

Annual Air Monitoring Network Plan for Minnesota

2018



Federal Regulation

40 CFR § 58.10 Annual monitoring network plan and periodic network assessment.

(a)(1) Beginning July 1, 2007, the state, or where applicable local, agency shall submit to the Regional Administrator an annual monitoring network plan which shall provide for the documentation of the establishment and maintenance of an air quality surveillance system that consists of a network of SLAMS monitoring stations that can include FRM, FEM, and ARM monitors that are part of SLAMS, NCore, CSN, PAMS, and SPM stations. The plan shall include a statement of whether the operation of each monitor meets the requirements of appendices A, B, C, D, and E of this part, where applicable. The Regional Administrator may require additional information in support of this statement. The annual monitoring network plan must be made available for public inspection and comment for at least 30 days prior to submission to the EPA and the submitted plan shall include and address, as appropriate, any received comments.

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Acronyms, abbreviations, and definitions

AIRNow – air quality forecasting program

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

CAA – Clean Air Act

CAS – Chemical Abstracts Service

CASTNET – Clean Air Status and Trends Network

CBSA – Core Base Statistical Area

CFR – Code of Federal Regulations

Class I area – remote area with pristine air quality

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 – U.S. Environmental Protection Agency

FEM – Federal Equivalent Method

FRM – Federal Reference Method

GC/MS – Gas Chromatography/Mass Spectrometry

H₂S – hydrogen sulfide

HAP – Hazardous Air Pollutant

Hg – mercury

HPLC – High Pressure Liquid Chromatography

ICAP-AES – Inductively Coupled Plasma Atomic Emission Spectrometry (a technique used for metals analysis)

IMPROVE – Interagency Monitoring of Protected Visual Environments

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

NDDN – National Dry Deposition Network

NO – nitric oxide

NO₂ – nitrogen dioxide

NO_x – oxides of nitrogen

NO_y – total reactive nitrogen

NTN – National Trends Network

O₃ – ozone

PAH – Polycyclic Aromatic Hydrocarbon

PAMS – Photochemical Assessment Monitoring Stations

Pb – lead

PM₄ – particulate matter less than 4 microns in diameter

PM_{2.5} – particulate matter less than 2.5 microns in diameter (fine particulate matter)

PM_{10-2.5} – particulate matter between 2.5 and 10 microns in diameter (coarse particulate matter)

PM₁₀ – particulate matter less than 10 microns in diameter

ppb – parts per billion
ppm – parts per million
PQAO – Primary Quality Assurance Organization
QAPP – Quality Assurance Project Plans
QA/QC – Quality Assurance/Quality Control
QMP – Quality Management Plan
SIP – State Implementation Plan
SLAMS – State and Local Air Monitoring Stations
SO₂ – sulfur dioxide
SPM – special purpose monitoring
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
UFP – ultrafine particles (particulate matter less than 0.1 microns in diameter)
USDA – United States Department of Agriculture
USDOl – United States Department of the Interior
USG – unhealthy for sensitive groups
VOC – Volatile Organic Compound

Introduction

The Minnesota Air Monitoring Network Plan is an annual report required under the Code of Federal Regulations [40 CFR 58 § 58.10(a)(1)]. The purpose of this plan is to provide evidence that the Minnesota Pollution Control Agency (MPCA) air monitoring network meets current federal monitoring requirements, to detail any changes proposed for the 18 months following publication, to provide specific information on each of the MPCA's existing and proposed monitoring sites, and to provide the opportunity for the public to comment on air monitoring activities conducted by the MPCA. The plan also includes information on known industrial monitoring activities and special air monitoring projects occurring in the state.

The Minnesota Pollution Control Agency (MPCA) monitors outdoor air quality throughout Minnesota. 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 monitors criteria pollutants to comply with the CAA.

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.

Network overview

The MPCA monitors ambient air quality at 53 sites throughout Minnesota (Figure 1). This includes monitoring at four tribal sites, three Interagency Monitoring of Protected Visual Environments (IMPROVE) sites, two Chemical Speciation Network (CSN) sites, and nine National Atmospheric Deposition Program (NADP) sites. In addition to these sites, there is a network of industrial air quality monitors that must conform to EPA standards but are owned and operated by the specific industrial facility.

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 to be in 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 IMPROVE site identification numbers, throughout Greater Minnesota (Figure 1 and Table 2) and in the Twin Cities metropolitan area (Figure 2 and Table 3).

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.

Minimum monitoring requirements

The EPA establishes the minimum number of monitoring sites required to meet national ambient monitoring objectives. The minimum monitoring requirements are codified in Appendix D of 40 CFR Part 58. Minimum

monitoring requirements are specific to each individual pollutant (e.g. ozone, PM_{2.5}) or are objective-based monitoring networks (e.g. NCore, PAMs). Minimum monitoring requirements typically rely on population and/or air pollution emissions data. Minnesota currently meets all minimum air monitoring requirements. Appendix B provides a detailed description of these requirements.

Monitoring objectives

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 a monitor. When designing an air monitoring network, one of the following six objectives should be considered:

1. Highest concentrations expected to occur in the area covered by the network
2. Representative concentrations in areas of high population density
3. Impact of specific sources on ambient pollutant concentrations
4. General background concentration levels
5. Extent of regional transport among populated areas and in support of secondary standards
6. Welfare-related impacts in the more rural and remote areas

Site selection

The selection of air monitoring sites is usually based on at least one of the following objectives:

- 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 and MAAQS
- Track pollution trends
- 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 to what extent major sources impact ambient pollution levels
- Validate control strategies designed to prevent or alleviate air pollution
- Provide a database for research and evaluation of air pollution effects
- Determine general background concentration levels

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

Network scales

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 1). 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 represents 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 1: Monitoring objectives and siting 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

Regional network assessment

In addition to this air monitoring network plan, the EPA requires states to complete a network assessment every five years. Under the direction of the Lake Michigan Air Directors Consortium (LADCO), Minnesota collaborated with other states in our region to develop the first network assessment, which was completed in 2010, http://www.ladco.org/reports/general/Regional_Network_Assessment/index.html. The network assessment provides a detailed evaluation of the regional air monitoring network, including network history, a re-evaluation of the types of pollutants monitored, and an evaluation of the network's objectives and costs. It also includes spatial analyses of ambient air monitoring data and a reconsideration of monitor placement based on changes in land use and population.

For the 2015 Network Assessment, the MPCA again collaborated with other EPA Region 5 states. The results of the 2015 Regional Network Assessment can be found on LADCO's website, at http://www.ladco.org/reports/general/Regional_Network_Assessment/RNA15.html.

Key findings of the 2015 Network Assessment:

- Criteria pollutant monitoring networks are adequate to meet EPA's minimum monitoring criteria.
- Monitoring equipment is aging and will require replacement in the coming years. The PM_{2.5} filter-based monitoring network in Minnesota was replaced in 2008, but is no longer being supported by vendors. Inability to access parts for instrument repairs may require instrument replacement sooner than anticipated.
- Disinvestment or relocation of existing PM_{2.5} and ozone monitoring sites is very difficult due to stringent EPA criteria for shutdown.
- Using these criteria, amongst all ozone and PM_{2.5} monitors in the state, only three PM_{2.5} monitors are eligible for disinvestment. These include monitors in Duluth, Virginia, and St. Cloud. While these monitors are eligible for disinvestment, we feel these monitors are valuable for spatial and temporal coverage and we do not intend to shut down these monitors at this time.

Table 2: Site information – Greater Minnesota sites active in 2017

MPCA Site ID	City	Site name	AQS Site ID	Address/Location	LAT	LONG	Year Started
MN08*	Hovland	Hovland	(none)	(open field)	47.8472	-89.9625	1996
MN16*	Balsam Lake	Marcell Experimental Forest	(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	27-137-0034	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 City Hall	27-137-7001	327 First St S	47.5212	-92.5393	1968
2013	Detroit Lakes	FWS Wetland Management District	27-005-2013	26624 N Tower Rd	46.8499	-95.8463	2004
2304***	Red Lake	Red Lake Nation	27-007-2304	24760 Hospital Drive	47.8782	-95.0292	2014
3051***	Mille Lacs	Mille Lacs Band	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
3204	Brainerd	Brainerd Lakes Regional Airport	27-035-3204	16384 Airport Rd	46.3921	-94.1444	2004
4210	Marshall	Southwest Minnesota Regional Airport	27-083-4210	West Highway 19	44.4559	-95.8363	2004
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	27-075-0005	Fernberg Rd	47.9466	-91.4956	1977
7417***	Cloquet	Fond du Lac Band	27-017-7417	28 University Rd	46.7137	-92.5117	2015
7545	Duluth	Oneota Street	27-137-0032	37 th 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	U of M - Duluth	27-137-7550	1202 East University Circle	46.8182	-92.0894	1998
7554	Duluth	Laura MacArthur School	27-137-7554	720 N Central Ave	46.7437	-92.1660	2012
7555	Duluth	Waseca Road	27-137-7555	Waseca Industrial Rd	46.7306	-92.1634	2001
7810***	Grand Portage	Grand Portage Band	27-031-7810	27 Store Rd	47.9701	-89.6910	2005
GRR11**	Winona	Great River Bluffs	27-169-9000	43605 Kipp Dr	43.9373	-91.4052	2002

*NADP Site ID

**IMPROVE Site ID

***Tribal Site

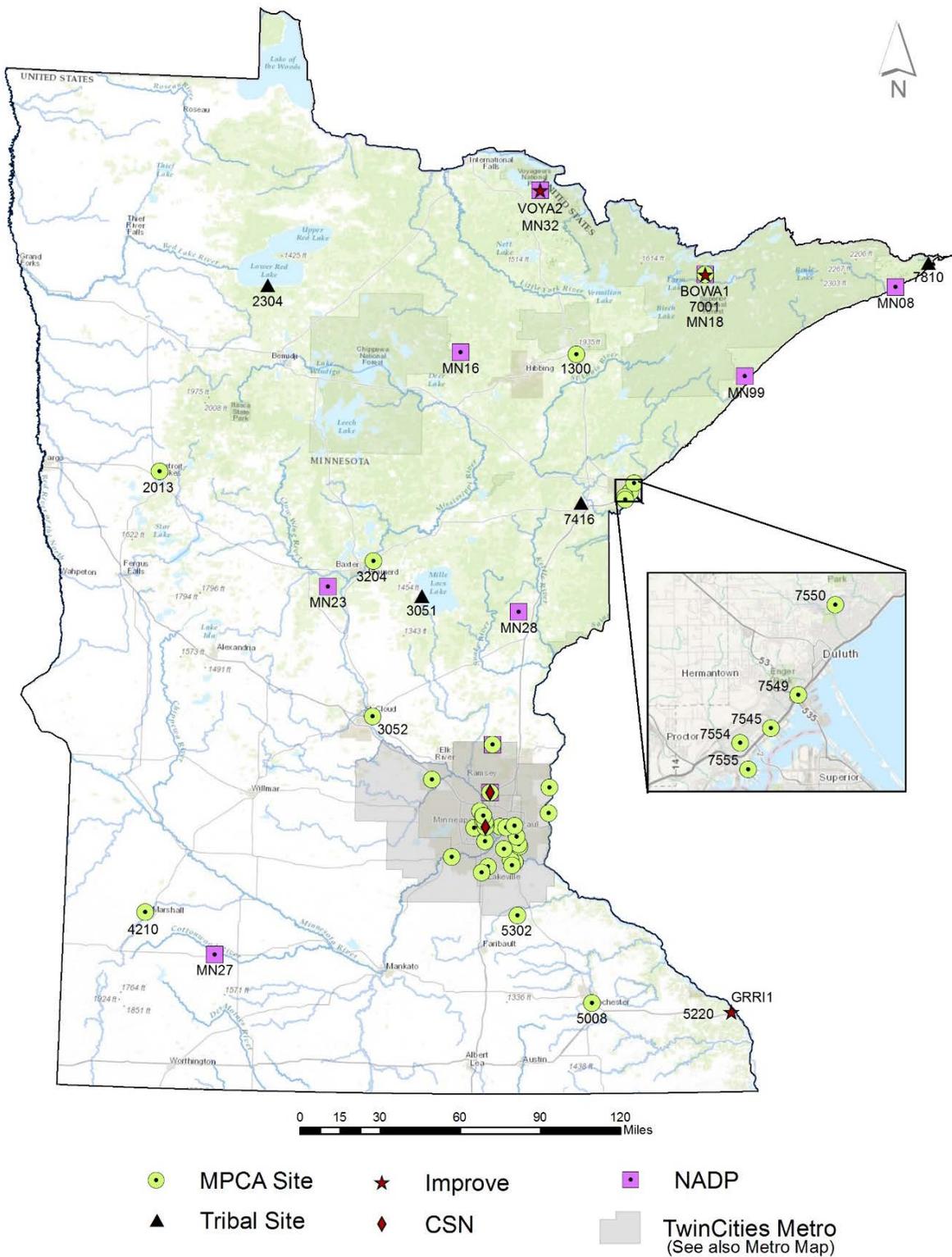


Figure 1: 2017 Air quality monitoring sites in Greater Minnesota

Table 3: Site information – Twin Cities metropolitan area sites active in 2017

MPC Site ID	City	Site name	AQS Site ID	Address	LAT	LONG	Year Started
250	St Louis Park	St. Louis Park City Hall	27-053-2006	5005 Minnetonka Blvd	44.9481	-93.3429	1972
420	Rosemount	Flint Hills Refinery 420	27-037-0020	12821 Pine Bend Tr	44.7632	-93.0325	1972
423	Rosemount	Flint Hills Refinery 423	27-037-0423	2142 120th St E	44.7730	-93.0627	1990
436	St. Paul Park	St. Paul Park Refinery 436	27-163-0436	649 5th St	44.8473	-92.9956	1989
438	Newport	St. Paul Park Refinery 438	27-163-0438	4th Ave & 2nd St	44.8599	-93.0035	1995
443	Rosemount	Flint Hills Refinery 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	-92.7742	2007
465	Eagan	Gopher Resources	27-037-0465	Hwy 149 & Yankee Doodle Rd	44.8343	-93.1163	2006
470	Apple Valley	Westview School	27-037-0470	225 Garden View Dr	44.7387	-93.2373	2000
480	Lakeville	Near Road I-35	27-037-0480	16750 Kenyon Ave	44.7061	-93.2858	2015
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
909	Minneapolis	Lowry Ave	27-053-0909	3104 N Pacific St	45.0121	-93.2767	2013
910	Minneapolis	Pacific Street	27-053-0910	2710 N Pacific St	45.0083	-93.2770	2015
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
962	Minneapolis	Near Road I-35/I-94	27-053-0962	1444 18 th St E	44.9652	-93.2548	2013
963	Minneapolis	Andersen School	27-053-0963	2727 10th Ave S	44.9535	-93.2583	2001
966	Minneapolis	City of Lakes Building	27-053-0966	309 2nd Ave S	44.9793	-93.2611	2002
1909	Minneapolis	Bottineau/Marshall Terrace	27-053-1909	2522 Marshall St NE	45.0136	-93.2721	2017
3201	St. Michael	St. Michael Elementary School	27-171-3201	101 Central Ave W	45.2092	-93.6690	2003
6010 MN98*	Blaine	Anoka County Airport	27-003-1002	2289 Co Rd J	45.1407	-93.2220	1979
6012 MN01*	East Bethel	U of M - Cedar Creek	27-003-1001	2660 Fawn Lake Drive NE	45.4018	-93.2031	1979
6016	Marine on St. Croix	St. Croix Watershed Research Station	27-163-6016	St. Croix Trail N	45.1680	-92.7651	2012

*NADP Site ID

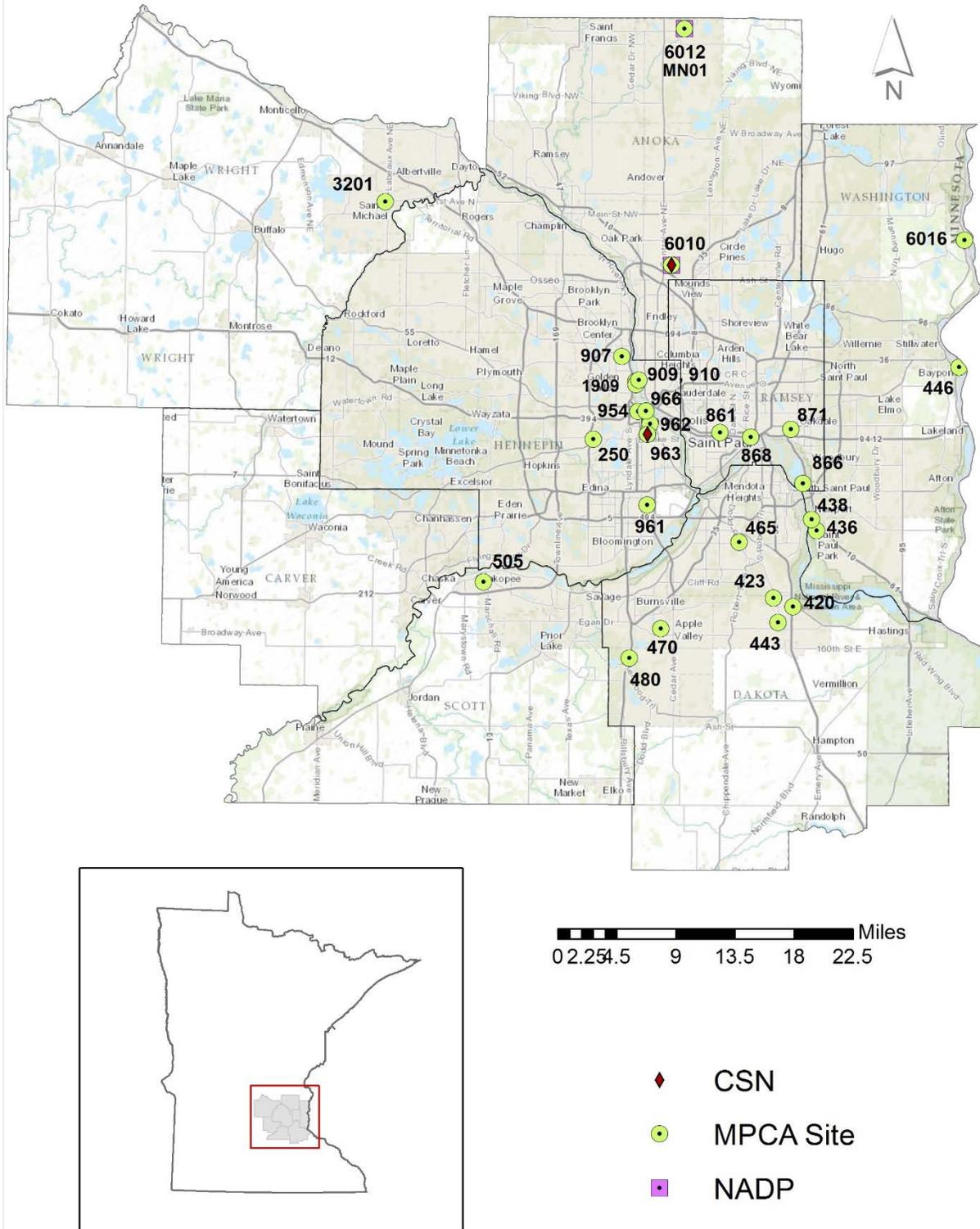


Figure 2: 2017 Air quality monitoring sites in the Twin Cities metropolitan area

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 Part 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
- 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. Additional inter-laboratory comparisons are performed periodically for air toxics monitoring.

As the Primary Quality Assurance Organization (PQAO) 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 that apply 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.

As part of the instrument performance audit, each monitoring site is assessed to ensure that all applicable EPA siting requirements are fully met. This also includes a safety inspection to assure a safe work environment for site operators and staff.

To meet the minimum monitoring requirements for the Minneapolis-St. Paul MN-WI MSA the MPCA and Wisconsin Department of Natural Resources Bureau of Air Management entered into a Memorandum of Agreement (MOA) in January 2011. The MOA formalized the collective agreement between the two States per requirements of 40 CFR 58 Appendix D, Section 2(e).

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 Minnesota.

State and Local Air Monitoring Stations (SLAMS)

The SLAMS network consists of about 3,500 monitoring sites across the United States. 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 monitoring sites in Minnesota are part of the SLAMS network. Sites in the SLAMS network may also belong to other monitoring networks, as described below.

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 measurements of six pollutants: fine particles (PM_{2.5}), particulate matter (PM₁₀), ground-level ozone (O₃), sulfur dioxide (SO₂), nitrogen dioxide (NO₂), and carbon monoxide (CO). The pollutants that most commonly influence the daily AQI, however, are fine particles and ozone. While official AQI values are determined on a daily basis, EPA's NowCast AQI values are updated hourly, and posted on the MPCA's website at www.pca.state.mn.us/aqi to help inform the public of current air quality conditions. There are currently 49 monitors located at 29 sites in the AQI network in Minnesota (Figure 3).

