Annual air monitoring network plan for Minnesota

2011

Minnesota Pollution Control Agency

Legislative Charge

40 CFR § 58.10(a) (1) Annual monitoring network plan and periodic network assessment
Beginning July 1, 2007, the State, or where applicable local, agency shall adopt and submit to the Regional Administrator an annual monitoring network plan which shall provide for the establishment and maintenance of an air quality surveillance system that consists of a network of SLAMS monitoring stations including FRM, FEM, and ARM monitors that are part of SLAMS, NCore stations, STN stations, State speciation stations, SPM stations, and/or, in serious, severe and extreme ozone nonattainment areas, PAMS stations, and SPM monitoring stations. The plan shall include a statement of purposes for each monitor and evidence that siting and operation of each monitor meets the requirements of appendices A, C, D, and E of this part, where applicable. The annual monitoring network plan must be made available for public inspection for at least 30 days prior to submission to EPA.

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Acronyms, Abbreviations, and Definitions

AIRMoN – Atmospheric Integrated Research Monitoring Network
Air Toxics – suite of parameters that includes VOCs, carbonyls, and metals
AQI – Air Quality Index
AQS – Air Quality System: EPA's repository of ambient air quality data
BAM – Beta Attenuation Mass
BWCAW – Boundary Waters Canoe Area Wilderness
CAA – Clean Air Act
CAS – Chemical Abstracts Service
CBSA – Core Base Statistical Area
CFR – Code of Federal Regulations
CO – carbon monoxide
Criteria Pollutants – the six pollutants regulated by the 1970 Clean Air Act (particulate matter, ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, and lead)
CSN – Chemical Speciation Network
EPA – Environmental Protection Agency
FEM – Federal Equivalent Method
FRM – Federal Reference Method
GC/MS – Gas Chromatography/Mass Spectrometry
H_2S – hydrogen sulfide
HAP – Hazardous Air Pollutant
Hg – mercury
HPLC – High Pressure Liquid Chromatography
HRV – Health Risk Value
ICAP – Inductively Coupled Argon Plasma: a technique used for metals analysis
IMPROVE – Interagency Monitoring of Protected Visual Environments
IO-3.1 – EPA method for extracting metals from TSP filters
IO-3.4 – EPA method for analyzing metals utilizing ICAP
LADCO – Lake Michigan Air Directors Consortium
MAAQS – Minnesota Ambient Air Quality Standard
MDH – Minnesota Department of Health
MDN – Mercury Deposition Network
MPCA – Minnesota Pollution Control Agency
MSA – Metropolitan Statistical Area
NAAQS – National Ambient Air Quality Standard
NADP – National Atmospheric Deposition Program
NCore – National Core Monitoring Network
NH_3 – ammonia
NO – nitric oxide
NO_2 – nitrogen dioxide
NO_x – oxides of nitrogen
NO_y – total reactive nitrogen
NPAP – National Performance Audit Program
NTN – National Trends Network
O_3 – ozone
Pb – lead
PEP – Performance Evaluation Program
PFC – perfluorochemical
$PM_{2.5}$ – particulate matter less than 2.5 microns in diameter (fine particulate matter)
PM_{10} – particulate matter less than 10 microns in diameter
ppb – parts per billion
ppm – parts per million
QAPP – Quality Assurance Project Plans
QA/QC – Quality Assurance/Quality Control
QMP – Quality Management Plan
SLAMS – State and Local Air Monitoring Stations
SO_2 – sulfur dioxide
SPM – special purpose monitoring
TEOM – Tapered Element Oscillating Microbalance
TMDL – Total Maximum Daily Load
TO-11A – EPA method for analyzing carbonyls utilizing HPLC
TO-15 – EPA method for analyzing VOCs utilizing GC/MS
tpy – tons per year
TRS – total reduced sulfur
TSP – total suspended particulate matter
U of M – University of Minnesota
USDA – United States Department of Agriculture
USG – unhealthy for sensitive groups
USGS – United States Geological Survey
VOC – Volatile Organic Compound

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Introduction

The Minnesota Pollution Control Agency (MPCA) monitors outdoor air quality throughout Minnesota. There are many reasons to monitor the quality of our outdoor air. The data collected by the MPCA helps determine major sources of ambient air pollution in Minnesota and whether we are protecting the public from its harmful health effects. Data are also used to address ways to reduce pollution levels and track concentrations of pollutants over time.

The MPCA's air quality data are used to determine compliance with National Ambient Air Quality Standards (NAAQS) and Minnesota Ambient Air Quality Standards (MAAQS). In 1970, the Clean Air Act (CAA) established NAAQS for six pollutants known to cause harm to human health and the environment. The CAA requires the MPCA to monitor these pollutants, called criteria pollutants, and report the findings to the U. S. Environmental Protection Agency (EPA). The criteria pollutants are particulate matter, lead, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide. The MPCA also monitors Minnesota's air for other pollutants called air toxics. Air toxics include a wide range of chemicals that are known or suspected to affect human health. These pollutants do not have federal standards; however, levels found in Minnesota are compared to health benchmarks established by the Minnesota Department of Health (MDH), the EPA, and the State of California.

This Air Monitoring Network Plan is an annual report that is issued by the MPCA. It is a requirement of the Code of Federal Regulations (40 CFR 58) that were established by the EPA on October 17, 2006. The purpose of this report is to provide evidence that current regulations are being met for our air monitoring network, to detail any changes proposed for the 18 months following its publication, and to provide specific information on each of the MPCA's existing and proposed monitoring sites.

In addition to this plan, the EPA required states to complete a network assessment every five years. The network assessment will provide a more detailed evaluation of our air monitoring network. It will contain a network history, a re-evaluation of the types of pollutants monitored, and an evaluation of the network's objectives and costs. It will also include more data analysis, including spatial analysis of ambient air monitoring data and a reconsideration of monitor placement based on changes in land use and population. Under the direction of the Lake Michigan Air Directors Consortium (LADCO), Minnesota is collaborating with other states in our region for the first network assessment which will be completed by July 1, 2010. The results from this network assessment will be considered in our 2012 Annual Air Monitoring Network Plan.

Network overview

The MPCA monitors ambient air quality at 54 sites throughout Minnesota. This includes monitoring at three tribal sites, four Interagency Monitoring of Protected Visual Environments (IMPROVE) sites, two Chemical Speciation Network (CSN) sites, and ten National Acid Deposition Program (NADP) sites. Figure 1 shows all of these sites.

Site location is partly dependent upon population density; therefore, the majority of sites are in the Twin Cities metropolitan area. For the purposes of this report any sites in the following eight counties are considered the Twin Cities metropolitan area: Hennepin, Ramsey, Wright, Anoka, Washington, Dakota, Scott, and Carver. The area of the state that lies outside the Twin Cities metropolitan area is commonly referred to as Greater Minnesota.

The maps on the following pages show sites labeled according to their MPCA, NADP, or Interagency Monitoring of Protected Visual Environments (IMPROVE) site identification numbers. Figure 1 shows the Greater Minnesota sites and figure 2 shows the Twin Cities metropolitan area sites.

Throughout the report, sites are referred to using the site name or the city where the site is located and the MPCA, NADP, or IMPROVE site identification number.

Table 1: Site information – Greater Minnesota

MPCA Site ID	City	Site name	AQS Site ID	Address	LAT	LONG	Year Started
MN08*	Hovland	Hovland	(none)	(open field)	47.8472	-89.9625	1996
MN16*	Balsam Lake	Marcell	(none)	Marcell Experimental Forest	47.5311	-93.4686	1978
MN23*	Pillager	Camp Ripley	(none)	(open field)	46.2494	-94.4972	1983
MN27*	Lamberton	Lamberton	(none)	U of M SW Agricultural Research and Outreach Center	44.2369	-95.3010	1979
MN28*	Sandstone	Grindstone Lake	(none)	Audubon Center of the North Woods	46.1208	-93.0042	1996
MN32* VOYA2**	International Falls	Voyageurs	27-137-9000	Voyageurs National Park - Sullivan Bay	48.4128	-92.8292	2000
MN99*	Finland	Wolf Ridge	(none)	6282 Cranberry Rd	47.3875	-91.1958	1996
1300	Virginia	Virginia	27-137-7001	327 First St S	47.5212	-92.5393	1968
2013	Detroit Lakes	Detroit Lakes	27-005-2013	26624 N Tower Rd	46.8499	-95.8463	2004
3051	Mille Lacs	Mille Lacs	27-095-3051	HCR 67 Box 194	46.2052	-93.7594	1997
3052	Saint Cloud	Talahi School	27-145-3052	1321 Michigan Ave SE	45.5497	-94.1335	1998
3053	Saint Cloud	Grede Foundries	27-145-3053	5200 Foundry Circle	45.5646	-94.2263	2010
3204	Brainerd	Brainerd Airport	27-035-3204	16384 Airport Rd	46.3921	-94.1444	2004
4210	Marshall	Marshall Airport	27-083-4210	West Highway 19	44.4559	-95.8363	2004
4415	Priam	Priam	27-067-4415	7231 Hwy 23 SW	45.0653	-95.1419	2000
5008	Rochester	Ben Franklin School	27-109-5008	1801 9th Ave SE	43.9949	-92.4504	1997
5302	Stanton	Stanton Air Field	27-049-5302	1235 Highway 17	44.4719	-93.0126	2003
7001 MN18* BOWA1**	Ely	Fernberg Road	27-075-0005	Fernberg Rd	47.9466	-91.4956	1977
7416	Cloquet	Cloquet	27-017-7416	175 University Rd	46.7030	-92.5233	2001
7526	Duluth	Torrey Building	27-137-0018	314 W Superior St	46.7834	-92.1027	1976
7545	Duluth	Oneota Street	27-137-0032	37th Ave W & Oneota St	46.7516	-92.1413	1985
7549	Duluth	Michigan Street	27-137-7549	1532 W Michigan St	46.7694	-92.1194	1994
7550	Duluth	WDSE	27-137-7550	1202 East University Circle	46.8182	-92.0894	1998
7551	Duluth	Lincoln Park School	27-137-7551	2424 W 5th St	46.7647	-92.1331	2000
7555	Duluth	Waseca Road	27-137-7555	Waseca Industrial Rd	46.7306	-92.1634	2001
7810	Grand Portage	Grand Portage	27-031-0001	27 Store Rd	47.9701	-89.6910	2005
BLMO1**	Luverne	Blue Mounds	27-133-9000	1410 161st St	43.7158	-96.1913	2002
GRRI1**	Winona	Great River Bluffs	27-169-9000	43605 Kipp Dr	43.9373	-91.4052	2002

*NADP Site ID
**IMPROVE Site ID

Figure 1: Air quality monitoring sites in Greater Minnesota

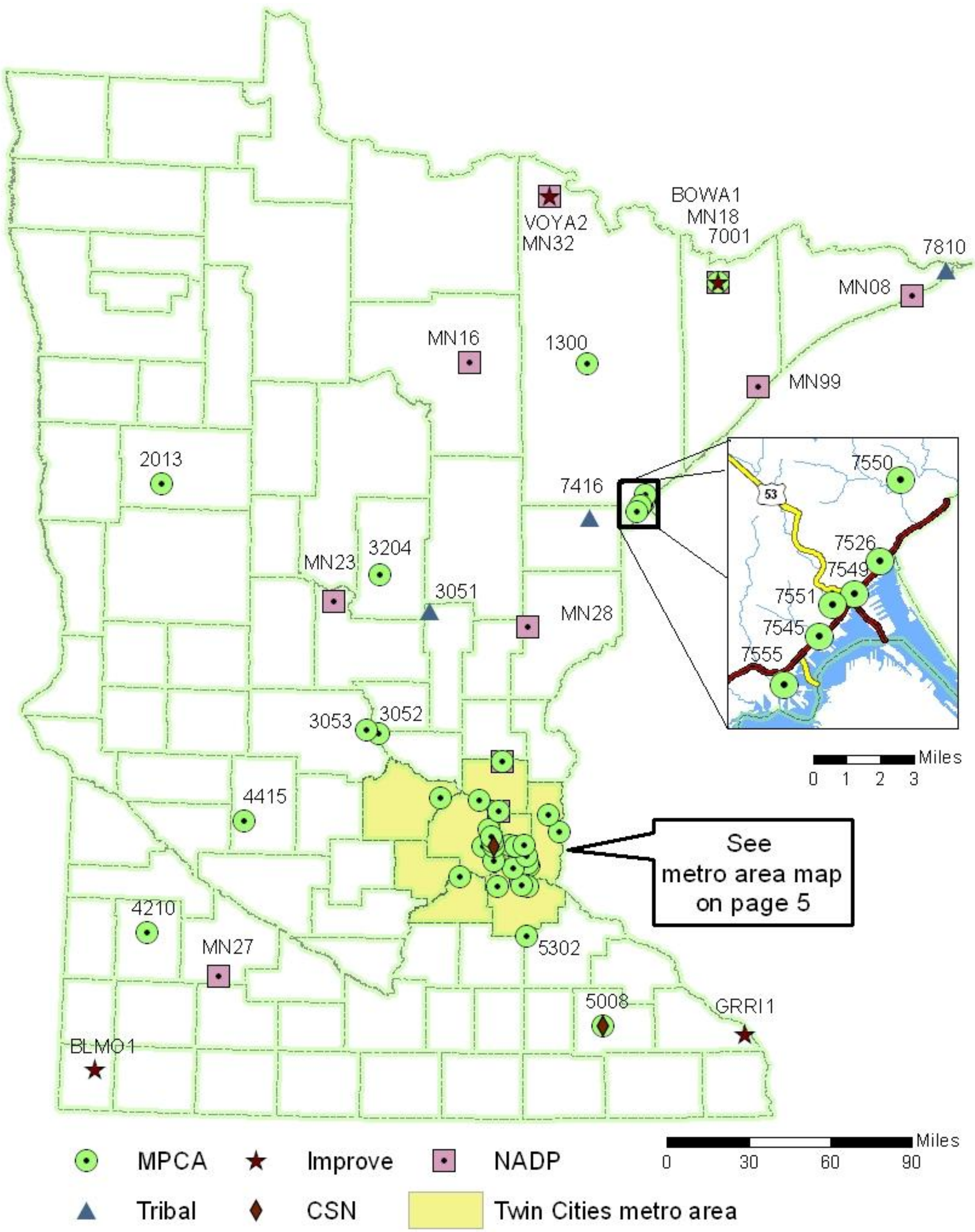
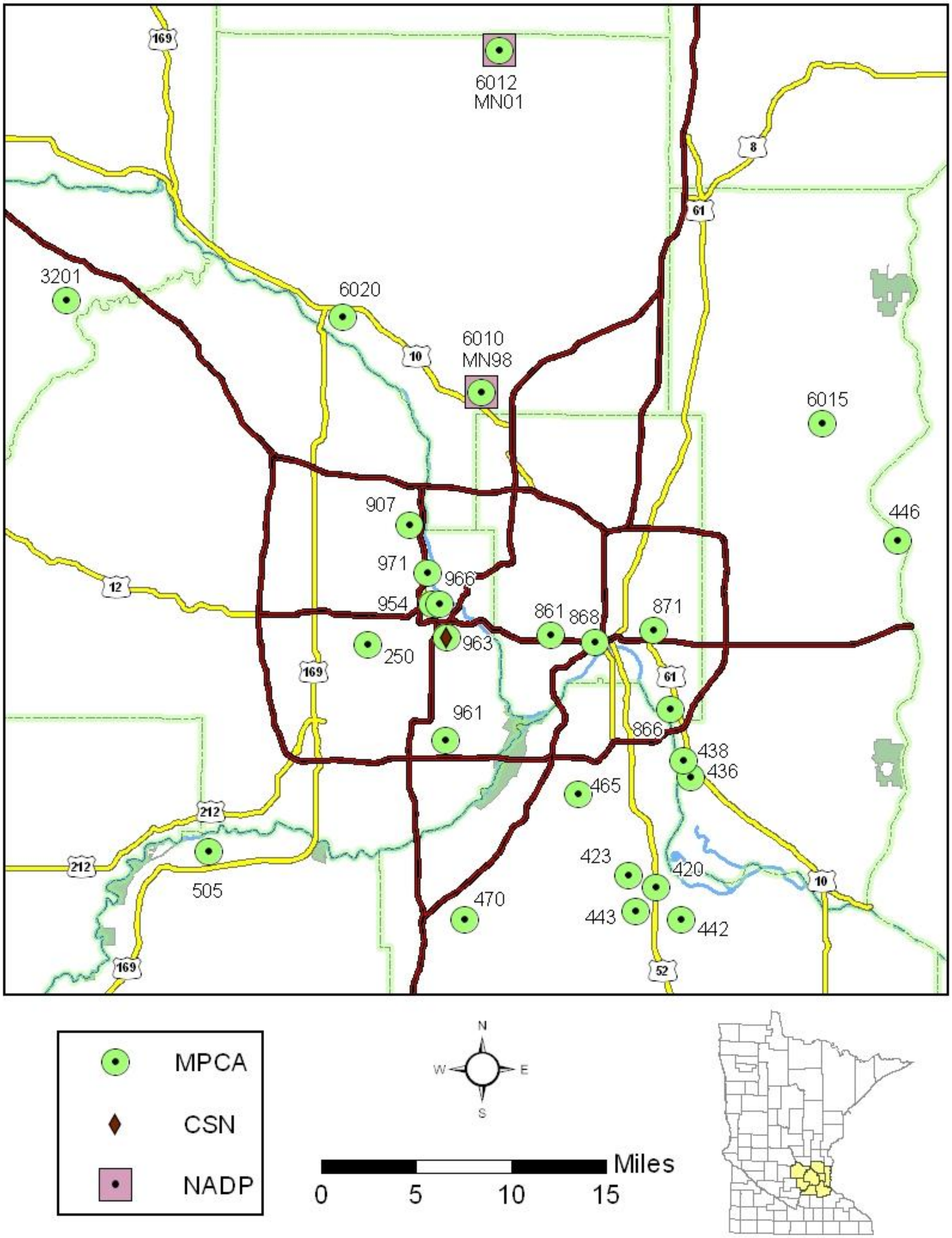


Table 2: Site information – Twin Cities metropolitan area

MPCA Site ID	City	Site name	AQS Site ID	Address	LAT	LONG	Year Started
250	St Louis Park	St. Louis Park	27-053-2006	5005 Minnetonka Blvd	44.9481	-93.3429	1972
420	Rosemount	FHR 420	27-037-0020	12821 Pine Bend Tr	44.7632	-93.0325	1972
423	Rosemount	FHR 423	27-037-0423	2142 120th St E	44.7730	-93.0627	1990
436	St. Paul Park	MPC 436	27-163-0436	649 5th St	44.8473	-92.9956	1989
438	Newport	MPC 438	27-163-0438	4th Ave & 2nd St	44.8599	-93.0035	1995
442	Rosemount	FHR 442	27-037-0442	County Rd 42	44.7385	-93.0056	2000
443	Rosemount	FHR 443	27-037-0443	14035 Blaine Ave E	44.7457	-93.0554	2008
446	Bayport	Point Road	27-163-0446	22 Point Rd	45.0280	-92.7738	2007
465	Eagan	Gopher Resources	27-037-0465	Hwy 149 & Yankee Doodle Rd	44.8343	-93.1163	2006
470	Apple Valley	Apple Valley	27-037-0470	225 Garden View Dr	44.7387	-93.2373	2000
505	Shakopee	B.F. Pearson School	27-139-0505	917 Dakota St	44.7894	-93.5125	2000
861	St. Paul	Lexington Avenue	27-123-0050	1088 W University Ave	44.9556	-93.1459	1987
866	St. Paul	Red Rock Road	27-123-0866	1450 Red Rock Rd	44.8994	-93.0171	1997
868	St. Paul	Ramsey Health Center	27-123-0868	555 Cedar St	44.9507	-93.0985	1998
871	St. Paul	Harding High School	27-123-0871	1540 East 6th St	44.9593	-93.0359	1998
907	Minneapolis	Humboldt Avenue	27-053-1007	4646 N Humboldt Ave	45.0397	-93.2987	1966
954	Minneapolis	Arts Center	27-053-0954	528 Hennepin Ave	44.9790	-93.2737	1989
961	Richfield	Richfield Intermediate School	27-053-0961	7020 12th Ave S	44.8756	-93.2588	1999
963	Minneapolis	H.C. Andersen School	27-053-0963	2727 10th Ave S	44.9535	-93.2583	2001
966	Minneapolis	City of Lakes	27-053-0966	309 2nd Ave S	44.9793	-93.2611	2002
971	Minneapolis	North Second Street	27-053-0971	2300 N Second St	45.00316	-93.2789	2009
3201	St. Michael	St. Michael	27-171-3201	101 Central Ave W	45.2092	-93.6690	2003
6010 MN98*	Blaine	Anoka Airport	27-003-1002	2289 CO Rd J	45.1407	-93.2220	1979
6012 MN01*	East Bethel	Cedar Creek	27-003-1001	2660 Fawn Rd	45.4018	-93.2031	1979
6015	Stillwater Township	Washington County	27-163-6015	11660 Myeron Rd N	45.1172	-92.8549	1997
6020	Anoka	Federal Cartridge	27-003-6020	900 Ehlen Dr	45.1981	-93.3709	2010

*NADP Site ID

Figure 2: Air quality monitoring sites in the Twin Cities metropolitan area



Types of networks

Air monitoring networks are designed to satisfy a variety of purposes including monitoring compliance with the NAAQS, public reporting of the Air Quality Index (AQI), assessing population exposure and risk from air toxics, determining pollution trends, monitoring specific emissions sources, investigating background conditions, and evaluating computer models. Below are descriptions of the existing monitoring networks in operation in Minnesota.

