Air quality

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2024 Minnesota Air Monitoring Data Report

2026 Minnesota Air Monitoring Network Plan

MINNESOTA POLLUTION CONTROL AGENCY

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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
CAA – Clean Air Act
CAS – Chemical Abstracts Service
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)
IMP – Chemical Speciation Network
Design Value – a statistic that describes the air quality status of a given location relative to the level of the National Ambient Air Quality Standards (NAAQS)
EPA – U.S. Environmental Protection Agency
Exceptional Events – unusual or naturally occurring events that can affect air quality but are not reasonably controllable using techniques that tribal, state or local air agencies may implement in order to attain and maintain the National Ambient Air Quality Standards.

FEM – Federal Equivalent Method
FRM – Federal Reference Method
IMPROVE – Interagency Monitoring of Protected Visual Environments
MAAQS – Minnesota Ambient Air Quality Standard
MDH – Minnesota Department of Health
MDN – Mercury Deposition Network
µg/m3 (ug/m3) – micrograms per cubic meter
MOA – Memorandum of Agreement
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
NO_2 – nitrogen dioxide
NO_x – oxides of nitrogen
NO_y – total reactive nitrogen
NTN – National Trends Network
O_3 – ozone
PAMS – Photochemical Assessment Monitoring Stations
Pb – lead
$PM_{2.5}$ – particulate matter less than 2.5 microns in diameter (fine particulate matter)
$PM_{10\text{-}2.5}$ – particulate matter between 2.5 and 10 microns in diameter (coarse particulate matter)
PM_{10} – particulate matter less than 10 microns in diameter
ppb – parts per billion by volume
ppm – parts per million by volume
PQAO – Primary Quality Assurance Organization
Primary Standard - NAAQS set to protect public health
QAPP – Quality Assurance Project Plans
QA/QC – Quality Assurance/Quality Control
QMP – Quality Management Plan
Secondary Standard - NAAQS set to protect the environment and public welfare (i.e. visibility, crops, animals, vegetation, and buildings)
SIP – State Implementation Plan
SLAMS – State and Local Air Monitoring Stations
SO_2 – sulfur dioxide
SPM – special purpose monitoring
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
USDOI – United States Department of the Interior
USG – unhealthy for sensitive groups
VOC – volatile organic compound

Introduction

The MPCA's air quality data are used to determine compliance with 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. All criteria pollutants also have MAAQS. In addition, there are also MAAQS for total suspended particulate matter (TSP) and H_2S.

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.

More information including current air quality, forecasts, tools to explore data from our monitoring network, and this plan can be found on the MPCA's Air Quality website (https://www.pca.state.mn.us/air).

1. Pollutants with standards (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 criteria pollutants are particulate matter (currently $PM_{2.5}$ and PM_{10}), lead (Pb), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO).

1.1. Air quality design values

A design value is a statistic that describes the air quality status of a given location relative to the level of the National Ambient Air Quality Standards (NAAQS). Design values are defined to be consistent with the individual NAAQS as described in 40 CFR Part 50 (https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50?toc=1). They are typically used to designate and classify nonattainment areas, as well as to assess progress towards meeting the NAAQS. Areas of the country where air pollution levels persistently exceed the national ambient air quality standards may be designated "nonattainment." The EPA Green Book (https://www.epa.gov/green-book) provides current information on nonattainment areas by state and pollutant.

Design values are computed and published annually by EPA's Office of Air Quality Planning and Standards and reviewed in conjunction with the EPA Regional Offices. More information can be found on EPA's Design Values webpage (https://www.epa.gov/air-trends/air-quality-design-values).

1.2. National Ambient Air Quality Standards

For each of these pollutants, the EPA has developed national ambient air monitoring quality standards (NAAQS). Primary standards are set to protect public health, while secondary standards are 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 latest updates to the standards can be

found at EPA's NAAQS webpage (https://www.epa.gov/criteria-air-pollutants/naaqs-table), also shown in Table 1.

Table 1. National Ambient Air Quality Standards (NAAQS).

Pollutant [final rule citation]		Primary/ Secondary	Averaging time	Level	Form
Carbon monoxide (CO) [76 FR 54294, Aug 31, 2011]		Primary	8 hours	9 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 (NO_2) [75 FR 6474, Feb 9, 2010] [77 FR 20218, April 3, 2012]		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 (O_3) [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	1 year	9.0 µg/m^3	Annual mean, averaged over 3 years
		Secondary	1 year	15.0 µg/m^3	Annual mean, averaged over 3 years
		Primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur dioxide (SO_2) [75 FR 35520, Jun 22, 2010] [84 FR 9866, April 17, 2019]		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/m^3 as a calendar quarter average) also remain in effect.**

(2) The level of the annual NO_2 **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) O_3 **standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.**

(4) The previous SO_2 **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 SO_2 standards or is not meeting the requirements of a SIP call under the previous SO_2 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.**