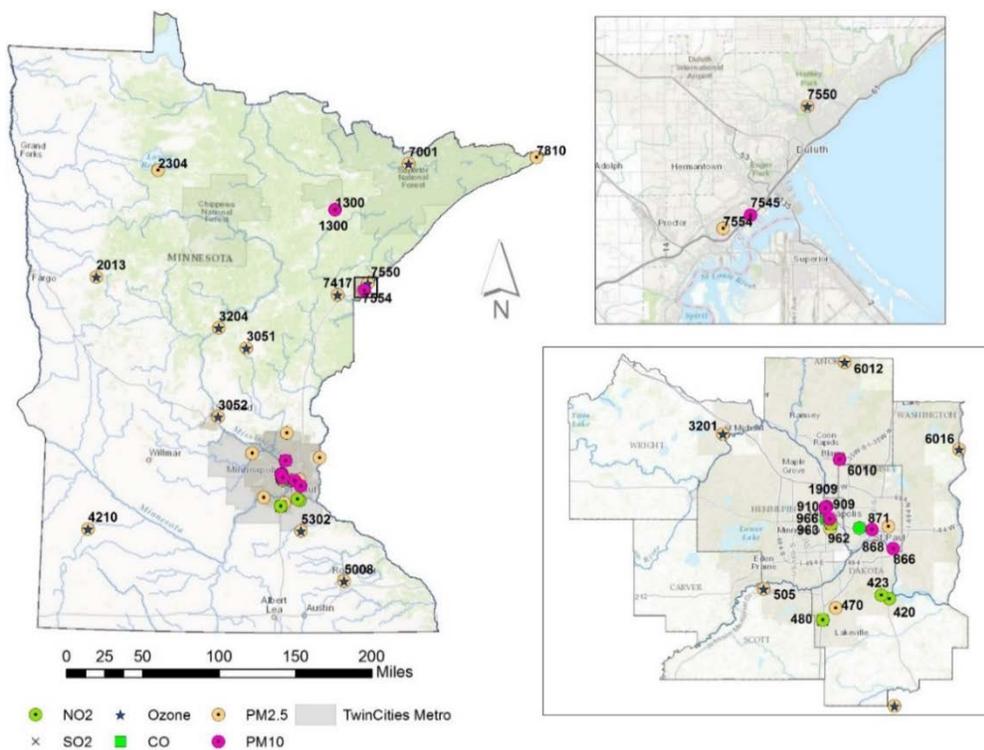


Figure 3: 2017 AQI monitoring network in Minnesota. Fine particles (PM_{2.5}) and ozone are the pollutants that most strongly influence daily AQI values.

The AQI categories developed by the EPA are green (good), yellow (moderate), orange [unhealthy for sensitive groups (USG)], red (unhealthy), and purple (very unhealthy) (Figure 4). In the past, MPCA has offered AQI forecasts of these categories for only the Twin Cities and Rochester. Starting June 1, 2017, the MPCA will begin issuing daily forecasts for the majority of its AQI monitor locations. If it is suspected through forecasting or monitoring that the daily AQI will be over 100, the MPCA will issue an Air Quality Alert to be disseminated by the National Weather Service, the media, and to individuals who have signed up to receive e-mail alerts. Forecasts and alerts allow the public to be proactive about protecting their health and reducing their own contributions to emissions and exposure to air pollution. Forecasts and alerts will be available on the MPCA’s website. The public can also receive air quality forecasts and alerts by email by signing up at <http://mn.enviroflash.info>. In addition, the Minnesota Air App will be updated this summer to offer push notifications of alerts to smartphone users.



Figure 4: Minnesota statewide AQI categories

In 2016, across all monitored locations in Minnesota, the majority of days were categorized as green for air quality. Grand Portage experienced the highest number of green air quality days (355) compared to the Twin Cities metropolitan area, which experienced the lowest number of green air quality days (258). The lower number of green AQI days in the Twin Cities is expected, since the AQI is based on pollutants that are more abundant in and around urban areas. Statewide, the number of green AQI days has been increasing over time, suggesting that overall air quality is improving.

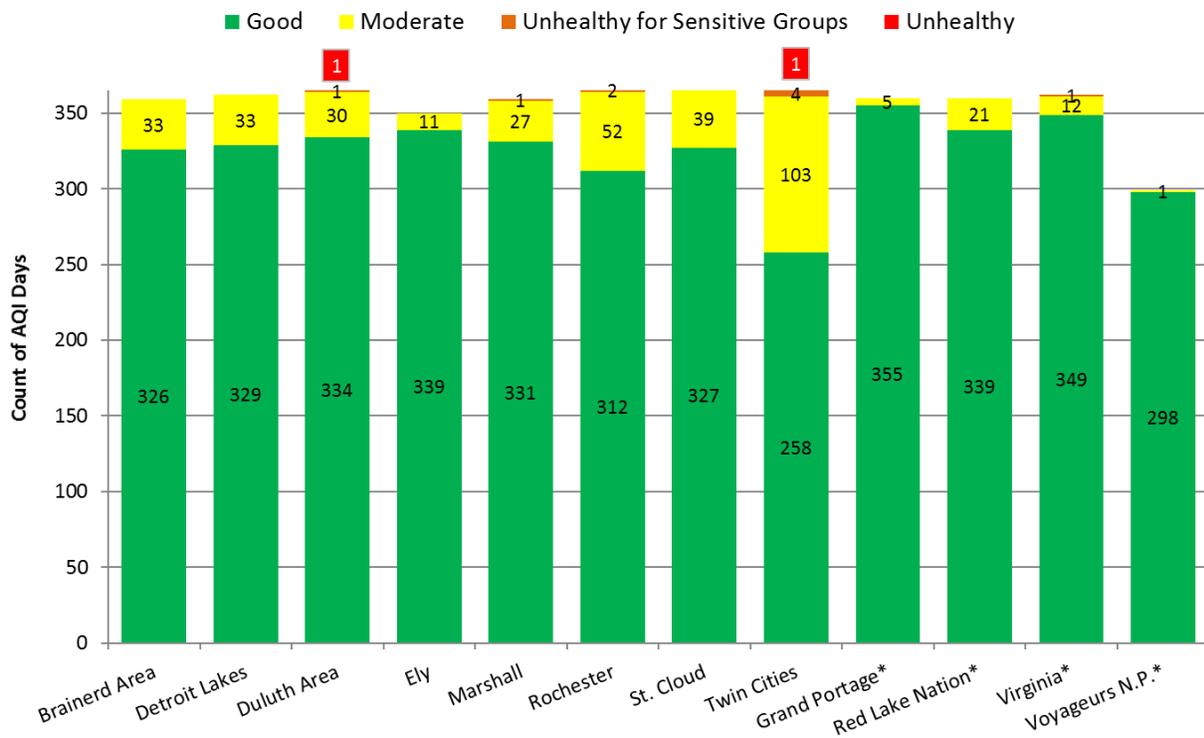


Figure 5: 2016 daily AQI category counts in Minnesota cities. *Grand Portage, Red Lake Nation, and Virginia AQI days are based on PM_{2.5} monitoring results only. Voyageurs N.P. results are based on ozone monitoring results only.

In 2016, the AQI reached the orange or red categories on seven days (Table 4). Fine particle pollution (PM_{2.5}) was the cause for six of these days, while ozone was the primary pollutant on May 21 around the Twin Cities. The majority of the high AQI days in 2016 were associated with Canadian and other regional wildfire smoke. In recent years, wildfire smoke has become a leading contributor to high AQI days in Minnesota.

Table 4: 2016 days with AQI greater than 100

Event Date	Duluth Area	Marshall	Rochester	Twin Cities*	Virginia	Event Description
1/14/2016				111		Transport of regional fine particles, light winds, and a low-level temperature inversion contributed to orange air quality levels.
1/15/2016				104		
5/6/2016	101					Smoke from fires in southwest Ontario Canada and northcentral Minnesota blanketed the state, causing widespread orange to red air quality levels.
5/7/2016	154		104	153	131	
5/8/2016			104	131		
5/21/2016				108		Clear skies, light winds, and regional smoke contributed to orange AQI levels in the northwest portion of the Twin Cities.
12/26/2016		110				Winds gusted over 60 mph, but the source of fine particles is unknown.
		Ozone		Fine Particles (PM _{2.5})		

*Note: Values in the table reflect the maximum AQI result for that date. In the Twin Cities, the highest monitored value is displayed from the network of monitors around the Twin Cities.

No changes are planned for the AQI monitoring network sites in 2018.

Chemical Speciation Network (CSN)

The CSN network is an EPA effort to gather data on the chemical composition of urban 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}. The EPA established this network, which consists of approximately 300 monitoring sites nationwide. CSN data can be useful for assessing trends and developing mitigation strategies to reduce emissions and ambient pollutant concentrations.

The programmatic objectives of the CSN network are:

- Temporal and spatial characterization of aerosols
- Air quality trends analysis and tracking progress of control programs
- Comparison of the urban chemical speciation data set to the rural data collected from the IMPROVE network
- Development of emission control strategies

There are currently two CSN sites in Minnesota, located in Minneapolis at the Andersen School (963) and at the NCore site in Blaine (6010).

No changes are planned for the CSN network in 2018.

Interagency Monitoring of Protected Visual Environments (IMPROVE)

The IMPROVE Aerosol Network is a cooperative rural 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 CAA 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 overseen by the U.S. Department of the Interior (USDOI) and national forests and wilderness areas overseen by the United States Department of Agriculture (USDA). The IMPROVE network comprises 156 monitoring sites nationwide, 110 of which are intended to represent visibility conditions in Class I areas.

The objectives of the IMPROVE network are:

- To establish current visibility and aerosol conditions in Class I areas
- To identify chemical species and emission sources responsible for existing man-made visibility impairment
- To document long-term trends for assessing progress towards the national visibility goal
- To, in conjunction with the enactment of the Regional Haze Rule, provide regional haze monitoring that is representative of all visibility-protected federal Class I areas (where practical)

The IMPROVE sites also provide PM_{2.5} speciation data; they are, therefore, a key component of the EPA's national fine particle monitoring network, and are critical to tracking progress related to the Regional Haze Regulations. Minnesota has three IMPROVE Aerosol Network sites (Figure 1). The sites are located at the Voyageurs National Park (VOYA2, U.S. Department of the Interior), near the Boundary Waters Canoe Area Wilderness at Ely (BOWA1, U.S. Department of Agriculture), and Great River Bluffs State Park (GRR11, Minnesota Department of Natural Resources).

No changes are planned for the IMPROVE network in 2018.

National Atmospheric Deposition Program (NADP)

Atmospheric deposition is monitored through the NADP program at over 250 sites, spanning the continental United States, Alaska, Puerto Rico, and the Virgin Islands (<http://nadp.sws.uiuc.edu/>). There are two sub-networks in Minnesota: the National Trends Network (NTN) and the Mercury Deposition Network (MDN), with nine NTN and five MDN sites in Minnesota (see Figure 30).

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

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

No changes are planned for sites in the MN NADP network in 2018.

Near-road Air Quality Monitoring

Air pollution can be higher close to roadways. In 2010, the EPA introduced a new air monitoring network to measure air pollution levels near heavily trafficked roadways. Near-road air monitoring sites are required to be located within 150 feet of the busiest roadways across the country. As a minimum, near-road monitoring sites are required to measure hourly levels of nitrogen dioxide (NO₂), carbon monoxide (CO), and fine particles (PM_{2.5}).

In Minnesota, the MPCA has installed two near-road monitoring sites. The first near-road monitoring site (962) began operating along the I-94 & I-35W freeway commons near downtown Minneapolis on January 1, 2013. The second near-road monitoring site (480) began operating along I-35 in Lakeville on January 1, 2015. Various parameters are being measured at each of the near-road sites (Table 5).

Table 5: Near-road parameters

MPCA Site ID	City Name	Site Name	PM _{2.5} FEM	TSP and Metals	O ₃	NO _x	CO	VOCs	Carbonyls	Other Parameters
962	Minneapolis	Near Road I35/I94	X	X	X	X	X	X	X	Meteorological Data, Ultrafine Particle Counter, Black Carbon
480	Lakeville	Near Road I35	X			X	X			Meteorological Data

The MPCA near-road air quality monitoring is described in more detail on the MPCA Near-road website at <https://www.pca.state.mn.us/air/near-road-monitoring>.

No changes are planned for the near-road network in 2018.

National Core Monitoring (NCore)

In October 2006, the 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 requires each state to have at least one NCore site; there are approximately 75 sites nationwide, mostly in urban areas.

Each NCore site must measure a minimum number of parameters (Table 6).

Table 6: NCore monitoring network site 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 total mass every third day
PM _{2.5} mass	One hour reporting interval (continuous)
PM _(10-2.5) mass	In anticipation of a PM _(10-2.5) standard (continuous)
Ozone (O ₃)	Continuous monitor consistent with other O ₃ sites
Carbon monoxide (CO) trace level	Continuous monitor capable of trace levels (low parts per billion [ppb] and below)
Sulfur dioxide (SO ₂) trace level	Continuous monitor capable of trace levels (low ppb and below)
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

Each site in the NCore monitoring network addresses the following monitoring objectives:

- Report data on a timely schedule to the public through
 - The AIRNow data reporting website (<https://www.airnow.gov/>)
 - Air quality forecasting
 - Other public reporting mechanisms
- Support the development of emission strategies through air quality model evaluation and other observational methods
- Track long-term trends of criteria and non-criteria pollutants and their precursors for the accountability of emission strategy progress
- Establish nonattainment/attainment areas via comparison and compliance with the NAAQS
- Support scientific studies ranging across technological, health, and atmospheric process disciplines; support long-term health assessments that contribute to ongoing reviews of the NAAQS
- Support ecosystem assessments, recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analysis

In 2011, the MPCA began operating the full suite of NCore parameters at the Anoka County Airport in Blaine (6010). The Anoka County Airport monitoring station is located approximately 11 miles north of downtown Minneapolis and approximately 15 miles northwest of downtown St. Paul. Appendix B of the 2010 Annual Air Monitoring Network Plan, <https://www.pca.state.mn.us/sites/default/files/aq10-03b.pdf>, contains a detailed report about Minnesota's NCore site in Blaine.

Minnesota's NCore site monitors data for multiple parameters (Table 6) because numerous chemical and physical interactions among other pollutants underlie the formation of particulates and ozone, and the formation and destruction of one can influence the creation of the others. Multi-pollutant monitoring will benefit health studies, long-term epidemiological studies, source apportionment studies, and air quality modeling.

The NCore site in Blaine monitors trace-level CO, SO₂, oxides of nitrogen (NO_x), and total reactive nitrogen. These pollutants are the predominant products of inorganic combustion, and are the most abundant inorganic elements in the atmosphere. Emissions reductions, mainly from power plants and motor vehicles, have lowered the concentrations of these pollutants in most urban and rural areas; they are precursor gases, however, and they continue to play an important role in the formation of ozone, particulate matter, and air toxics at both local and regional scales. The trace-level data that this site provides helps us understand the role of these pollutants in the environment at levels far below the NAAQS. Trace-level monitors have been operating at the NCore site in Blaine (6010) since 2009. Performance issues with the monitoring equipment resulted in unreliable and/or incomplete trace level measurements, until the MPCA replaced the trace-level monitoring instruments in 2014.

No changes are planned for the NCore site in 2018.

Industrial networks

In Minnesota, air quality permits are required to legally operate certain industrial facilities, to begin construction on new facilities, or to modify certain facilities. Air quality permits contain state and federal requirements aiming to minimize the environmental impact of air emissions from these facilities. Some federal programs specify performance standards for certain types of facilities or processes within a facility. Others address the impact of newly constructed facilities, or modifications to existing facilities, on ambient air quality.

Facilities that are required to monitor nearby ambient air quality to demonstrate compliance with MAAQS and/or NAAQS receive assistance from MPCA through siting evaluations, instrument performance audits, data review, and submission of data to the EPA's Air Quality System (AQS) database. The facilities are responsible for their own data validation and for other QA/QC activities.

The MPCA is currently assisting the following facilities:

- American Crystal Sugar Company in Moorhead, Crookston, and East Grand Forks
- Andersen Corporation in Bayport, MN
- Northshore Mining Company in Silver Bay, MN
- Southern Minnesota Beet Sugar Cooperative in Renville, MN
- 3M in Maplewood, MN

Two additional monitoring site installations are planned for the 3M site in 2018. More information on these sites is available in Appendix B of this report.

Photochemical Assessment Monitoring Stations (PAMS)

The PAMS network provides enhanced monitoring of ozone, NO_x, and volatile organic compounds (VOCs) in order to obtain more comprehensive and representative data on ozone air pollution. The primary data objectives of the PAMS network include:

- Providing a speciated ambient air database that is both representative and useful in evaluating control strategies and understanding the mechanisms of pollutant transport by ascertaining ambient profiles and distinguishing among various individual VOCs

- Providing local, current meteorological and ambient data to serve as initial and boundary condition information for photochemical grid models
- Providing a representative, speciated ambient air database that is characteristic of source emission impacts to be used in analyzing emissions inventory issues and corroborating progress toward attainment
- Providing ambient data measurements that would allow later preparation of unadjusted and adjusted pollutant trends reports
- Providing additional measurements of selected criteria pollutants for attainment/nonattainment decisions and to construct NAAQS maintenance plans
- Providing additional measurements of selected criteria and non-criteria pollutants to be used for evaluating population exposure to air toxics as well as criteria pollutants

In October 2015, the EPA revised the PAMs monitoring network requirements in 40 CFR Part 58. Beginning on June 1, 2019, state and local monitoring agencies are required to collect and report PAMS measurements at each NCore site located in a Core Base Statistical Area (CBSA) with a population of one million or more. The revised PAMS requirements will result in the commencement of PAMS measurements at the NCore site in Blaine. Minnesota's PAMS Implementation Plan will be included in the 2019 Annual Network Plan, which will be available for public inspection in May 2018.

Clean Air Status and Trends Network (CASTNET)

CASTNET provides long-term monitoring of air quality in rural areas to determine trends in regional atmospheric nitrogen, sulfur, and ozone concentrations, and deposition fluxes of sulfur and nitrogen pollutants. The objective of the CASTNET network is to evaluate the effectiveness of national and regional air pollution control programs. CASTNET began collecting measurements in 1991 with the incorporation of 50 sites from the National Dry Deposition Network (NDDN), which had been in operation since 1987. CASTNET operates more than 80 regional sites throughout the contiguous United States, Alaska, and Canada. Sites are located in areas where urban influences are minimal (<http://epa.gov/castnet>).

There are two CASTNET sites in Minnesota (Figure 1). One site, located at Voyageurs National Park (VOYA2), is operated by the National Park Service. The other, in Red Lake (2304), is operated by the Red Lake Band of Chippewa Indians. The MPCA does not have any role in this monitoring.

Parameter networks

The MPCA monitors different types of measurable air properties, called parameters. The group of sites where a parameter is monitored is referred to as a parameter network. Generally, parameters refer to pollutants such as fine particles or air toxics, but parameters also include non-concentration data such as wind speed and temperature. There are currently 53 sites across Minnesota that are being monitored for various parameters (Tables 7 and 8), using appropriate methods and equipment (Table 9).

The MPCA monitors the six criteria pollutants established by the 1970 CAA to show compliance with the NAAQS. The criteria pollutants are particulate matter (PM_{2.5} and PM₁₀), lead (Pb), ozone (O₃), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and carbon monoxide (CO).

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 currently monitored at five 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. In 2014, the MPCA began monitoring ultrafine particles (UFP) and black carbon at the near-road monitoring site (962) in Minneapolis.

The MPCA also monitors pollutants that pose a potential risk to human health and the environment, but are not regulated by national standards. These pollutants include air toxics, such as VOCs, carbonyls, polycyclic aromatic hydrocarbons (PAHs), and metals; acid rain; and mercury (Hg). Acid rain and mercury are monitored across Minnesota through the NADP network.

Compounds containing sulfur are monitored, as they may cause irritation to the eyes, nose, and throat. Hydrogen sulfide (H₂S) is monitored to show compliance with the MAAQS. Total reduced sulfur (TRS), which contains H₂S, is monitored near industrial sources. TRS is used as a conservative measurement to demonstrate compliance with the H₂S MAAQS.

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

Generally, parameters are monitored either continuously or as integrated data, using various methods and equipment (Table 9). Continuous data give incremental readings on a real-time basis, such as every 5 or 15 minutes or every hour. Integrated samples are usually 24-hour averages, collected midnight to midnight 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 transported to the MPCA lab for further analysis.