State and Local Air Monitoring Stations (SLAMS)

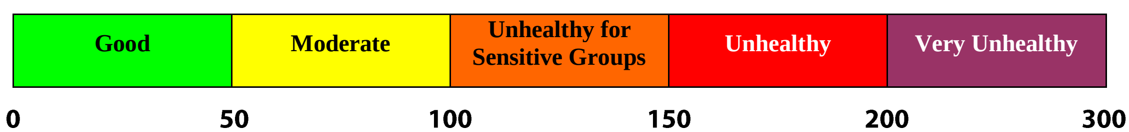
This network consists of about 3,500 monitoring sites across the United States. The size and distribution of the sites are largely determined by the needs of state and local air pollution control agencies to meet their respective State Implementation Plan (SIP) requirements and monitoring objectives. Most Minnesota monitoring sites are part of the SLAMS network.

Air Quality Index (AQI)

The AQI was developed by the EPA to provide a simple, uniform way to report daily air quality conditions. Minnesota AQI numbers are determined by hourly measurements of four pollutants: $PM_{2.5}$, ground-level ozone, SO_2, and CO. The pollutant with the highest value determines the AQI for that hour. The most common pollutants to drive the AQI are $PM_{2.5}$ and ozone. AQI values are updated hourly and posted on the MPCA's web site at http://aqi.pca.state.mn.us.

Air quality is ranked as good, moderate, unhealthy for sensitive groups (USG), unhealthy, or very unhealthy (figure 3). If it is suspected through forecasting or monitoring that one of the four pollutants may be unhealthy for sensitive groups or higher, the MPCA issues an Air Pollution Health Alert to the media and to individuals who have signed up to receive e-mail alerts. Alerts allow the public to be proactive about protecting their health and reducing their own contributions to emissions and exposure to pollution. To receive e-mail alerts and air quality forecasts, sign up at http://mn.enviroflash.info

Figure 3: AQI categories



The MPCA reports the AQI for nine regions across the state. The number and type of monitors vary from region to region, with the most monitors in the Twin Cities metropolitan area. Table 3 describes the network of sites the MPCA operates to collect hourly AQI data.

Table 3: AQI Sites by Region

Sites	Brainerd Area	Detroit Lakes	Duluth Area	Ely	Grand Portage	Marshall	St. Cloud Area	Rochester	Twin Cities
Total	2	1	4	1	1	1	2	1	12
$PM_{2.5}$	1	1	1	1	1	1	1	1	6
Ozone	2	1	2	1		1	1	1	6
CO			1				1		2
SO_2									1

Figure 4 shows the number of good, moderate, and USG days at sites in Minnesota over the course of 2009. Regions may not show a total of 365 days because of monitoring problems or non-operational days. In 2009, the cleanest air was in Grand Portage with 323 good air days and only 15 moderate days. The worst air quality was in the Twin Cities metropolitan area. The Twin Cities had 145 moderate days, ten USG days, and two unhealthy days. There were no very unhealthy days in Minnesota in 2009.

Figure 4: 2009 AQI days in Minnesota cities

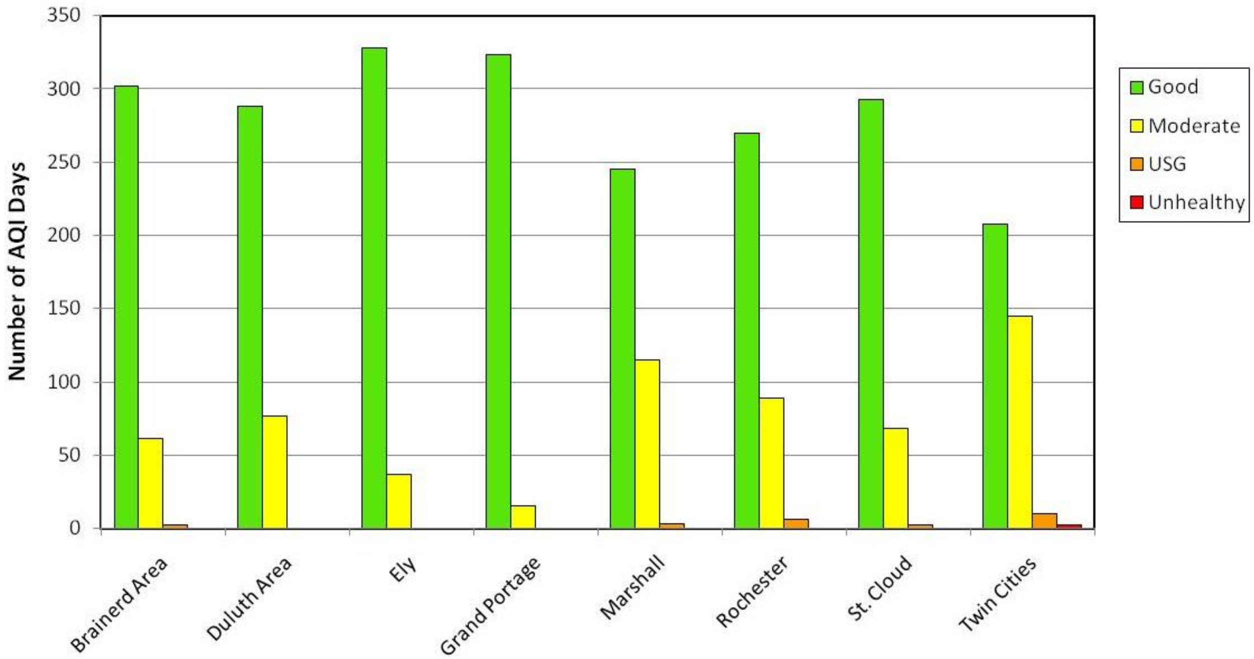


Table 4 shows the days the AQI reached a value over 101 in 2009. All high AQI days in 2009 were due to fine particle pollution. Consistent with the nature of fine particle formation and transport, the 2009 high AQI days can be described as three individual multi-day air pollution events. While the duration of these events varies, consecutive days of poor air quality are typically the result of persistent environmental conditions such as air stagnation, wind direction and flow, and temperature.

Table 4: 2009 days with AQI greater than 100

	Twin Cities	Duluth	St. Cloud	Rochester	Ely	Brainerd	Marshall	Grand Portage
1/22/2009	127							
1/23/2009	137			102				
3/5/2009			102				102	
3/6/2009	110		112			105		
7/5/2009	124							
7/6/2009	102							
11/23/2009	115			110				
11/24/2009	154			132				
11/25/2009	152			127				
12/18/2009	137			124		110	122	
12/19/2009	122			124			127	
Total Days	10	0	2	6	0	2	3	0

The Twin Cities metropolitan area had the highest number of days (10 days), followed by Rochester (6 days), Marshall (3 days), and Brainerd and St. Cloud (2 days). Duluth, Ely, and Grand Portage did not exceed 101 in 2009.

National Core Monitoring (NCore)

In October 2006, the United States Environmental Protection Agency (EPA) established the National Core (NCore) multi-pollutant monitoring network in its final amendments to the ambient air monitoring regulations for criteria pollutants (codified in 40 CFR parts 53 and 58). EPA expects each state to have at least one NCore site. Nationwide, there will be approximately 50 sites in urban locations and 20 sites in rural areas.

The NCore monitoring network addresses the following monitoring objectives which are equally valued at each site:

- timely reporting of data to the public through AIRNow, air quality forecasting, and other public reporting mechanisms;
- support development of emission strategies through air quality model evaluation and other observational methods;
- accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors;
- compliance through establishing nonattainment/attainment areas by comparison with the NAAQS;
- support of scientific studies ranging across technological, health, and atmospheric process disciplines; support long-term health assessments that contribute to ongoing reviews of the National Ambient Air Quality Standards (NAAQS); and
- support of ecosystem assessments, recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analysis.

At a minimum NCore monitoring sites must measure the parameters listed in Table 5.

Table 5: NCore parameters

Parameter	Comments
$PM_{2.5}$ speciation	Organic and elemental carbon, major ions and trace metals (24 hour average every 3rd day)
$PM_{2.5}$ FRM mass	24 hour average every third day
continuous $PM_{2.5}$ mass	one hour reporting interval
continuous $PM_{(10-2.5)}$ mass	in anticipation of a $PM_{(10-2.5)}$ standard
lead (Pb)	24 hour sample every sixth day
ozone (O_3)	continuous monitor consistent with other O_3 sites
carbon monoxide (CO)	continuous monitor consistent with other CO sites
carbon monoxide (CO) trace level	continuous monitor capable of trace levels (low ppb and below)
sulfur dioxide (SO_2)	continuous monitor consistent with other SO_2 sites
sulfur dioxide (SO_2) trace level	continuous monitor capable of trace levels (low ppb and below)
oxides of nitrogen (NO_X)	continuous monitor consistent with other NO_X sites
total reactive nitrogen (NO/NO_y)	continuous monitor capable of trace levels (low ppb and below)
surface meteorology	wind speed and direction, temperature, barometric pressure, and relative humidity

In 2007, the EPA provided funding to the MPCA to begin the process of establishing an NCore station in the Twin Cities metropolitan area. After evaluating the existing monitoring network, historical data, population trends and meteorology, the MPCA identified the existing monitoring site at the Anoka County Airport in Blaine (6010) as a candidate NCore site. The Anoka Airport monitoring station is approximately 11 miles north of downtown Minneapolis and approximately 15 miles northwest of downtown St. Paul.

Minnesota's NCore site in Blaine (6010) focuses on providing multi-pollutant monitoring data. Numerous chemical and physical interactions between pollutants underlie the formation of particulates and ozone and the presence of other pollutants. In addition, emission sources tend to release multiple pollutants or their precursors simultaneously. Multi-pollutant monitoring will benefit health studies, long-term epidemiological studies, source apportionment studies, and air quality models.

Another focus of the NCore site in Blaine is trace level monitoring of carbon monoxide, sulfur dioxide, oxides of nitrogen, and total reactive nitrogen. These pollutants are dominant inorganic combustion products, as well as the most abundant inorganic elements in the atmosphere. Emissions reductions have reduced the concentrations of these pollutants in most urban and rural areas; however, they are precursor gases that continue to play an important role in the formation of ozone, particulate matter, and air toxics on both local and regional scales. The trace level data that this site provides will help us understand the role of these pollutants in the environment at levels far below the NAAQS.

A detailed report about Minnesota's NCore site in Blaine can be found on the MPCA website at www.pca.state.mn.us/air/monitoringnetwork.html.

Interagency Monitoring of Protected Visual Environments (IMPROVE)

The IMPROVE Aerosol Network is a cooperative air quality monitoring effort between federal land managers; regional, state, and tribal air agencies; and the EPA. This program was established in 1985 in response to the 1977 Clean Air Act Amendments to aid in developing Federal and State implementation plans for the protection of visibility in Class I areas. Class I areas are National Parks and other wilderness areas that are designated by the United States Department of Agriculture (USDA). The IMPROVE network presently comprises 175 monitoring sites nationally.

The objectives of the IMPROVE network are to:

- establish current visibility and aerosol conditions in Class I areas;
- identify chemical species and emission sources responsible for existing man-made visibility impairment; and
- document long-term trends for assessing progress towards the national visibility goal.

The IMPROVE sites also provide $PM_{2.5}$ speciation data; therefore, they are a key component of the EPA's national fine particle monitoring and are critical to tracking progress related to the Regional Haze Regulations. Minnesota has four IMPROVE Aerosol Network sites. They are located at Voyageurs National Park (VOYA2), near the Boundary Waters Canoe Area Wilderness at Ely (BOWA1), Blue Mounds State Park (BLMO1), and Great River Bluffs State Park (GRRI1). Figure 1 shows the locations of these sites.

Chemical Speciation Network (CSN)

The CSN is an EPA effort to gather data on the chemical composition of $PM_{2.5}$ and to provide a basic, long-term record of the concentration levels of selected ions, metals, carbon species, and organic compounds found in $PM_{2.5}$. EPA has established a chemical speciation network consisting of approximately 300 monitoring sites. It is currently anticipated that 54 of these sites will be used to determine trends in the chemical composition of $PM_{2.5}$ particles over a period of several years. The chemical speciation data serve the needs associated with assessing trends and developing mitigation strategies to reduce emissions and ambient concentrations.

The programmatic objectives of the CSN are:

- temporal and spatial characterization of aerosols;
- air quality trends analysis and tracking the progress of control programs;
- comparison of the chemical speciation data set to the data collected from the IMPROVE network; and development of emission control strategies.

There are currently two CSN sites in Minnesota. One is located in Minneapolis at the H.C. Andersen School (963) and the other is located in Rochester (5008). Figure 1 shows the locations of these sites. In order to make the CSN data more comparable to the IMPROVE data, URG3000N carbon samplers were added to the CSN network over the last several years. Minneapolis (963) started sampling with a URG3000N carbon sampler on May 3, 2007 and Rochester (5008) started on October 4, 2009.

A third site will be added to the NCore site in Blaine (6010) on January 1, 2011.

National Atmospheric Deposition Program (NADP)

The NADP comprises three sub-networks: the National Trends Network (NTN), the Mercury Deposition Network (MDN), and the Atmospheric Integrated Research Monitoring Network (AIRMoN). There are currently over 250 sites in the NADP spanning the continental United States, Alaska, Puerto Rico, and the Virgin Islands. More information can be found at http://nadp.sws.uiuc.edu/.

NTN collects weekly precipitation samples for pH, sulfate, nitrate, ammonium, chloride, and base cations (such as calcium and magnesium). NTN provides long-term, high-quality data for determining spatial and temporal trends in the chemical composition of precipitation.

MDN collects precipitation samples for analysis of total mercury and methylmercury concentrations. Its objective is to develop a national database of the weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. Samples are collected weekly and sent to Frontier Geosciences, Inc. in Seattle, Washington for analysis.

AIRMoN was formed for the purpose of studying precipitation chemistry with greater temporal resolution. Precipitation samples are collected daily and samples are analyzed for the same constituents as NTN sites. AIRMoN currently operates eight sites nationally, with the full network expected to grow to about 20-30 wet and dry deposition sites. The AIRMoN sites provide a research-based foundation for operations of the other deposition monitoring networks. Currently there are no AIRMoN sites in Minnesota.

Minnesota has NADP sites at the following locations: Blaine (MN98), Camp Ripley (MN23), Cedar Creek (MN01), Ely (MN18), Grindstone Lake (MN28), Hovland (MN08), Lamberton (MN27), Marcell (MN16), Voyageurs National Park (MN32), and Wolf Ridge (MN99). Figure 1 shows the locations of these sites.

Quality Assurance/Quality Control (QA/QC) program

The purpose of the QA/QC program is to assure the quality of data obtained from the MPCA air monitoring networks. The MPCA meets or exceeds the QA requirements defined in 40 CFR 58 and all applicable appendices.

The QA/QC program includes but is not limited to the following activities:

- instrument performance audits,
- monitor siting evaluations,
- precision and span checks,
- bias determinations,
- flow rate audits,
- leak checks, and
- data validation.

For independent quality assurance activities, the MPCA participates in the National Performance Audit Program and the Performance Evaluation Program for criteria pollutant monitoring and performance. Additional inter-laboratory comparisons are performed quarterly for air toxics monitoring.

As the Primary Quality Assurance Organization for ambient air monitoring activities in Minnesota, the MPCA operates under an EPA approved Quality Management Plan (QMP) and utilizes Quality Assurance Project Plans (QAPP) for each statewide monitoring network. The primary purpose of the QAPP is to provide an overview of the project, describe the need for the measurements, and define QA/QC activities to be applied to the project. All other ambient air monitoring initiatives including state, tribal, and industrial projects must have an MPCA approved monitoring plan for each specific project.

Network scales

Since it is not possible to monitor everywhere in the state, the concept of spatial scales is used to clarify the link between monitoring objectives and the physical location of the monitor. When designing an air monitoring network one of the following six objectives should be determined:

1. the highest concentrations expected to occur in the area covered by the network;
2. representative concentrations in areas of high population density;
3. the impact of specific sources on ambient pollutant concentrations;
4. general background concentration levels;
5. the extent of regional transport among populated areas and in support of secondary standards; or
6. welfare-related impacts in the more rural and remote areas.

The EPA developed a system which specifies an exclusive area or spatial scale that an air monitor represents. The goal in establishing air monitoring sites is to correctly match the spatial scale that is most appropriate for the monitoring objective of the site. Table 6 displays the recommended siting scales for the appropriate monitoring objective.

The representative measurement scales are:

- **Micro Scale (10-100) m -** defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters. Measurements on the micro scale typically include concentrations in street canyons, intersections, and in areas next to major emission sources.
- **Middle Scale (100-1,000) m -** defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 to 1,000 meters.
- **Neighborhood Scale (1-4) km -** defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the one to four kilometers range. Generally, these stations represent areas with moderate to high population densities.
- **Urban Scale (4-50) km -** defines the overall, citywide conditions with dimensions on the order of four to 50 kilometers. This scale represents conditions over an entire metropolitan area and is useful in assessing city-wide trends in air quality.
- **Regional Scale/ Background (50-1,000) km -** usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.
- **National/Global -** concentrations characterizing the nation and the globe as a whole.

Table 6: Network scales

Monitoring Objective	Appropriate Siting Scales
Highest Concentration	Micro, Middle, Neighborhood (sometimes Urban)
Population Exposure	Neighborhood, Urban
Source Impact	Micro, Middle, Neighborhood
General/Background	Urban, Regional (sometimes Neighborhood)
Regional Transport	Urban, Regional
Welfare – Related	Urban, Regional

Site Selection

The selection of air monitoring sites is usually based on one of the basic monitoring objectives listed below:

- determine representative concentrations and exposure in areas of high population density;
- determine the highest concentrations of pollutants in an area based on topography and/or wind patterns;
- judge compliance with and/or progress made towards meeting the NAAQS within a geographic area
- observe pollution trends throughout the region, including non urban areas;
- determine the highest concentrations of pollutants within the state based on the known atmospheric chemistry of specific pollutants and wind patterns;
- determine the extent of regional pollutant transport to and from populated areas;
- determine the impact on ambient pollution levels of major sources or source categories;
- validate control strategies that prevent or alleviate air pollution episodes near major sources;
- determine the source/transport related impacts in more rural and remote areas;
- provide a data base for research and evaluation of air pollution effects within geographic areas; or
- determine general background concentration levels.

The exact location of a site is most often dependant on the logistics of the area chosen for monitoring, such as site access, security and power availability.

Parameter Networks

The MPCA monitors different types of measurable properties called parameters. The group of sites where a parameter is monitored is referred to as a parameter network. Generally, parameters are pollutants such as fine particles or air toxics. However, parameters also include non-concentration data such as wind speed and temperature. Table 7 lists the types of pollutants monitored by the MPCA along with the methods and equipment used.

The MPCA monitors the six criteria pollutants established by the 1970 Clean Air Act to show compliance with the NAAQS. The criteria pollutants are particulate matter ($PM_{2.5}$ and PM_{10}), lead, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide.

Other types of particulate matter are also collected in Minnesota. Total suspended particulate matter (TSP) is monitored to show compliance with Minnesota Ambient Air Quality Standards (MAAQS). Chemical speciation of $PM_{2.5}$ is monitored at six sites in Minnesota through the IMPROVE network and CSN. Speciation data are used for trends analysis and to better understand the sources of fine particles.