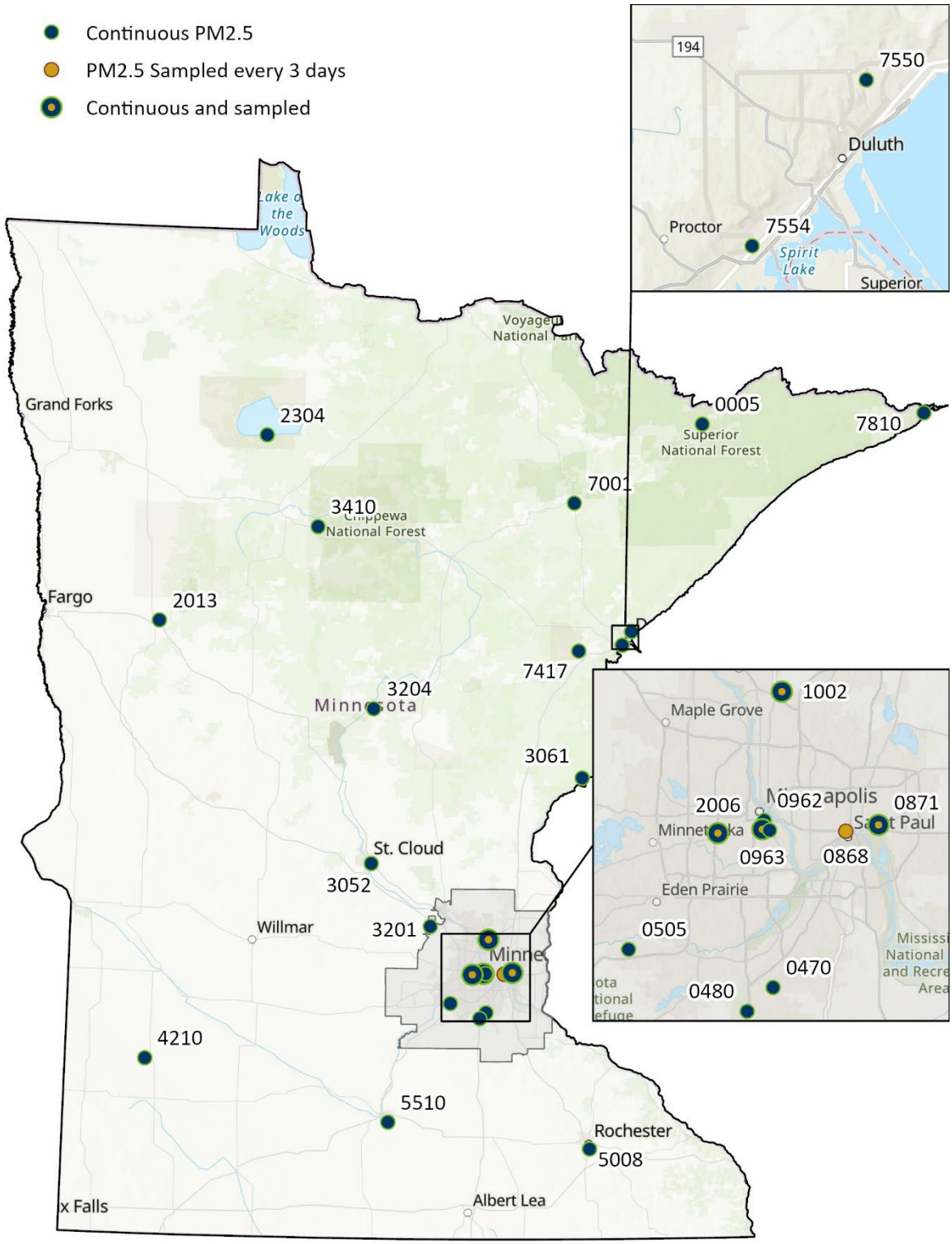
1.3. Particulate Matter

The MPCA monitors four different sizes of particulates: fine particulate matter ($PM_{2.5}$), coarse particulate matter ($PM_{10\text{-}2.5}$), PM_{10}, and TSP. $PM_{2.5}$ and PM_{10} are regulated by the NAAQS and TSP is regulated by the MAAQS. There are currently no state or federal air quality standards for $PM_{10\text{-}2.5}$.

1.3.1. $PM_{2.5}$ - Fine particulate matter

There were 26 FRM and FEM $PM_{2.5}$ sites in Minnesota in 2024, 11 in the Twin Cities metropolitan area.

Figure 1. 2024 $PM_{2.5}$ monitoring sites in Minnesota.



$PM_{2.5}$ Regulatory network overview

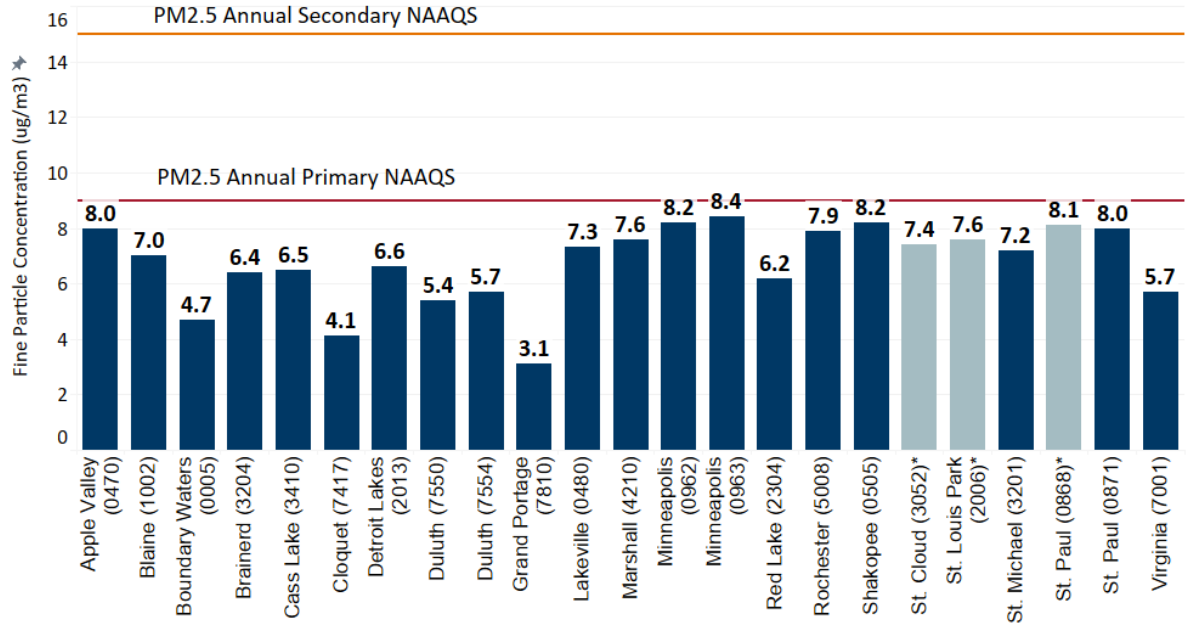
The $PM_{2.5}$ regulatory network includes FRM and FEM monitors. Currently, the MPCA operates FRM samplers at five sites and FEM monitors at 24 sites (Figure 1). Since $PM_{2.5}$ NAAQS are based on three

years of data and Mankato (5510) and Minneapolis (1904) were established in 2024; those sites are not included the NAAQS charts below.

On February 7, 2024, EPA strengthened the NAAQS for Particulate Matter. EPA is changing the level of the primary (health-based) annual $PM_{2.5}$ standard from 12.0 micrograms per cubic meter to 9.0 micrograms per cubic meter to provide increased public health protection, consistent with the available health science. EPA is not changing the current secondary annual $PM_{2.5}$ standard nor the daily $PM_{2.5}$ standard. For more information, visit https://www.epa.gov/pm-pollution/final-reconsideration-national-ambient-air-quality-standards-particulate-matter-pm.

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 9 µg/m^3. Results from $PM_{2.5}$ monitors in 2022-2024 show Minnesota annual average $PM_{2.5}$ concentrations ranged from 3.1 µg/m^3 in Grand Portage (7810) to 8.4 µg/m^3 in Minneapolis (0963); all below the current annual standard of 9 µg/m^3 (Figure 2). 2024 design values have decreased relative to previous years because the calculations no longer include data from the 2021 wildfire smoke season. However, 2023 wildfire smoke values are still included in the 2024 design value calculations.