Table 7: 2017 Site parameters – Greater Minnesota

MPCA Site ID	City Name	Site Name	PM _{2.5} FRM	PM _{2.5} FEM	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			X						Acid Deposition
MN99*	Finland	Wolf Ridge												Acid Deposition
1300	Virginia	Virginia		X		X	X							
2013	Detroit Lakes	Detroit Lakes		X				X						
2304***	Red Lake	Red Lake Nation		X										
3051***	Mille Lacs	Mille Lacs						X						
3052	Saint Cloud	Talahi School		X				X						
3204	Brainerd	Brainerd Airport		X				X						
4210	Marshall	Marshall Airport		X				X						
5008	Rochester	Ben Franklin School	X	X				X						
5302	Stanton	Stanton Airfield						X						
7001 MN18* BOWA1**	Ely	Fernberg Road		X	IMP			X						Acid and Hg Deposition
7417***	Cloquet	Fond du Lac Band		X				X						
7545	Duluth	Oneota Street				X								Collocated PM ₁₀
7549	Duluth	Michigan Street					X					X	X	
7550	Duluth	WDSE (U of M)	X					X						Collocated PM _{2.5} FRM
7554	Duluth	Laura MacArthur School	X	X										
7555	Duluth	Waseca Road					X							Collocated TSP and metals
7810***	Grand Portage	Grand Portage		X										
GRR11**	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)

*** Tribal monitor

Table 8: 2017 Site parameters – Twin Cities metropolitan area

MPCA Site ID	City Name	Site Name	PM _{2.5} FRM	PM _{2.5} FEM	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	Flint Hills Refinery 420					X		X	X	X	X	X	Collocated TSP and Metals, TRS, PAH (ending July 1), Meteorological Data
423	Rosemount	Flint Hills Refinery 423					X		X	X	X	X	X	TRS, Meteorological Data
436	St. Paul Park	St. Paul Park Refinery 436								X		X	X	TRS, Collocated VOCs and Carbonyls
438	Newport	St. Paul Park Refinery 438					X					X	X	PAH (starting July 1)
443	Rosemount	Flint Hills Refinery 443								X		X	X	
446	Bayport	Point Road					X					X	X	
465	Eagan	Gopher Resources					X ^L							Collocated TSP and Metals
470	Apple Valley	Apple Valley	X	X			X					X	X	
480	Lakeville	Near Road I35		X					X		X			Meteorological Data
505	Shakopee	Shakopee	X					X						
861	St. Paul	Lexington Avenue									X			
866	St. Paul	Red Rock Road				X								Collocated PM ₁₀
868	St. Paul	Ramsey Health Center	X			X ^C						X	X	
871	St. Paul	Harding High School	X	X			X					X	X	Collocated PM _{2.5} FRM and PM _{2.5} FEM
907	Minneapolis	Humboldt Avenue					X					X	X	PAH (ending Jul 1)
909	Minneapolis	Lowry Ave				X ^C	X					X	X	Meteorological Data, PAH (starting July 1)
910	Minneapolis	Pacific Street				X ^C	X							
954	Minneapolis	Arts Center								X	X			
961	Richfield	Richfield Intermediate School										X	X	
962	Minneapolis	Near Road I35/I94		X			X	X	X		X	X	X	Meteorological Data, Ultrafine Particle Counter, Black Carbon
963	Minneapolis	H.C. Andersen School	X	X	CSN		X					X	X	PAH (ending July 2018)
966	Minneapolis	City of Lakes				X	X					X	X	Collocated VOCs and Carbonyls
1909	Minneapolis	Bottineau/Marshall Terrace		X			X					X	X	
3201	Saint Michael	Saint Michael		X				X						
6010	Blaine	Anoka Airport	X	X	CSN	X ^C	X	X	X ^T	X ^T	X ^T	X	X	^T NCore trace level gases, Hg Deposition, PM _{10-2.5} , and Meteorological Data
6012	East Bethel	Cedar Creek						X						Acid Deposition
6016	Marine on St. Croix	Marine on St. Croix						X						

^LSource-oriented Lead

^CPM₁₀ Continuous

Table 9: Methods and equipment used for parameter networks in Minnesota

Monitoring parameter	Methods and equipment	Analyzing agency
Acid Deposition	Weekly wet-only precipitation collection	NADP
Black Carbon	Teledyne API Model 633	MPCA
Carbonyls	HPLC – ATEC Model 2200 sampler	MPCA
CO	Infrared Absorption – Teledyne API Models 300E/T300	MPCA
CO trace level	Infrared Absorption – Teledyne API Model T300U	MPCA
H ₂ S	Honeywell Analytics MDA Model SPM Chemcassette using hydride tape	MPCA
Mercury Deposition	Weekly wet-only precipitation collection	NADP
Metals	Inductively Coupled Argon Plasma (ICAP-AES) from TSP filters	MPCA
Meteorological Data	Various meteorological sensors	MPCA
NO/NO _y trace level	Chemiluminescence – Teledyne API Model T200U	MPCA
NO _x	Chemiluminescence – Teledyne API Models 200A/T200	MPCA
O ₃	Ultraviolet Absorption – Teledyne API Models 400E/ T400	MPCA
PM ₁₀	Gravimetric – Andersen Hi-Vol samplers	MPCA
PM ₁₀ Continuous	Beta Attenuation – MetOne Instruments BAM-1020	MPCA
PM _{10-2.5}	Beta Attenuation – MetOne Instruments BAM-1020	MPCA
PM _{2.5} FEM	Beta Attenuation – MetOne Instruments BAM-1020 FEM	MPCA
PM _{2.5} FRM	Gravimetric – Thermo Partisol-Plus Model 2025 PM _{2.5} Sequential Air Sampler	MPCA
PM _{2.5} Speciation - CSN	MetOne Instruments SAAS Speciation Sampler; URG3000N Carbon Samplers	US EPA
PM _{2.5} Speciation - IMPROVE	IMPROVE Sampler	IMPROVE
SO ₂	Pulsed Fluorescence – Teledyne API Models 100E/T100	MPCA
SO ₂ trace level	Pulsed Fluorescence – Teledyne API Model T100U	MPCA
TRS	SO ₂ analyzer (pulsed fluorescence) with thermal oxidizer	MPCA
TSP	Gravimetric –High Volume samplers	MPCA
Ultrafine Particles	TSI Model 3031 Ultrafine Particle Monitor	MPCA
VOCs	GCMS – ATEC Model 2200 sampler	MPCA

Criteria pollutants

In 1970, the CAA authorized the EPA to establish standards for six pollutants known to cause harm to human health and the environment; these were given the name criteria pollutants. The CAA requires each state – subsequently, the PCA in Minnesota – to monitor these pollutants, then to report the findings to the EPA. The criteria pollutants are particulate matter (PM_{2.5} and PM₁₀), lead (Pb), ozone (O₃), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and carbon monoxide (CO).

For each of these pollutants, the EPA has developed national primary and secondary ambient air monitoring concentration 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. The EPA website describes the latest updates to the NAAQS, at <https://www.epa.gov/criteria-air-pollutants/naaqs-table> (Table 10). Any expected changes to criteria pollutant monitoring networks are described below.

Table 10: EPA National Ambient Air Quality Standards (NAAQS), April 2017

Pollutant [final rule citation]	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO) [76 FR 54294, Aug 31, 2011]	primary	8 hours	9 parts per million (ppm)	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb) [73 FR 66964, Nov 12, 2008]	primary and secondary	Rolling 3 month average	0.15 µg/m ³ ⁽¹⁾	Not to be exceeded
Nitrogen Dioxide (NO₂) [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb ⁽²⁾	Annual Mean
Ozone (O₃) [80 FR 65292, Oct 26, 2015]	primary and secondary	8 hours	0.070 ppm ⁽³⁾	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM) [78 FR 3086, Jan 15, 2013]	PM _{2.5}	primary	12.0 µg/m ³	annual mean, averaged over 3 years
		secondary	15.0 µg/m ³	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m ³
	PM ₁₀	primary and secondary	24 hours	150 µg/m ³
Sulfur Dioxide (SO₂) [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]	primary	1 hour	75 ppb ⁽⁴⁾	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m³ as a calendar quarter average) also remain in effect.

(2) The level of the annual NO₂ standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O₃ standards additionally remain in effect in some areas. Revocation of the previous (2008) O₃ standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO₂ standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO₂ standards or is not meeting the requirements of a SIP call under the previous SO₂ standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Particulate matter

The MPCA monitors five different sizes of particulates: ultrafine particulate matter (UFP), which has an aerodynamic diameter of less than 0.1 microns; fine particulate matter (PM_{2.5}); coarse particulate matter (PM_{10-2.5}), which has an aerodynamic diameter ranging from 2.5 to 10 microns; PM₁₀; and total suspended particulate matter (TSP), which includes the total mass of particles found in a sample of ambient air. PM_{2.5} and PM₁₀ are regulated by the NAAQS, and TSP is regulated by the MAAQS. There are currently no state or federal air quality standards for UFP or PM_{10-2.5}.

Ultrafine Particulate Matter (UFP)

UFPs are particulates with an aerodynamic diameter less than 1.0 microns. UFPs are released directly into the air through combustion, or are formed in the environment when other pollutant gases react in the air. Motor vehicles are a significant source of UFPs; the highest concentration levels are found along roadways. Similar to PM_{2.5}, UFPs can be inhaled deeply into the lungs and may enter the blood stream, impacting respiratory and cardiovascular health. Due to their small size and unique physical characteristics, however, emerging health research suggests that exposure to UFPs may be a more significant driver of health effects than exposure to PM_{2.5}. To date, the EPA has not found sufficient evidence to support the creation of a distinct health-related UFP standard, but continues to examine available data.

In 2014, the MPCA installed a UFP monitor at the Minneapolis near-road monitoring site (962) along I-94 and I-35W in downtown Minneapolis. In contrast to particulate monitors for PM_{2.5}, PM_{10-2.5}, PM₁₀, and TSP, which measure the total mass of particles in a sample of air, the UFP monitor counts the number of particles contained in the sample across six distinct size fractions (20–30 nm, 30–50 nm, 50–70 nm, 70–100 nm, 100–200 nm, and 200–1000 nm).

The addition of the UFP monitor in Minnesota's particulate monitoring network can support future research activities ranging across technological, health, and atmospheric process disciplines, and can help to inform long-term health assessments that contribute to ongoing reviews of the NAAQS.

Fine particulate matter (PM_{2.5})

PM_{2.5} is a chemically and physically diverse mixture of very small particles measuring less than 2.5 microns in diameter. This mixture is comprised of a complex blend of chemicals including ammonium sulfate, ammonium nitrate, particle-bound water, elemental carbon, hundreds or thousands of organic compounds, and inorganic material, including soil and metals.

PM_{2.5} can be inhaled deeply into the lungs, and 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.

There are currently 25 PM_{2.5} sites in Minnesota, 11 of which are in the Twin Cities metropolitan area (Figure 6). Four types of PM_{2.5} monitors are operated in Minnesota: filter-based Federal Reference Method (FRM), Continuous Federal Equivalent Method (FEM), monitors in the Chemical Speciation Network (CSN), and monitors in the IMPROVE network. Monitors classified as FRM or FEM are regulatory-grade monitors, which can be used to demonstrate compliance with the PM_{2.5} NAAQS. Monitors in the CSN and IMPROVE networks are not eligible for regulatory comparisons.

The FRM monitors collect a 24-hour mass sample of PM_{2.5} on Teflon filters. All FRM sites in Minnesota run once every three days. PM_{2.5} data collected using this method are compared to the NAAQS to demonstrate compliance.

The FEM PM_{2.5} monitors are Met One Instruments BAM-1020 (BAM) continuous mass monitors that collect and report hourly PM_{2.5} concentrations. All BAM monitors operating in Minnesota are designated as FEM, and can be used to demonstrate compliance with the PM_{2.5} NAAQS. Hourly PM_{2.5} data are also used to calculate the AQI and develop AQI forecasts for Minnesota. Continuous data are reported to the MPCA's AQI

website (www.pca.state.mn.us/air) and the EPA's AIRNow website (<http://airnow.gov/>), as well as the Air Quality System (AQS).

CSN and IMPROVE monitors collect 24-hour samples once every three days and are analyzed for chemical composition. Data from the PM_{2.5} speciation networks are used for trends analysis and to better understand sources and health effects.

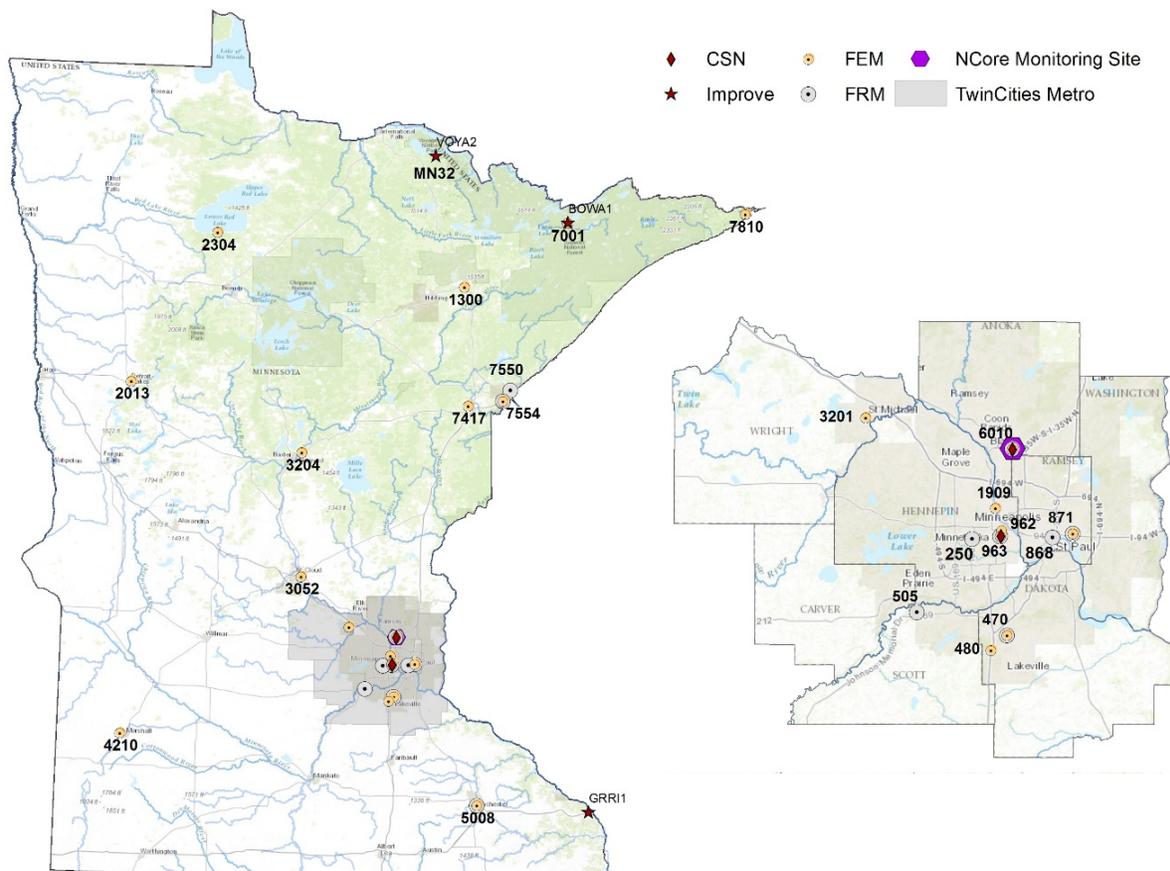


Figure 6: 2017 PM_{2.5} monitoring sites in Minnesota

PM_{2.5} regulatory network overview

The PM_{2.5} regulatory network includes FRM and FEM monitors. Currently, the MPCA operates FRM monitors at 10 sites and FEM monitors at 19 sites (Figure 6).

A special-purpose PM_{2.5} FEM monitor was added to a short-term site (1908) as part of the Community Air Monitoring Project in 2016. After collecting data for one year, this monitor has been relocated to the Bottineau/Marshall Terrace site (1909) for 2017 and part of 2018. More information about these special-purpose projects can be found on the Community Air Monitoring Project website (<https://www.pca.state.mn.us/air/community-air-monitoring-project>).

No other changes are expected to the PM_{2.5} regulatory network in 2018.

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 given 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 12 µg/m³. From 2014-2016, Minnesota annual average PM_{2.5} concentrations ranged from 4.3 µg/m³ in Ely (7001) to 8.7 µg/m³ in Minneapolis (962); thus, all sites were below the annual standard of 12 µg/m³ (Figure 7).

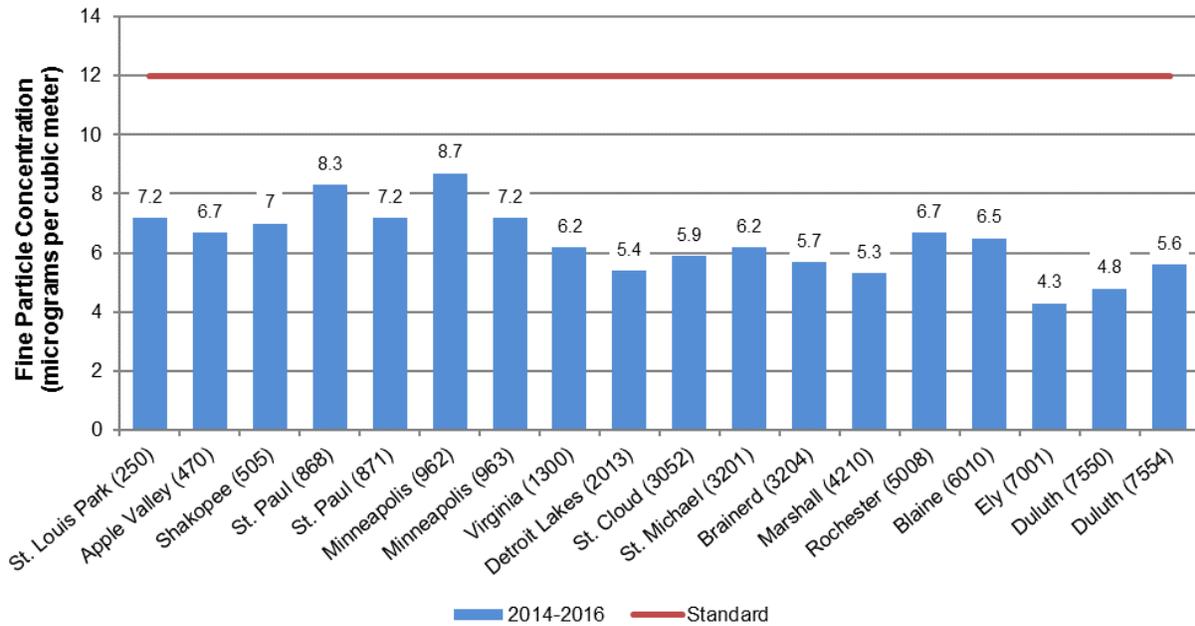


Figure 7: Annual PM_{2.5} concentrations compared to the NAAQS, 2014-2016

A site meets the 24-hour NAAQS if the 98th percentile of the 24-hour PM_{2.5} concentrations in a year, averaged over three years, is less than or equal to 35 µg/m³. From 2014-2016, the 98th percentile of the daily PM_{2.5} averages in Minnesota ranged from 13 µg/m³ in Ely (7001) to 22 µg/m³ in St. Paul (868); thus, all sites were below the 24-hour standard of 35 µg/m³ (Figure 8).

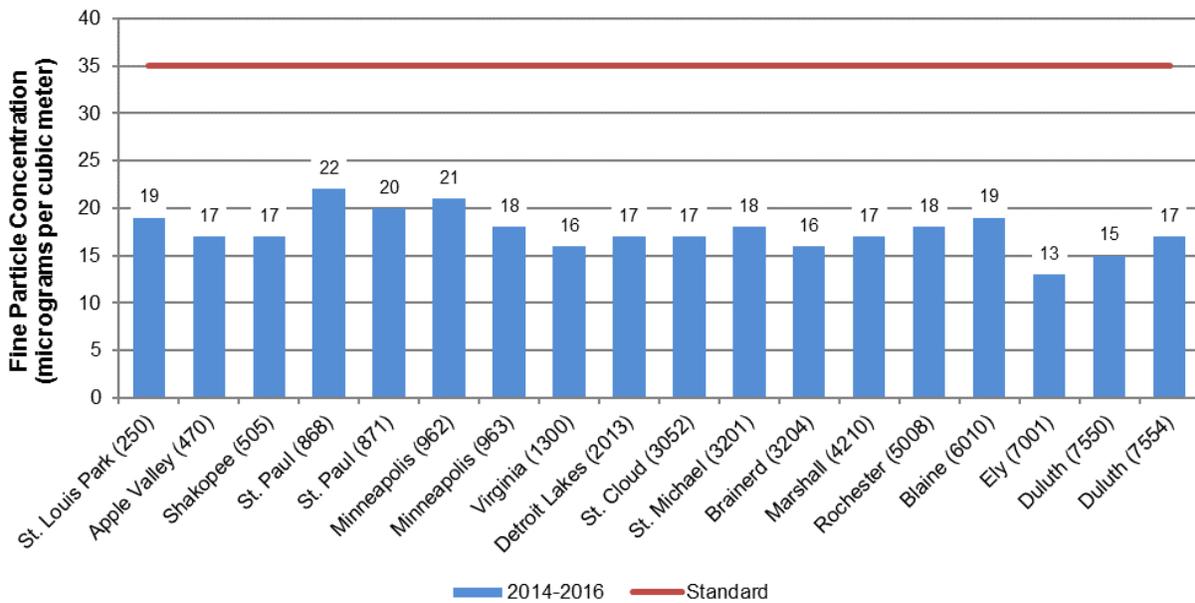


Figure 8: 24-hour PM_{2.5} concentrations compared to the NAAQS, 2014-2016

PM_{2.5} continuous network

The MPCA currently operates 19 FEM PM_{2.5} sites in Minnesota. This includes an FEM PM_{2.5} monitor at Grand Portage (7810), which is owned and operated by the Grand Portage Band of Lake Superior Chippewa. A special-purpose monitor has been moved from site 1908 to a new location in the Bottineau/Marshall Terrace neighborhood (1909), as part of the Community Air Monitoring Project, for 2017 and 2018.

The PM_{2.5} continuous (FEM) data provide two key types of information that are not available from the FRM network. First, continuous data capture high concentration days that might be missed in the one-in-three day FRM sampling schedule. Second, daily monitoring allows for temporal contrasts between sites on an ongoing basis, providing better, more informative comparisons. Additionally, continuous PM_{2.5} monitoring provides hourly data that assist in understanding how concentrations vary throughout the day. Understanding such daily fluctuations helps determine sources of PM_{2.5} and when health risks from fine particles are greatest. Increased understanding of concentrations and risks aids in prioritizing emission reduction efforts.