The MPCA also monitors pollutants that pose a potential risk to human health and the environment, but are not regulated by standards including air toxics, acid rain, and mercury. Air toxics include volatile organic compounds (VOCs), carbonyls, and metals. Acid rain and mercury are monitored through the NADP across Minnesota.

Compounds containing sulfur are also monitored since they may cause irritation to the eyes, nose, and throat. Hydrogen sulfide (H_2S) is monitored to show compliance with the MAAQS. Total reduced sulfur (TRS) contains H_2S; it is monitored around industrial sources and used as conservative measure to compare to the H_2S MAAQS.

Temperature, wind speed and direction, barometric pressure, and relative humidity strongly influence the concentrations and transport of pollutants. Meteorological data are collected at three sites in the Twin Cities metropolitan area. Meteorological data from other sources near air monitoring stations can also be used to interpret air quality monitoring data.

Generally, parameters are monitored continuously or as integrated data. Continuous data gives readings on a real time basis, in short increments such as every five or 15 minutes or every hour. Integrated samples are usually 24-hour averages. Integrated samples are collected daily, once every three days or once every six days. Continuous data are collected and analyzed at the site. For integrated data, samples are collected at sites and then transported to the lab for further analysis.

Tables 8 and 9 list all of the air quality monitoring sites in Minnesota and the parameters monitored at each.

Table 7: Methods and equipment

Monitoring parameter	Methods and equipment	Analyzing agency
$PM_{2.5}$ FRM	Gravimetric – Thermo Partisol-Plus model 2025 $PM_{2.5}$ Sequential Air Sampler and Andersen RAAS-100 Single Channel samplers	MPCA
$PM_{2.5}$ Continuous	Beta Attenuation – MetOne Instruments BAM-1020	MPCA
$PM_{2.5}$ Speciation - CSN	Gravimetric, GC/MS, Ion Chromatography – MetOne Instruments SAAS Speciation Sampler; URG3000N Carbon Samplers	RTI
$PM_{2.5}$ Speciation - IMPROVE	Gravimetric, GC/MS, Ion Chromatography – IMPROVE Speciation Sampler	Cal Davis
PM_{10}	Gravimetric – Andersen Plastic samplers	MPCA
PM_{10} Continuous	Beta Attenuation – MetOne Instruments BAM-1020	MPCA
TSP	Gravimetric – Andersen Plastic T samplers	MPCA
Ozone	Ultraviolet Absorption – API 400E, TE 49C analyzers	MPCA
NO_X	Chemiluminescence – API 200A, TE 42, Monitor Labs analyzers	MPCA
NO/NO_y trace level	Chemiluminescence – American Ecotech model EC9841T	MPCA
SO_2	Pulsed Fluorescence – Dasibi 4108 analyzers	MPCA
SO_2 trace level	Pulsed Fluorescence – American Ecotech model EC9850T	MPCA
CO	Infrared Absorption – Monitor Labs 9830, Dasibi 3008 analyzers	MPCA
CO trace level	Infrared Absorption – American Ecotech model EC9830T	MPCA
VOCs	Gas Chromatography and Mass Spectrometry – ATEC model 2200 sampler	MPCA
Carbonyls	Liquid Chromatography – ATEC model 2200 sampler	MPCA
Metals	Inductively Coupled Argon Plasma (ICP-OES) from TSP filters	MPCA
Acid Deposition	Wet-only precipitation collection, Chromatography analysis	IL Survey
Mercury Deposition	Wet-only precipitation collection, Inductively Coupled Argon Plasma analysis	Frontier
H_2S	Honeywell Analytics MDA model SPM Chemcassette	MPCA
TRS	SO_2 analyzer (pulsed fluorescence) with thermal oxidizer	MPCA
Meteorological Data	Various meteorological sensors	MPCA
Asbestos	MDH Method 852 – TE-2000 TSP sampler	MDH
Black Carbon	Optical Transmission Absorption – Magee Scientific Aethalometer AE21ER	MPCA
PFCs	TE-1000 PUF sampler	Axys

Table 8: 2010 Site parameters - Greater Minnesota

MPCA Site ID	City Name	Site Name	$PM_{2.5}$ FRM	$PM_{2.5}$ Continuous	$PM_{2.5}$ Speciation	PM_{10}	TSP and Metals	Ozone	Oxides of Nitrogen	Sulfur Dioxide	Carbon Monoxide	VOCs	Carbonyls	Other Parameters
MN08*	Hovland	Hovland												Acid Deposition
MN16*	Balsam Lake	Marcell												Acid and Hg Deposition
MN23*	Pillager	Camp Ripley												Acid and Hg Deposition
MN27*	Lamberton	Lamberton												Acid and Hg Deposition
MN28*	Sandstone	Grindstone Lake												Acid Deposition
MN32* VOYA1	International Falls	Voyageurs			IMP									Acid Deposition
MN99*	Finland	Wolf Ridge												Acid Deposition
1300	Virginia	Virginia	X			X	X							
2013	Detroit Lakes	Detroit Lakes		X				X						
3051	Mille Lacs	Mille Lacs						X						
3052	Saint Cloud	Talahi School	X	X				X						
3053	Saint Cloud	Grede Foundries					X							
3204	Brainerd	Brainerd Airport		X				X						
4210	Marshall	Marshall Airport		X				X						
4415	Priam	Priam					X[t]							[t] Metals are not analyzed
5008	Rochester	Ben Franklin School	X	X	CSN			X						
5302	Stanton	Stanton Air Field						X						
7001	Ely	Fernberg Road		X	IMP		X	X				X	X	Acid and Hg Deposition
7416	Cloquet	Cloquet					X	X	X			X	X	
7526	Duluth	Torrey Building								X	X			
7545	Duluth	Oneota Street				X								
7549	Duluth	Michigan Street										X	X	
7550	Duluth	WDSE	X					X						
7551	Duluth	Lincoln Park School	X	X										
7555	Duluth	Waseca Road					X							
7810	Grand Portage	Grand Portage		X										
BLMO1**	Luverne	Blue Mounds			IMP									
GRRI1**	Winona	Great River Bluffs			IMP									

*NADP Site ID (no MPCA site ID exists)
**IMPROVE Site ID (no MPCA site ID exists and not an NADP site)

Table 9: 2010 Site parameters - Twin Cities metropolitan area

MPCA Site ID	City Name	Site Name	$PM_{2.5}$ FRM	$PM_{2.5}$ Continuous	$PM_{2.5}$ Speciation	PM_{10}	TSP and Metals	Ozone	Oxides of Nitrogen	Sulfur Dioxide	Carbon Monoxide	VOCs	Carbonyls	Other Parameters
250	St. Louis Park	St. Louis Park	X									X	X	
420	Rosemount	FHR 420					X		X	X	X	X	X	TRS, Meteorological Data
423	Rosemount	FHR 423							X	X	X	X	X	TRS, Meteorological Data
436	St. Paul Park	MPC 436								X		X	X	TRS
438	Newport	MPC 438					X					X	X	
442	Rosemount	FHR 442								X		X	X	
443	Rosemount	FHR 443								X		X	X	TRS
446	Bayport	Point Road					X					X	X	
465	Eagan	Gopher Resources					X							
470	Apple Valley	Apple Valley	X	X			X					X	X	
505	Shakopee	Shakopee	X					X						
861	St. Paul	Lexington Avenue									X			
866	St. Paul	Red Rock Road				X								
868	St. Paul	Ramsey Health Center	X			X^{C}						X	X	$^{C}PM_{10}$ Continuous, Asbestos
871	St. Paul	Harding High School	X	X			X					X	X	
907	Minneapolis	Humboldt Avenue				X	X					X	X	
954	Minneapolis	Arts Center								X	X			
961	Richfield	Richfield Intermediate School										X	X	
963	Minneapolis	H.C. Andersen School	X	X	CSN		X					X	X	
966	Minneapolis	City of Lakes				X	X					X	X	
971	Minneapolis	North Second Street				X^{C}	X^{t}							$^{C}PM_{10}$ Continuous, ^{t} Metals are not analyzed
3201	Saint Michael	Saint Michael		X				X						
6010	Blaine	Anoka Airport	X	X				X	X					NCore trace level gases, Hg Deposition, Meteorological Data
6012	East Bethel	Cedar Creek						X						Acid Deposition
6015	Stillwater Township	Washington County						X						
6020	Anoka	Federal Cartridge					X							

Criteria pollutants

In 1970, the Clean Air Act (CAA) established standards for six pollutants known to cause harm to human health and the environment. The CAA requires the MPCA to monitor these pollutants, called criteria pollutants, and report the findings to the EPA. The criteria pollutants are particulate matter, lead, ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide. For each of these pollutants the EPA has developed primary and secondary National Ambient Air Quality Standards (NAAQS). Primary standards are set to protect public health, while the secondary standard is set to protect the environment and public welfare (i.e. visibility, crops, animals, vegetation, and buildings).

The CAA requires the EPA to review the scientific basis of these standards every five years to ensure they are protective of public health and the environment. Most recently during the standard review for nitrogen dioxide (NO_2), the EPA announced it would retain the existing annual standard, but in light of stronger evidence that short term exposures to elevated NO_2 may also cause adverse health effects, the EPA instituted a new 1-hour NO_2 standard. Table 10 describes the current NAAQS, including the recent standard revisions for lead and NO_2.

Table 10: Current NAAQS

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual	same as primary	
	35 µg/m^3	24-hour		
Particulate Matter (PM_{10})	150 µg/m^3	24-hour	same as primary	
Lead	0.15 µg/m^3	Rolling 3-Month Average	same as primary	
Ozone	0.075 ppm	8-hour	same as primary	
	0.12 ppm	1-hour		
Nitrogen Dioxide	0.053 ppm	Annual	same as primary	
	0.100 ppm	1-hour		
Sulfur Dioxide	0.03 ppm	Annual	0.5 ppm	3-hour
	0.14 ppm	24-hour		
Carbon Monoxide	9 ppm	8-hour	none	
	35 ppm	1-hour		

By the end of 2011, the EPA will complete the current suite of NAAQS reviews. Table 11 describes the current timeline for review, and if available, EPA's proposed standard revisions.

Table 11: NAAQS Changes

Pollutant	Date of Final Rule	Proposed Primary Standards	Proposed Secondary Standards
Particulate Matter (PM_{10})	Expected July 2011	Expected November 2010	
Particulate Matter ($PM_{2.5}$)			
Lead	Finalized in 2008	*(see Table 10)*	*(see Table 10)*
Ozone	Reconsideration expected August 2010	Range for 8-hour standard: 0.60 – 0.70 ppm	New standard called W126 Range: 7-15 ppm-hours
Nitrogen Dioxide	Finalized January 22, 2010	*(see Table 10)*	Expected July 2011
Sulfur Dioxide	Expected June 2010	Eliminate existing annual and 24-hour standards Range for 1-hour standard: 50 – 100 ppb	Expected July 2011
Carbon Monoxide	Expected May 2011	Expected October 2010	

Particulate matter

The MPCA monitors for three different particle sizes: fine particulate matter ($PM_{2.5}$) which has an aerodynamic diameter of less than 2.5 microns, PM_{10} which has an aerodynamic diameter of less than ten microns, and total suspended particulate matter (TSP) which includes the total mass of particles found in a sample of ambient air. $PM_{2.5}$ and PM_{10} are regulated by the NAAQS and TSP is regulated by the MAAQS. In the future, the MPCA also plans to monitor for coarse particles which are particles with an aerodynamic diameter ranging from 2.5 to 10 microns.

Fine Particulate Matter ($PM_{2.5}$)

$PM_{2.5}$ is a chemically and physically diverse mixture of different sizes of very small particles most of which are smaller than 2.5 microns in diameter. $PM_{2.5}$ can be inhaled deeply into the lungs. Elevated concentrations of $PM_{2.5}$ are associated with a rise in heart attacks, acute and chronic bronchitis, asthma attacks, and respiratory symptoms. In children, reduced lung function growth and increased respiratory illness are also associated with elevated $PM_{2.5}$ concentrations.

$PM_{2.5}$ contains a complex mixture of chemicals. They include ammonium sulfate, ammonium nitrate, particle-bound water, elemental carbon, hundreds or thousands of organic compounds, and inorganic material including soil and metals.

Three types of $PM_{2.5}$ networks run in Minnesota: the Federal Reference Method (FRM), continuous, and speciation networks. There are currently 21 $PM_{2.5}$ sites in Minnesota, eight of which are in the Twin Cities metropolitan area. Figure 5 shows the locations of the sites in Minnesota.

$PM_{2.5}$ Federal Reference Method (FRM) network

The FRM method collects a 24-hour mass sample of $PM_{2.5}$ on Teflon filters. Samples can be collected daily, once every three days, or once every six days. $PM_{2.5}$ data collected using this method are compared to the NAAQS to demonstrate compliance. Currently the MPCA is operating 12 $PM_{2.5}$ FRM sites. All sites currently run once every three days except Virginia (1300) which runs once every six days. By January 1, 2011 Virginia will move to a one in three day schedule to be consistent with the rest of the network.

Minnesota does not spatially average $PM_{2.5}$ values from multiple sites to determine compliance with the annual $PM_{2.5}$ NAAQS. Instead each site is compared to the NAAQS individually. None of Minnesota's sites currently exceed the NAAQS. If a $PM_{2.5}$ FRM monitoring site were lost due to circumstances beyond the MPCA's control, a replacement site would be established if the lost site exceeded the NAAQS or if it is the "design value site" for a particular metropolitan statistical area (MSA). In this case, all possible efforts would be made to find a new site that is physically close to the lost site and has a similar scale and monitoring objective. However, if the "design value site" for that MSA is still operational, the MPCA would not establish a replacement site because the "design value site" would be used to determine compliance with the $PM_{2.5}$ NAAQS.

A monitoring site meets the annual $PM_{2.5}$ NAAQS if the three-year average of the annual average $PM_{2.5}$ concentration is less than or equal to 15 $\mu g/m^3$. Figure 6 shows the average of the 2007 through 2009 annual averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 6 $\mu g/m^3$ in Virginia (1300) to 11 $\mu g/m^3$ in St. Paul (866). All sites were below the annual standard.

A site meets the 24-hour standard if the 98^{th} percentile of the 24-hour $PM_{2.5}$ concentrations in a year, averaged over three years, is less than or equal to 35 $\mu g/m^3$. Figure 7 shows the 2007 through 2009 98^{th} percentile of the daily averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 16 $\mu g/m^3$ in Virginia (1300) to 34 $\mu g/m^3$ in St. Paul (871). All sites were below the 24-hour standard; however, since St. Paul (871) was within 15% of this standard it will move to a daily monitoring schedule in 2011.

As resources are available, the MPCA will replace FRM samplers with continuous (real-time) monitors that the EPA has approved to also be comparable to the NAAQS. These monitors will capture more data and improve the efficiency of $PM_{2.5}$ network operations in 2011. The first FRM monitors that will be replaced are in St. Cloud (3052) and Rochester (5008). There is more information about these monitors in the $PM_{2.5}$ continuous network section on page 20.

