
CATECHOL	636.00				636.00	100.00			
CHLORINE	18,219.18	503,638.82			521,858.01	3.49	96.51		
CHLOROACETIC	0.22				0.22	100.00			
CHLOROBENZ	596.10	342,674.25			343,270.35	0.17	99.83		
CHLOROETHANE	11,941.51	42,200.48			54,141.99	22.06	77.94		
CHLOROFORM	43,863.66	10,793.32			54,656.98	80.25	19.75		
CHLOROPRENE	1.00				1.00	100.00			
CLACETOPHE,2	130.11	0.03			130.14	99.98	0.02		

Pollutant Code	Emissions (lb)				Percent (%)				
	Point	Area	Onroad	Nonroad	Total	Point	Area	Onroad	Nonroad
CRESOL MX IS	51,146.52				51,146.52	100.00			
CRESOL,O	42.61				42.61	100.00			
CRESOL,P	1.19				1.19	100.00			
CUMENE	34,233.18	13,297.58			47,530.76	72.02	27.98		
CYANIDE	48,479.92	10.87			48,490.78	99.98	0.02		
D,2,4		168,350.00			168,350.00		100.00		
DIBENZOFURAN	3.97	35.34			39.31	10.09	89.91		
DIBROMOET,12	560.57	4.63			565.21	99.18	0.82		
DIBUTYL PHTH	2,376.57	165.20			2,541.76	93.50	6.50		
DICHLORETH12	1,592.77	1,048.46			2,641.23	60.30	39.70		
DICLBENZ,14	409.82	372,012.07			372,421.89	0.11	99.89		
DICLETH,11-	15.23	965.82			981.05	1.55	98.45		
DICLPROPE,13	46.56	764,081.28			764,127.84	0.01	99.99		
DIETH SULFAT	6.22				6.22	100.00			
DIETHANOLAMI	150.93	33.53			184.46	81.82	18.18		
DIEYLHEX PHT	9,842.46	24.64			9,867.10	99.75	0.25		
DIMETH PHTHA	3,590.75	21.29			3,612.04	99.41	0.59		
DIMETH SULFA	892.16	0.21			892.37	99.98	0.02		
DIMETHFORMAM	10,061.34	47,000.31			57,061.65	17.63	82.37		
DINITROPH,24	145.35				145.35	100.00			
DINITRTOL,24	5.20	0.00			5.21	99.98	0.02		
DIOCTYL PHTH	1,044.00				1,044.00	100.00			
DIOXANE	12,324.18	74.42			12,398.60	99.40	0.60		
ETH ACRYLATE	4,647.03	4.34			4,651.38	99.91	0.09		
ETHYLBENZENE	258,021.99	95,003.55	2,746,200.54	2,415,876.76	5,515,102.84	4.68	1.72	49.79	43.80
ETHYLENE GLY	46,138.98	155,147.11			201,286.08	22.92	77.08		
ETHYLENE OXI	11,174.30	103,782.31			114,956.61	9.72	90.28		
FORMALDEHYDE	898,746.84	5,104,578.89	3,016,415.59	3,008,306.92	12,028,048.25	7.47	42.44	25.08	25.01
GLYCOL ETHRS	1,073,238.96	2,246,176.29			3,319,415.26	32.33	67.67		
HCL	25,887,389.64	67,537.78			25,954,927.42	99.74	0.26		
HEXAMETHYL16	3,647.52	0.32			3,647.84	99.99	0.01		
HEXANE	2,393,601.04	3,410,659.87	2,401,854.85	1,733,422.54	9,939,538.30	24.08	34.31	24.16	17.44
HF	2,736,834.14	720.95			2,737,555.09	99.97	0.03		

Pollutant Code	Emissions (lb)					Percent (%)			
	Point	Area	Onroad	Nonroad	Total	Point	Area	Onroad	Nonroad
HYDRAZINE	1.00				1.00	100.00			
HYDROGEN CYA	464.00	142,561.55			143,025.55	0.32	99.68		
HYDROQUINONE	2,340.74	4,232.53			6,573.28	35.61	64.39		
ISOPHORONE	11,063.19	15,318.56			26,381.75	41.94	58.06		
LINDANE ISO	3.00				3.00	100.00			
MALEIC ANHYD	641.70				641.70	100.00			
METH ETH KET	1,196,731.00	3,543,610.60			4,740,341.60	25.25	74.75		
METH HYDRAZI	3,159.73	0.74			3,160.47	99.98	0.02		
METH IODIDE	5.08				5.08	100.00			
METH ISOBUT	355,728.04	1,793,342.85			2,149,070.89	16.55	83.45		
METH METHACR	82,161.92	16.45			82,178.38	99.98	0.02		
METH TERT BU	4,529.80	102.83	12,564.98		17,197.60	26.34	0.60	73.06	
METHANOL	2,200,433.93	3,475,184.93			5,675,618.85	38.77	61.23		
METHENE DIAN	151.00				151.00	100.00			
METHENE(B)4-	63,704.15	554.89			64,259.04	99.14	0.86		
METHYL CHLOR	99,140.01	246,332.26			345,472.27	28.70	71.30		
METHYLENE CL	182,879.04	574,467.70			757,346.74	24.15	75.85		
NITROBENZ	480.13				480.13	100.00			
NITROPHENL,4	427.38				427.38	100.00			
NITROPROPA,2		9.26			9.26		100.00		
PCBS	1.14	0.11			1.25	90.92	9.08		
PCDD	0.27	3.31			3.58	7.41	92.59		
PCDF	1.18	13.96			15.15	7.81	92.19		
PCP	1.01				1.01	100.00			
PERC	76,842.92	328,340.18			405,183.10	18.96	81.04		
PHENOL	291,964.22	31.49			291,995.71	99.99	0.01		
PHENYLENED,P	99.00				99.00	100.00			
PHOSPHINE	439.70	419.70			859.40	51.16	48.84		
PHOSPHORUS	42,491.85	34,347.56			76,839.41	55.30	44.70		
PHTHALIC ANH	758.21				758.21	100.00			
PROPIONALDEH	19,259.02	1.65	159,883.84	276,887.71	456,032.22	4.22	0.00	35.06	60.72
PRPLENE DICH	6.74	201.07			207.81	3.24	96.76		
PRPLENE OXID	1,394.83				1,394.83	100.00			