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. There is considerable variability between sites, however, even as the general trend stays uniform. Such differences in concentrations tend to be driven by local sources, especially those in closer proximity to large urban areas. Disparities between urban and rural areas demonstrate the effect of man-made emission sources on fine particulate concentrations (Figure 9).

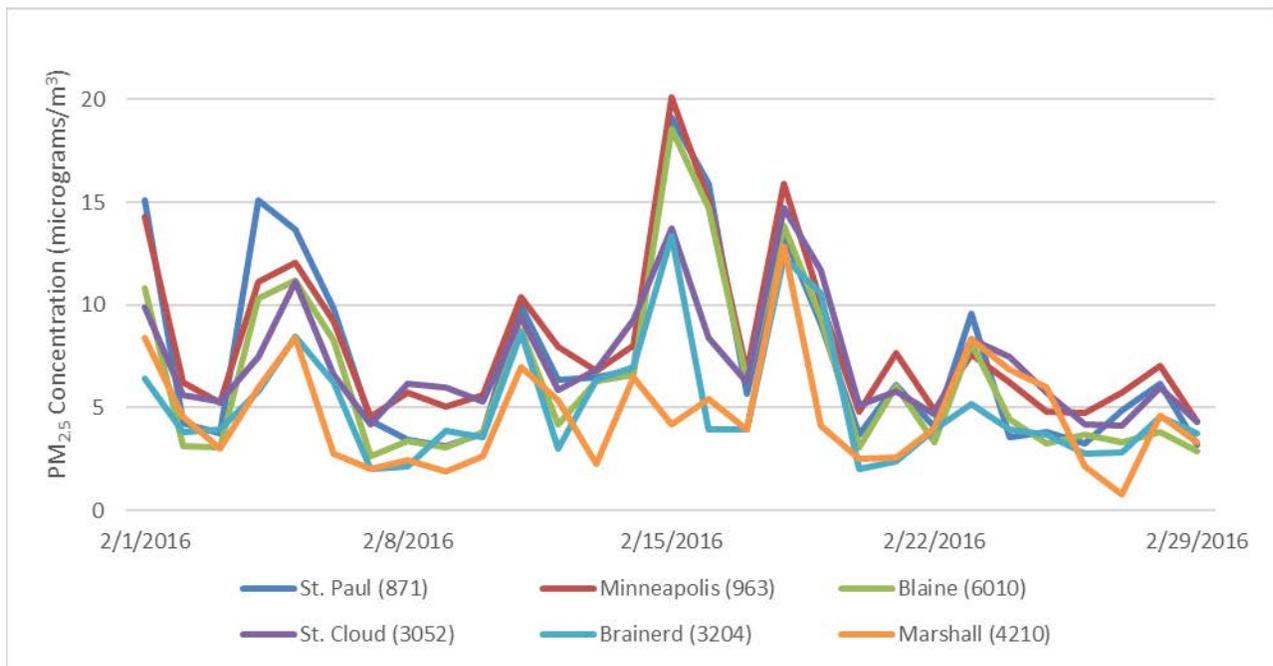


Figure 9: PM_{2.5} daily average concentrations at several Minnesota sites, February 2016

PM_{2.5} emissions in urban areas tend to follow a daily pattern (Figure 10). The mid-morning peak concentration results from traffic. As temperatures rise in the day, the atmospheric mixing height increases. This allows for dilution of fine particle concentrations and lowered concentrations throughout 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.

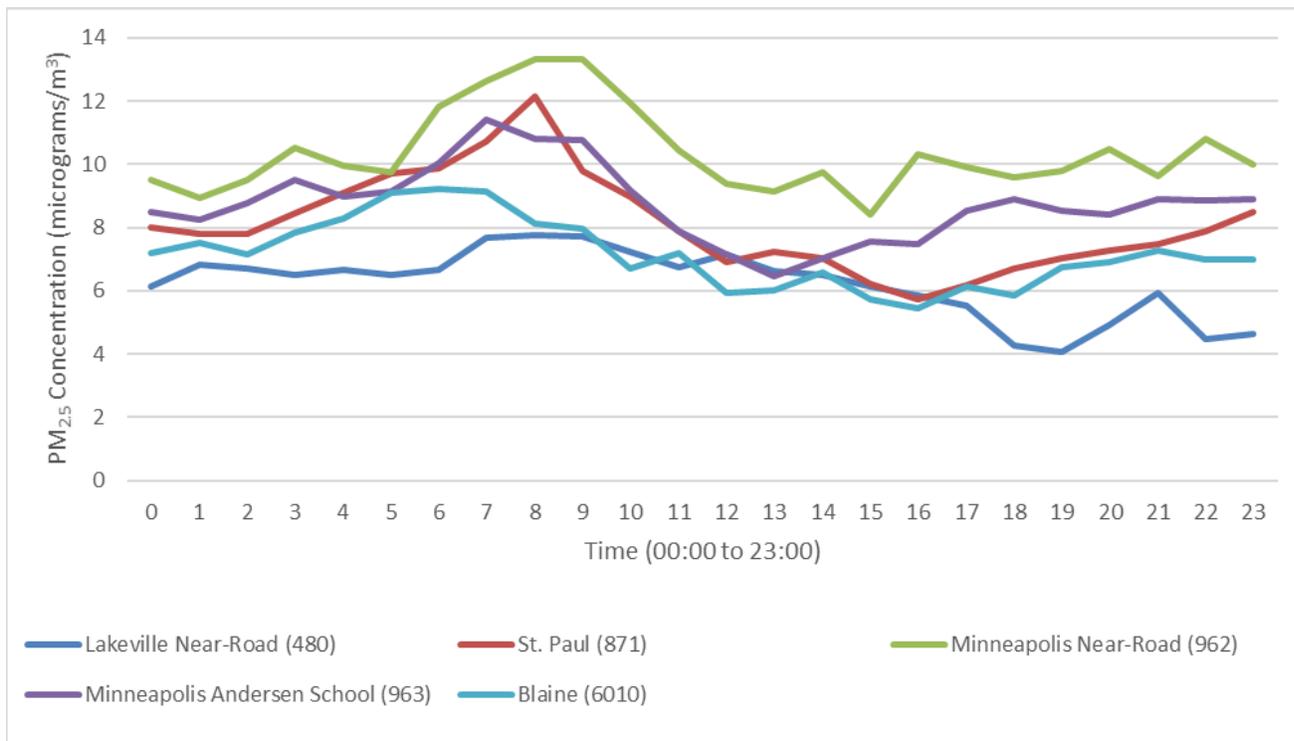


Figure 10: PM_{2.5} average hourly concentrations at several Minnesota sites, weekdays, February 2016

PM_{2.5} speciation

Currently, five monitors measure PM_{2.5} chemical speciation in Minnesota. The monitors in Minneapolis (963) and Blaine (6010) are part of the EPA's CSN (<http://www.epa.gov/ttn/amtic/speciepg.html>), which focuses on urban locations. The monitors at Voyageurs (VOYA2), Ely (BOWA1), and Great River Bluffs (GRR11) are part of the IMPROVE network (<http://vista.cira.colostate.edu/IMPROVE/>), which focuses on visibility issues, primarily in rural locations. Sampling frequency for these sites is once every three days. Samples are analyzed at contracted labs selected by the EPA and the IMPROVE program.

The particulate monitoring portion of the IMPROVE program measures PM_{2.5} for optical absorption, major and trace elements, organic and elemental carbon, and nitrate. CSN monitoring is similar, except that it does not include optical absorption, and does include analysis for ammonium.

Coarse particulate matter (PM_{10-2.5})

The national monitoring requirements defined in Appendix D of 40 CFR Part 58 contain a requirement for PM_{10-2.5} mass monitoring to be conducted at NCore multipollutant monitoring sites. The MPCA started monitoring PM_{10-2.5} at the NCore site in Blaine (6010) in 2011. No additional sites are expected at this time.

PM₁₀

PM₁₀ includes all particulate matter with an aerodynamic diameter less than 10 microns. Short-term exposure to PM₁₀ is linked to hospitalization, even premature death, in people with heart or lung disease. Decreased lung function and increased respiratory symptoms in children are also associated with PM₁₀ exposure.

The MPCA currently operates four PM₁₀ FRM monitors. The FRM method collects mass samples of PM₁₀ over a 24-hour period once every six days. There are also continuous PM₁₀ FEM monitors that measure hourly PM₁₀ concentrations at four sites: St. Paul (868), Minneapolis (909), Minneapolis (910), and Blaine (6010) (Figure 11). The majority of the PM₁₀ monitors are located in the Twin Cities metropolitan area, with additional monitors in Duluth (7545) and Virginia (1300). No changes to the PM₁₀ network are expected in 2018.

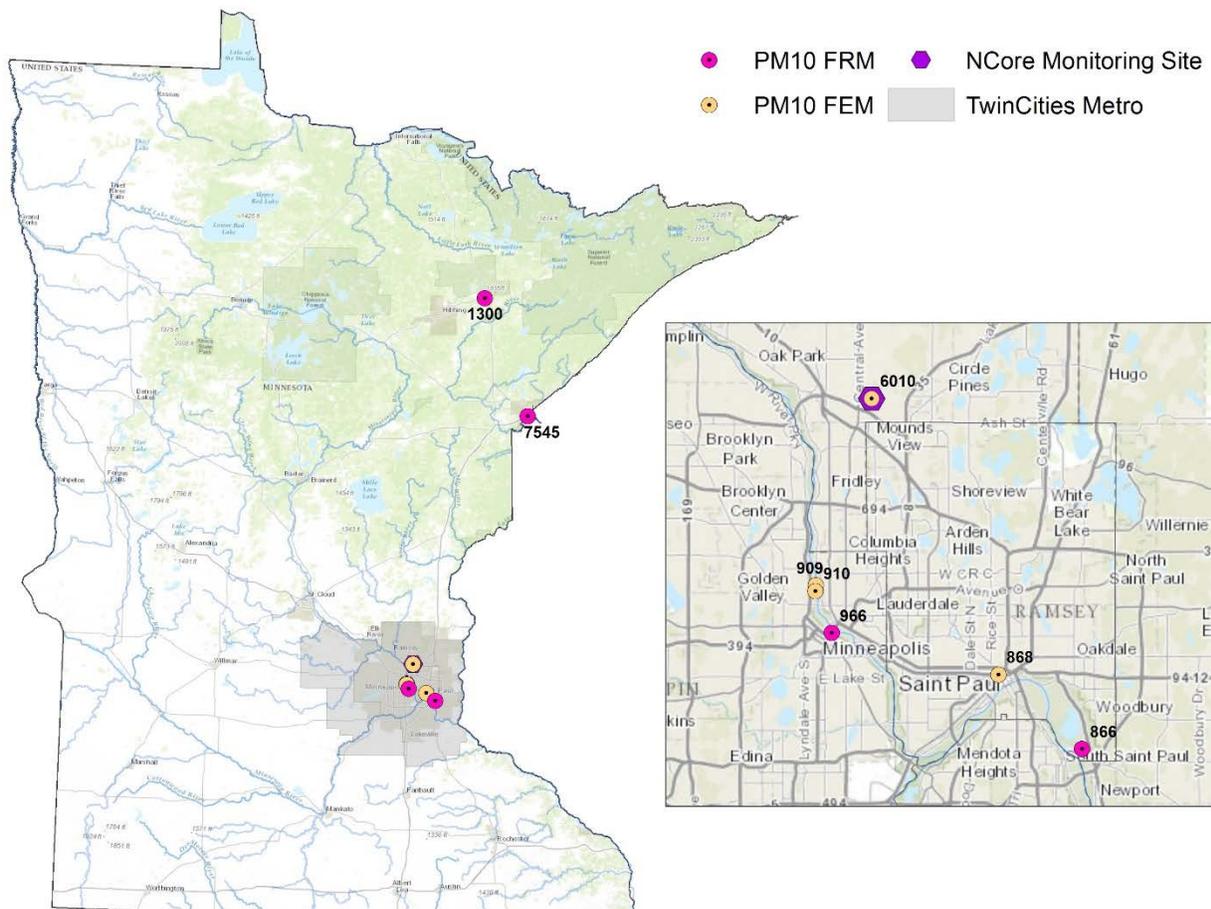


Figure 11: 2017 PM₁₀ monitoring sites in Minnesota

Minnesota currently meets applicable NAAQS for PM₁₀ at sites with three years of complete data, collected 2014-2016 (Figure 12). A monitoring site meets the 24-hour PM₁₀ NAAQS when the level of 150 $\mu\text{g}/\text{m}^3$ is not exceeded more than once per year, on average, over three years.

To describe the magnitude of daily PM₁₀ measurements, the MPCA reports the daily PM₁₀ background concentration, which is calculated following the methodology established in EPA's "PM₁₀ SIP Development Guidance" ([EPA-450/2-86-001, June 1987, Table 6-1](#)). Depending on the total number of samples collected over a three-year period, the daily PM₁₀ background concentration is calculated as the 1st, 2nd, 3rd, or 4th highest daily PM₁₀ concentration measured over three years. Minnesota values ranged from 60 $\mu\text{g}/\text{m}^3$ in St. Paul (868) to 100 $\mu\text{g}/\text{m}^3$ in St. Paul (866). There is no longer a MAAQS for PM₁₀; the annual MAAQS was revoked in December 2016 as the result of an omnibus rulemaking in the Minnesota state legislature.

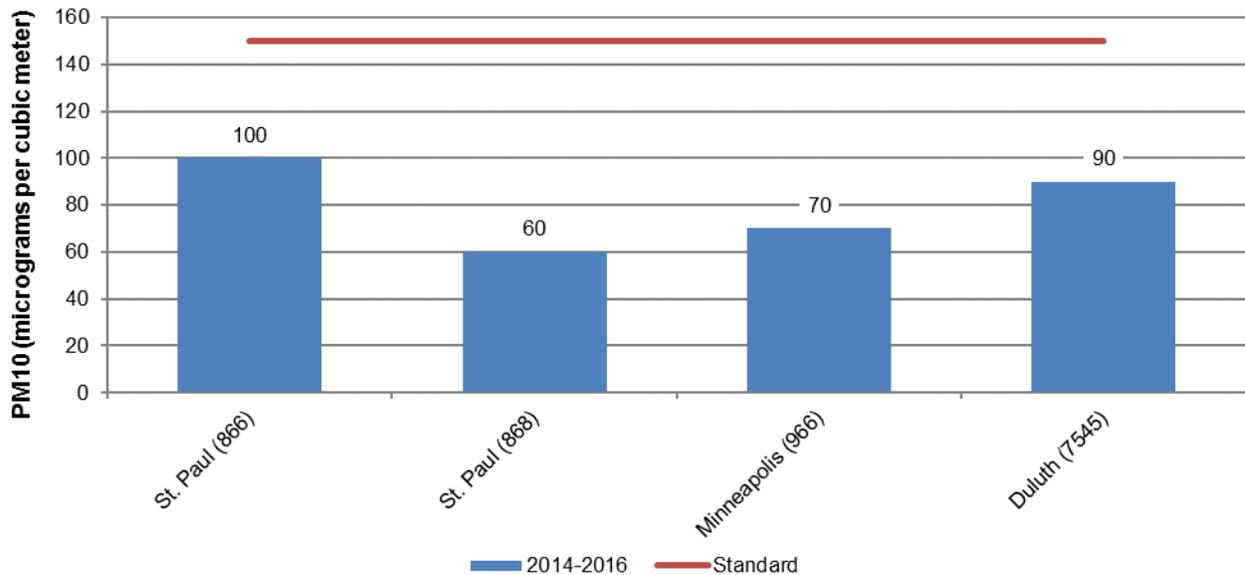


Figure 12: 24-hour PM₁₀ concentrations compared to the NAAQS, 2014-2016

Total suspended particulate matter (TSP)

TSP includes the total mass 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 pollutants, but was replaced by the PM₁₀ standard in 1987. Generally, smaller particles, such as PM₁₀ and PM_{2.5}, are expected to have greater health impacts than TSP. Today, TSP levels are regulated at the state level by the MAAQS. The MAAQS includes four distinct standards for TSP (Table 11).

Table 11: Minnesota Ambient Air Quality Standards for TSP

Standard Type	Time Interval	Level of Standard	A monitoring site meets the standard if...
Primary ¹	Daily (24-hour)	260 micrograms per cubic meter	...the annual 2 nd highest daily TSP concentration is less than or equal to 260 µg/m ³
	Annual	75 micrograms per cubic meter	...the annual geometric mean is less than or equal to 75 µg/m ³
Secondary ²	Daily (24-hour)	150 micrograms per cubic meter	...the annual 2 nd highest daily TSP concentration is less than or equal to 150 µg/m ³
	Annual	60 micrograms per cubic meter	...the annual geometric mean is less than or equal to 60 µg/m ³

¹A primary standard is set to protect against human health effects associated with exposure to an air pollutant.

²A secondary standard is set to protect against environmental or public welfare effects associated with exposure to an air pollutant.

The MPCA currently operates 18 TSP monitoring sites (Figure 13). Mass samples of TSP are collected over a 24-hour period once every six days. In addition to TSP, the filters are analyzed for metals, under the auspices of the air toxics program, using the ICAP-AES method. Metals are discussed further in the air toxics section of this report (beginning on page 40).

In 2016 a TSP monitor was added to South St. Anthony Park (1908) as part of the Community Air Monitoring Project; this monitor was moved in 2017, after collecting one year of data. The new site is in the Bottineau/Marshall Terrace neighborhood (1909). More information can be found on the project website, <https://www.pca.state.mn.us/air/community-air-monitoring-project>. Site 1909 will operate through mid-2018.

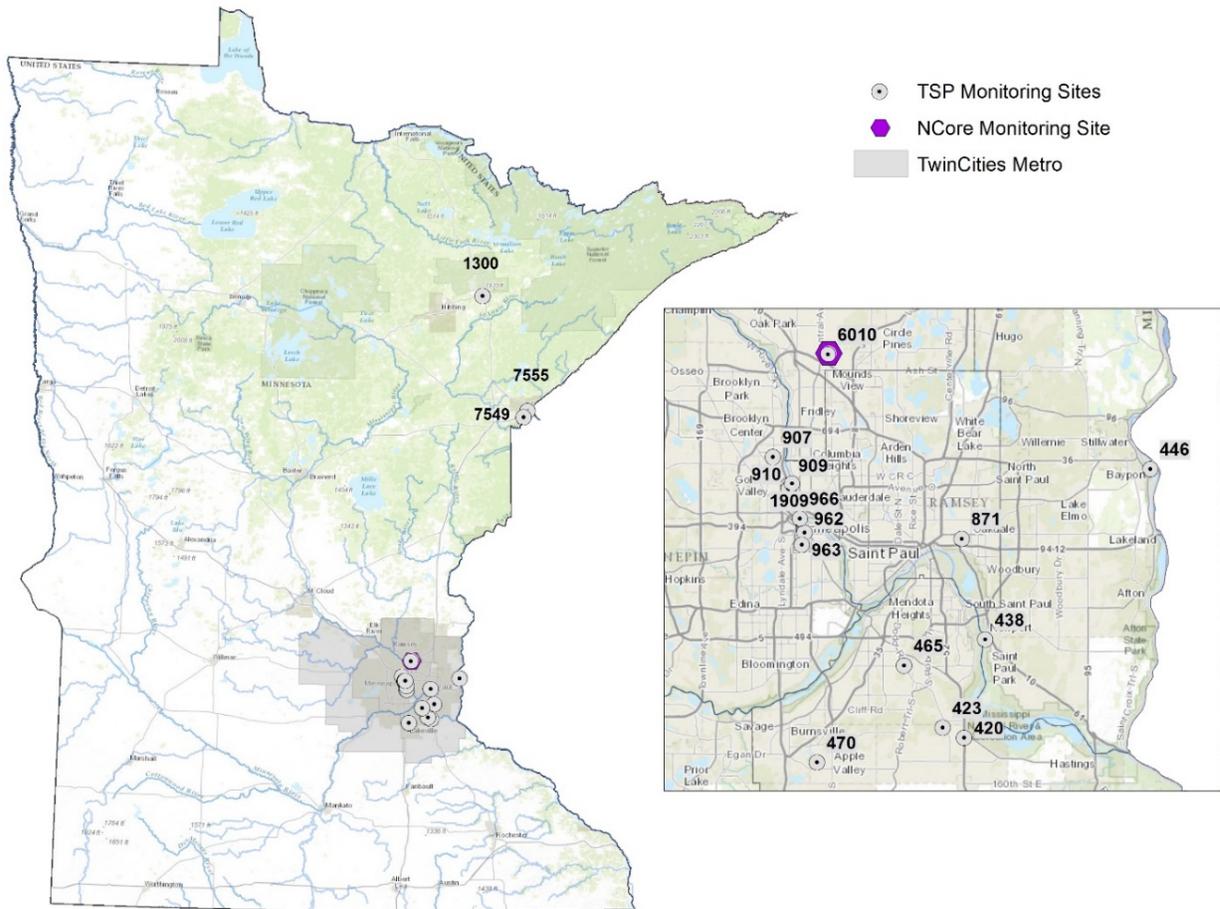


Figure 13: 2017 TSP monitoring sites in Minnesota

In 2016, Minnesota annual TSP averages ranged from 20 $\mu\text{g}/\text{m}^3$ in Blaine (6010) and Bayport (446) to 105 $\mu\text{g}/\text{m}^3$ at the Minneapolis Pacific Street (910) site. The Minneapolis Pacific Street site (910) is the only site that violated the annual primary MAAQS in 2016, but the Minneapolis Lowry Avenue site (909) also violated the annual secondary TSP MAAQS (Figure 14). There were no other primary or secondary violations.