Figure 5: PM$_{2.5}$ monitoring sites in Minnesota

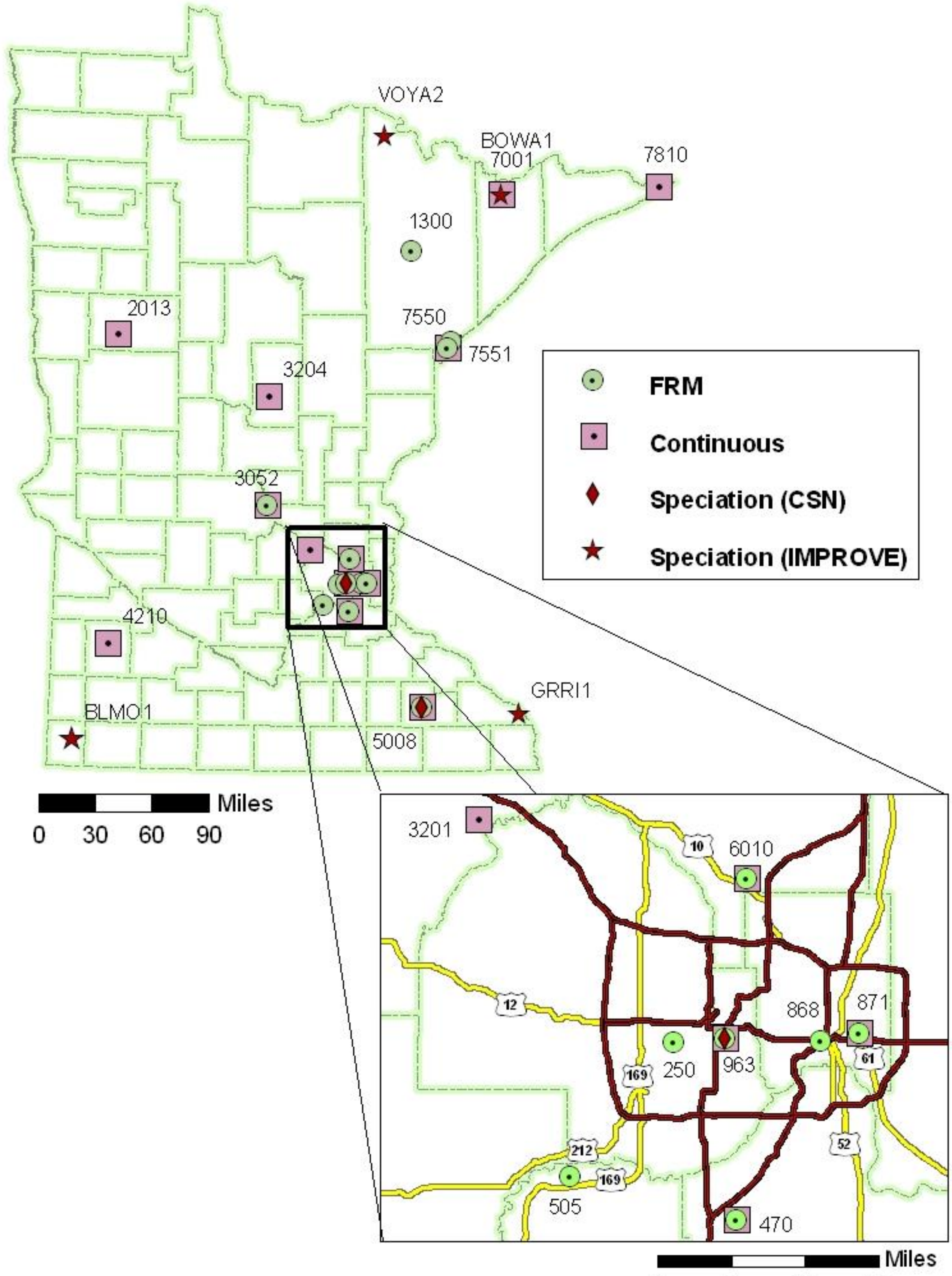


Figure 6: Annual $PM_{2.5}$ concentrations compared to the NAAQS

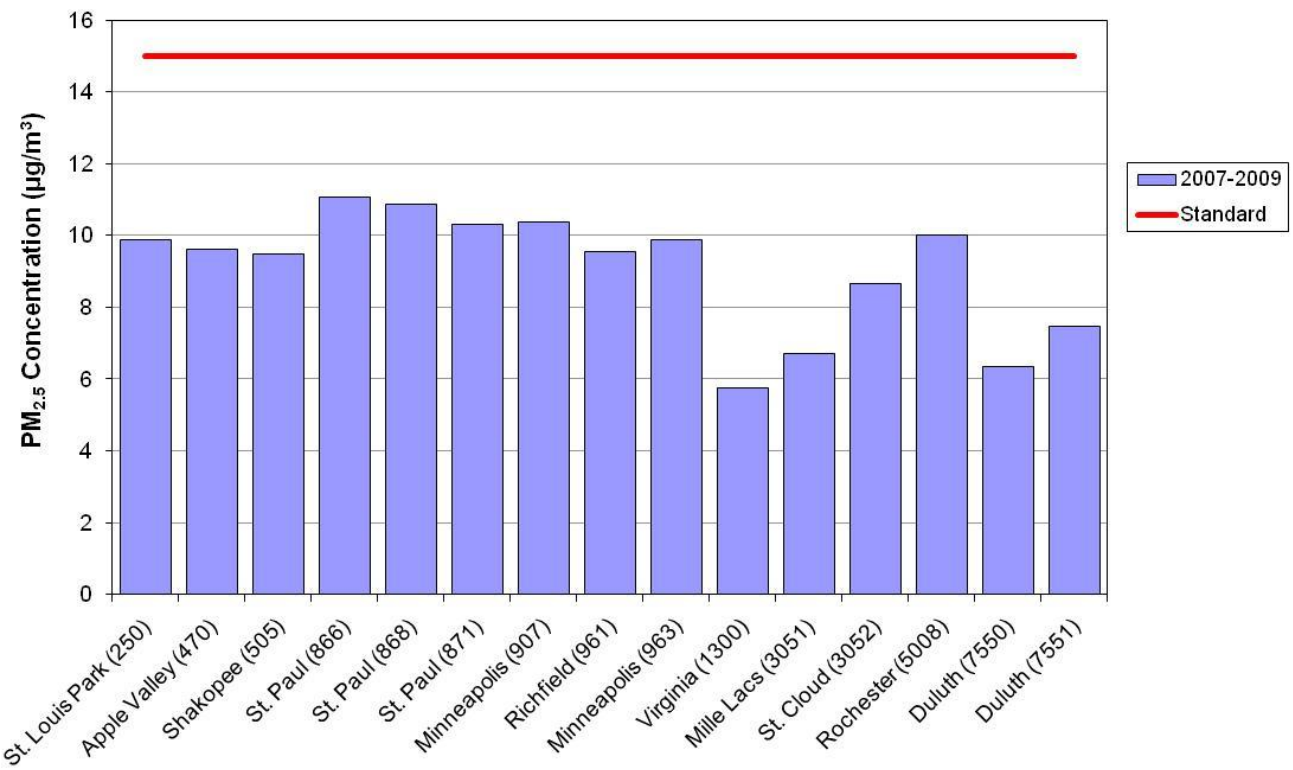
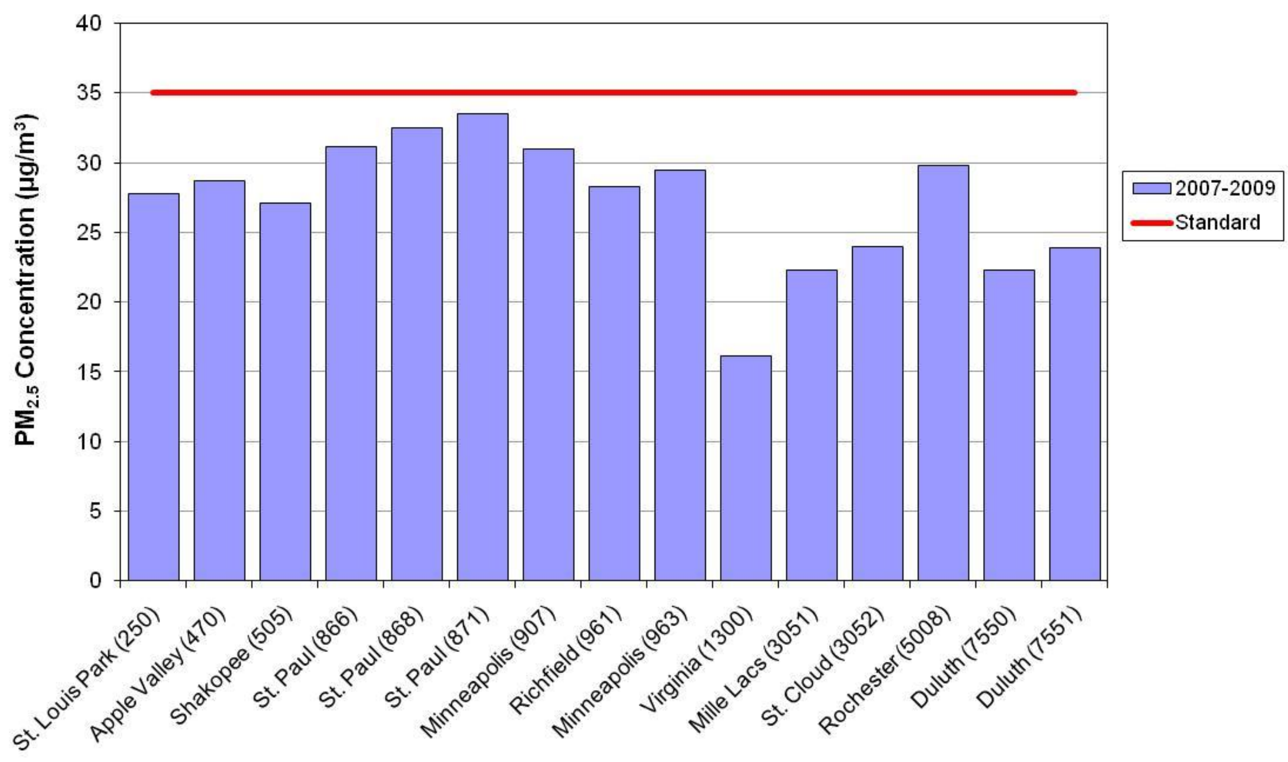


Figure 7: 24-hour $PM_{2.5}$ concentrations compared to the NAAQS



$PM_{2.5}$ continuous network

The MPCA uses MetOne Instruments BAM-1020 (BAM) continuous mass monitors to collect and report hourly $PM_{2.5}$ concentrations. The data are used to calculate the AQI and develop AQI forecasts for Minnesota. Continuous data are reported to the MPCA's AQI website and the EPA's AIRNow website (http://airnow.gov/) as well as the Air Quality System (AQS).

The continuous data provides two key types of information that are not available from the FRM network. Continuous data capture high concentration days that might be missed in the one in three or one in six day FRM sampling schedule. Daily monitoring also allows for temporal comparisons between sites on an ongoing basis, providing better comparisons. In addition, continuous $PM_{2.5}$ monitoring provides hourly data that assists in understanding how concentrations vary throughout the day. Understanding these daily fluctuations helps determine sources of $PM_{2.5}$ and when health risks from fine particles are greatest. This increased understanding of concentrations and risks aids in prioritizing emission reduction efforts.

The MPCA currently operates 13 continuous $PM_{2.5}$ sites in Minnesota. As resources are available, the MPCA proposes to upgrade several existing continuous $PM_{2.5}$ monitors to a version that the EPA has certified as a Federal Equivalent Method (FEM). Data from the $PM_{2.5}$ FEM monitor, by definition, can be considered equivalent to the data from the FRM monitors and used to demonstrate attainment with the $PM_{2.5}$ NAAQS. Non-FEM monitors will be used solely for reporting the AQI.

Ideally, the MPCA would like to upgrade its entire inventory of non-FEM monitors, but given budget constraints will begin by upgrading six monitors in 2010. As the upgrades are completed, the MPCA will prioritize sites for deployment starting with Harding (871), Rochester (5008), and St. Cloud (3052). Long-term, the MPCA intends to use continuous $PM_{2.5}$ FEM monitors across the entire network and minimize, to the extent possible, the use of $PM_{2.5}$ FRM monitors.

Figure 8 shows daily $PM_{2.5}$ concentrations from six BAM monitors across Minnesota. This chart illustrates how continuous data show the variability between sites. $PM_{2.5}$ is a regional pollutant with some addition from local sources; therefore, concentrations tend to rise and fall in unison across the state. The difference in concentration between sites, with higher concentrations often in Rochester and the Twin Cities metropolitan area, tends to be driven by local sources and closer proximity to large $PM_{2.5}$ sources to the south. Ely and Grand Portage tend to have the lowest concentrations since they are farthest from major sources. The difference between urban and rural areas demonstrates the affect of man-made sources on fine particulate concentrations.

Figure 8: $PM_{2.5}$ daily concentrations in February and March 2009

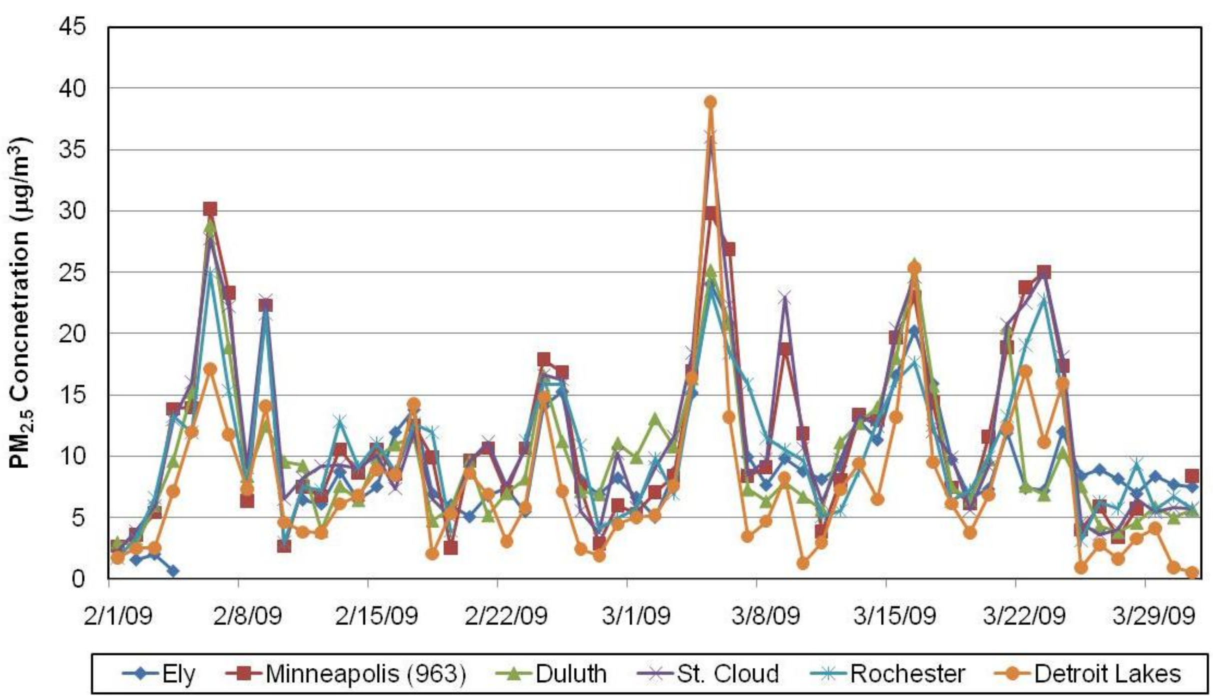
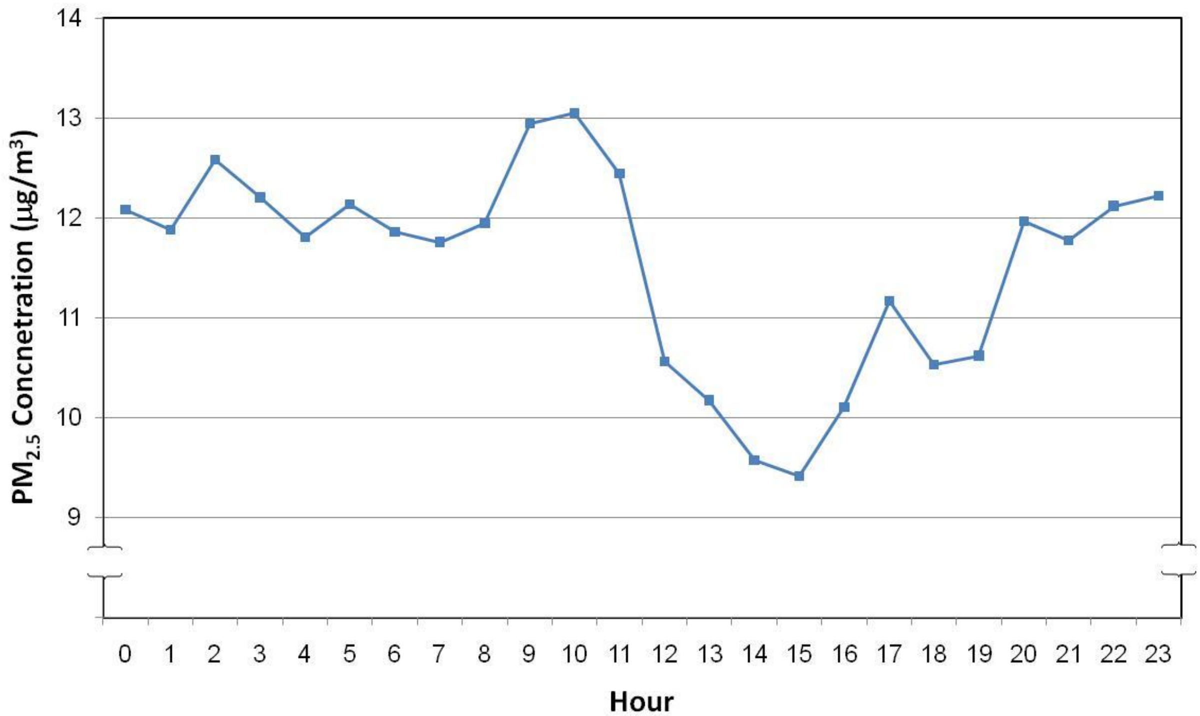


Figure 9 shows the average hourly concentrations in February and March 2009 in Minneapolis (site 963). It shows a classic traffic pattern in an urban area. The peak concentration around 9:00 a.m. results from rush hour traffic. As temperatures rise in the day, the atmospheric mixing height increases. This allows for dilution of fine particle concentrations and lowered concentrations in the afternoon. Temperatures fall in the evening, lowering the mixing height and trapping the particles, including those emitted during evening rush hour. This results in elevated concentrations throughout the night.

Figure 9: $PM_{2.5}$ average hourly concentrations at HC Andersen School (963) in February and March 2009



$PM_{2.5}$ Speciation

Currently, six monitors measure $PM_{2.5}$ chemical speciation in Minnesota. Figure 5 shows the locations of the sites in Minnesota. The monitors at Voyageurs (VOYA2), Ely (BOWA1), Blue Mounds (BLMO1), and Great River Bluffs (GRRI1) are part of the IMPROVE network (http://vista.cira.colostate.edu/IMPROVE/) which focuses on visibility issues primarily in rural locations. The monitors in Minneapolis (963) and Rochester (5008) are part of the EPA's Chemical Speciation Network (http://www.epa.gov/ttn/amtic/speciepg.html) which focuses on urban locations. Sampling frequency for these sites is once every three days except Rochester (5008) where sampling is done once every six days. Samples are analyzed at contract labs selected by the EPA and the IMPROVE program.

The particulate monitoring portion of the IMPROVE program measures $PM_{2.5}$ for mass, optical absorption, major and trace elements, organic and elemental carbon, and nitrate. CSN monitoring is similar except that it also includes analysis for ammonium and does not include optical absorption. In order to make the CSN data more comparable to the IMPROVE data, URG3000N carbon samplers were added to the CSN network over the last few years. Minneapolis (963) started sampling with a URG3000N carbon sampler on May 3, 2007 and Rochester (5008) started on October 4, 2009. In late 2010 a CSN speciation monitor will be added to the NCore site in Blaine (6010).

Speciation data are used for trends analysis and to better understand sources of fine particles and health effects. In 2008, the MPCA worked with Desert Research Institute to better understand the sources of fine particles based on Minnesota's speciation data.

Coarse Particulate Matter ($PM_{10-2.5}$)

The 2006 Ambient Air Monitoring Regulations contain a requirement for $PM_{10-2.5}$ mass and speciation monitoring to be conducted at NCore multipollutant monitoring sites. The collocation of both $PM_{10-2.5}$ and $PM_{2.5}$ speciation monitoring at NCore sites is consistent with the multipollutant objectives of the NCore network and will support further research in understanding the chemical composition and sources of PM_{10}, $PM_{10-2.5}$, and $PM_{2.5}$ at a variety of urban and rural locations. This additional data should help future regulation provide more targeted protection from health effects of coarse particles.

The MPCA will deploy a $PM_{10-2.5}$ monitor to the NCore site in Blaine by January 1, 2011. A plan for the implementation of this site was approved by the EPA in October 2009; it can be found on the MPCA website at www.pca.state.mn.us/air/monitoringnetwork.html.

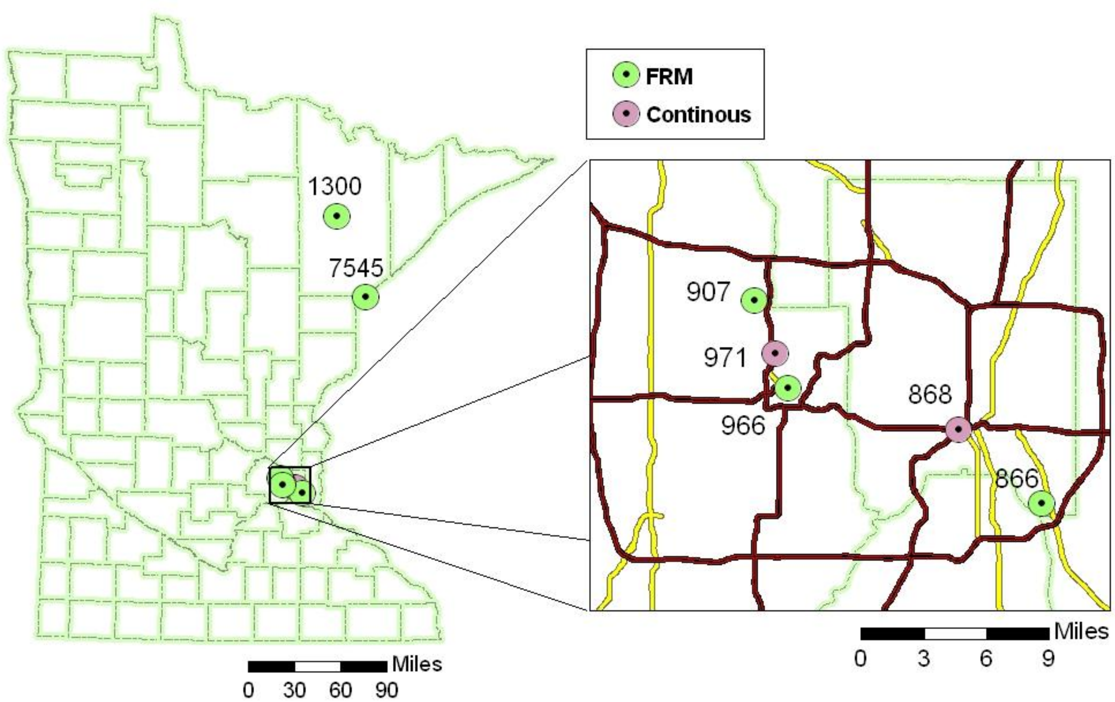
PM_{10}

PM_{10} includes all particles with an aerodynamic diameter less than 10 microns. Short-term exposure to PM_{10} is linked to hospitalization and even premature death in people with heart or lung disease. Decreased lung function and increased respiratory symptoms in children are also associated with PM_{10} exposure.

The MPCA currently operates five PM_{10} Federal Reference Method (FRM) monitors. This method collects mass samples of PM_{10} over a 24-hour period once every six days. There are also continuous PM_{10} monitors in St. Paul (868) and Minneapolis (971). The majority of the PM_{10} monitors are located in the Twin Cities metropolitan area with additional monitors in Duluth (7545) and Virginia (1300). Figure 10 shows the locations of the PM_{10} monitors in Minnesota. The PM_{10} monitor at Minneapolis (971) will shut down at the end of 2010 if none of the samples exceed the NAAQS during 2010.

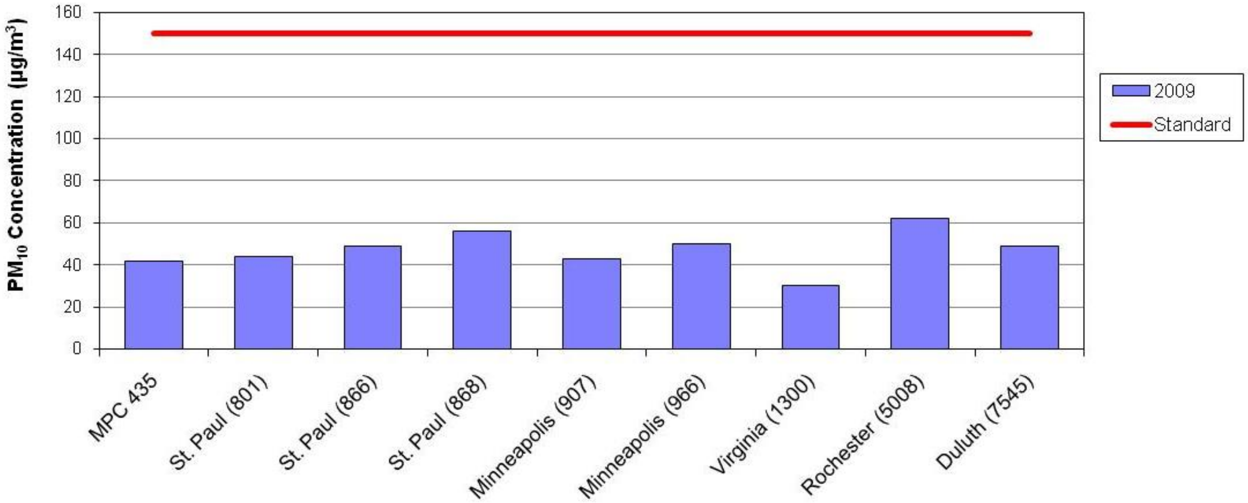
The long-term goal is to use continuous PM_{10} FEM monitors across the entire network and eliminate, to the extent possible, the use of the filter based PM_{10} FRM monitors. Continuous monitors capture more data and reduce operational costs associated with weighing, deploying, and recovering filters from the network.