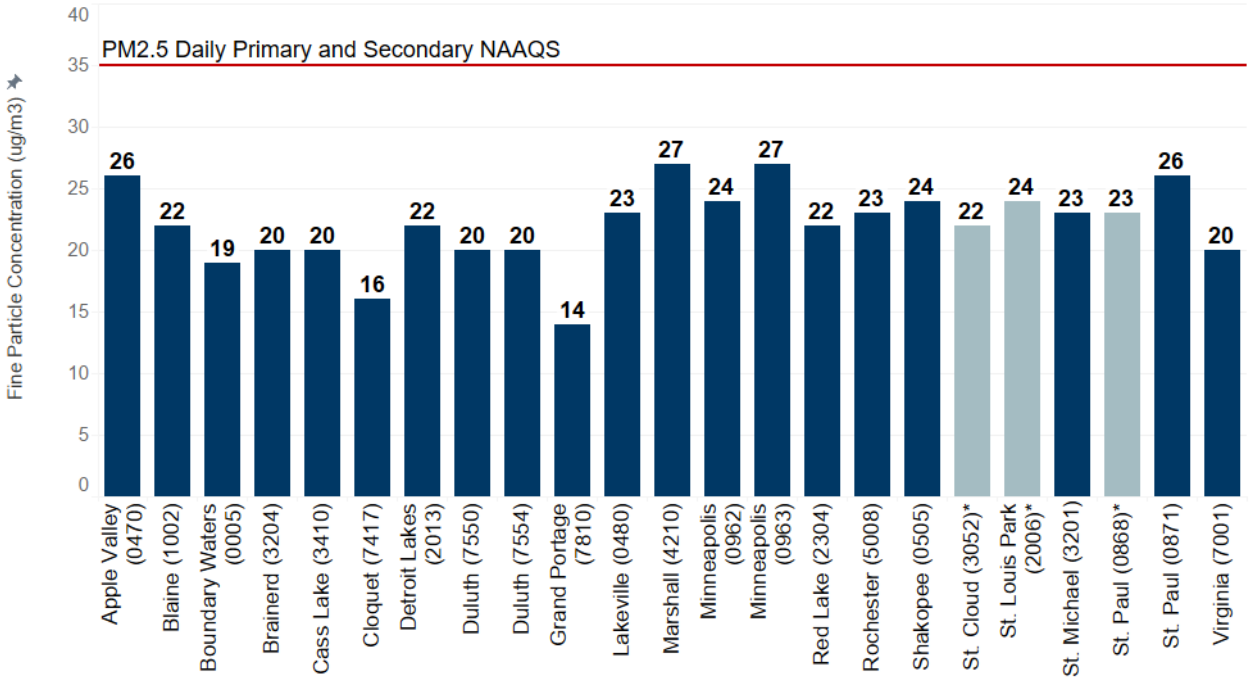
Figure 2. 2024 $PM_{2.5}$ design values compared to the annual NAAQS



***Site did not meet data completeness criteria**

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/m^3. Results from FEM monitors in 2022-2024 show the 98th percentile of the daily $PM_{2.5}$ averages in Minnesota ranged from 14 µg/m^3 in Grand Portage (8710) to 27 µg/m^3 in Marshall (4210) and Minneapolis (0963); all below the 24-hour standard of 35 µg/m^3 (Figure 3). All $PM_{2.5}$ daily design values are considered preliminary as of the draft publication date for this document.

Figure 3. 2024 $PM_{2.5}$ design values compared to the 24-hour NAAQS.



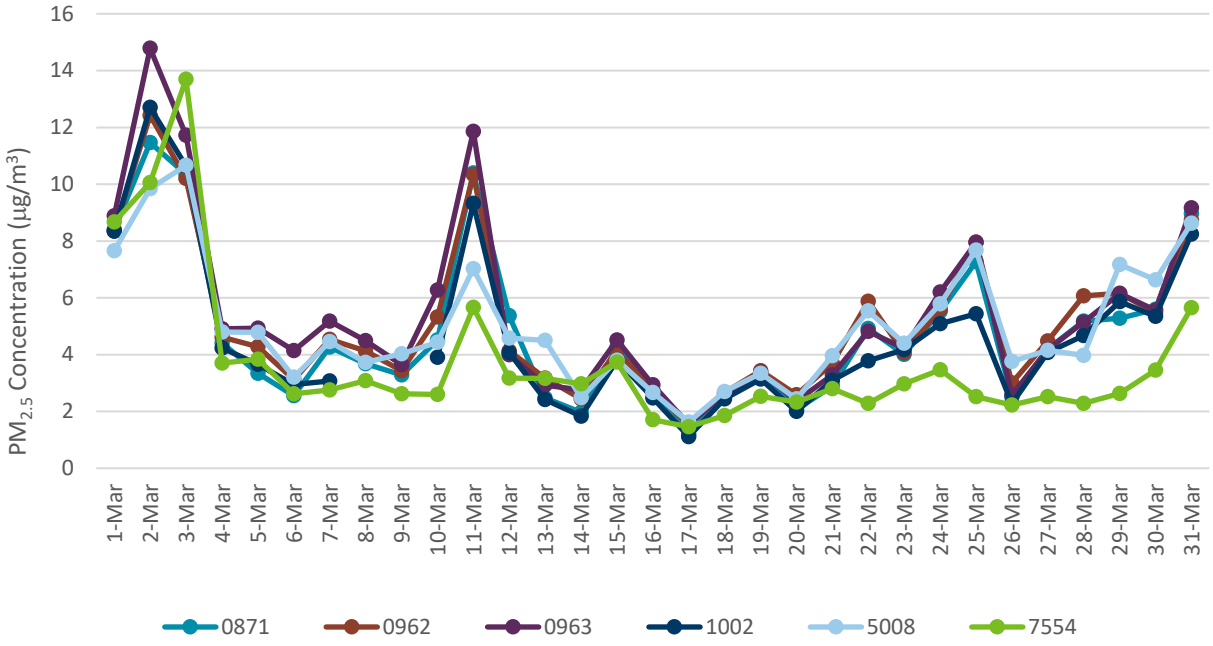
***Site did not meet data completeness criteria**

$PM_{2.5}$ Continuous network

The MPCA currently supports 24 FEM $PM_{2.5}$ sites in Minnesota. In addition to providing NAAQS comparable data, 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.