Recurring TSP MAAQS violations at the Minneapolis Lowry Avenue (909) and Pacific Street (910) sites, which collectively bracket the Northern Metal Recycling facility, have caused the location to come under scrutiny. These violations and other concerns have resulted in a settlement with Northern Metals that involves the relocation of the facility outside of the urban metro area. More information regarding the settlement process and results is available on the MPCA's website, at <https://www.pca.state.mn.us/air/north-minneapolis-air-monitoring-project>.

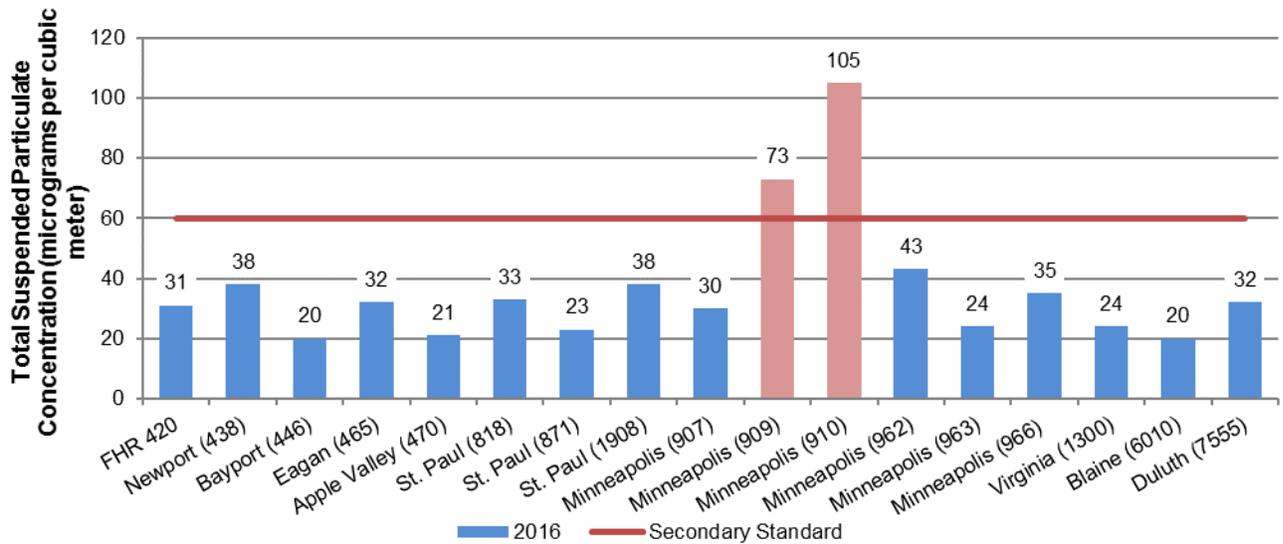


Figure 14: Annual average TSP concentrations compared to the secondary MAAQS, 2016

In 2016, daily TSP values in Minnesota ranged from 55 µg/m³ in Bayport (446) to 455 µg/m³ at the Minneapolis Pacific Street site (910) (Figure 15). The Minneapolis Pacific Street site violated the daily primary TSP MAAQS (910). Three additional sites violated the daily secondary TSP standard - St. Paul (1908), Minneapolis Lowry Avenue (909), and Duluth (7555). All other sites met both the primary and secondary TSP standards.

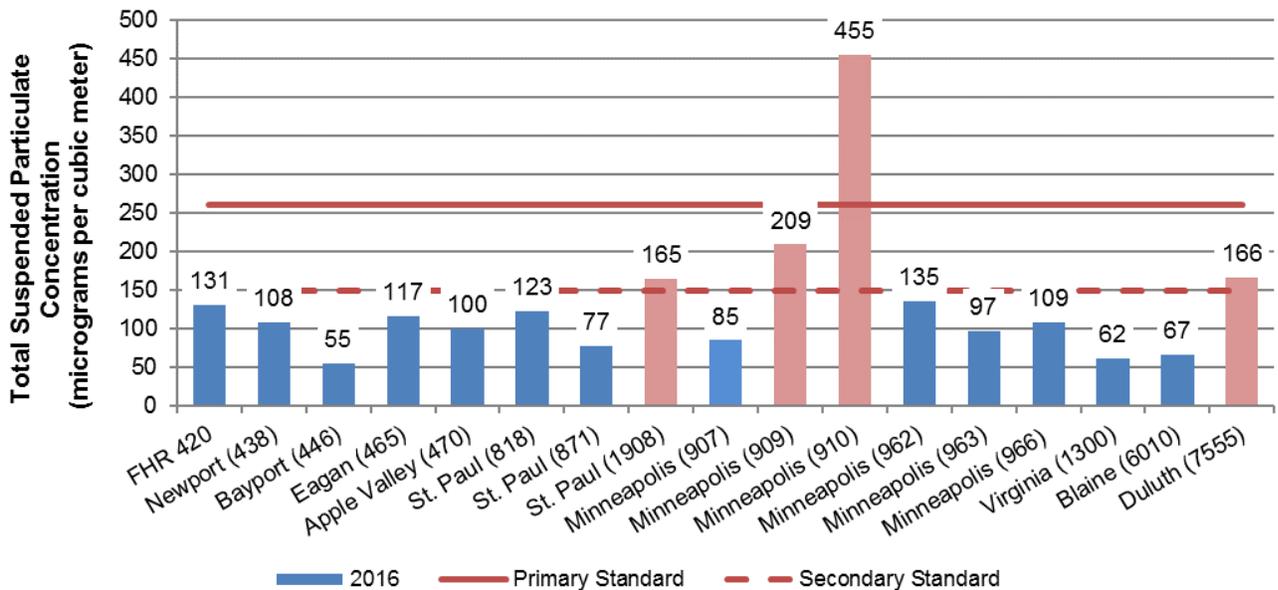


Figure 15: 24-hour (daily) TSP concentrations compared to the primary and secondary MAAQS, 2016

Lead (Pb)

Lead (Pb) is a metal found naturally in the environment, as well as in manufactured products. After lead was removed from gasoline, air emissions and ambient air concentrations 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 can be 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 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 levels are also detrimental to animals and to the environment. Ecosystems near sources 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.

The MPCA monitors lead at 18 sites, of which one is a source-oriented monitoring site: Gopher Resources Corporation in Eagan (465). As part of our air toxics program, the MPCA also monitors lead and 12 other heavy metals at 17 additional TSP sites, including one new CAMP site in the Minneapolis Bottineau/Marshall Terrace neighborhood (site 1909) (Figure 16). The monitor at site 1909 will operate through mid-2018.

All lead monitoring sites in Minnesota meet the 2008 lead NAAQS of $0.15 \mu\text{g}/\text{m}^3$ based on the most recent data, which show the three-year maximum rolling quarter average concentration at monitored sites from 2014-2016. Minnesota values range from $0.00 \mu\text{g}/\text{m}^3$ at several locations to $0.13 \mu\text{g}/\text{m}^3$ in Eagan (465); the majority of sites are at levels equal to or less than $0.01 \mu\text{g}/\text{m}^3$ (Figure 17).

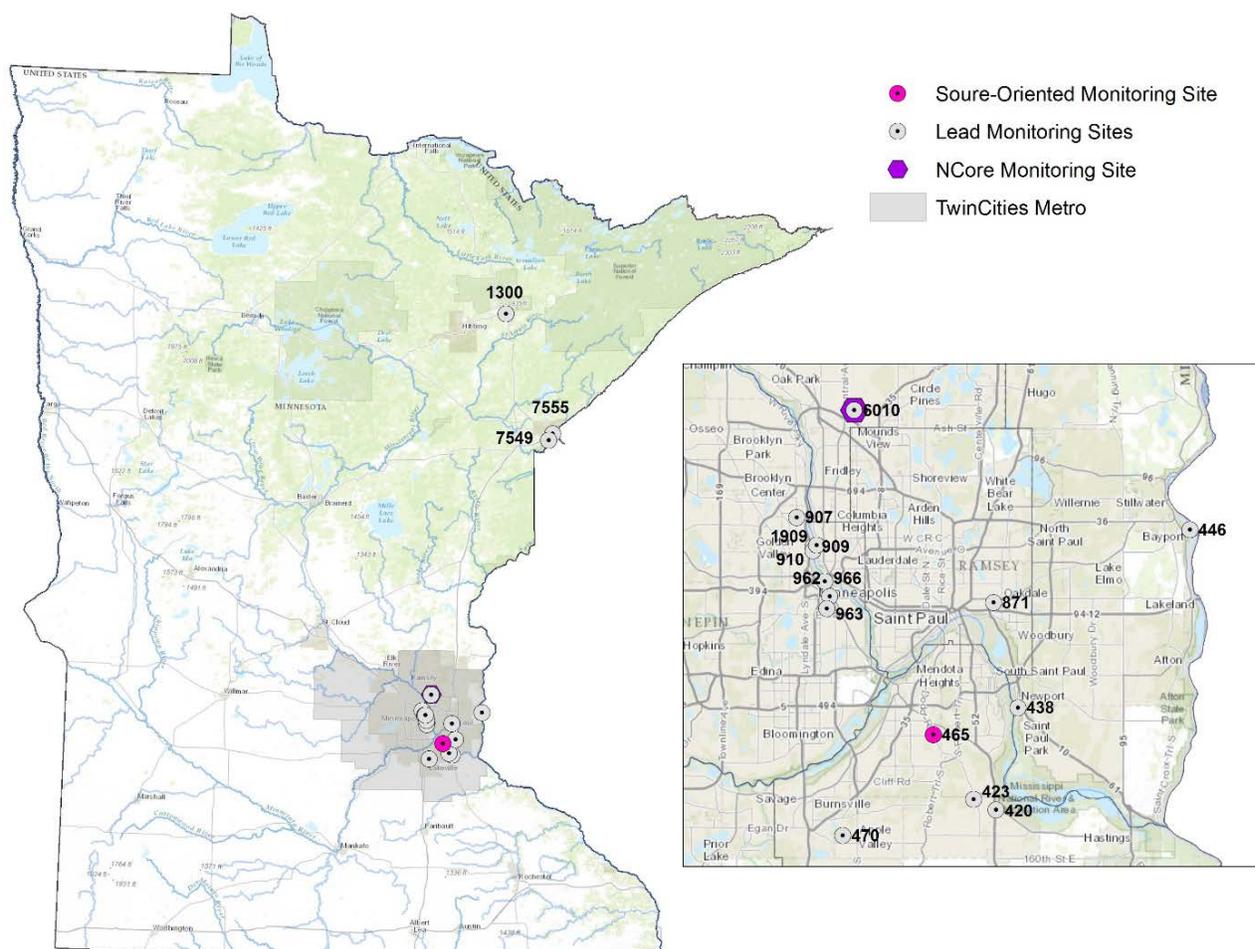


Figure 16: 2017 Lead monitoring sites in Minnesota

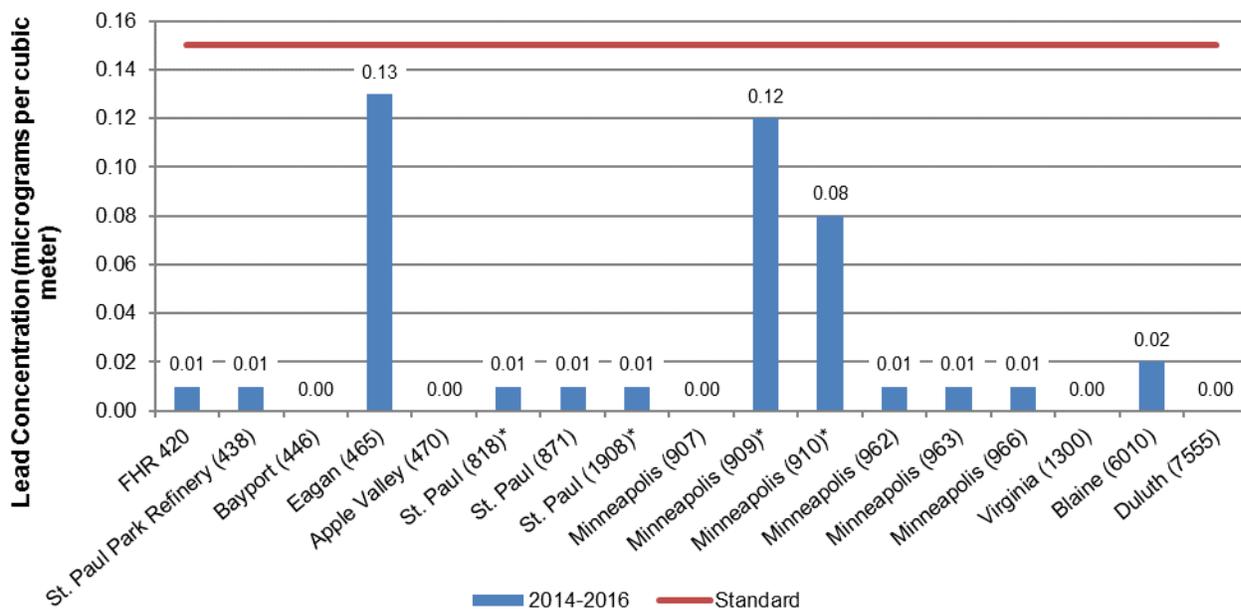


Figure 17: Lead concentrations compared to the NAAQS, 2014-2016. *Sites 818, 909, 910, and 1908 have not been monitored for three years and, therefore, cannot be compared to the NAAQS for lead.

Ozone (O₃)

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

Breathing air containing ozone can reduce lung function and inflame airways, which may, in turn, 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. Exposure increases the risk of premature death from heart and lung disease. Children are at increased risk 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, increased susceptibility to disease and damage from insects, and harsher weather. These effects can have adverse impacts on ecosystems, including loss of species and changes to habitat quality and water and nutrient cycles.

MPCA monitors ozone at 16 monitoring sites. An additional monitor, located at Voyageurs National Park (AQS site 27-137-0034 or VOYA2), is operated by the National Park Service (Figure 18). Since the MPCA does not have any role in the maintenance or use of this monitor, it is not included in our SLAMS or AQI monitoring networks.

As ozone formation requires high temperatures and sunny conditions, the EPA only requires Minnesota to monitor ozone seasonally. Beginning in 2017, the ozone monitoring season will be scheduled to run from March 1 through October 31 each year. The majority of ozone monitoring in Minnesota follows this seasonal schedule; the exception is the NCore site in Blaine (6010), at which ozone is monitored year-round. Additional ozone monitors may operate year-round to support modeling or research. The data collected from ozone monitors are used to determine compliance with the NAAQS, and are reported as part of the AQI.

No changes in ozone monitoring are expected in 2018.

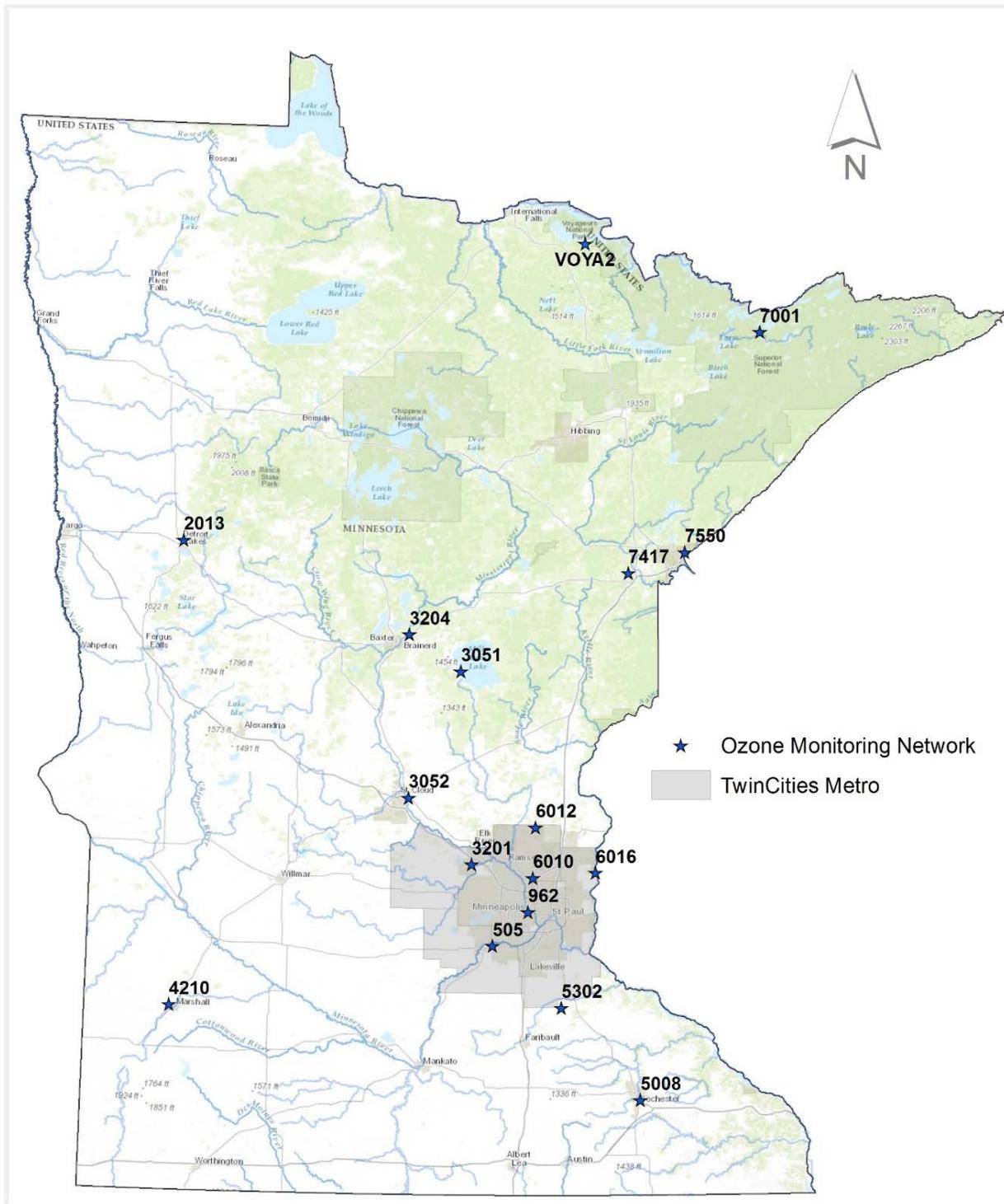


Figure 18: 2017 Ozone monitoring sites in Minnesota

A monitoring site meets the primary ozone NAAQS if the three-year average of the 4th highest daily maximum 8-hour concentration is less than or equal to 70 ppb. From 2014-2016, Minnesota eight-hour averages ranged from 53 ppb in Duluth (7550) to 63 ppb in Blaine (6010). All sites were below the eight-hour standard (Figure 19).

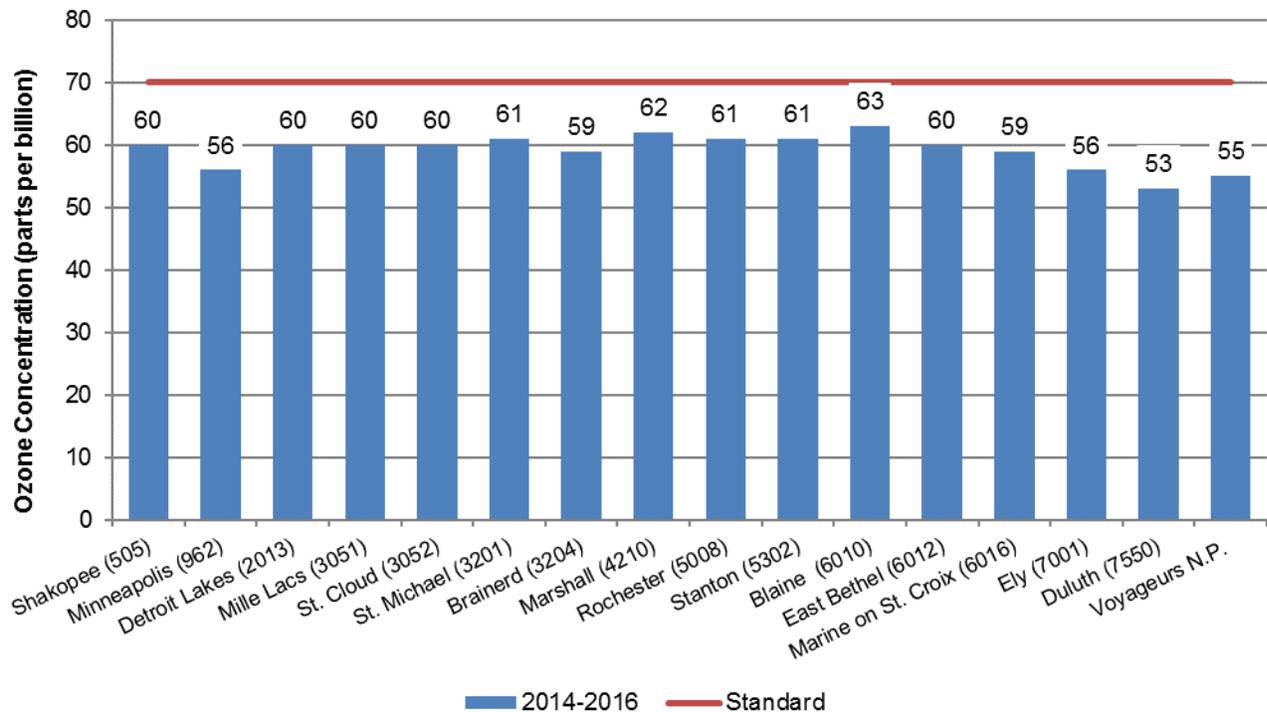


Figure 19: 8-hour average ozone concentrations compared to the NAAQS, 2014-2016

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 (nitrogen) oxide (NO) and nitrogen dioxide (NO₂). NO₂ is the federally regulated pollutant; it can often be seen as a reddish-brown layer in the air over urban areas.