Pollutant Code	Emissions (lb)					Percent (%)			
	Point	Area	Onroad	Nonroad	Total	Point	Area	Onroad	Nonroad
QUINOLINE	0.22				0.22	100.00			
QUINONE	1,868.25				1,868.25	100.00			
STYRENE	2,064,422.87	1,176.02	556,695.28	225,030.16	2,847,324.33	72.50	0.04	19.55	7.90
TCDD,2378	0.0025	0.0067			0.0091	26.86	73.14		
TCDF,2378	0.0262	0.3987			0.4249	6.17	93.83		
TCE,111	5,640.16	1,727,228.68			1,732,868.84	0.33	99.67		
TETCLET,1122	72.09	1,063.79			1,135.88	6.35	93.65		
TOLUENE	2,310,235.02	10,333,742.24	18,620,142.76	24,549,946.51	55,814,066.52	4.14	18.51	33.36	43.99
TOLUENE24DII	4,887.55	62.37			4,949.92	98.74	1.26		
TRICHLORETHY	396,772.85	29,304.02			426,076.87	93.12	6.88		
TRICLBNZ,124	7,315.20				7,315.20	100.00			
TRICLETH,112	97.70				97.70	100.00			
TRIETHAMINE	590.18	4,006.65			4,596.83	12.84	87.16		
TRIFLURALIN		84,240.00			84,240.00		100.00		
TRIME-PENTAN	6,687.80	408,291.83	6,432,286.76	9,785,967.77	16,633,234.17	0.04	2.45	38.67	58.83
VINLIDENE CL	213.75	2,249.99			2,463.74	8.68	91.32		
VINYL ACETAT	28,861.75	12,500.65			41,362.40	69.78	30.22		
VINYL CHLOR	824.09	12,543.97			13,368.06	6.16	93.84		
XYLENE,M	305.98	3,095.40			3,401.38	9.00	91.00		
XYLENE,O	7,531.91	199,701.31			207,233.22	3.63	96.37		
XYLENE,P	132.74				132.74	100.00			
XYLENES ISO	2,059,504.53	7,069,664.93	10,469,753.86	10,026,089.08	29,625,012.40	6.95	23.86	35.34	33.84
<b>Non-Metal Total</b>	<b>45,848,319.87</b>	<b>51,377,827.04</b>	<b>53,660,166.82</b>	<b>57,475,845.57</b>	<b>208,362,159.30</b>	<b>22.00</b>	<b>24.66</b>	<b>25.75</b>	<b>27.58</b>
<b>Grand Total</b>	<b>46,431,517.26</b>	<b>52,377,174.05</b>	<b>53,842,476.64</b>	<b>57,670,282.39</b>	<b>210,321,450.35</b>	<b>22.08</b>	<b>24.90</b>	<b>25.60</b>	<b>27.42</b>

**Table D-3: Comparison of the 2001 and 1998 mercury emissions inventories from mobile sources in the State of Minnesota.**

Sub-Source Category	2001 Emissions (lb)	1998 Emissions (lb)
Onroad Vehicles	914.84	115.70
Nonroad Equipment	408.32	318.02
Aircraft		
Locomotives	45.32	
Commercial Marine Vessels	37.50	
Total Mobile Sources	1,405.99	433.72

**Table D-4: 2001 Minnesota statewide summary of mercury emissions.**

SIC Code	Description	Emissions (lb)	Percent (%)
4911	Electric services	1,524.32	29.15
Onroad Vehicles	Onroad Vehicles	914.84	17.50
1011	Metal mining, iron ores	859.56	16.44
Nonroad Equipment	Nonroad Equipment	408.32	7.81
4952	Sewerage systems	379.29	7.25
4953	Refuse systems	261.77	5.01
3312	Blast furnaces and steel mills	176.21	3.37
MSW Landfills	Municipal solid waste landfills	175.1	3.35
2911	Petroleum refining	103.26	1.97
3341	Secondary nonferrous metals	96.62	1.85
Residential Fossil Fuel Combustion	Residential fossil fuel combustion	68.01	1.30
Locomotives	Locomotives	45.32	0.87
Commercial Marine Vessels	Commercial Marine Vessels	37.5	0.72
2063	Beet sugar	33.88	0.65
4922	Natural gas transmission	33.37	0.64
2621	Paper mills	29.51	0.56
Fluorescent Lamp Breakage and Recycling	Fluorescent Lamp Breakage and Recycling	26.94	0.52
2611	Pulp mills	23.91	0.46
4931	Electric and other services combined	7.02	0.13
2075	Soybean oil mills	6.37	0.12
2759	Commercial printing	5.64	0.11

<b>SIC Code</b>	<b>Description</b>	<b>Emissions (lb)</b>	<b>Percent (%)</b>
Human Cremation	Human Cremation	4.37	0.08
8062	General medical & surgical hospitals	4.17	0.08
8221	Colleges and universities	2.56	0.05
4961	Steam and air-conditioning supply	1.18	0.02
Other		12.34	0.24
<b>Total</b>		<b>5,229.04</b>	<b>100.00</b>