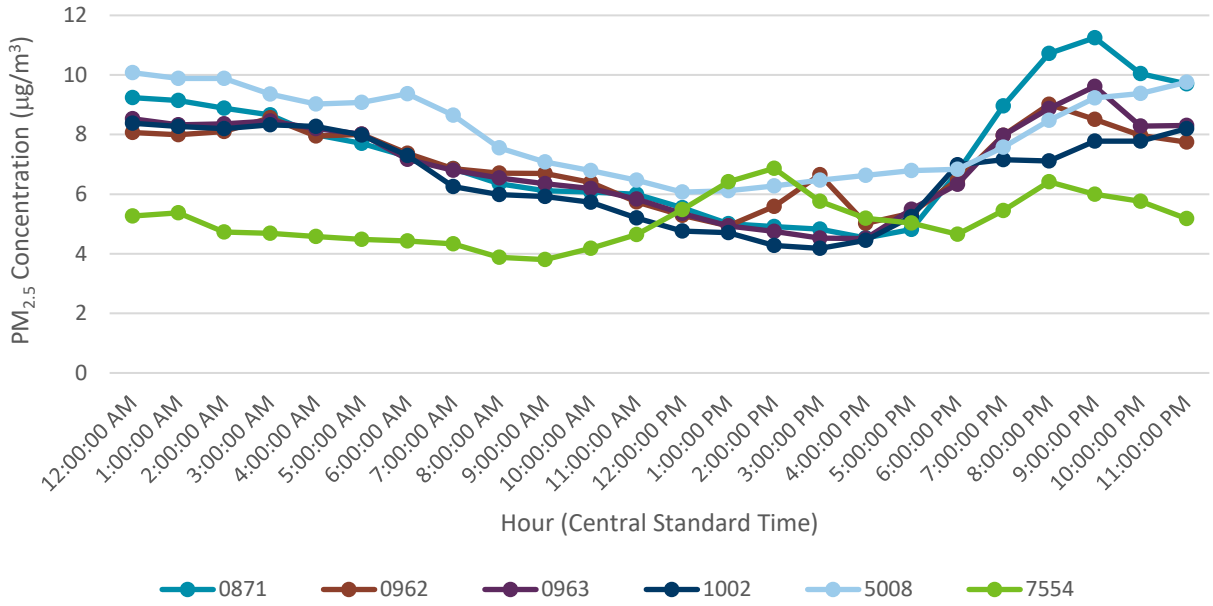
$PM_{2.5}$ is a regional pollutant, with some addition from local sources; therefore, concentrations tend to rise and fall in unison across the state. There is considerable variability between sites, however, even as the general trend stays uniform. Such differences in concentrations tend to be driven 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 4).

Figure 4. Daily average of hourly $PM_{2.5}$ concentrations at several Minnesota sites, weekdays in March 2024



$PM_{2.5}$ emissions in urban areas tend to follow a daily pattern (Figure 5). 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.

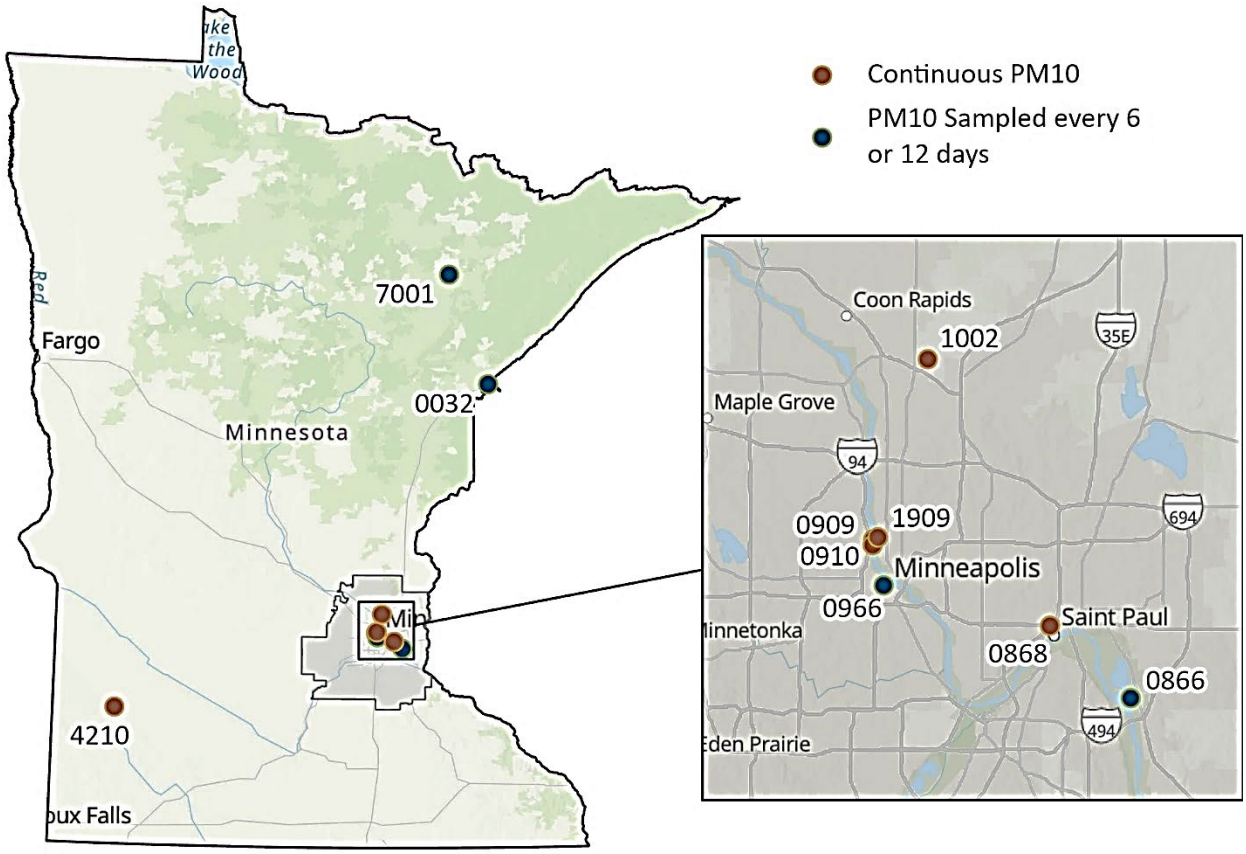
Figure 5. Average $PM_{2.5}$ concentrations per hour of the day at several Minnesota sites, May 2024