NO_x contribute to a wide range of health and environmental effects. NO₂ itself can irritate the lungs and lower resistance to respiratory infections. More importantly, NO_x react to form ground-level ozone, PM_{2.5}, acid rain, and other toxic chemicals. NO_x can also lead to visibility and water quality impairment due to increased nitrogen loading in water bodies. Nitrous oxide (N₂O), another component of NO_x, is a greenhouse gas that contributes to climate change.

Currently, the MPCA monitors NO₂ and NO at five sites in the Twin Cities metropolitan area (Figure 20). Trace-level NO/NO_y has been monitored at the NCore site in Blaine (6010) since 2009. This trace-level data will help us understand the role of these pollutants at levels far below the NAAQS; due to performance issues with the monitoring equipment, however, trace-level monitoring results had been unreliable and/or incomplete. The trace-level NO/NO_y analyzer at the NCore site in Blaine (6010) was replaced and tested in early 2014; valid data collection resumed as of May 1, 2014 and is ongoing.

In February 2010, the EPA finalized new minimum monitoring requirements for the NO₂ monitoring network in support of a one-hour NO₂ NAAQS. Per the new requirements, state and local air agencies were required to install near-road NO₂ monitoring stations at locations where peak hourly NO₂ concentrations are expected to occur within the near-road environment in large urban areas. The Minneapolis-St. Paul-Bloomington CBSA is the only area in Minnesota that requires near-road monitoring. Two monitoring stations had to be installed by January 2015. The first near-road monitoring site (962), along I-94 and I-35W in downtown Minneapolis, began operating in January 2013. The second near-road monitoring site (480), along I-35 in Lakeville, began operating on January 1, 2015. MPCA near-road air quality monitoring is

described in more detail on the MPCA near-road website, at <https://www.pca.state.mn.us/air/near-road-monitoring>.

No changes to the NO_x network are expected in 2018.

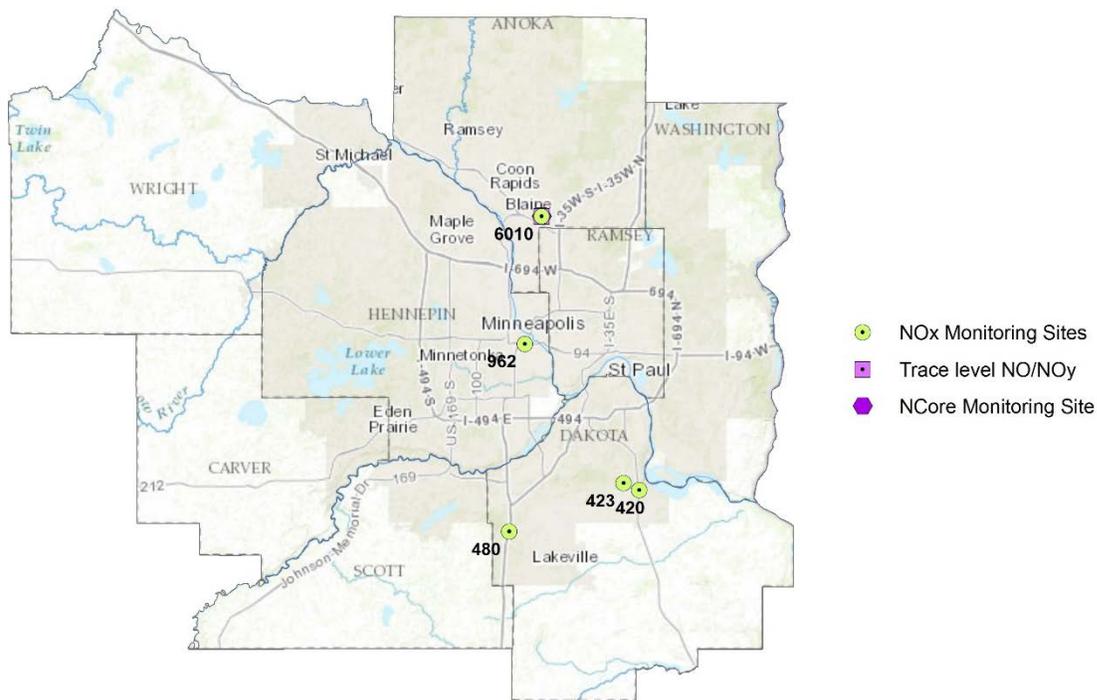


Figure 20: 2017 NO_x monitoring sites in the Twin Cities metropolitan area

A monitoring site meets the annual NAAQS for NO₂ if the annual average is less than or equal to 53 ppb. Minnesota averages ranged from 5 ppb at Flint Hills Refinery 423 to 13 ppb at the Near Road I-35/I-94 site (962); therefore, Minnesota currently meets the annual NAAQS for NO₂ (Figure 21).

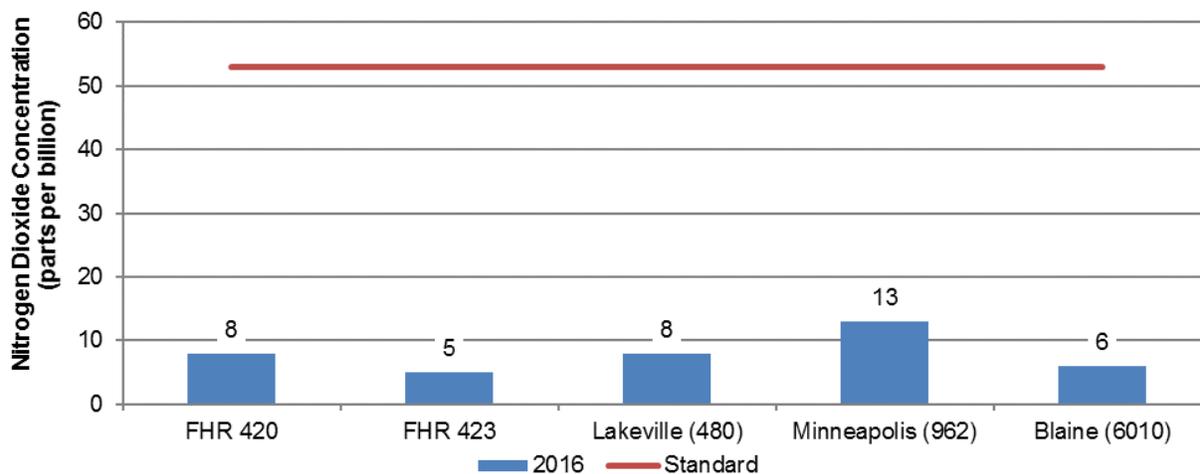


Figure 21: Annual average NO₂ concentrations compared to the NAAQS, 2016

On January 22, 2010 the EPA finalized revisions to the NO₂ NAAQS. As part of the standard review process, the EPA retained the existing annual NO₂ NAAQS, but also created an additional one-hour standard. The new one-hour NAAQS is intended to protect against adverse health effects associated with short-term exposures

to elevated NO₂. To meet this standard, the three-year average of the annual 98th percentile daily maximum one-hour NO₂ concentration must not exceed 100 ppb. Minnesota averages ranged from 26 ppb at Flint Hills Refinery 423 to 46 ppb at Blaine (6010); therefore, all Minnesota sites currently meet the one-hour NAAQS for NO₂ (Figure 22).

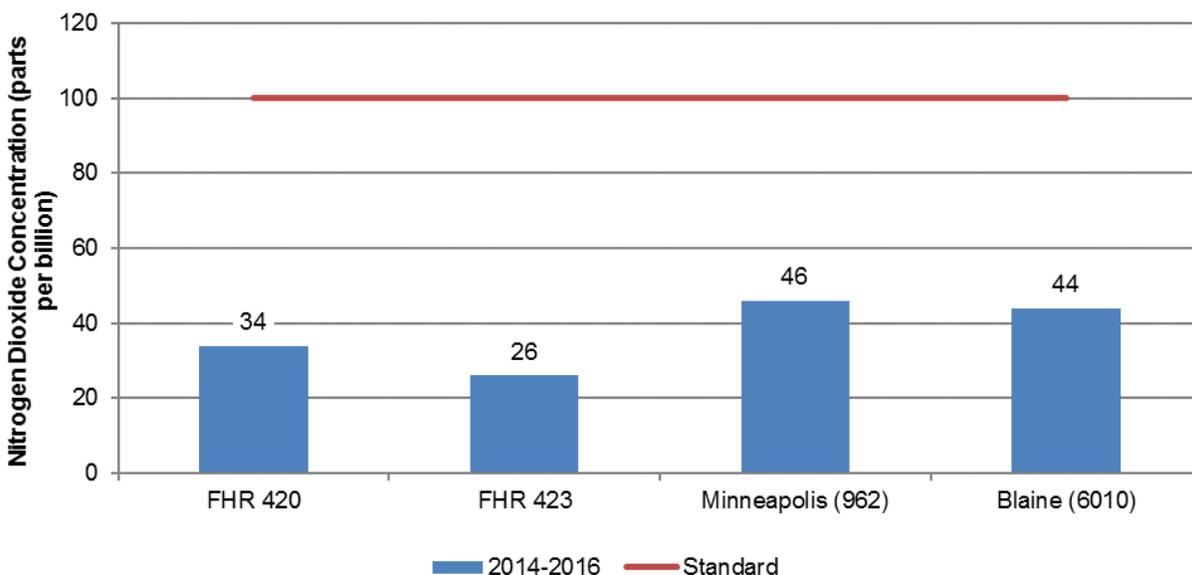


Figure 22: 1-hour NO₂ concentrations compared to the NAAQS, 2014-2016

Sulfur dioxide (SO₂)

SO₂ belongs to the family of sulfur oxide (SO_x) gases. SO₂ reacts with other chemicals in the air to form sulfate particles. Exposure to SO₂, sulfate aerosols, and PM_{2.5} contribute to respiratory illness, and aggravate existing heart and lung diseases. High levels of SO₂ emitted over a short period, such as throughout the course of a day, can be particularly problematic for people with asthma. SO₂ also contributes to the formation of PM_{2.5}, visibility impairment, and acid rain. SO₂ is monitored on a continuous basis; data are reported in hourly increments. Collected data are used to determine compliance with the NAAQS and are reported as part of the AQI. Minnesota currently meets all applicable NAAQS for SO₂; however, continued reductions are sought due to its role in forming PM_{2.5}.

The MPCA monitors SO₂ at six sites in the Twin Cities metropolitan area (Figure 23). In 2014, an SO₂ monitor was added to Rochester (5008); monitoring there was discontinued at the end of 2016, after collecting 3 years of data. Trace level SO₂ at the NCore site in Blaine (6010) will help us understand the role of SO₂ at levels far below the NAAQS.

No changes are planned for SO₂ monitoring in 2018.

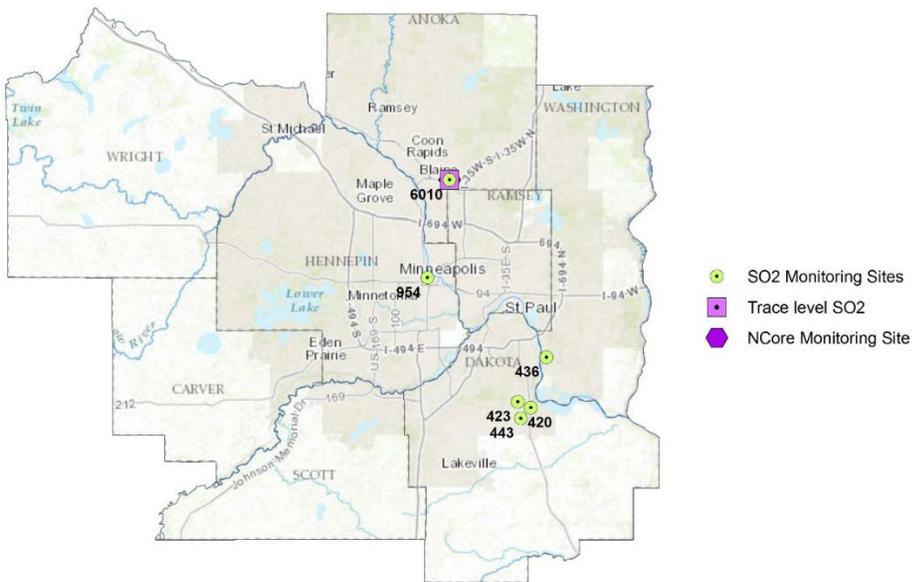


Figure 23: 2017 SO₂ monitoring sites in the Twin Cities metropolitan area

On June 2, 2010, the EPA finalized revisions to the primary SO₂ NAAQS. EPA established a new one-hour standard, which is met if the three-year average of the annual 99th percentile daily maximum one-hour SO₂ concentration is less than 75 ppb. Previous standards were revoked under the new rule. Minnesota averages from 2014-2016 ranged from 2 ppb at Rochester (5008) to 12 ppb at Flint Hills Refinery (420); therefore, all Minnesota sites currently meet the one-hour NAAQS for SO₂ (Figure 24).

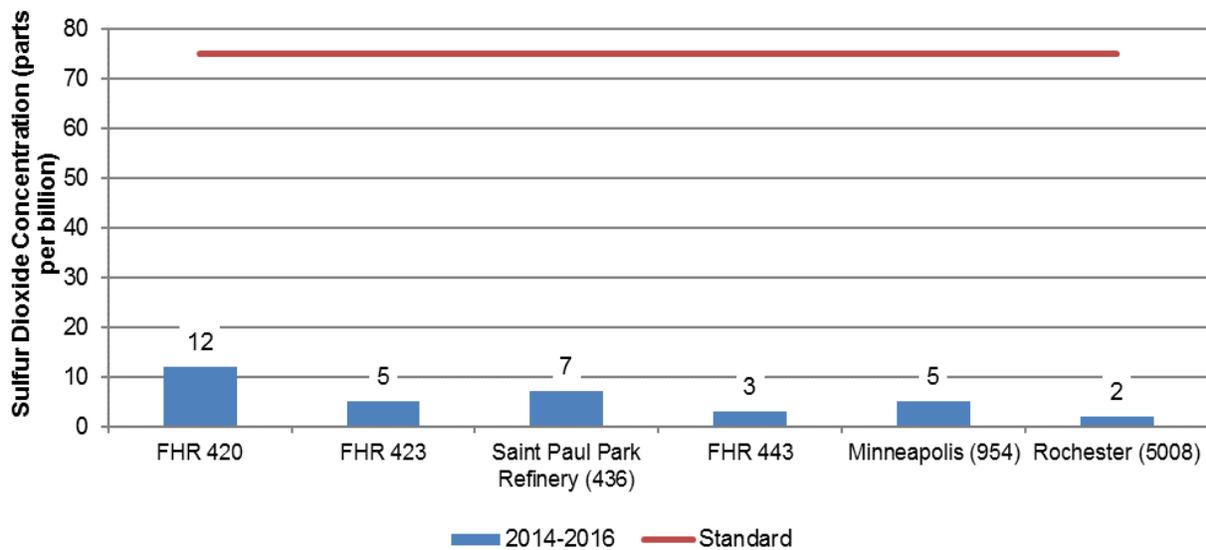


Figure 24: 1-hour SO₂ concentrations compared to the NAAQS, 2014-2016

In addition to evaluating the monitored sites in Minnesota’s network for compliance with the 2010 SO₂ one-hour standard, in 2015 EPA finalized requirements for air agencies to monitor or model SO₂ levels in areas with large sources of SO₂ emissions. The rule required air agencies to characterize air quality around sources that emit 2,000 tons per year (TPY) or more of SO₂. The MPCA identified four sources with emissions above 2,000 TPY. Additional information can be found in Appendix B: Minimum Monitoring Requirements and 2017 Monitor Classifications in AQS.

Carbon monoxide (CO)

CO is a colorless, 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 (CO₂), which contributes to climate change.

The MPCA monitors CO at seven sites in the Twin Cities metropolitan area (Figure 25). CO is monitored on a continuous basis, and is reported in hourly increments. Data are used to determine compliance with the NAAQS, and are reported as part of the AQI. Trace-level CO at the NCore site in Blaine (6010) also helps us understand the role of CO at levels far below the NAAQS.

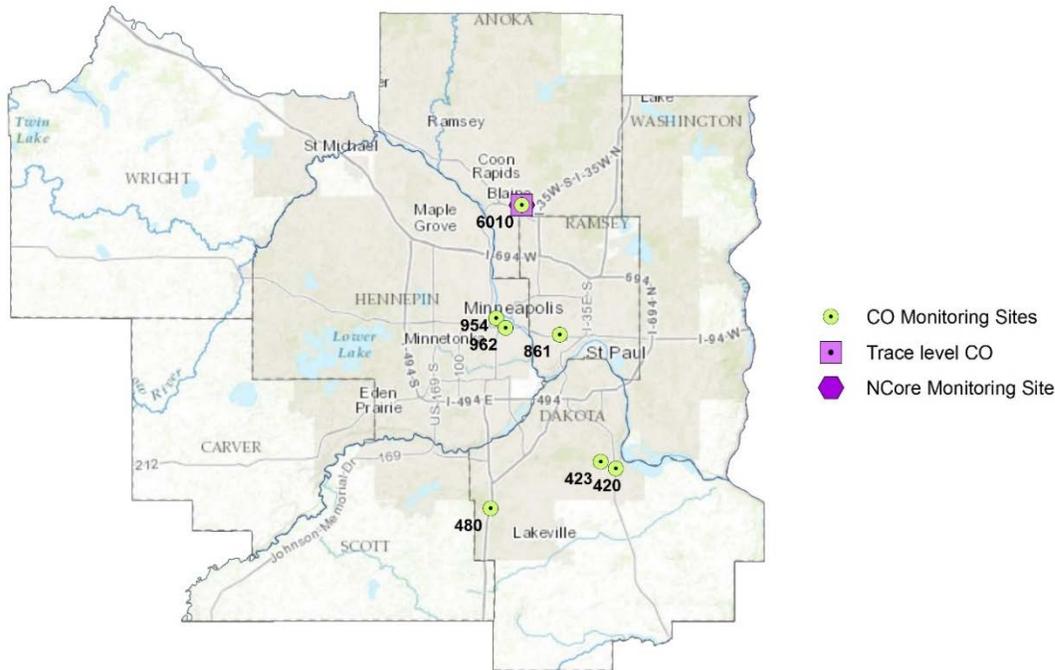


Figure 25: 2017 CO monitoring sites in the Twin Cities metropolitan area

Minnesota currently meets applicable eight-hour NAAQS for CO. A monitoring site meets the eight-hour CO NAAQS when the level of 9 ppm is not exceeded more than once per year. Minnesota values in 2016 ranged from 0.5 ppm at the Flint Hills Refinery sites (420 and 423) to 1.7 ppm at St. Paul (861) (Figure 26). There is currently no secondary NAAQS for CO.

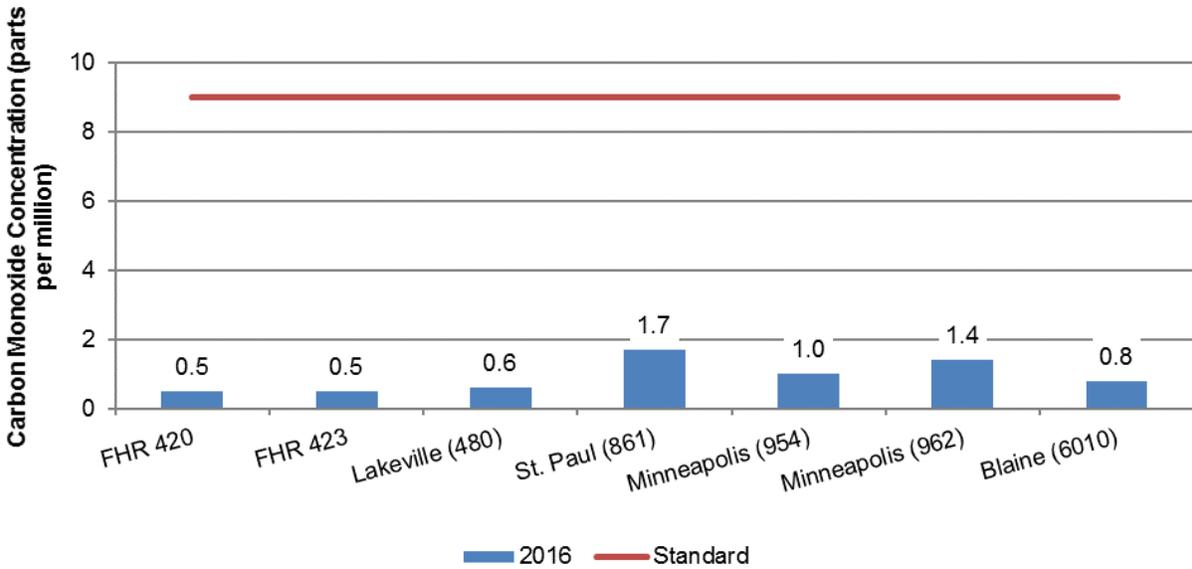


Figure 26: 8-hour average CO concentrations compared to the NAAQS, 2016

The one-hour CO NAAQS is met when the level of 35 ppm is not exceeded more than once per year. Minnesota values in 2016 ranged from 0.8 ppm at the Flint Hills Refinery sites (420 and 423) to 2.3 ppm in St. Paul (861) (Figure 27).