Figure 10: PM_{10} monitoring sites in Minnesota



Minnesota currently meets applicable NAAQS for PM_{10} at all sites. A monitoring site meets the 24-hour PM_{10} NAAQS when the level of 150 $\mu g/m^3$ is not exceeded more than once per year. Figure 11 shows the 2009 second highest daily maximums at Minnesota sites and compares them to the standard. The Minnesota values ranged from 30 $\mu g/m^3$ in Virginia (1300) to 62 $\mu g/m^3$ in Rochester (5008); therefore, all sites were below the 24-hour standard in 2009. There is no annual standard for PM_{10}.

Figure 11: 24-hour PM_{10} concentrations compared to the NAAQS

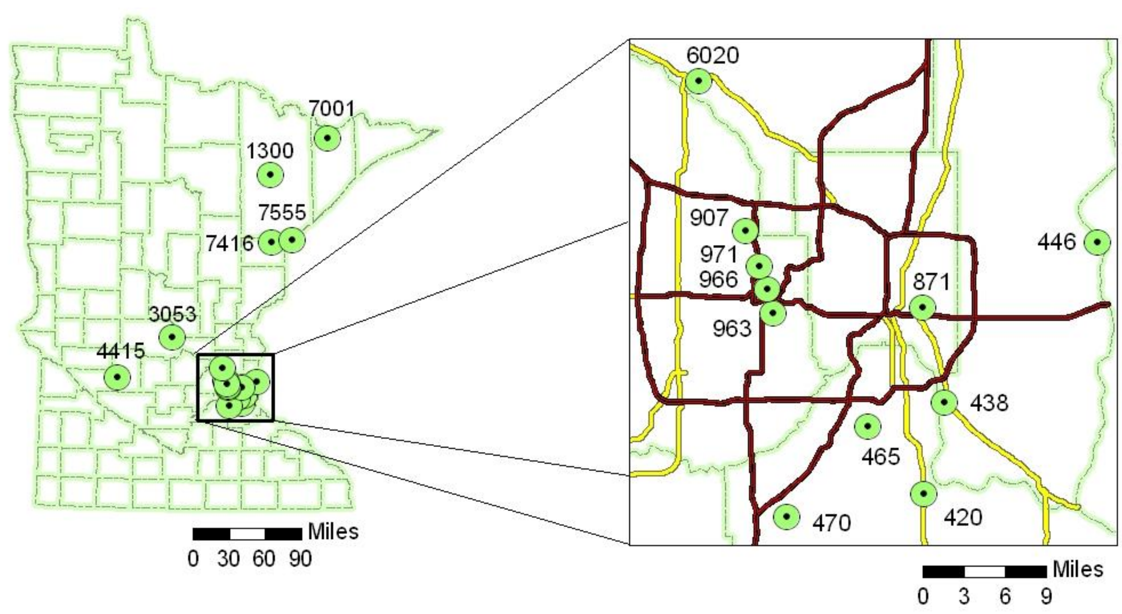


Total Suspended Particulate Matter (TSP)

TSP includes the total number of particles of solid or liquid matter - such as soot, dust, aerosols, fumes, and mist - found in a sample of ambient air. TSP was one of the original NAAQS; however, it was replaced in 1987 by the PM_{10} standard at the national level. Generally, more health effects are expected from smaller particles such as PM_{10} and $PM_{2.5}$. Today, TSP levels are regulated by the MAAQS in Minnesota.

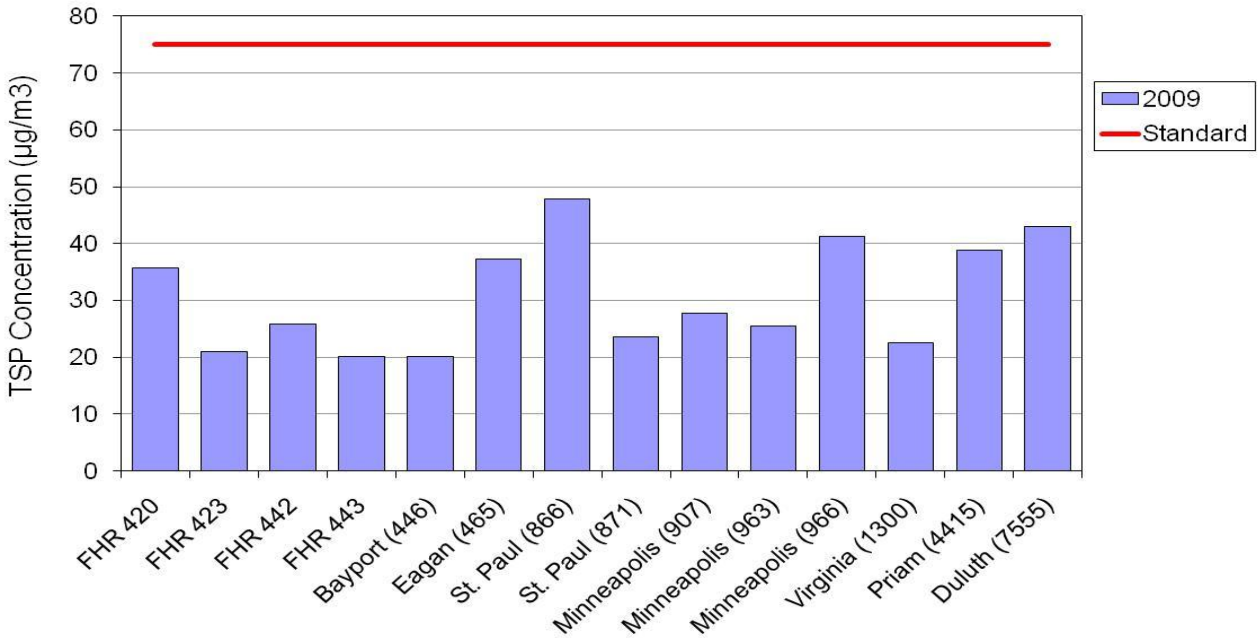
The MPCA currently operates 17 TSP monitoring sites. Figure 12 shows the location of the existing sites in Minnesota. Mass samples of TSP are collected over a 24 hour period once every six days. TSP filters are also extracted and analyzed using Inductively Coupled Argon Plasma (ICAP) for metals as part of the air toxics program. Metals are discussed further in the air toxics section of this report. In 2011, a TSP monitor will be added to Blaine (6010) to fulfill the requirement that lead be monitored at all NCore sites.

Figure 12: TSP monitoring sites in Minnesota



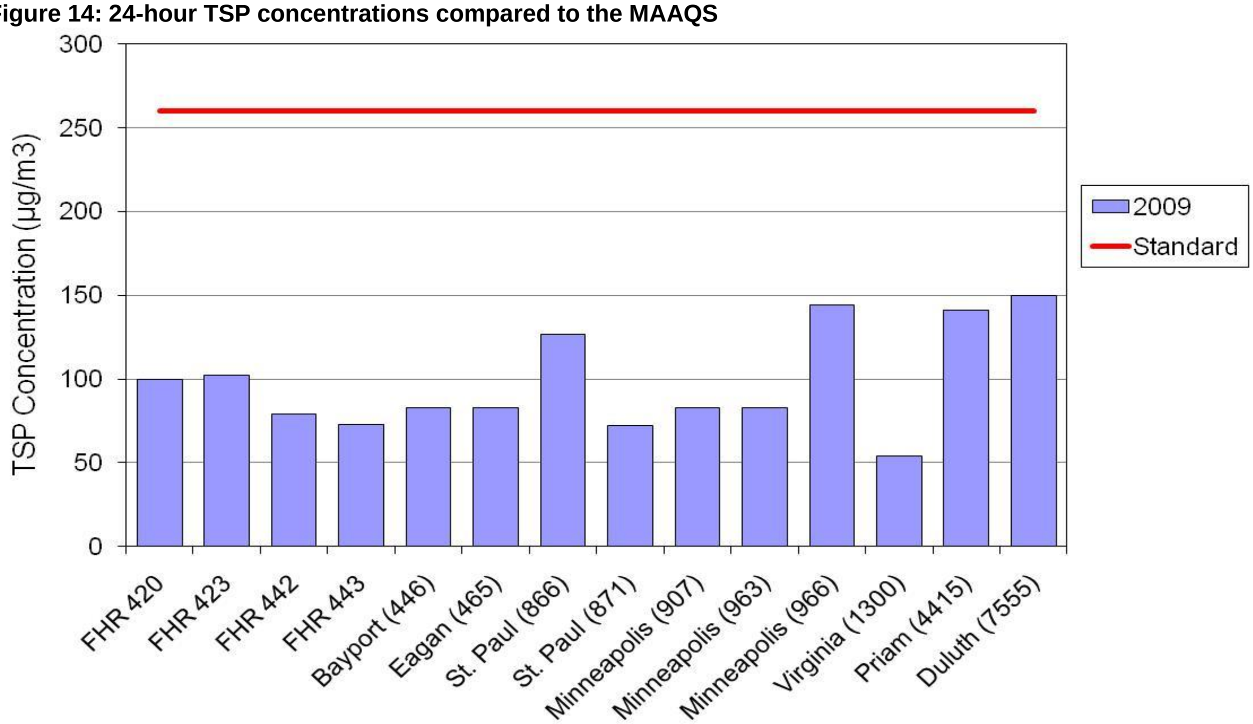
Minnesota currently meets applicable MAAQS for TSP. A monitoring site meets the annual TSP standard if the annual geometric average is less than or equal to 75 μg/m^3. Figure 13 shows the 2009 annual averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 20 μg/m^3 in Bayport (446) and at FHR 443 to 48 μg/m^3 in St. Paul (866); therefore, all sites were below the annual standard.

Figure 13: Annual average TSP concentrations compared to the MAAQS



A monitoring site meets the 24-hour standard when the level of 260 μg/m^3 is not exceeded more than once per year. Figure 14 shows the 2009 second highest daily maximums at Minnesota sites and compares them to the standard. Minnesota values ranged from 54 μg/m^3 in Virginia (1300) to 150 μg/m^3 in Duluth (7555); therefore, all sites were below the 24-hour standard in 2009.

Figure 14: 24-hour TSP concentrations compared to the MAAQS



Lead (Pb)

Lead is a metal found naturally in the environment as well as in manufactured products. Since lead was phased out of gasoline, air emissions and ambient air concentrations have decreased dramatically. Currently, metals processing facilities (lead and other metals smelters) and leaded aviation fuel are the primary sources of lead emissions.

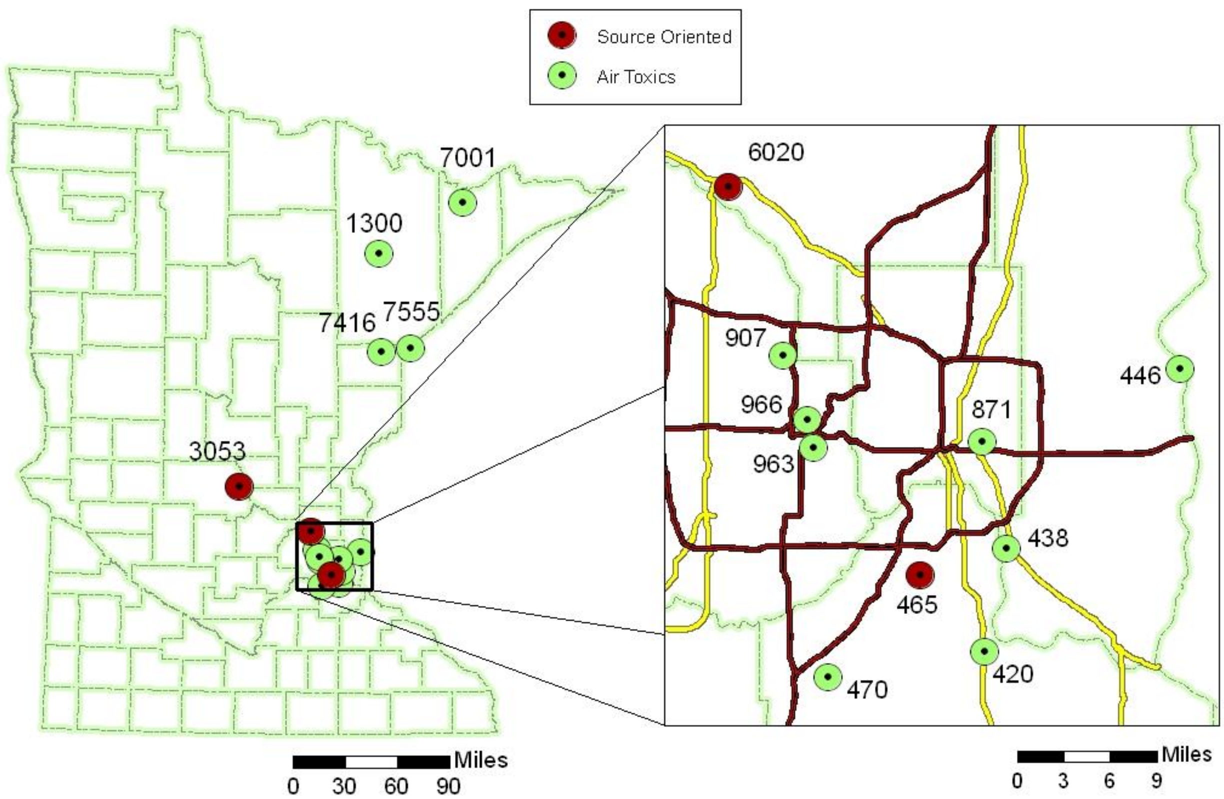
Lead emitted into the air can be inhaled directly or ingested after it settles onto surfaces or soils. Scientific evidence about the health effects of lead has expanded significantly in the last 30 years. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory, and behavior. There is no known safe level of lead in the body.

Elevated lead levels are also detrimental to animals and to the environment. Ecosystems near sources of lead show many adverse effects including losses in biodiversity, changes in community composition, decreased growth and reproductive rates in plants and animals, and neurological effects in animals.

As part of the 2008 NAAQS revision for lead, the EPA expanded the existing lead monitoring network by requiring monitoring near sources with lead emissions equal to or greater than 1.0 ton per year (tpy) by January 1, 2010, and in urban areas with more than 500,000 people by January 1, 2011. The MPCA has begun operations of a new source-oriented lead monitoring network, which includes an existing lead site at Gopher Resources in Eagan, and new sites in Anoka and St. Cloud.

The MPCA monitors lead at 15 sites across the state, including the three source-oriented monitoring sites. Lead is also monitored at most sites where TSP is collected as part of the Air Toxics Program metals analysis. Figure 15 shows the locations where lead is monitored in 2010. In 2011, a TSP monitor will be added to Blaine (6010) to fulfill the requirement that lead be monitored at all NCore sites.

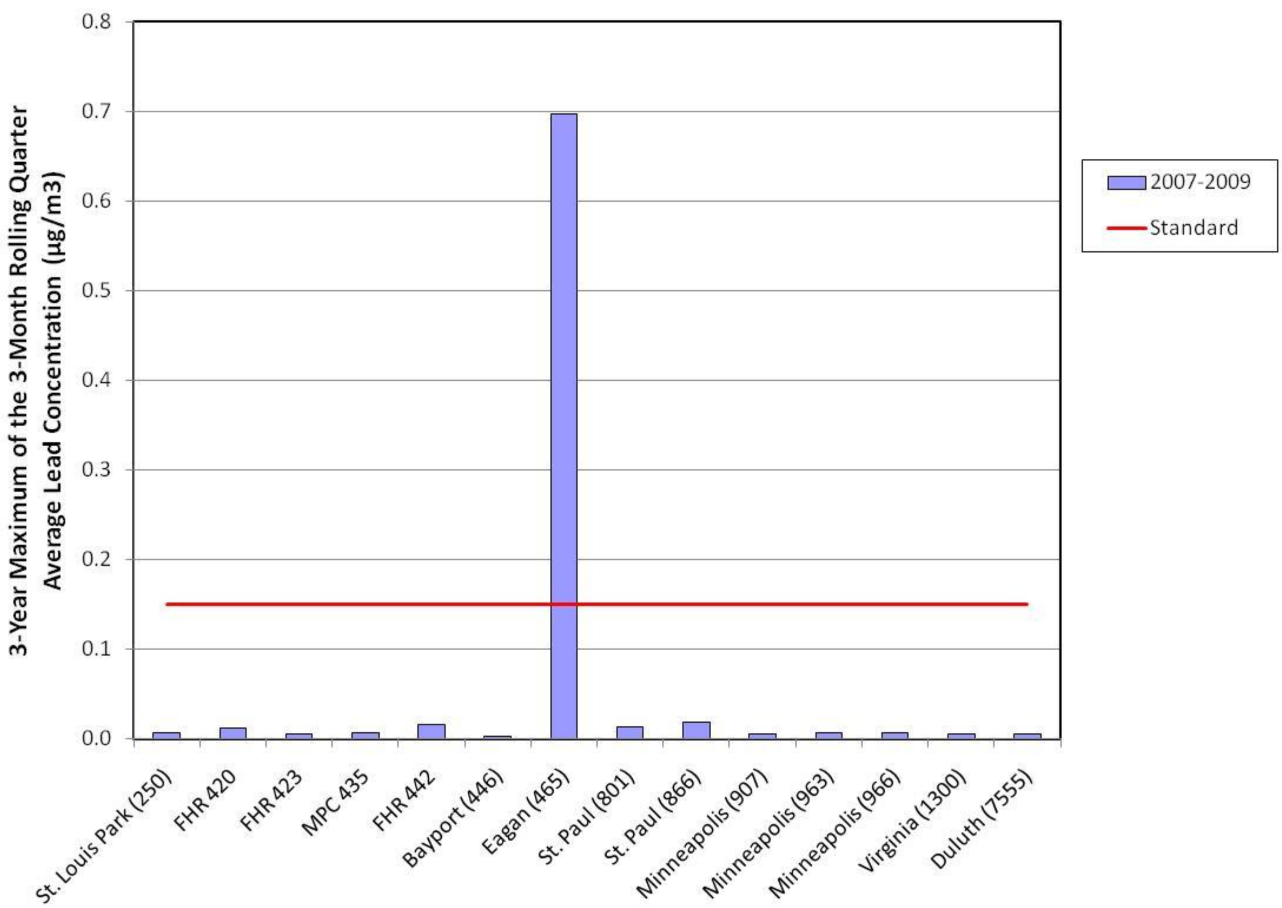
Figure 15: Lead monitoring sites in Minnesota



Due to the coverage of the lead network associated with the Air Toxics Program, the MPCA did not anticipate siting any additional monitors as a result of the population oriented lead monitoring requirement. However, on December 23, 2009, the EPA announced proposed revisions to the ambient monitoring requirements for lead. If finalized, these proposed revisions will replace the population based monitoring requirement with a requirement that lead monitors be placed at all National Core (NCore) monitoring sites by January 1, 2011. Additionally, the proposed revision lowers the emissions threshold for required source-oriented lead monitoring from 1.0 tpy to 0.50 tpy. The EPA took comment on these proposed revisions in early 2010 and a final rule is expected this fall.

With the exception of the site located near Gopher Resource Corporation in Eagan (446), all existing lead monitoring sites in Minnesota meet the 2008 lead NAAQS of 0.15 µg/m^3. Figure 16 shows the 3-year maximum rolling quarter average concentration at monitored sites from 2007-2009. Minnesota values range from 0.70 µg/m^3 in Eagan (465) to 0.003 µg/m^3 in Bayport (446), with the majority of sites below 0.01 µg/m^3.