1.3.2. PM_{10}

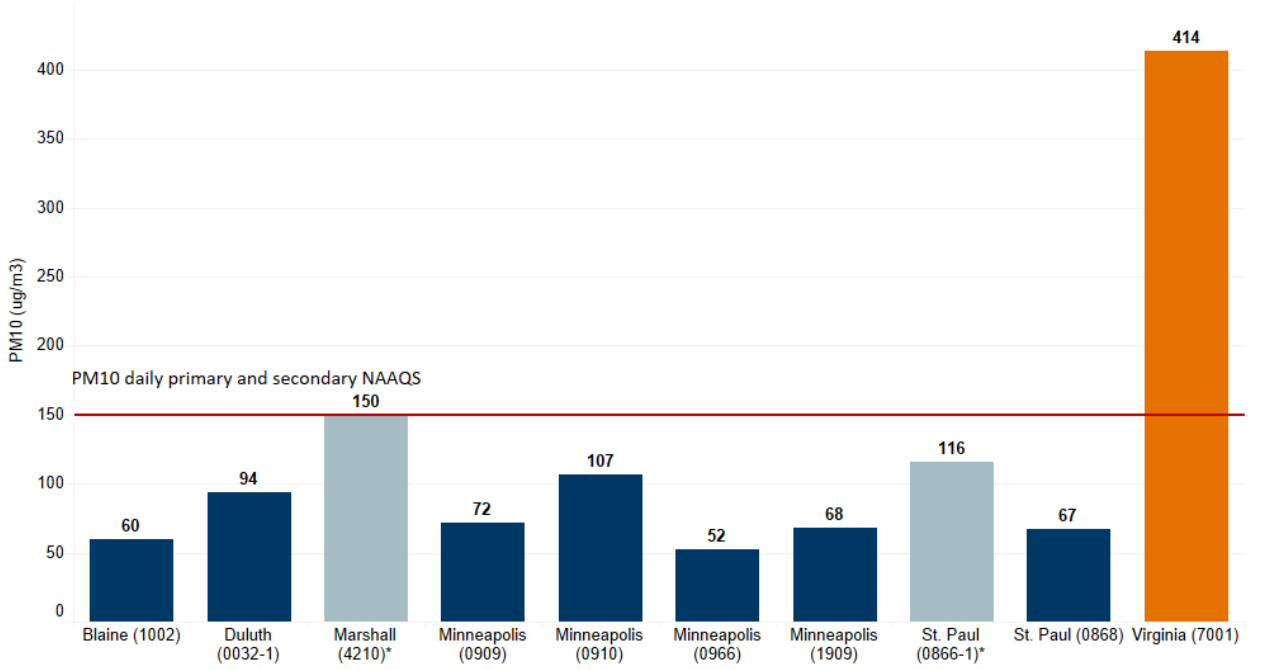
In 2024, the MPCA currently operated PM_{10} FRM samplers in St Paul (0866), Minneapolis (0966), and Duluth (0032). The FRM method collects mass samples of PM_{10} over a 24-hour period once every six days. There are also continuous PM_{10} FEM monitors that measure hourly PM_{10} concentrations at sites: St. Paul (0868), Minneapolis (0909), Minneapolis (0910), Minneapolis (1909), Blaine (1002), Marshall (4210), and Virginia (7001) (Figure 6).

Figure 6. 2024 PM_{10} monitoring sites in Minnesota.



To describe the magnitude of daily PM_{10} measurements, the MPCA reports the daily PM_{10} background concentration, which is calculated following the methodology established in EPA's "PM_{10} 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 PM_{10} background concentration is calculated as the 1st, 2nd, 3rd, or 4th highest daily average PM_{10} concentration measured over three years. PM_{10} concentrations ranged from 52 µg/m^3 at Minneapolis (0966) to 414 µg/m^3 at Virginia (7001) in 2024 (Figure 7).

Figure 7. 2024 PM_{10} background concentrations compared to the daily NAAQS.



***Site did not meet data completeness criteria**

A monitoring site meets the 24-hour PM_{10} NAAQS when the level of 150 µg/m^3 is not exceeded more than once per year, on average, over three years. The standards are attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m^3 is equal to or less than one. Minnesota currently meets applicable NAAQS at nine out of ten sites. In 2022-2024, there were no expected exceedances for all sites except Virginia (7001), where the three-year design values was two expected exceedances (Table 2).

Table 2. 2024 PM_{10} estimated exceedances

Site ID	PM_{10} 3-year estimated exceedances	Completeness criteria met
27-003-1002	0	Yes
27-053-0909	0	Yes
27-053-0910	0	Yes
27-053-0966	0	Yes
27-053-1909	0	Yes
27-083-4210	0.3	No
27-123-0866	0	No
27-137-0868	0	Yes
27-137-0032	0	Yes
27-137-7001	2	Yes

1.3.3. Total Suspended Particulate matter (TSP)

TSP was one of the original NAAQS pollutants but was replaced by the PM_{10} standard in 1987. Generally, smaller particles, such as PM_{10} 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 3).

Table 3. Minnesota Ambient Air Quality Standards for TSP

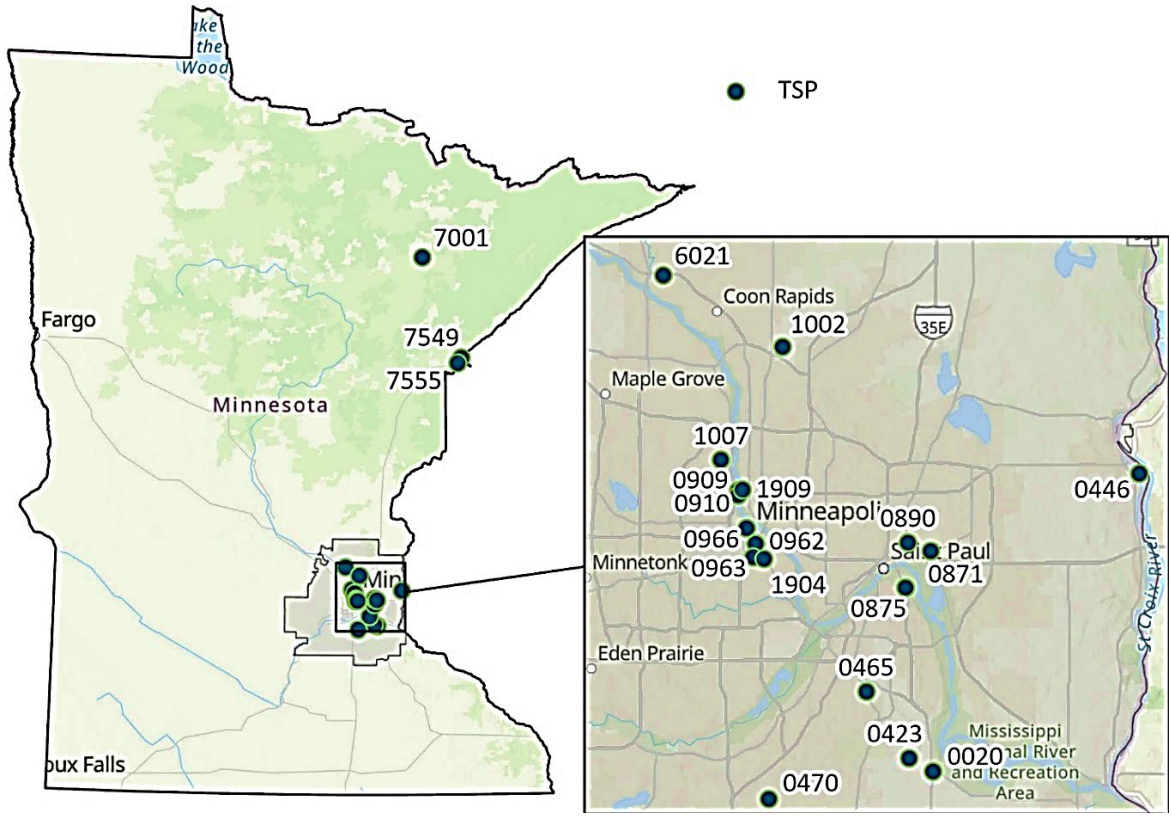
Standard type	Time interval	Level of standard	A monitoring site meets the standard if…
Primary[1]	Daily (24-hour)	260 µg/m^3	…the annual 2nd highest daily TSP concentration is less than or equal to 260 µg/m^3
	Annual	75 µg/m^3	...the annual geometric mean is less than or equal to 75 µg/m^3
Secondary[2]	Daily (24-hour)	150 µg/m^3	...the annual 2nd highest daily TSP concentration is less than or equal to 150 µg/m^3
	Annual	60 µg/m^3	...the annual geometric mean is less than or equal to 60 µg/m^3