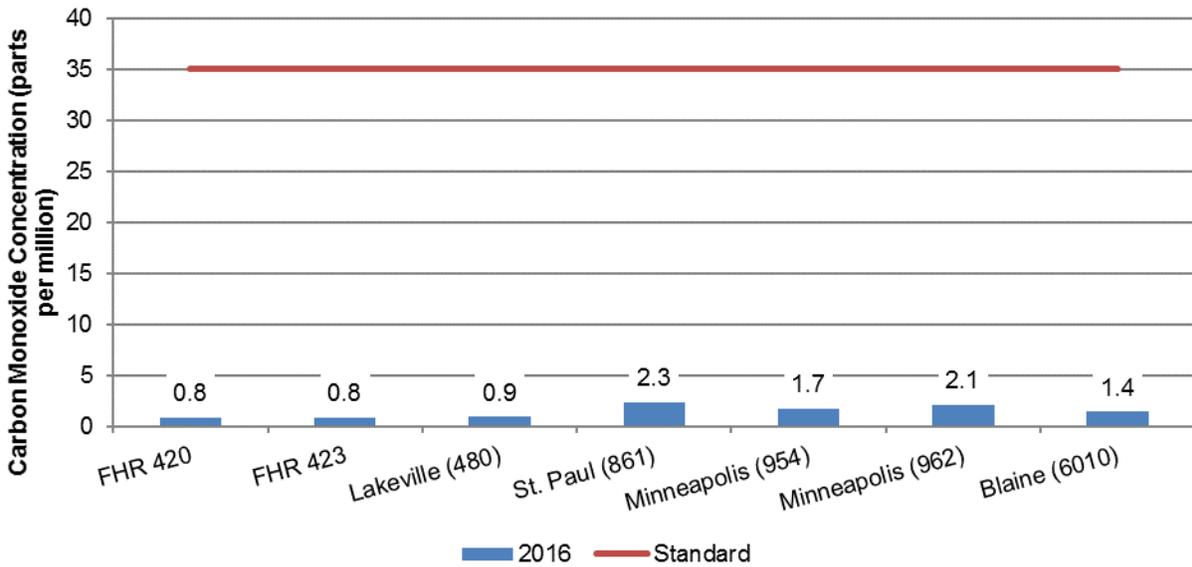


Figure 27: 1-hour average CO concentrations compared to the NAAQS, 2016

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 CAA Amendments (see <http://www.epa.gov/ttn/atw/orig189.html> for a list of HAPs). There are no federal requirements for air toxics monitoring, but the MPCA monitors for a variety of compounds in order to understand potential risks to Minnesota citizens and to track reductions in emissions and concentrations.

The MPCA uses guidelines, called health benchmarks, to determine risk. Health benchmarks come from a variety of sources, including the Minnesota Department of Health, <http://www.health.state.mn.us/divs/eh/risk/guidance/air/table.html>; the EPA's Integrated Risk Information System (IRIS), <http://www.epa.gov/iris/>; California's Office of Health Hazard Assessment (OEHHA), <http://www.oehha.ca.gov/air.html>; and EPA's Superfund Program, <https://hhpprtv.ornl.gov/>.

The MPCA monitors three types of air toxics: 55 VOCs, 7 carbonyls, and 13 metals (Figure 29). For information on concentrations of and risks from air toxics in Minnesota, visit the MPCA website at <https://www.pca.state.mn.us/air/air-toxics-minnesota>. Samples are collected once every six days, over a 24-hour period; the resulting concentration is a 24-hour average.

In 2017, air toxics monitors were added to Bottineau/Marshall Terrace (1909) as part of the Community Air Monitoring Project; more information can be found on the project website (<https://www.pca.state.mn.us/air/community-air-monitoring-project>). Monitoring at site 1909 will continue through mid-2018. Monitoring at South St. Anthony Park (1908) and at the St. Paul Downtown Airport (818) were one-year projects, and the sites were closed in December 2016. No other changes to the air toxics network are expected in 2018.

Air Toxics Monitoring Web App

Annual air toxics monitoring results from 2002 through 2016 are available online at <https://www.pca.state.mn.us/air/air-toxics-data-explorer>. The Minnesota Air Toxics Monitoring Web App provides interactive maps, charts, and data tables that summarize annual air toxics monitoring results (see example of formaldehyde in Figure 28).

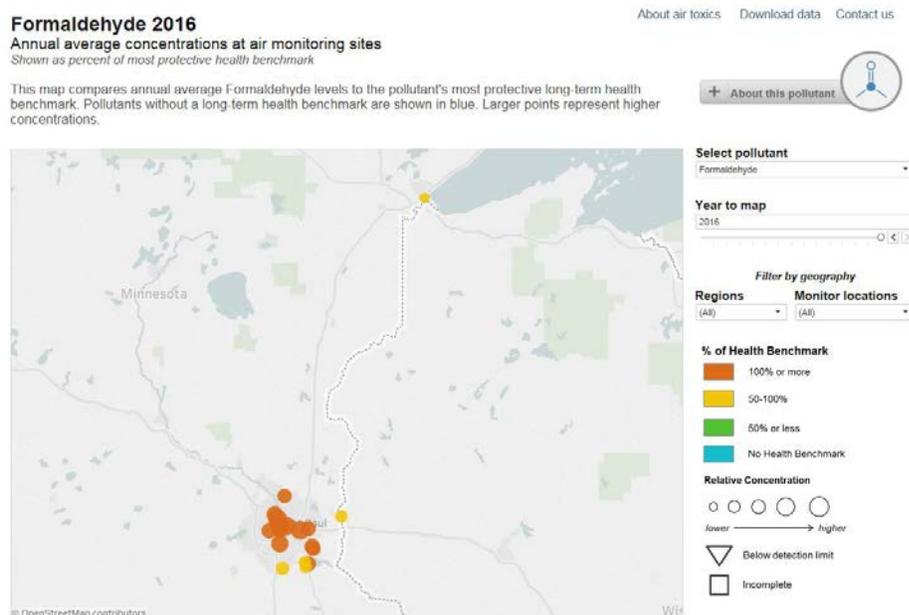


Figure 28: Air Toxics Monitoring Web App for formaldehyde, data year 2016

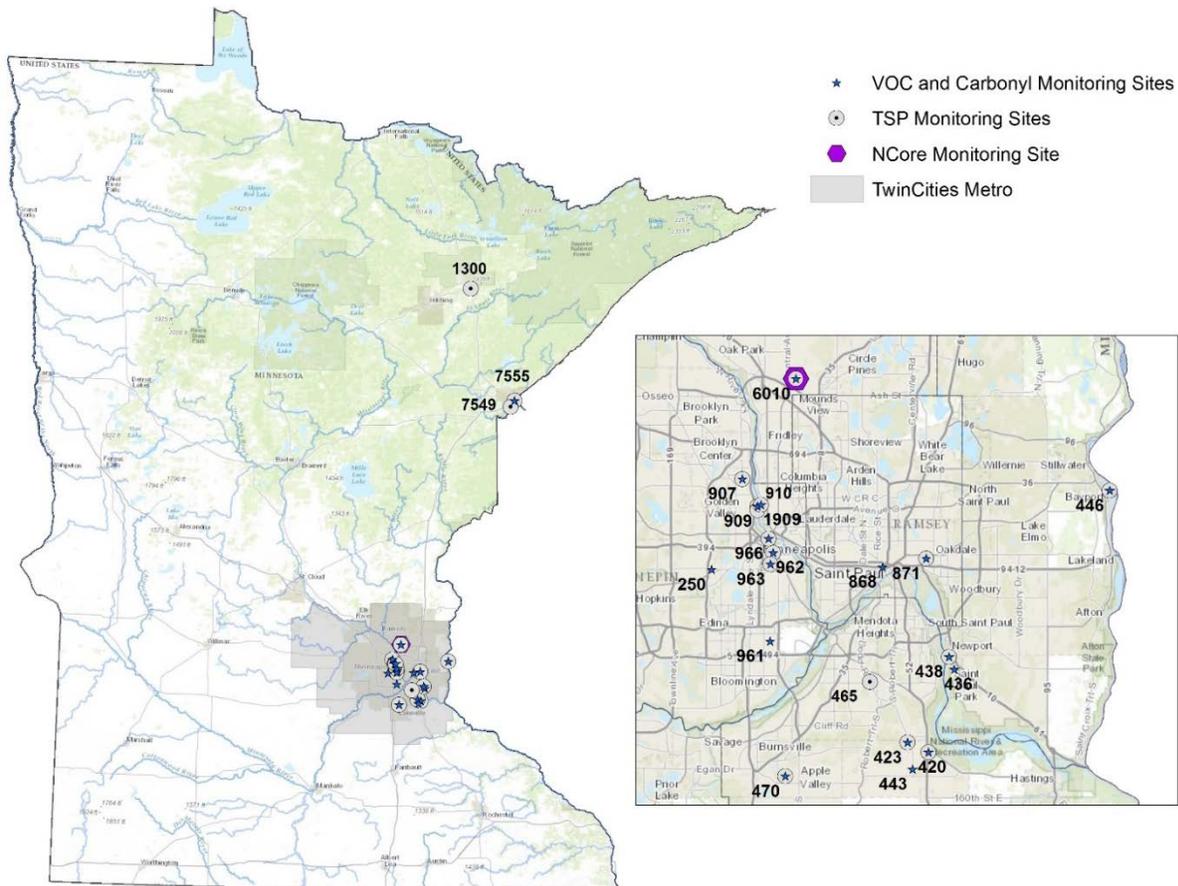


Figure 29: 2017 Air toxics monitoring sites in Minnesota

Metals

The MPCA monitors metals at 18 TSP monitoring sites in Minnesota. These sites are primarily located in the Twin Cities metropolitan area, with additional sites in Virginia (1300) and Duluth (7555) (see Figure 29). Network siting, operation, and periodic flow verification adhere to QA requirements defined in 40 CFR Part 58 and all applicable appendices.

Metals are extracted from TSP filters and are analyzed using ICAP-AES, following an EPA FEM method for lead determination ([EQL-0311-196](#)). There are 13 metals that MPCA is tracking in the state (Table 12).

During the three-month Community Air Monitoring Project sampling period in the St. Paul West Side neighborhood, monitoring results indicated average metal values were below health benchmarks but were higher than other Twin Cities metro monitoring sites. In addition, the three-month average lead concentration was $0.09 \mu\text{g}/\text{m}^3$, which is more than 50% of the lead standard ($0.15 \mu\text{g}/\text{m}^3$). In response to these elevated metals levels, the MPCA established a monitoring site at the St. Paul Downtown Airport (818) to evaluate lead levels and potential sources near the original Community Air Monitoring Project site. The monitor did not show elevated metals concentrations and the site was closed in December 2016 after a complete year of monitoring.

In 2017, air toxics monitors, including metals, were added in the Bottineau/Marshall Terrace (1909) neighborhood in Minneapolis as part of the Community Air Monitoring Project; more information can be found on the project website (<https://www.pca.state.mn.us/air/community-air-monitoring-project>). Monitoring at site 1909 will continue through mid-2018. Monitoring at South St. Anthony Park (1908) was a one-year project, and the site was closed in December 2016. No other changes to the metals network are expected in 2018.

Table 12: 2017 Metals monitored by MPCA

Parameter	CAS #	EPA Parameter Code
Antimony (Sb)	7440-36-0	12102
Arsenic (As)	7440-38-2	12103
Barium (Ba)	7440-39-3	12107
Beryllium (Be)	7440-41-7	12105
Cadmium (Ca)	7440-43-9	12110
Chromium (Cr)	16065-83-1	12112
Cobalt (Co)	7440-48-4	12113
Iron (Fe)	15438-31-0	12126
Lead (Pb)	7439-92-1	14129
Manganese (Mn)	7439-96-5	12132
Nickel (Ni)	7440-02-0	12136
Selenium (Se)	7782-49-2	12154
Zinc (Zn)	7440-66-6	12167

Volatile organic compounds (VOCs) and carbonyls

The MPCA analyzes samples for seven carbonyls (Table 13) and 55 VOCs (Table 14). Samples are analyzed using EPA Compendium Methods TO-15 for VOCs and TO-11A for carbonyls.

The MPCA monitors VOCs and carbonyls at 19 sites in Minnesota (see Figure 29). These sites are primarily located in the Twin Cities metropolitan area, with an additional site for VOCs and carbonyls in Duluth (7549).

In 2017, air toxics monitors were added to the Bottineau/Marshall Terrace (1909) neighborhood in Minneapolis as part of the Community Air Monitoring Project; more information can be found on the project website (<https://www.pca.state.mn.us/air/community-air-monitoring-project>). Monitoring at site 1909 will continue through mid-2018. Monitoring at South St. Anthony Park (1908) was a one-year project and the site was closed in December 2017. No other changes to the VOC and carbonyl network are expected in 2018.

Table 13: 2017 Carbonyls monitored by MPCA

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
Trans-Crotonaldehyde	123-73-9	43516
Formaldehyde	50-00-0	43502
Propionaldehyde	123-38-6	43504

Table 14: 2017 VOCs monitored by MPCA

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
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 methacrylate	91-20-3	43441
Methyl tert-butyl ether	1634-04-4	43372
Naphthalene	80-62-6	17141
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

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 Hg and methylmercury concentrations. It supports a regional database of the weekly concentrations of Hg in precipitation and the seasonal and annual flux of total Hg in wet deposition.

No changes are expected for the NADP network in 2018.

Acid deposition (NTN)

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; resulting air pollution contains SO₂ 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 monitoring sites that are part of the NADP (<http://nadp.sws.uiuc.edu/>) to monitor acid rain and Hg. 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 and is 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 (Figure 30).

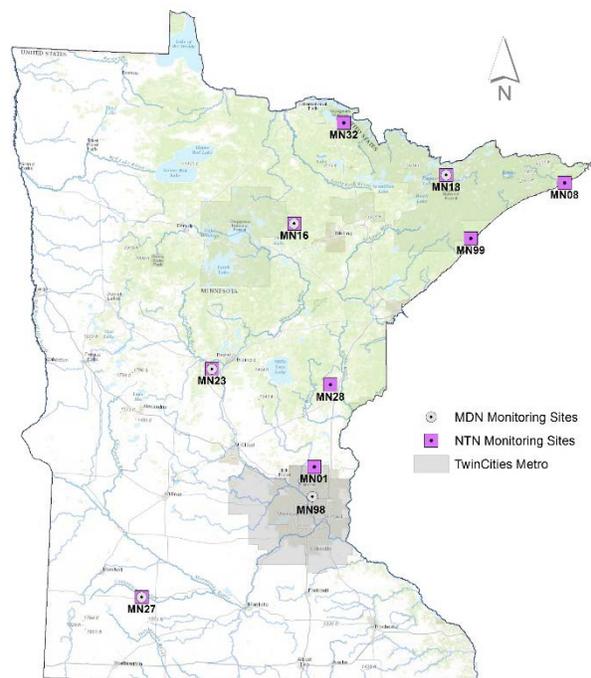


Figure 30: Atmospheric deposition sites in Minnesota

Mercury (Hg) deposition (MDN)

Wide-spread mercury contamination of fish is a well-documented problem in Minnesota. The Minnesota Department of Health (MDH) advises people to restrict their consumption of large sport fish from all lakes and rivers. More than 95% 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% 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), <http://nadp.sws.uiuc.edu/mdn/>, which began in 1996 and now consists of over 85 sites nationwide. MDN monitors collect 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 Lambertson (MN27). A site at Mille Lacs (MN22) operated from April 2002 to April 2007. An urban site opened in Blaine (MN98) in February 2008; this location is also currently operational, bringing the total number of MDN sites to five (Figure 30).

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 few of the sites participate in the methylmercury analysis.

The MPCA 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 (H₂S)

H₂S is a flammable, colorless gas that smells like rotten eggs, even at low levels. H₂S occurs naturally in sources such as crude petroleum and natural gas, results from bacterial breakdown of organic matter, and is produced by human and animal wastes. Exposure to low concentrations of H₂S may cause irritation to the eyes, nose, and throat, and may also cause difficulty breathing for some asthmatics. Industrial activities such as food processing, coke ovens, kraft paper mills, petroleum refineries, and confined animal feedlots also emit H₂S.

Minnesota's state standard for H₂S 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. H₂S is primarily a concern in the summer, when biological activity is at a peak. The MPCA has monitored several confined animal feedlots and municipal wastewater facilities as a result of odor complaints and health concerns. The MPCA currently 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 H₂S, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide; SO₂ is not included. Since the majority of TRS is H₂S and the other components are considered to be less toxic than H₂S, TRS can be used as a conservative measure and compared to the H₂S standard. No federal or state standard for TRS is currently available. The MPCA measures TRS at sites 420 and 423 near the Flint Hills Refinery in Rosemount and at site 436 near the St. Paul Park Refining Company in St. Paul Park. Boise White Paper, L.L.C. in International Falls discontinued TRS monitoring in 2015. No changes are planned for the MPCA TRS monitors in 2018.

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; site 909 in North Minneapolis; at the near-road sites in Lakeville (480) and Minneapolis (962); and at the NCore site in Blaine (6010). In Blaine, temperature, relative humidity, and barometric pressure are also measured.

Special studies

Black carbon

Black carbon (or soot) is a component of fine particulate matter. It is correlated with elemental carbon, which is monitored as part of the PM_{2.5} speciation networks (CSN). Elemental carbon particles are emitted into the air from virtually all combustion activity, but are especially prevalent in diesel exhaust and smoke from the burning of wood, other biomass, and wastes. Black carbon can be continuously monitored using an aethalometer, while elemental carbon is only available in Minnesota as a 24-hour average every three days. MPCA began monitoring black carbon at the near-road site in Minneapolis (962) in 2014. No changes are expected in 2018.

Community air monitoring project

In 2013, the Minnesota Legislature funded a two-year air monitoring study to monitor air quality in seven Minnesota communities where low income or communities of color might be disproportionately impacted by pollution from highway traffic, air traffic, and industrial sources. These are areas of potential concern for environmental justice (Figure 31). Communities were monitored for three months, after which the monitoring equipment was moved to the next site. The first community monitoring site started operating on October 1, 2013, and projects are ongoing (Table 15). The Minnesota legislature has continued funding for community monitoring through at least June 2017.

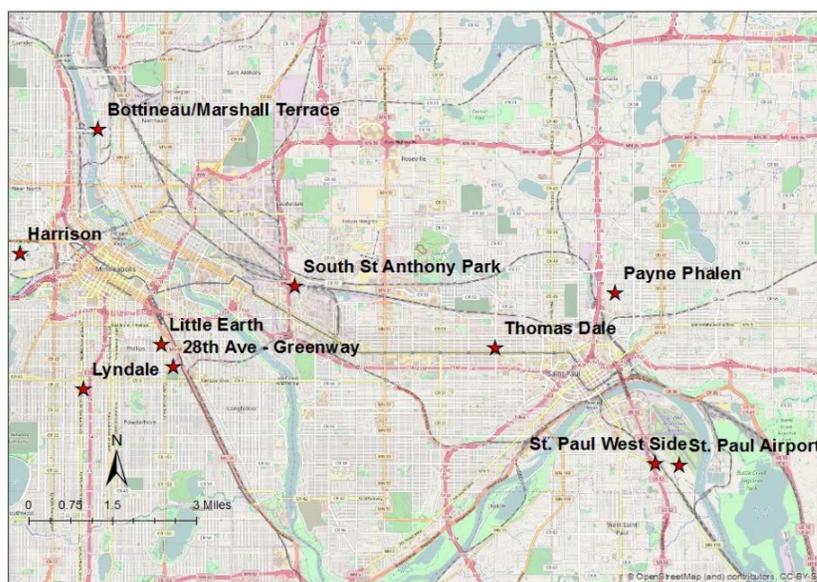


Figure 31: Locations of community air monitoring project sites in the Twin Cities metropolitan area

Due to the limitations of three-month monitoring, starting in July 2015, community sites have instead been monitored for six to 12 months. In 2017, the community monitor was moved from the South St. Anthony Park community in St. Paul to the Bottineau/Marshall Terrace neighborhood in Minneapolis. Monitoring in this community is expected to continue through mid-2018.

Table 15: Community air monitoring project sites and dates of operation

MPCA Site ID	AQS Site ID	Operation Dates	Site Name	City
1901	27-053-1901	Oct-Dec 2013	Little Earth	Minneapolis
1902	27-123-1902	Jan-Mar 2014	Thomas Dale	St. Paul
1903	27-123-1903	Apr-Jun 2014	West Side	St. Paul
1904	27-053-1904	Jul-Oct 2014	Greenway	Minneapolis
1905	27-053-1905	Oct-Dec 2014	Harrison	Minneapolis
1906	27-053-1906	Jan-Mar 2015	Lyndale	Minneapolis
1907	27-123-1907	Apr-Jun 2015	Payne Phalen	St. Paul
7549	27-137-7549	Jul-Dec 2015	Michigan Street	Duluth
7554	27-137-7554	Jul-Dec 2015	Laura MacArthur School	Duluth
1908	27-123-1908	Jan-Dec 2016	South St. Anthony Park	St. Paul
1909	27-053-1909	Jan-mid-2018	Bottineau/Marshall Terrace	Minneapolis

While monitoring from April to June, 2014 in the St. Paul West Side community, monitoring results indicated that average metal values were below health benchmarks, but were higher than other Twin Cities metro monitoring sites. In response to these findings and community concerns, MPCA returned to the St. Paul West Side area to monitor levels of metal particles in the community ambient air. This monitor was placed in the southwest corner of the St. Paul Downtown Airport (818). Monitoring started the first week of January, 2016. Monitoring results did not show elevated metals concentrations and the site was closed in December 2016 after a complete year of monitoring.