Figure 16: Lead concentrations compared to the NAAQS



Ozone (O_3)

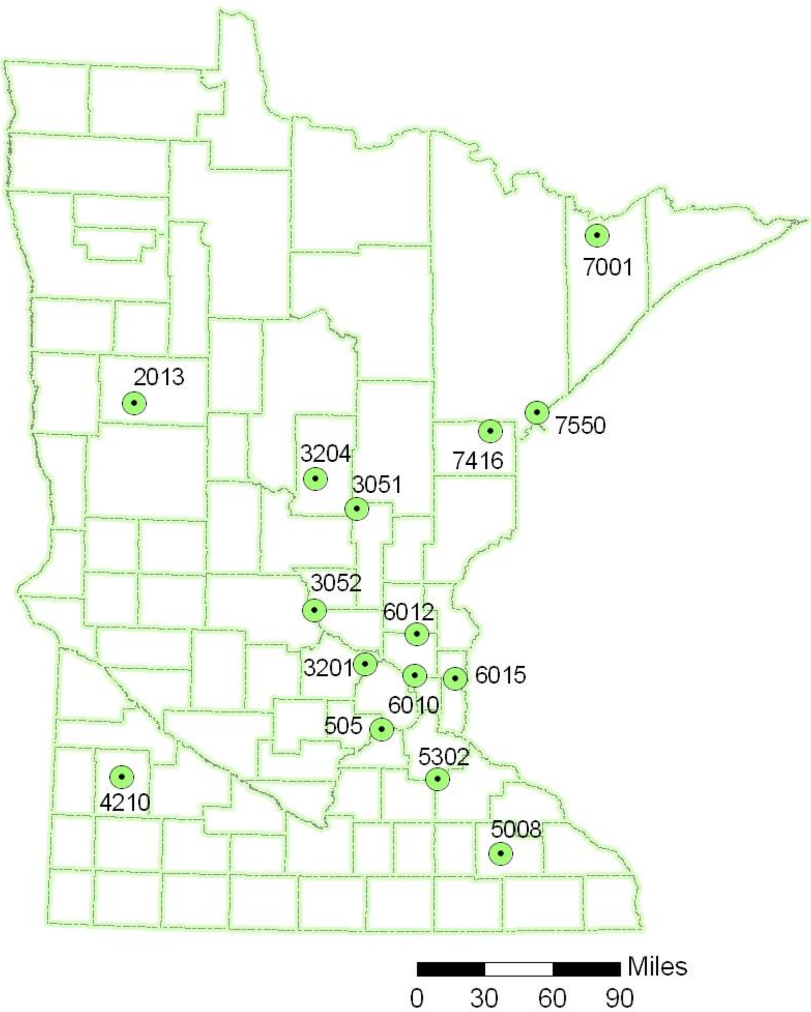
Ozone is an odorless, colorless gas composed of three atoms of oxygen. Ground-level ozone is not emitted directly into the air, but is created through a reaction of nitrogen oxides and volatile organic compounds in the presence of sunlight.

Breathing air containing ozone can reduce lung function and inflame airways, which can increase respiratory symptoms and aggravate asthma or other lung diseases. Ozone exposure has also been associated with increased susceptibility to respiratory infections, medication use, doctor and emergency department visits and hospital admissions for individuals with lung disease. Ozone exposure also increases the risk of premature death from heart and lung disease. Children are at increased risk from ozone because their lungs are still developing and they are more likely to have increased exposure since they are often active outdoors.

In addition, cumulative ozone exposure can lead to reduced tree growth; visibly injured leaves and increased susceptibility to disease, damage from insects and harsh weather. These effects can have adverse impacts on ecosystems, including loss of species and changes to habitat quality, and water and nutrient cycles.

Ozone is monitored on a continuous basis at 15 monitoring sites and is reported in hourly increments. Because ozone formation requires high temperatures and sunny conditions, the EPA only requires Minnesota to monitor for ozone from April 1 – September 30 each year. The majority of ozone sites in Minnesota follow this monitoring season; however ozone is measured year round at the NCore site in Blaine. The data collected from these ozone monitors are used to determine compliance with the NAAQS and are reported as part of the AQI. Figure 17 shows the locations of the ozone sites in Minnesota.

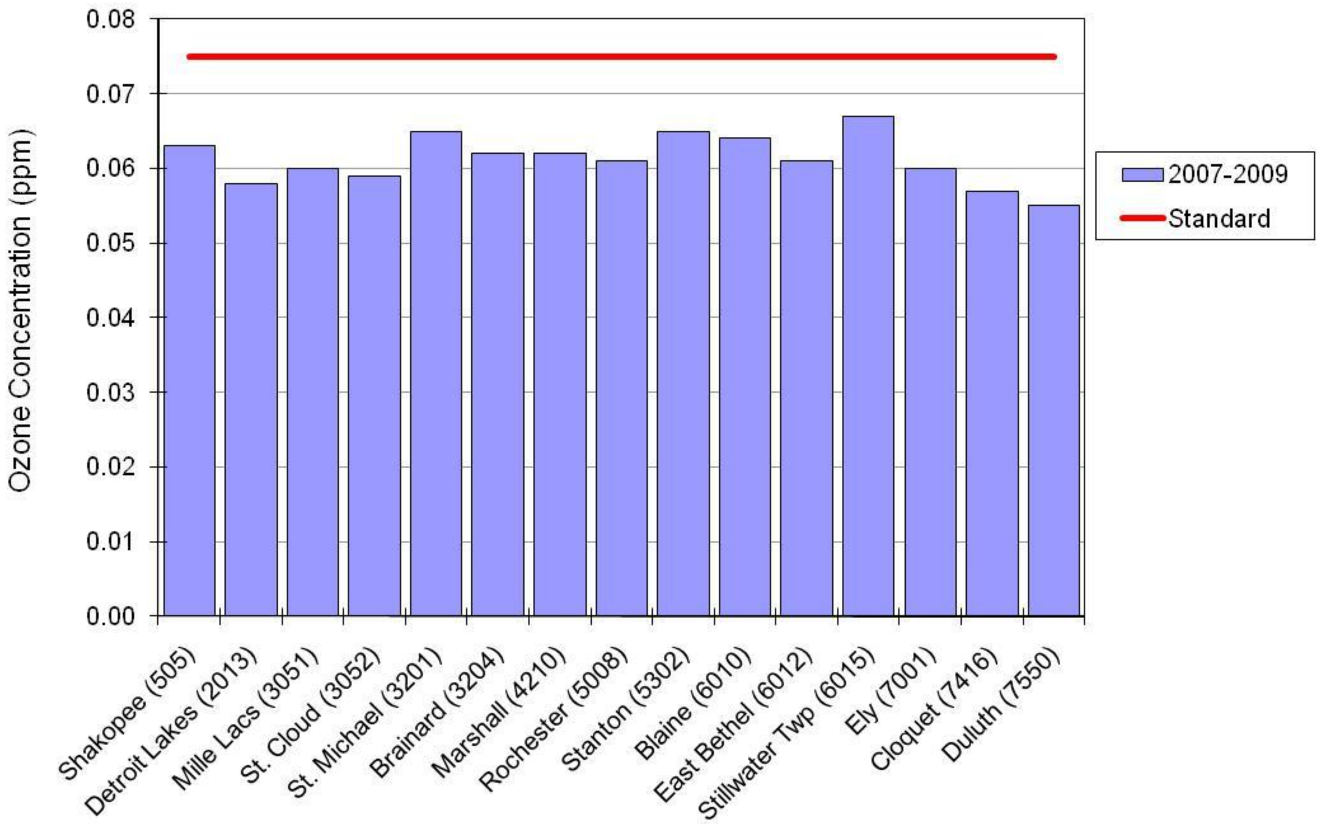
Figure 17: Ozone monitoring sites in Minnesota



In 2011, MPCA will look for opportunities to deploy a monitor in the St. Paul or Minneapolis downtown corridors; however, no resources are available at this time. EPA is currently reviewing the ozone NAAQS, with a final reconsideration expected in August 2010. Changes to Minnesota's ozone network will be dependent upon the new NAAQS and the results of the Network Assessment being completed by LADCO in coordination with the MPCA and the other EPA Region V States.

A monitoring site meets the primary ozone NAAQS if the three year average of the fourth highest daily maximum 8-hour concentration is less than or equal to 0.075 ppm. Figure 18 shows the 2007 through 2009 8-hour averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 0.055 ppm in Duluth (7550) to 0.067 ppm in Stillwater (6015); therefore, all sites were below the 8-hour standard.

Figure 18: 8-hour average ozone concentrations compared to the NAAQS



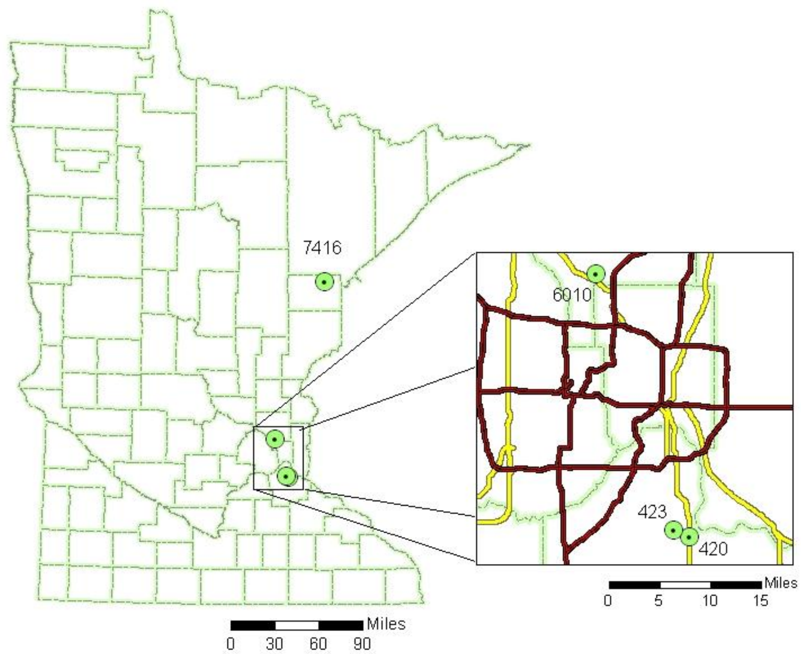
Oxides of Nitrogen (NO_X)

NO_X is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. The two primary components are nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is the regulated pollutant; it can often be seen as a reddish-brown layer in urban areas.

NO_x contribute to a wide range of health and environmental effects. NO_2 itself can irritate the lungs and lower resistance to respiratory infections. More importantly, nitrogen oxides react to form ground–level ozone, $PM_{2.5}$, acid rain and other toxic chemicals. They also can lead to visibility and water quality impairment due to increased nitrogen loading in water bodies. In addition, nitrous oxide, another component of NO_x, is a greenhouse gas that contributes to climate change.

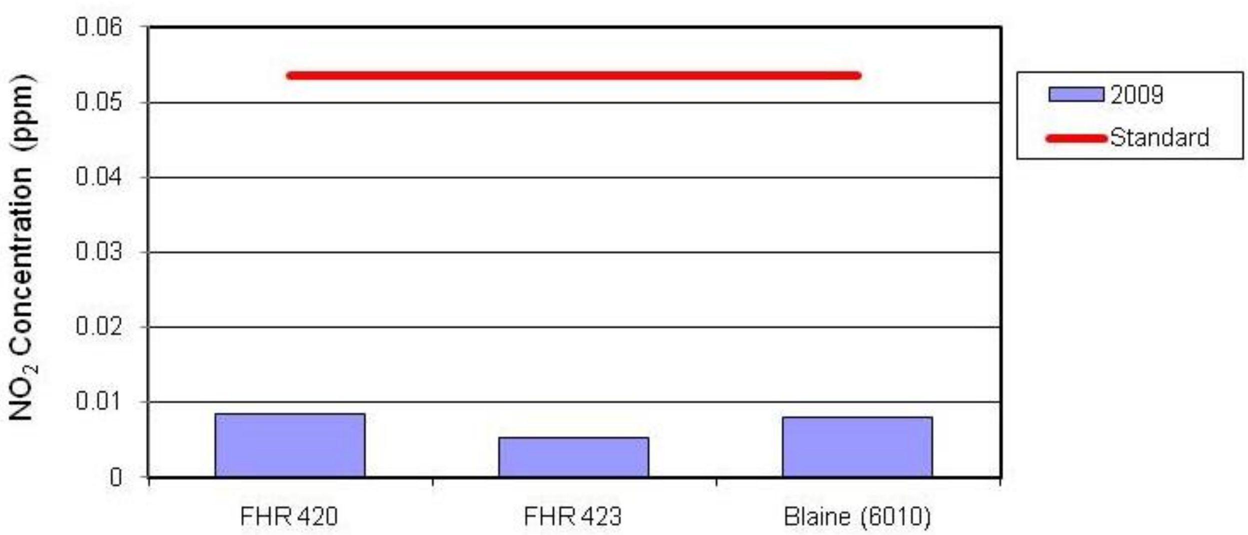
Currently, the MPCA monitors NO_2 and NO at three sites in the Twin Cities metropolitan area; it also supports monitoring at the Cloquet tribal monitoring site (7416) which is run by the Fond du Lac Band of Chippewa. Figure 19 shows the NO_X monitoring sites in Minnesota. Trace level NO/NO_y was added to the NCore site in Blaine (6010) in 2009. This trace level data will help us understand the role of these pollutants at levels far below the NAAQS.

Figure 19: NO_X monitoring sites in Minnesota



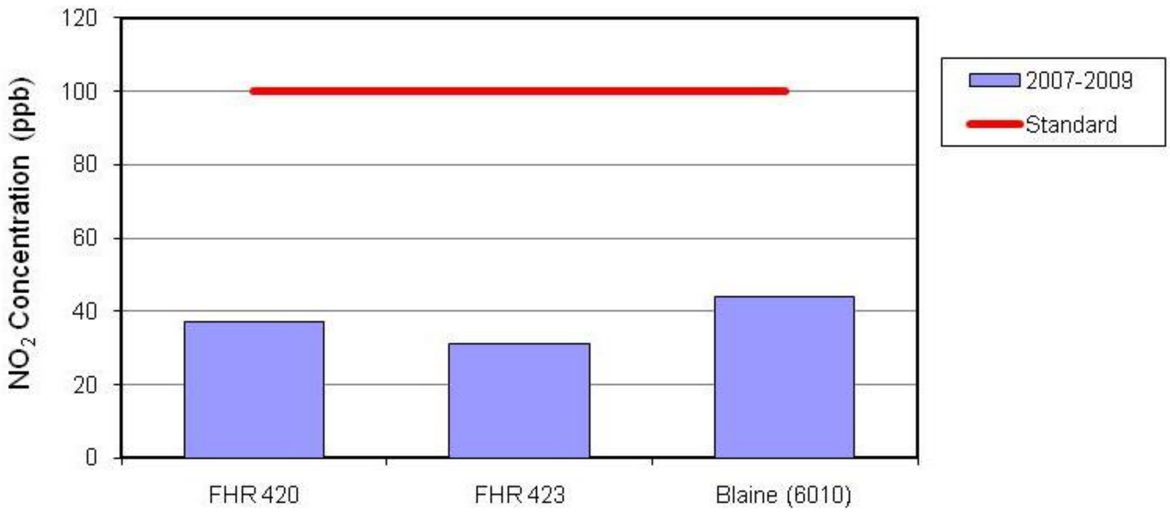
A monitoring site meets the NAAQS for NO_2 if the annual average is less than or equal to 0.053 ppm. Figure 20 shows the 2009 averages at Minnesota sites and compares them to the standard. Minnesota averages ranged from 0.005 ppm at FHR 423 to 0.009 ppm at FHR 420; therefore, Minnesota currently meets the annual NAAQS for NO_2.

Figure 20: Annual average NO_2 concentrations compared to the NAAQS



On January 22, 2010 the EPA finalized revisions to the NO_2 NAAQS. As part of the standard review process, the EPA retained the existing annual NO_2 NAAQS, but also created a new 1-hour standard. This new 1-hour NAAQS will protect against adverse health effects associated with short term exposures to elevated NO_2. To meet this standard, the three-year average of the annual 98^{th} percentile daily maximum 1-hour NO_2 concentration must not exceed 100 ppb. Figure 21 shows the 2007-2009 average of the annual 98^{th} percentile daily maximum 1-hour NO_2 concentrations at Minnesota sites and compares them to the 1-hour standard. Minnesota averages ranged from 31 ppb at FHR 423 to 44 ppb at Blaine (6010); therefore, all Minnesota sites currently meet the1-hour NAAQS for NO_2.

Figure 21: 1-hour NO_2 concentrations compared to the NAAQS



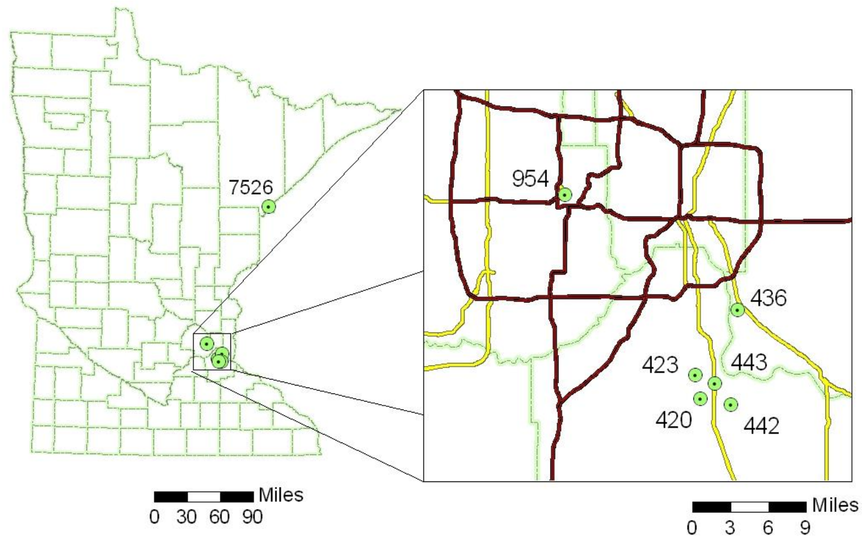
To ensure areas are meeting the new 1-hour standard, the EPA has also finalized changes to the ambient monitoring requirements for NO_2. By January 1, 2013, urban areas with a population greater than or equal to 500,000 will be required to monitor for NO_2 within 50 meters of a heavily trafficked roadway. A second monitor is required near another major road in areas with either a population greater than or equal to 2.5 million people, or one or more road segments with an annual average daily traffic (AADT) count greater than or equal to 250,000 vehicles. In Minnesota, the Minneapolis-St. Paul Core Based Statistical Area (CBSA), with a 2009 population estimate of 3,269,814 people, requires two near roadway NO_2 monitors. The MPCA is beginning to identify areas for these new near road monitoring sites, and additional information on these sites will be available in the 2012 and 2013 Air Monitoring Network Plans. No changes are planned for the NO_X network in 2011.

Sulfur Dioxide (SO_2)

SO_2 belongs to the family of sulfur oxide gases. SO_2 reacts with other chemicals in the air to form sulfate particles. Exposures to SO_2, sulfate aerosols, and fine particles contribute to respiratory illness, and aggravate existing heart and lung diseases. High levels of SO_2 emitted over a short period, such as a day, can be particularly problematic for people with asthma. SO_2 also contributes to the formation of $PM_{2.5}$, visibility impairment and acid rain. SO_2 is monitored on a continuous basis and reported in hourly increments. Data are used to determine compliance with the NAAQS and is reported as part of the AQI. Minnesota currently meets all applicable NAAQS for SO_2; however, continued reductions are sought due to its role in forming fine particles

The MPCA monitors SO_2 at the seven sites in Minnesota shown in Figure 22. Trace level SO_2 was added to the NCore site in Blaine (6010) in 2009. This trace level data will help us understand the role of SO_2 at levels far below the NAAQS. An additional monitor was added to site 7526 in Duluth in 2010 for a one year assessment. This assessment will end in 2011 so the site will close pending a review of the data.