[1] primary standard is set to protect against human health effects associated with exposure to an air pollutant.
[2] secondary standard is set to protect against environmental or public welfare effects associated with exposure to an air pollutant.

In addition to TSP, the filters are analyzed for metals as part of the air toxics program, using the ICP/MS method. Metals are discussed further in the air toxics section of this report.

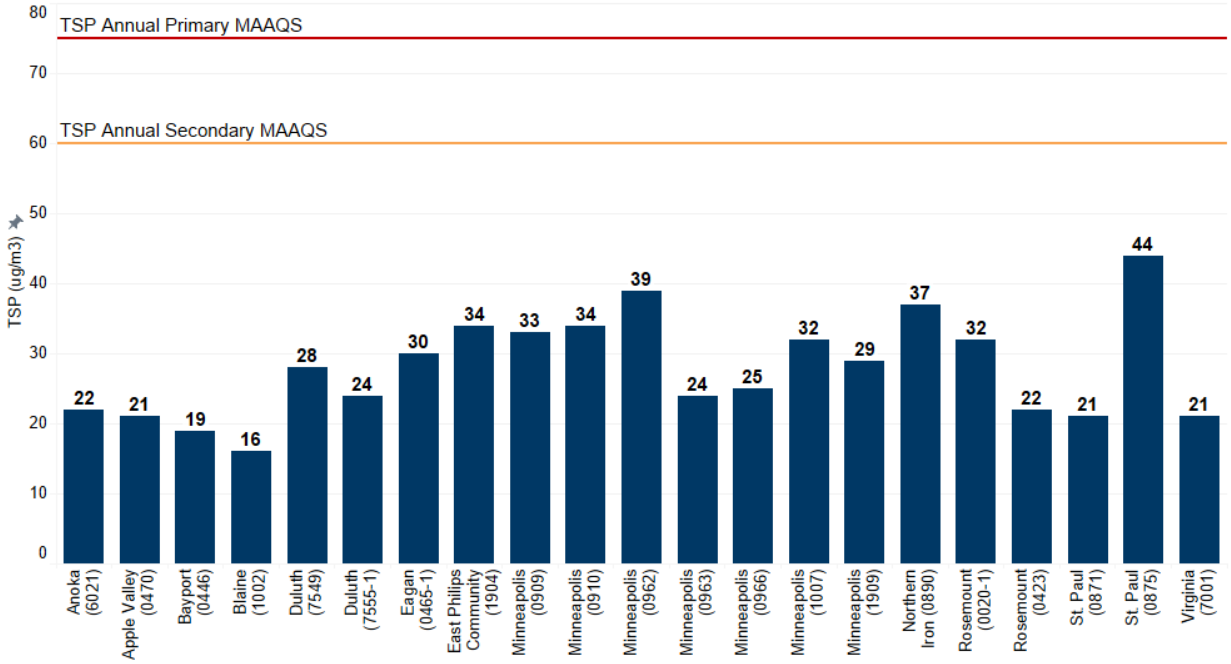
The MPCA currently operates 21 TSP monitoring sites (Figure 8). Mass samples of TSP are collected over a 24-hour period once every six days.

Figure 8. 2024 TSP monitoring sites in Minnesota



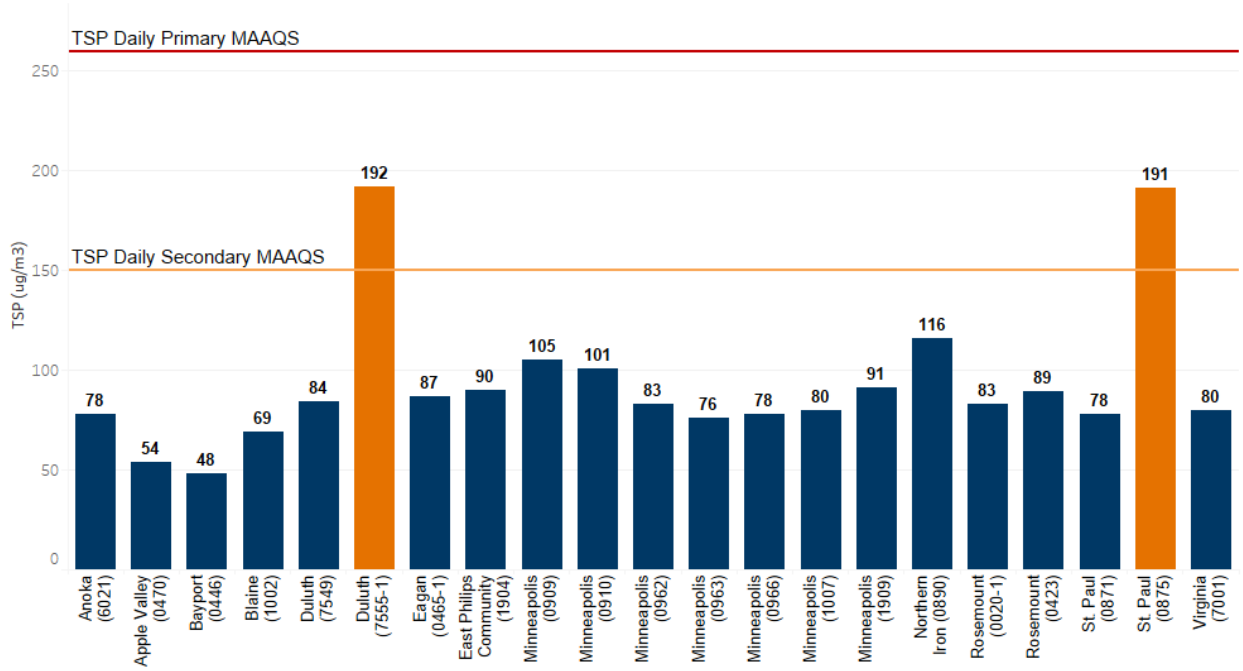
In 2024, Minnesota annual TSP averages ranged from 16 µg/m^3 in Blaine (1002) to 44 µg/m^3 in St. Paul (0875) (Figure 9). All sites met the annual primary MAAQS in 2024.