The Community Air Monitoring Project website provides site information, summaries of completed data analyses, and raw data for each community site (<https://www.pca.state.mn.us/air/community-air-monitoring-project>). As data analyses are completed for the remaining monitoring sites, results will be posted on the project website. A final report discussing lessons learned from the data analyses of the first nine sites can also be found on the project website.

Silica sand mining and facility-related monitoring

In 2010, the MPCA began receiving public inquiries about projects to mine silica sand for use in hydraulic fracturing, or “fracking,” a drilling method used for natural gas and oil wells. Southeastern and south central Minnesota and southwestern Wisconsin have extensive deposits of sand that meets the specifications required for fracking. Mining of certain types of these deposits has been occurring in the region for many years; however, there are new issues based on the quantity, type, and depth of mining.

There are no federal or state standards for silica concentrations in ambient air. The MPCA uses a health-based value, developed by MDH, to assess potential human health effects from ambient air exposure to respirable crystalline silica (particle size smaller than four microns). There are state standards for TSP and state and federal air quality standards for PM₁₀ and for PM_{2.5}. This is an evolving field, and there are no generally accepted ambient monitoring methods for PM₄ silica. Regardless, certain Minnesota facilities are monitoring for silica using a method adapted from common regulatory monitoring techniques.

Ambient air monitors were placed at two sites at the Shakopee Sands facility (Jordan, MN) that collected TSP, PM₁₀, and respirable crystalline silica (measured as PM₁₀) data starting in third quarter of 2012. Ambient air data was also collected at the Titan Lansing Transload facility in North Branch, MN (previously Tiller LLC) for PM₁₀, PM_{2.5}, and PM₄ silica. Jordan Sands, LLC in Mankato, MN began monitoring for TSP, PM₁₀, PM_{2.5}, and PM₄ silica at their industrial sand mining and processing facility in 2014. One year of data are required for comparison to the TSP standards and the respirable crystalline silica health benchmark and three years of data are required for comparison to the PM₁₀ and PM_{2.5} standards. Monitoring for Shakopee Sands and Titan Lansing Transload facility has been completed.

The MPCA also conducted community based monitoring at two sites. A new site was created in Winona, MN (5520) where PM₄ silica, PM_{2.5} FEM, and meteorological parameters were monitored. In addition, PM₄ silica was added to the existing ozone site in Stanton, MN (5302). This monitoring started in January 2014 and closed in December 2014 upon the completion of one year of monitoring.

Preliminary data from these monitoring efforts and more information about silica sand mining are available on the MPCA's website (<https://www.pca.state.mn.us/air/air-monitoring-minnesota-silica-sand-facilities>).

The MPCA air monitoring program will continue to provide technical support to local units of government, permitted facilities, and to a Technical Advisory Team being formed by the Environmental Quality Board.

Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) can occur naturally in the environment, but they are also created during combustion (example sources include motor vehicles, home heating, diesel trucks, tobacco smoke, and wood smoke). PAHs are a priority to environmental health agencies because they stay in the environment for long periods of time and exposure to high levels of PAHs are associated with health effects such as cancer and respiratory irritation.

The MPCA received an EPA Community Scale Air Toxics Grant to study PAH levels in the air in South Minneapolis and Mille Lacs. The MPCA, the Minnesota Department of Health (MDH) and the Mille Lacs Band of Ojibwe Department of Natural Resources and Environment (DNRE) monitored PAHs using passive and active techniques during the two-year study. The monitoring started in June 2013 and was completed in June 2015. Monitored concentrations of PAHs were compared to estimated health values. A video describing the project, and all the data visualized in maps and bar charts, are available at the project website, <https://www.pca.state.mn.us/air/air-monitoring-polycyclic-aromatic-hydrocarbons-urban-and-rural-sites>.

The MPCA continues to monitor PAHs near facilities with known PAH emissions, in addition to one reference site (Figure 32). At the time of this publication, the data were too few to summarize appropriately; results will be available for inclusion in the 2019 Air Network Monitoring Plan.

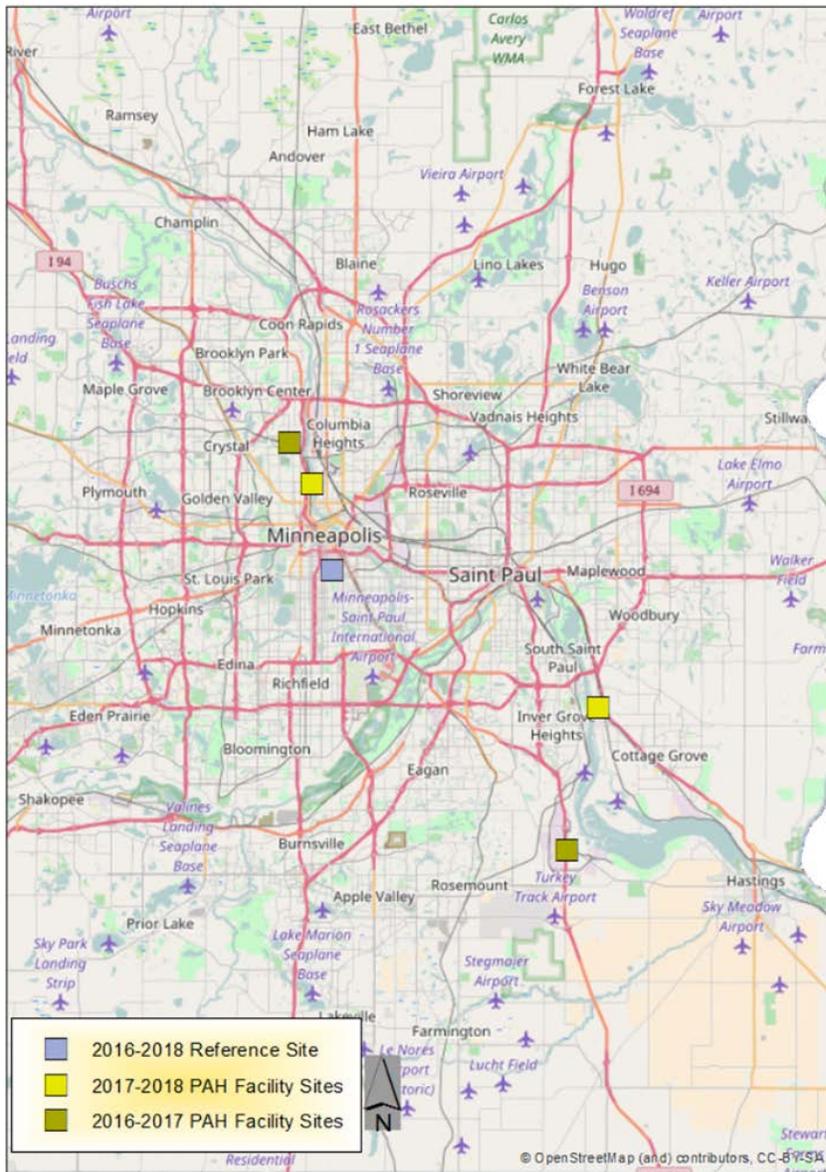


Figure 32: PAH monitoring sites in Minneapolis

Visibility

Air pollution can reduce visibility over wide areas, a phenomenon called regional haze. Haze occurs when sunlight encounters fine particles in the air, which absorb and scatter light. Haze-causing pollutants come from a variety of sources, both natural and man-made, including motor vehicles, electric utilities, taconite processing facilities, agricultural activities, and wildfires.

In 1999, the EPA established a regulatory program to reduce haze caused by man-made air pollution at national parks and wilderness (Class I) areas. The goal of the regional haze rule is to achieve natural visibility conditions in Class I areas by 2064, with interim progress goals set every 10 years. The first interim progress goal is set for 2018.

Minnesota has two Class I areas – the Boundary Waters Canoe Area Wilderness and Voyageurs National Park (Figure 33).

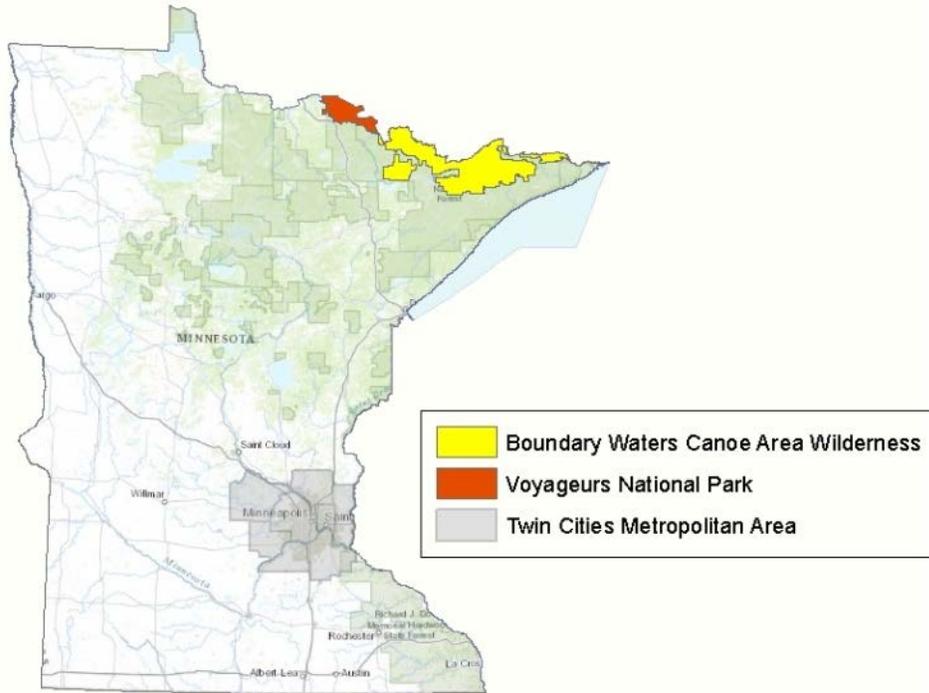


Figure 33: Class I areas in Minnesota impacted by regional haze

Visibility is calculated from PM_{2.5} species measurements through the IMPROVE Aerosol Network (<http://vista.cira.colostate.edu/IMPROVE/>). Minnesota has an IMPROVE site in each of the two Class I areas. An additional site was installed at the Great River Bluffs State Park in southeastern Minnesota to help better understand the regional transport of pollutants that impair visibility into Minnesota from the Southeast (see Figure 1).

IMPROVE network PM_{2.5} speciation measurements are mathematically processed to express visibility as a five-year rolling average deciview (dv) value. A human observer is thought to be able to visually perceive a one to two deciview difference in scene appearance. The MPCA aims to see measured deciview values less than or equal to the interim progress goal by 2018. Both the Boundary Waters (Figure 34) and Voyageurs (Figure 35) sites achieved the 2018 interim goal by 2015.

In a final rule published January 2017, the EPA modified the tracking metrics used to calculate visibility progress in Class I areas. The rule revision intends to mitigate the impact of uncontrollable events, such as wildfires, on the visibility progress demonstration. This would allow controls on man-made emission sources to become more readily apparent. For example, using the original tracking metrics, visibility improvements at the Boundary Waters site were impacted in 2011 by the Pagami Creek wildfire, which burned 145 square miles of forest, resulting in a marked peak in the five-year rolling average dv value that year (Figure 34). Inclusion of the natural, uncontrollable impacts of wildfire in the original tracking metric obscures the ability to see overall progress associated with changes to man-made emissions. The Voyageurs site, which was not impacted by the fire, does not have a corresponding peak in dv values, and the trend continues downward more apparently than at the Boundary Waters site (Figure 35). As of the writing of this document, the EPA has yet to publish final guidance with instructions on calculating the new tracking metrics promulgated in the revised rule.

The MPCA anticipates providing new metrics covering the entire measurement period in the 2019 monitoring plan.

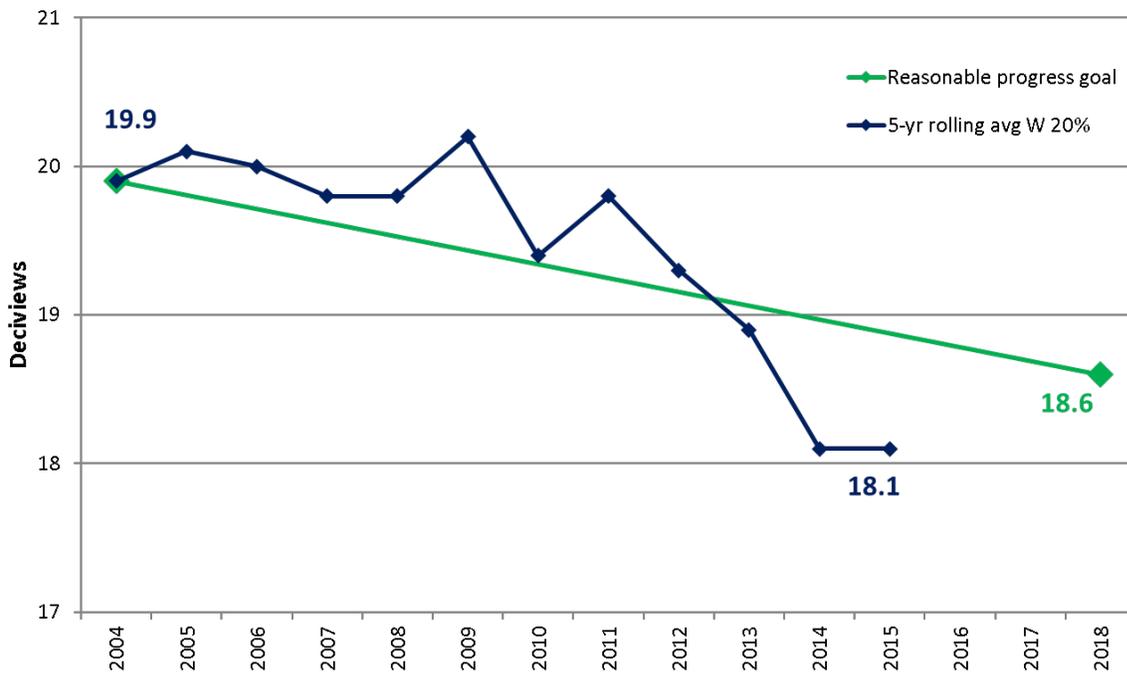


Figure 34: Reasonable progress visibility goal for the Class I Boundary Waters Site, 2004-2015

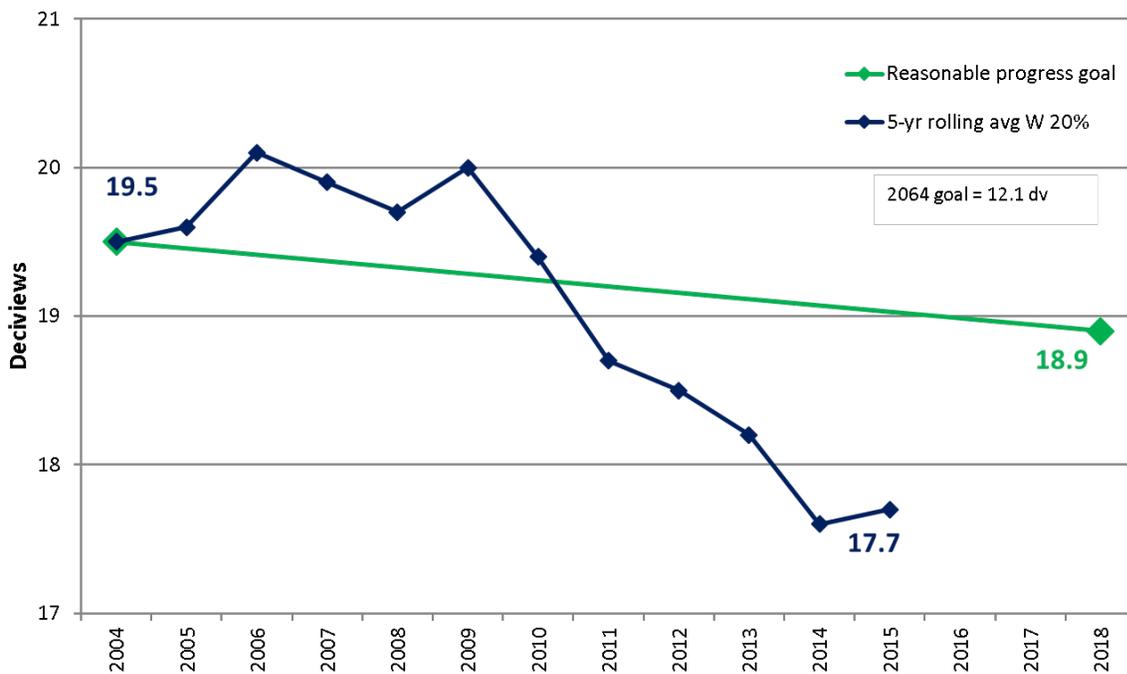


Figure 35: Reasonable progress visibility goal for the Class I Voyageurs Site, 2004-2015

Network changes

Changes to the MPCA Air Monitoring Network are intended to improve the effectiveness of monitoring efforts and to ensure compliance with the EPA National Ambient Air Monitoring Strategy. Some changes are planned well in advance and are detailed in the Network Plan each year. Other changes are a result of legislation, administrative directives, land-use changes, loss of funding, enforcement actions, or are in response to complaints, and cannot be foreseen when this report is created. This section of the document contains all changes that were made in 2017 and the changes that are planned for 2018.

2017 Network changes

In some cases, changes that were planned were not instituted and in other cases changes that were not foreseen did occur. In 2017, each of the three changes proposed in the 2017 network plan were applied (Table 16); additional, unforeseen changes were also made (Table 17).

Table 16: Changes proposed in the 2017 Annual Network Plan

MPCA Site ID	City Name	Site Name	Site Status	PM _{2.5} FEM	Sulfur Dioxide	TSP and Metals	VOCs	Carbonyls
1908	St. Paul	South St. Anthony Park	T	T		T	T	T
TBD	TBD	CAMP	A	A		A	A	A
5008	Rochester	Ben Franklin School			T			

A = proposed to add
T = proposed to terminate

Table 17. Changes actually made to the Network in 2017

MPCA Site ID	City Name	Site Name	Site Status	PM _{2.5} FRM	PM _{2.5} FEM	Sulfur Dioxide	TSP and Metals	VOCs	Carbonyls	Fibers	PAH
420	Rosemount	Flint Hills Refinery 420									T
423	Rosemount	Flint Hills Refinery 423					A				
438	Newport	St. Paul Park Refinery 438									A
505	Shakopee	B.F. Pearson School		T	A						
818	St. Paul	Holman Field	T				T				
868	St. Paul	Ramsey Health Center								T	
907	Minneapolis	Humboldt Avenue									T
909	Minneapolis	Lowry Avenue									A
1908	St. Paul	South St. Anthony Park (CAMP)	T		T		T	T	T		
1909	Minneapolis	Bottineau/Marshall Terrace (CAMP)	A		A		A	A	A		
5008	Rochester	Ben Franklin School				T					

- PAH monitoring was terminated at Flint Hills Refinery 420 and Humboldt Avenue (907) after being monitored for one year, from July 2016 to June 2017. PAH monitors were added at St. Paul Park Refinery 438 and Lowry Avenue (909) in June 2017.
- The Community Air Monitoring Project (CAMP) site in South St. Anthony Park (1908) was terminated and moved to a new site in Minneapolis, Bottineau/Marshall Terrace (1909).
- SO₂ monitoring at the Ben Franklin School in Rochester was terminated after three years of monitoring was completed to establish the background concentration.
- Fiber monitoring at the Ramsey Health Center (868) was terminated, and is no longer being used as a reference for the North Shore Mining Company fiber monitors in Silver Bay and Beaver Bay, MN.

2018 Proposed changes

The changes that are proposed for 2018 are summarized below (Table 18). Following the table, each of the proposed changes are summarized according to parameter network.

Table 18: 2018 Proposed Changes

MPCA Site ID	City Name	Site Name	PAMS	PAH	PM _{2.5} FEM	TSP and Metals	VOCs	Carbonyls
438	Newport	St. Paul Park Refinery		T				
909	Minneapolis	Lowry Avenue		T				
963	Minneapolis	Andersen School		T				
1909	Minneapolis	Bottineau/Marshall Terrace			T	T	T	T
6010	Blaine	Anoka Airport	A					

A = proposed to add
T = proposed to terminate

- PAH monitors will be removed from St. Paul Park Refinery site 438, Lowry Avenue (909), and Andersen School (963) in July 2018.
- Site 1909 will be closed in mid-2018.
- The PAMS Implementation Plan will be published in the 2019 Annual Air Monitoring Network Plan. Instruments may be added to the Anoka Airport site in late 2018 for testing in advance of the June 1, 2019 deadline to begin monitoring.

Public inspection period

This report was available for public inspection from May 18, 2017 through June 23, 2017. No comment letters regarding the 2018 Air Monitoring Network Plan were received during the public inspection period.

The public is welcome to comment on our air monitoring activities at any time throughout the year.