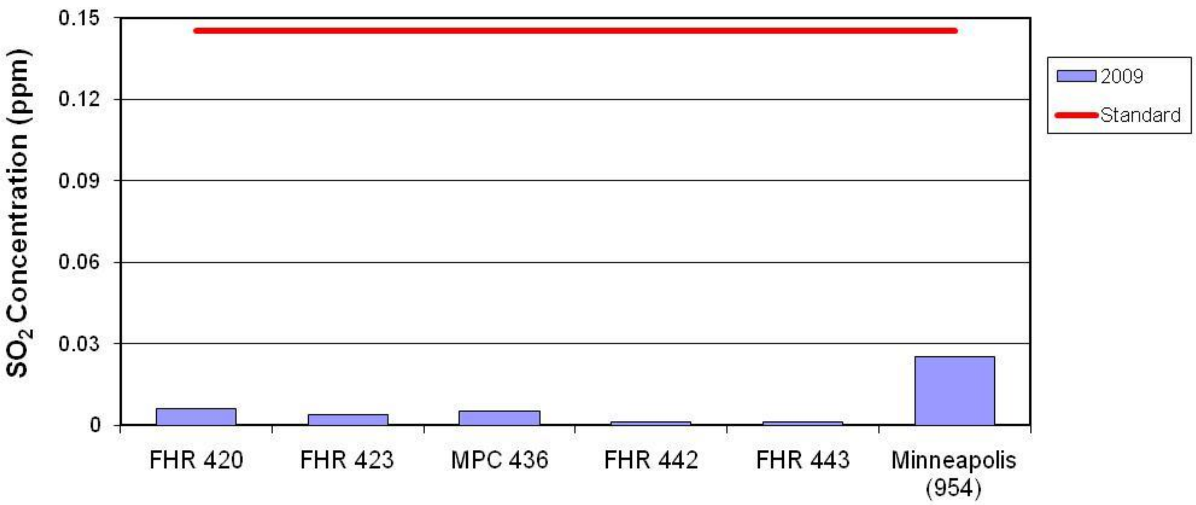
Figure 22: SO_2 monitoring sites in Minnesota



A monitoring site meets the primary annual standard for SO_2 if the annual average is less than or equal to 0.03 ppm. The highest annual average SO_2 concentration at all Minnesota sites is less than 0.002 ppm. A secondary NAAQS (which protects public welfare such as visibility, buildings, and vegetation) is met if a three hour average level of 0.5 ppm is not exceeded more than once per year. The second highest three hour average SO_2 level at all Minnesota sites was less than 0.043 ppm in 2009.

A monitoring site meets the primary 24-hour SO_2 NAAQS when the level of 0.14 ppm is not exceeded more than once per year. Figure 23 shows the second highest daily maximum SO_2 concentrations at Minnesota sites in 2009 and compares them to the standard. Minnesota values range from 0.001 ppm at FHR 443 to 0.013 ppm in Minneapolis (954).

Figure 23: 24-hour SO_2 concentrations compared to the NAAQS



Carbon Monoxide (CO)

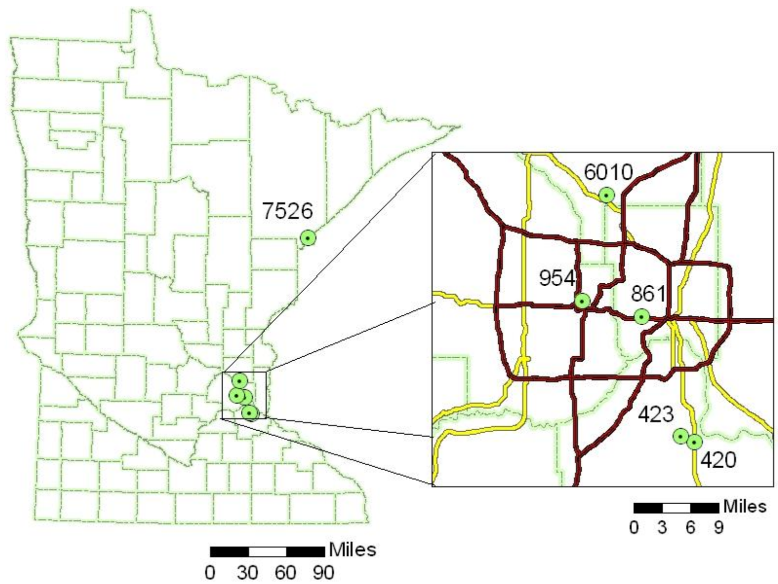
CO is a colorless and odorless toxic gas formed when carbon in fuels is not burned completely. CO enters the bloodstream and reduces the delivery of oxygen to the body's organs and tissues. Exposure to elevated CO concentrations is associated with vision problems, reduced ability to work or learn reduced manual dexterity, and difficulty performing complex tasks. Prolonged exposure to high levels can lead to death. Carbon monoxide is also oxidized to form carbon dioxide (CO_2) which contributes to climate change and the formation of ground-level ozone.

CO is monitored on a continuous basis and reported in hourly increments. Data are used to determine compliance with the NAAQS and reported as part of the AQI.

The MPCA monitors for CO at six sites in Minnesota. Figure 24 shows the locations of those sites. Trace level CO was added to the NCore site in Blaine (6010) in 2008. This trace level data will help us understand the role of CO at levels far below the NAAQS. In response to budget constraints the MPCA proposes to close the CO site in Duluth (7526) in 2011, pending EPA approval.

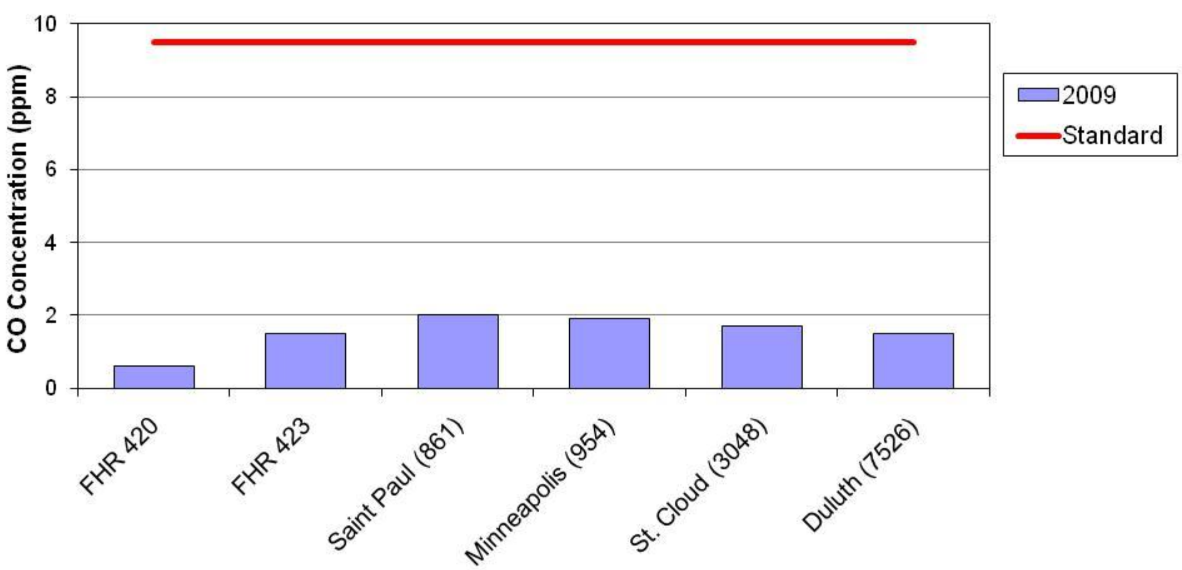
Minnesota currently meets applicable NAAQS for CO.

Figure 24: CO monitoring sites in Minnesota



A monitoring site meets the 8-hour CO NAAQS when the level of 9 ppm is not exceeded more than once per year. Figure 25 shows the second highest 8-hour average at Minnesota sites in 2009 and compares them to the standard. Minnesota values range from 0.6 ppm at FHR 420 to 2.0 ppm in St. Paul (861). The 1-hour CO NAAQS is met when the level of 35 ppm is not exceeded more than once per year. The second highest 1-hour average CO level at all Minnesota sites was less than 4 ppm in 2009.

Figure 25: 8-hour average CO concentrations compared to the NAAQS



Air toxics

The EPA defines air toxics as those pollutants that cause or may cause cancer or other serious health effects (such as reproductive or birth defects), or adverse environmental and ecological effects. Air toxics include, but are not limited to, the 188 Hazardous Air Pollutants (HAPs) specified in the 1990 Clean Air Act Amendments (see http://www.epa.gov/ttn/atw/orig189.html for a list of HAPs). There are no federal requirements for air toxics monitoring in Minnesota, but the MPCA monitors for a variety of compounds in order to understand the risk to Minnesota citizens and to track reductions in emissions and concentrations of potentially hazardous compounds.

Air toxics do not have standards. Instead, the MPCA uses guidelines called health benchmarks. These benchmarks come from a variety of sources including the Minnesota Department of Health's Health Risk Values (HRVs) found at http://www.health.state.mn.us/divs/eh/risk/guidance/air/table.html, the EPA's Integrated Risk Information System (IRIS) found at http://www.epa.gov/iris/, and California's Office of Health Hazard Assessment found at http://www.oehha.ca.gov/air.html. One of the clean air goals in the MPCA's strategic plan is to meet all environmental and human health benchmarks for toxic air pollutants.

The MPCA monitors three types of air toxics: 56 volatile organic compounds (VOCs), seven carbonyls, and 15 metals. For information on concentrations of and risks from air toxics in Minnesota, visit the MPCA website at http://www.pca.state.mn.us/air/airtoxics.html.

The MPCA monitors VOCs and carbonyls at 18 sites and metals at 15 sites in Minnesota. These sites are primarily located in the Twin Cities metropolitan area, with additional in Duluth (7549), Ely (7001), and Cloquet (7416). Metals are also monitored in Virginia (1300) and St. Cloud (3053). Figure 26 shows the locations of the sites.

Air toxics monitoring has been conducted at Ely (7001) for one year to establish background levels for VOCs, carbonyls, and metals for use in risk assessment and to better understand the sources of air toxics. This site will close once a complete year of data has been collected.

The MPCA also plans to close the Cloquet site in 2011 after one year of monitoring. This monitor will used for another one year assessment at a new tribal site starting in 2011. The goal of this one year rotation is to better understand the concentration of and risk from air toxics in tribal and rural areas of Minnesota.

Volatile Organic Compounds (VOCs) and Carbonyls

VOC and carbonyl samples are collected once every six days over a 24-hour period and analyzed using EPA Compendium Methods TO-15 for VOCs and TO-11A for carbonyls. The resulting concentration is a 24-hour average. The MPCA analyzes samples for 56 VOCs and 7 carbonyls. Table 12 lists the VOCs and table 13 lists the carbonyls monitored by the MPCA.

Metals

Metals are extracted from TSP filters following EPA Compendium Method IO-3.1. They are analyzed using ICAP and following EPA Compendium Method IO-3.4. TSP and metals samples are collected once every six days over a 24-hour period providing a 24-hour average. Table 14 lists the metals analyzed by MPCA.

Figure 26: Air Toxics monitoring sites in Minnesota

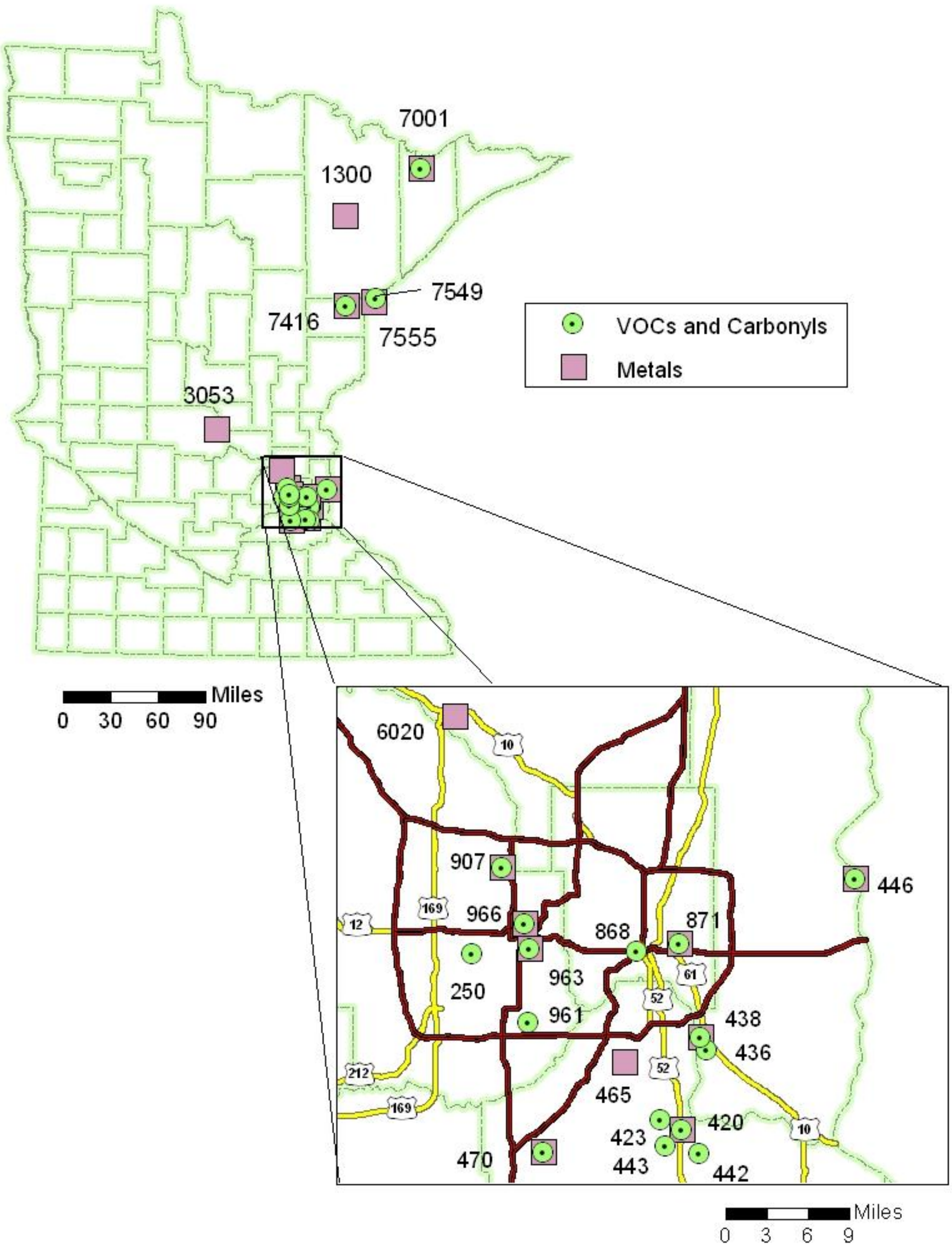


Table 12: VOCs monitored by MPCA in 2010

Parameter	CAS #	EPA Parameter Code
1,1,2,2-tetrachloroethane	79-34-5	43818
1,1,2,3,4,4-Hexachloro-1,3-butadiene	87-68-3	43844
1,1,2-Trichloroethane	79-00-5	43820
1,1-Dichloroethane	75-34-3	43813
1,1-diChloroEthene	75-35-4	43826
1,2,4-Trichlorobenzene	120-82-1	45810
1,2,4-Trimethylbenzene	95-63-6	45208
1,2-Dichloropropane	78-87-5	43829
1,3,5-Trimethylbenzene	108-67-8	45207
1,3-Butadiene	106-99-0	43218
2-Propanol	67-63-0	43312
4-Ethyltoluene	622-96-8	45228
Benzene	71-43-2	45201
Benzyl chloride	100-44-7	45809
Bromodichloromethane	75-27-4	43828
Carbon disulfide	75-15-0	42153
Carbon tetrachloride	56-23-5	43804
Chlorobenzene	108-90-7	45801
Chloroform	67-66-3	43803
cis-1,2-Dichloroethene	156-59-2	43839
cis-1,3-Dichloropropene	10061-01-5	43831
Cyclohexane	110-82-7	43248
Dibromochloromethane	124-48-1	43832
Dichlorobenzene (m)	541-73-1	45806
Dichlorobenzene (o)	95-50-1	45805
Dichlorobenzene (p)	106-46-7	45807
Dichlorodifluoromethane (Freon 12)	75-71-8	43823
Dichloromethane	75-09-2	43802
Dichlorotetrafluoroethane (Freon 114)	76-14-2	43208
Ethyl Chloride	75-00-3	43812
Ethylbenzene	100-41-4	45203
Ethylene chloride	107-06-2	43815
Ethylene dibromide	106-93-4	43843
Heptane	142-82-5	43232
Hexane	110-54-3	43231
Methyl bromide	74-83-9	43819
Methyl butyl ketone	591-78-6	43559
Methyl chloride	74-87-3	43801
Methyl chloroform	71-55-6	43814
Methyl ethyl ketone	78-93-3	43552
Methyl tert-butyl ether	1634-04-4	43372
Propylene	115-07-1	43205
Styrene	100-42-5	45220
Tetrachloroethene	127-18-4	43817
Tetrahydrofuran	109-99-9	46401
Toluene	108-88-3	45202
trans-1,2-Dichloroethene	156-60-5	43838
trans-1,3-Dichloropropene	10061-02-6	43830
Tribromomethane	75-25-2	43806
Trichloroethene	79-01-6	43824
Trichlorofluoromethane (Freon 11)	75-69-4	43811
Trichlorotrifluoroethane	76-13-1	43207
Vinyl acetate	108-05-4	43447
Vinyl chloride	75-01-4	43860
Xylene (m&p)	108-38-3	45109
Xylene (o)	95-47-6	45204

Table 13: Carbonyls monitored by MPCA in 2010

Parameter	CAS #	EPA Parameter Code
Acetaldehyde	75-07-0	43503
Acetone	67-64-1	43551
Benzaldehyde	100-52-7	45501
Butryaldehyde	123-72-8	43510
Crotonaldehyde	4170-30-3	43520
Formaldehyde	50-00-0	43502
Propionaldehyde	123-38-6	43504

Table 14: Metals monitored by MPCA in 2010

Parameter	CAS #	EPA Parameter Code
Aluminum	7429-90-5	12101
Antimony	7440-36-0	12102
Arsenic	7440-38-2	12103
Barium	7440-39-3	12107
Beryllium	7440-41-7	12105
Cadmium	7440-43-9	12110
Chromium	16065-83-1	12112
Cobalt	7440-48-4	12113
Copper	7440-50-8	12114
Iron	15438-31-0	12126
Lead	7439-92-1	12128
Manganese	7439-96-5	12132
Nickel	7440-02-0	12136
Selenium	7782-49-2	12154
Zinc	7440-66-6	12167

Atmospheric deposition

Atmospheric deposition is monitored through the NADP. The NADP has two active sub-networks in Minnesota: the National Trends Network (NTN) and the Mercury Deposition Network (MDN).

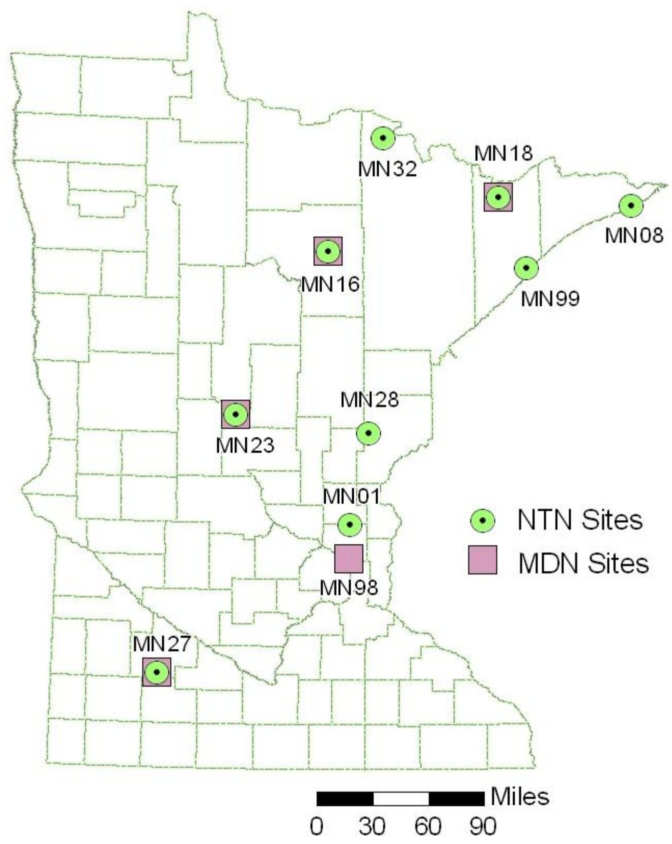
NTN collects weekly precipitation samples for pH, sulfate, nitrate, ammonium, chloride, and base cations (such as calcium and magnesium). NTN provides long-term, high-quality data for determining spatial and temporal trends in the chemical composition of precipitation. MDN collects weekly precipitation samples for analysis of total mercury and methylmercury concentrations. It supports a regional database of the weekly concentrations of mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition.