Figure 9. 2024 TSP concentrations compared to the annual primary and secondary MAAQS.



In 2024, daily TSP values in Minnesota ranged from 48 µg/m^3 at Bayport (0446) to 192 µg/m^3 at Duluth (7555-1) (Figure 10). St. Paul (0875) and Duluth (7555-1) violated the daily secondary TSP MAAQS; all other sites met the TSP standards.

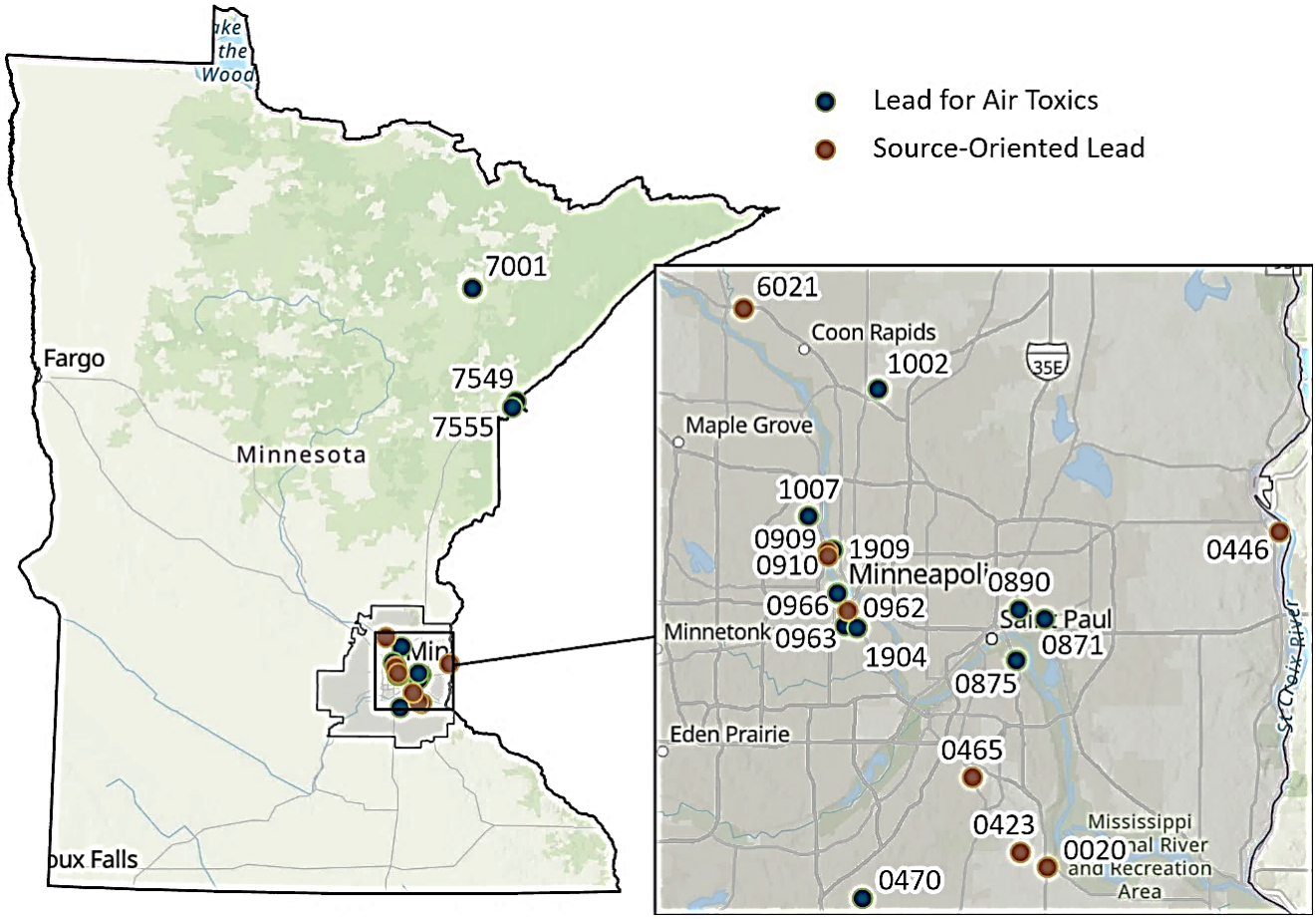
Figure 10. 2024 TSP concentrations compared to the 24-hour primary and secondary MAAQS.



1.4. Lead (Pb)

The MPCA monitored lead at 21 sites in 2024 (Figure 11), including NCore (1002). Eight lead monitoring sites are considered source-oriented: Gopher Resources Corporation in Eagan (0465), Federal Ammunition in Anoka, MN (6021), Flint Hills (0020 and 0423), North Minneapolis near a former Northern Metals Recycling location (0909 and 0910), Near Road I-94/I-35 (0962), and Bayport (0446), located between two potential sources. The remaining sites are part of the air toxics program.