Acid deposition

Acid deposition, or acid rain, is monitored as part of the NTN. Acid deposition begins with the burning of fossil fuels (such as coal, gas, or oil) for energy. The resulting air pollution contains SO_2 and NO_X. These gases react in the atmosphere to form various acidic compounds. These compounds may be deposited on the Earth by dry deposition, a process where acidic particles or gases settle on, or are absorbed by, plants, land, water, or building materials. The acidic compounds may also be deposited through rain, snow, and cloud water. These pathways are known as wet deposition.

The MPCA sponsors several sites that are part of the rain NADP (http://nadp.sws.uiuc.edu/) to monitor acid rain and mercury. The purpose of the network is to collect data on the chemistry of precipitation for monitoring of geographical and long-term trends. The precipitation at each station is collected weekly. It is then sent to a national contract laboratory where it is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and cations (such as calcium, magnesium, potassium, and sodium). Minnesota has nine monitoring sites for wet deposition. These sites are highlighted in Figure 28.

Figure 28: Atmospheric deposition sites



Mercury (Hg) deposition

Mercury contamination of fish is a well documented problem in Minnesota. Because of wide-spread mercury contamination, the Minnesota Department of Health (MDH) advises people to restrict their consumption of large sport fish from all lakes and rivers. More than 95 percent of the mercury in Minnesota surface water comes from the atmosphere. In 2007, the EPA accepted Minnesota's mercury Total Maximum Daily Load (TMDL) plan that concludes that atmospheric mercury deposition must be reduced by 76 percent to achieve compliance with aquatic mercury standards.

Mercury is monitored in wet deposition in Minnesota as part of the NADP through the Mercury Deposition Network (MDN), which began in 1996 and now consists of over 85 sites. The MDN website can be found at http://nadp.sws.uiuc.edu/mdn/. The MDN collects weekly samples of precipitation, which are analyzed for total mercury. The objective of the MDN is to provide a nationally consistent survey of mercury in precipitation so that atmospheric loading to surface water can be quantified and long-term changes can be detected.

Minnesota was on the leading edge of mercury monitoring, establishing four sites as part of the MDN network in 1996, which are still operating. They include Marcell (MN16), Fernberg Road (MN18), Camp Ripley (MN23), and Lamberton (MN27). A site at Mille Lacs (MN22) operated from April 2002 to April 2007. A new urban site opened in Blaine (MN98) in February 2008. Figure 27 shows the locations of these sites.

In addition to quantifying total mercury, the MPCA also cooperates with the MDN network to measure methylmercury in four-week composites of the precipitation samples. Only a minority of the sites participate in the methylmercury analysis.

The MPCA also cooperates with the states of Michigan and Wisconsin to share the use of a trailer equipped with atmospheric mercury monitoring equipment. The equipment includes two Tekran 2537 mercury vapor analyzers, a generator, and a meteorological tower that can record wind speed and direction. The trailer is used to identify local sources of mercury vapor.

Hydrogen Sulfide (H_2S)

H_2S is a flammable, colorless gas that smells like rotten eggs even at low levels. It occurs naturally in sources such as crude petroleum and natural gas. It also results from bacterial breakdown of organic matter and is produced by human and animal wastes. Industrial activities such as food processing, coke ovens, kraft paper mills, petroleum refineries, and confined animal feed lots also emit H_2S.

Exposure to low concentrations of H_2S may cause irritation to the eyes, nose, and throat. It may also cause difficulty in breathing for some asthmatics.

Minnesota's state standard for H_2S is a 30-minute average of 30 ppb not to be exceeded more than twice in five days, or a 30-minute average of 50 ppb not to be exceeded more than twice per year. H_2S is primarily a concern in the summer, when biological activity is at a peak. Each summer, MPCA monitors several confined animal feedlots based on complaints due to odor and health effects from H_2S created from animal waste. H_2S can also be a concern from beet sugar facilities, as wastewater lagoons may release H_2S. Therefore, in addition to confined animal feedlot monitoring, the MPCA oversees industrial monitoring at the Southern Minnesota Beet Sugar Cooperative processing plant in Renville, and the American Crystal Sugar processing plants in Moorhead, Crookston, and East Grand Forks.

Total Reduced Sulfur (TRS)

TRS consists of the total sulfur from various compounds, including hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide. Sulfur dioxide is not included. Since the majority of TRS is H_2S and the other components are considered to be less toxic than H_2S, TRS can be used as a conservative measure and compared to the H_2S standard. No standard for TRS is available. The MPCA measures TRS at sites 420, 423, and 443 near the Flint Hills Refinery in Rosemount and at site 436 near the Marathon Petroleum Company Refinery in St. Paul Park. Boise Cascade paper mill in International Falls also monitors TRS near its facility as a requirement of their operating permit. In 2011, the Flint Hills Refinery network will be reduced to two sites.

Meteorological data

Air pollution concentrations are strongly influenced by atmospheric conditions. Meteorological data can be an important tool for understanding and interpreting concentration data. The MPCA collects hourly wind speed, and wind direction data at sites 420 and 423 in Rosemount near the Flint Hills Resources refinery, at the NCore site in Blaine (6010), and at most H_2S monitoring sites. In Blaine, temperature, relative humidity, and barometric pressure are also measured.

Special studies

Asbestos

As part of a U.S. District Court ordered compliance determination for North Shore Mining Company, Silver Bay Facility, asbestos must be monitored in Silver Bay and in a control city in which taconite ore is not processed. The court order further states that the average ambient asbestos fiber levels in Silver Bay are not to exceed the average ambient asbestos fiber levels in the control city

The MPCA chose the city of St. Paul as a control city and is presently monitoring asbestos fibers in air at the Ramsey Health Center (868). The asbestos fiber levels in Silver Bay are being monitored by the North Shore Mining Company. The MDH is responsible for the analysis of all asbestos samples collected by both parties.

Figure 28 shows the locations of the asbestos monitors in Minnesota.

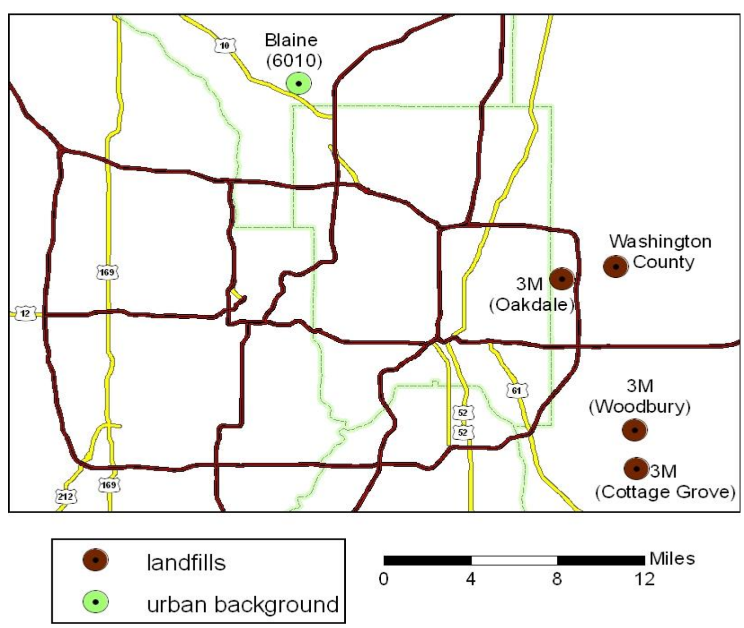
Figure 28: Asbestos sites in Minnesota

Perfluorochemicals (PFCs)

PFCs are a family of manmade chemicals that are used to make products such as nonstick cookware and stain-resistant carpets and fabrics. They are also used as components of fire-fighting foam and in other industrial applications. Some of the chemicals in the PFC group are perfluorooctane sulfonate (PFOS; $C_8F_{17}SO_3$), perfluorooctanoic acid (PFOA; $C_8F_{15}O_2H$), and perfluorobutanoic acid (PFBA; $C_4F_7O_2H$). The chemical structures of PFCs make them extremely resistant to breakdown in the environment.

While the human health effects of PFCs are not well understood, studies show that nearly all people have some PFCs in their blood. The MPCA, in conjunction with other groups and agencies such as the MDH, is working to better understand the concentrations of PFCs found in Minnesota and how the through chemicals move the environment. Some experts suggest that long PFCs in air can travel distances, deposit on soil, and leach into ground water. In May 2009, the MPCA began a special study to characterize the level of PFCs in the ambient air near Twin Cities metropolitan area landfills undergoing PFC cleanup activities and at an urban background location. Presently, the MPCA is monitoring PFCs at three locations in the metropolitan area including: the NCore site in Blaine (urban background), the Washington County Landfill in Lake Elmo, and at 3M Cottage Grove. During the summer of 2009, the MPCA also monitored for PFCs at a 3M landfill in Woodbury, and may return to that location in 2010. The MPCA will also conduct monitoring at a 3M landfill in Oakdale once cleanup activities begin. The locations of these sites are highlighted in figure 29.

Figure 29: PFC monitoring sites in the Twin Cities metro



Visibility

Air pollution that reduces visibility is called haze. Haze is caused when sunlight encounters fine particles in the air which absorb and scatter light. This haze can affect visibility in some of the most pristine and remote parts of Minnesota. In 1999, EPA issued new rules to implement the national goal in the Clean Air Act to prevent any future and remedy any ongoing impairment of visibility in Class I areas. The requirements of the Regional Haze rules are directed at achieving natural visibility conditions in the Class I areas by 2064. Minnesota has two Class I areas – the BWCAW and Voyageurs National Park.

Visibility is measured through the IMPROVE Aerosol Network (http://vista.cira.colostate.edu/IMPROVE/). As discussed in the $PM_{2.5}$ section of this report, the IMPROVE network measures $PM_{2.5}$ speciation as well as employing transmissometers and nephelometers to measure light extinction and light scattering. Minnesota has an IMPROVE site in each of the two Class I areas (BWCAW and Voyageurs). There are also additional sites in two southern Minnesota state parks, Blue Mounds and Great River Bluffs, to help better understand the regional transport of pollutants that impair visibility.

The MPCA also has a haze camera located in St. Paul which captures the downtown St. Paul skyline. On good visibility days, the downtown Minneapolis skyline is visible. The pictures are updated every 15 minutes and can be viewed at http://www.mwhazecam.net/stpaul.html.

Summary of Proposed Changes

The changes that are proposed for 2011 are intended to improve the effectiveness of the MPCA Air Monitoring Network and to ensure compliance with the EPA National Ambient Air Monitoring Strategy. Table 15 lists the sites which will be affected by proposed changes and details those changes. Following the table, changes are summarized according to parameter network.

Table 15: Proposed Changes

MPCA Site ID	City Name	Site Name	Site Closing	$PM_{2.5}$ FRM	FEM $PM_{2.5}$ Continuous	$PM_{2.5}$ Continuous (non-FEM)	$PM_{2.5}$ Speciation	$PM_{10-2.5}$	PM_{10}	TSP and Metals	Sulfur Dioxide	Carbon Monoxide	VOCs	Carbonyls
871	St. Paul	Harding High School			A	T								
971	Minneapolis	North Second Street							T	T				
3052	Saint Cloud	Talahi School		T	A									
5008	Rochester	Ben Franklin School		T	A	T								
6010	Blaine	Anoka Airport					A	A		A				
7416	Cloquet	Cloquet								T			T	T
7526	Duluth	Torrey Building	X								T	T		
TBD	TBD	Tribal								A			A	A

A = proposed to add
T = proposed to terminate
X = site closing

Particulate Matter

$PM_{2.5}$ FRM

Currently the MPCA is operating 12 $PM_{2.5}$ FRM sites. All sites currently run once every three days except Virginia (1300) which runs once every six days. By January 1, 2011 Virginia will move to a one in three day schedule to be consistent with the rest of the network. Monitoring in St. Paul (871) will move to a daily schedule since this site was within 15% of the NAAQS in 2009

As resources are available, the MPCA will replace FRM samplers with continuous (real-time) monitors that the EPA has approved to also be comparable to the NAAQS. These monitors will capture more data and improve the efficiency of $PM_{2.5}$ network operations in 2011. The first FRM monitors that will be replaced are in St. Cloud (3052) and Rochester (5008).

Continuous $PM_{2.5}$

The MPCA currently operates 13 continuous $PM_{2.5}$ sites in Minnesota. As resources are available, the MPCA proposes to upgrade several existing continuous $PM_{2.5}$ monitors to a version that the EPA has certified as a Federal Equivalent Method (FEM).

Ideally, the MPCA would like to upgrade its entire inventory of non-FEM monitors, but given budget constraints will begin by upgrading six monitors in 2010. As the upgrades are completed, the MPCA will prioritize sites for deployment starting with Harding (871), Rochester (5008), and St. Cloud (3052). Long-term, the MPCA intends to use continuous $PM_{2.5}$ FEM monitors across the entire network and minimize, to the extent possible, the use of $PM_{2.5}$ FRM monitors.

$PM_{2.5}$ Speciation

Currently, six monitors measure $PM_{2.5}$ chemical speciation in Minnesota. In 2011 a CSN speciation monitor will be added to the NCore site in Blaine (6010).

Coarse Particulate Matter ($PM_{10-2.5}$)

The MPCA will deploy a $PM_{10-2.5}$ monitor to the NCore site in Blaine by January 1, 2011 to fulfill NCore requirements.

PM_{10}

The MPCA currently operates five PM_{10} Federal Reference Method (FRM) monitors. The PM_{10} monitor at Minneapolis (971) will shut down at the end of 2010 if none of the samples exceed the NAAQS during 2010.

The long-term goal is to use continuous PM_{10} FEM monitors across the entire network and eliminate, to the extent possible, the use of the filter based PM_{10} FRM monitors. Continuous monitors capture more data and reduce operational costs associated with weighing, deploying, and recovering filters from the network.

Total suspended particulate matter (TSP)

The MPCA currently operates 17 TSP monitoring sites. In 2011 a TSP monitor will be added to Blaine (6010) to fulfill the requirement that lead be monitored at all NCore sites. The TSP monitor at Minneapolis (971) will shut down at the end of 2010 if none of the samples exceed the NAAQS during 2010.

The MPCA also plans to close the Cloquet site in 2011 after one year of monitoring. This monitor will be used for another one year assessment at a new tribal site starting in 2011. The goal of this one year rotation is to better understand the concentration of and risk from air toxics in tribal and rural areas of Minnesota.

Lead (Pb)

The MPCA monitors lead at 15 locations across the state, including the three source-oriented monitoring sites. Lead is monitored at most sites where TSP is collected as part of the Air Toxics Program metals analysis. In 2011, a TSP monitor will be added to Blaine (6010) to fulfill the requirement that lead be monitored at all NCore sites.

Ozone (O_3)

Ozone is monitored on a continuous basis at 15 monitoring sites and is reported in hourly increments. In 2011, MPCA will look for opportunities to deploy a monitor in the St. Paul or Minneapolis downtown corridors; however, no resources are available at this time. EPA is currently reviewing the ozone NAAQS, with a final reconsideration expected in August 2010. Changes to Minnesota's ozone network will be dependent upon the new NAAQS and the results of the Network Assessment being completed by LADCO in coordination with the MPCA and the other EPA Region V States.

Oxides of Nitrogen (NO_X)

Currently, the MPCA monitors NO_2 and NO at three sites in the Twin Cities metropolitan area; it also supports monitoring at the Cloquet tribal monitoring site (7416) which is run by the Fond du Lac Band of Chippewa.

By January 1, 2013, urban areas with a population greater than or equal to 500,000 will be required to monitor for NO_2 within 50 meters of a heavily trafficked roadway. A second monitor is required near another major road in areas with either a population greater than or equal to 2.5 million people, or one or more road segments with an annual average daily traffic (AADT) count greater than or equal to 250,000 vehicles. In Minnesota, the Minneapolis-St. Paul Core Based Statistical Area (CBSA), with a 2009 population estimate of 3,269,814 people, requires 2 near roadway NO_2 monitors. The MPCA is beginning to identify areas for these new near road monitoring sites, and additional information on these sites will be available in the 2012 and 2013 Air Monitoring Network Plans. No changes are planned for the NO_X network in 2011.

Sulfur Dioxide (SO_2)

The MPCA monitors SO_2 at seven sites in Minnesota. A monitor was added to site 7526 in Duluth in 2010 for a one year assessment. This assessment will end in 2011 so the site will close pending a review of the data.

Carbon Monoxide

The MPCA monitors for CO at six sites in Minnesota. In response to budget constraints the MPCA proposes to close the CO site in Duluth (7526) in 2011, pending EPA approval.

Air Toxics

The MPCA monitors VOCs and carbonyls at 18 sites and metals at 15 sites in Minnesota. In 2011, a TSP monitor will be added to Blaine (6010) to fulfill the requirement that lead be monitored at all NCore sites. In addition, the TSP monitor that is currently in Duluth at site 7555 may move to site 7526 so metals are collocated with the VOC and carbonyl monitors.

Air toxics monitoring has been conducted at Ely (7001) for one year to establish background levels for VOCs, carbonyls, and metals for use in risk assessment and to better understand the sources of air toxics. This site will close once a complete year of data has been collected.

The MPCA also plans to close the Cloquet site in 2011 after one year of monitoring. These monitors will used for another one year assessment at a new tribal site starting in 2011. The goal of this one year rotation is to better understand the concentration of and risk from air toxics in tribal and rural areas of Minnesota.

Atmospheric Deposition

Acid Deposition

Acid deposition is currently monitored at nine sites in Minnesota through the NTN. No changes are planned for 2011.

Mercury Deposition

Mercury deposition is currently monitored at five sites in Minnesota through the MDN. No changes are planned for 2011.

Hydrogen Sulfide (H_2S)

Each summer MPCA monitors three to four confined animal feedlots based on complaints due to odor and health effects from H_2S created from animal waste. The MPCA also oversees industrial monitoring of H_2S at the Southern Minnesota Beet Sugar Cooperative processing plant in Renville, and the American Crystal Sugar processing plants in Moorhead, Crookston, and East Grand Forks. Monitoring will not change in 2011.

Total Reduced Sulfur (TRS)

The MPCA measures TRS at three sites near the Flint Hills Refinery in Rosemount and at one site near the Marathon Petroleum Company Refinery in St. Paul Park. Boise Cascade paper mill in International Falls also monitors TRS near its facility as a requirement of their operating permit. In 2011, the Flint Hills Refinery network will be reduced to two sites.

Meteorological data

The MPCA collects hourly meteorological data at sites 420 and 423 in Rosemount near the Flint Hills Resources refinery, at the NCore site in Blaine (6010), and at most H_2S monitoring sites. No changes are planned for 2011.

Special studies

Asbestos

The MPCA is currently working in cooperation with the MDH to measure asbestos at two sites. No changes are expected in 2011.

Perfluorochemicals (PFCs)

Presently, the MPCA is monitoring for PFCs at three locations in the Twin Cities metropolitan area. The MPCA will conduct monitoring at a 3M landfill in Oakdale once cleanup activities begin and may return to a 3M landfill in Woodbury in 2010.

Visibility

Visibility is measured through the IMPROVE Aerosol Network (http://vista.cira.colostate.edu/IMPROVE/).

The MPCA also has a haze camera located in St. Paul which captures the downtown St. Paul skyline. The pictures are updated every 15 minutes and can be viewed at http://www.mwhazecam.net/stpaul.html.

No changes are expected with respect to visibility monitoring in 2011.

Summary of the Public Comment Period

This report is available for public comment from May 19, 2010 through June 18, 2010. Two comment letters were received. The following is a summary of the issues addressed in those comments and the response from the Air Monitoring Unit at the MPCA:

COMMENT: The City of Cottage Grove has asked the MPCA to establish an air toxics monitoring site downwind of the 3M Cottage Grove facility to characterize VOCs, carbonyls and metals.

RESPONSE: This request is currently under consideration. The City will be notified as soon as a decision has been made. The City has also been working with 3M to develop a monitoring program independent of the MPCA.

COMMENT: The Fond du Lac Band of Lake Superior Chippewa would like us to add an elevation above local terrain to the site information tables.

RESPONSE: The MPCA will get the elevation above local terrain for all of the monitors at the Cloquet site (7416) and provide them to the tribe. For all of our sites we currently have an elevation above sea level. For all of our monitors we keep a record of the probe location, such as on top of a building or on the ground level. However, we do not currently have an elevation above local terrain for each monitor.