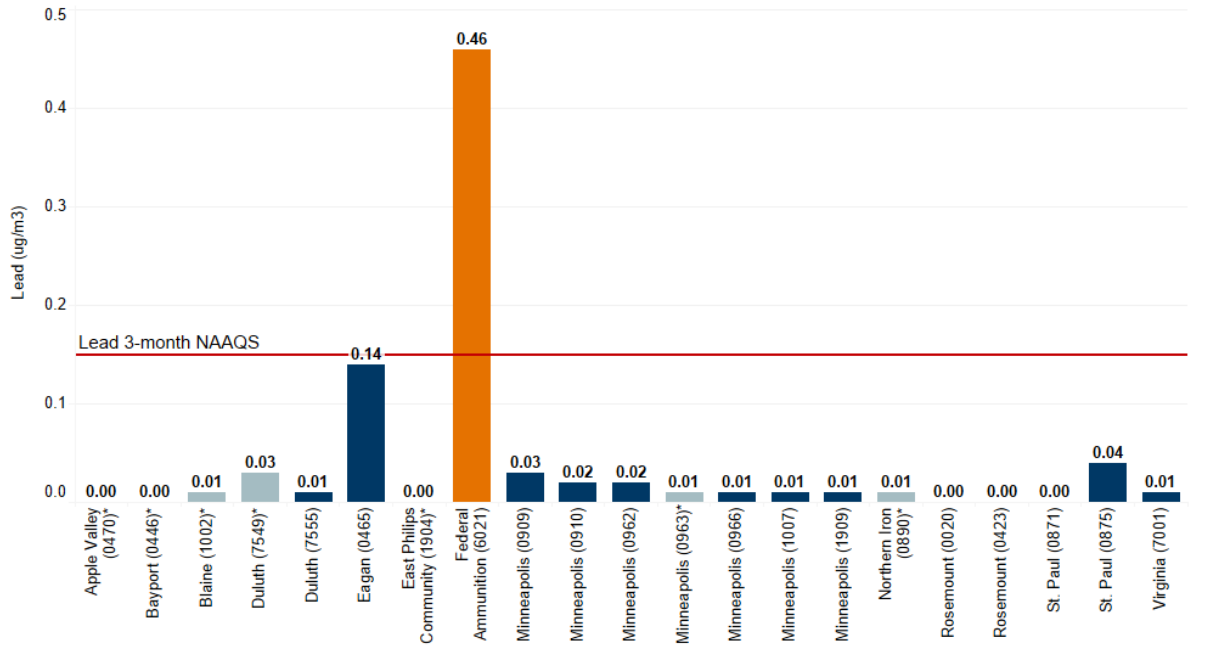
Figure 11. 2024 lead monitoring sites in Minnesota.



20 out of 21 lead monitoring sites in Minnesota met the 2008 lead NAAQS of 0.15 µg/m^3 in 2024 based on the most recent data, which show the three-year maximum 3-month rolling average concentration at monitored sites from 2022-2024. The highest monitored lead design value was 0.46 µg/m^3 at Federal Ammunition (6021) followed by 0.14 µg/m^3 at Gopher Resources (0465) in Eagan. 18 sites were at levels equal to or less than 0.04 µg/m^3 (Figure 12).

The TSP/metals sampler was deployed near Federal Ammunition in Anoka, MN (27-003-6021) in December 2022 to meet the requirement of Appendix D of 40 CFR Part 58, section 4.5. This requirement identifies there must be one source-oriented SLAMS site located to measure the maximum Pb concentration in ambient air resulting from each non-airport Pb source which emits 0.50 or more tons per year. Federal Ammunition identified emissions above the 0.5 tons lead on their annually air emission inventory for 2019 - 2022. The MPCA and EPA are working together on an enforcement investigation to address elevated lead emissions at Federal Ammunition.

Figure 12. 2024 lead design values compared to the 3-month NAAQS.

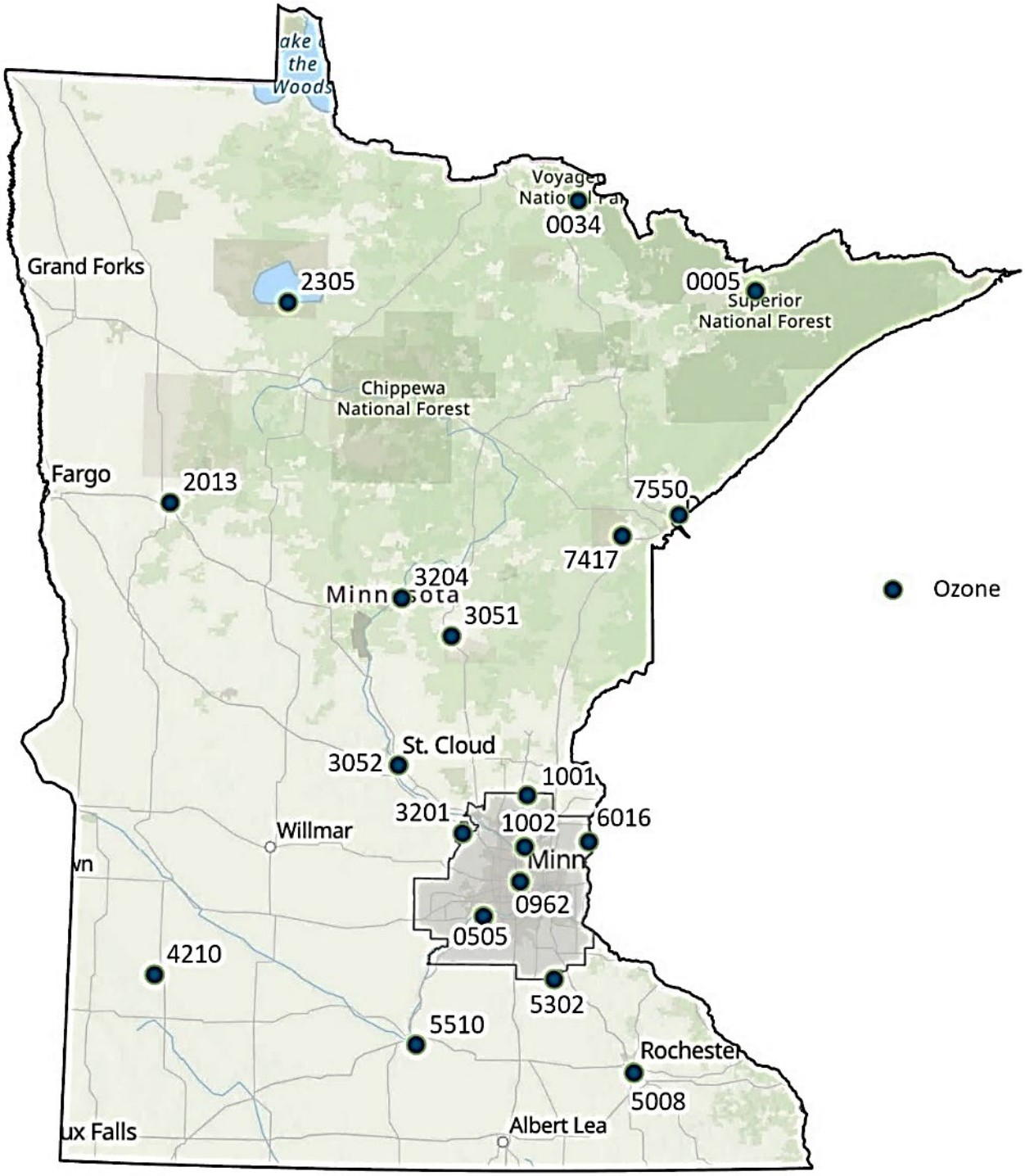


***Site did not meet data completeness criteria**

1.5. Ozone (O_3)

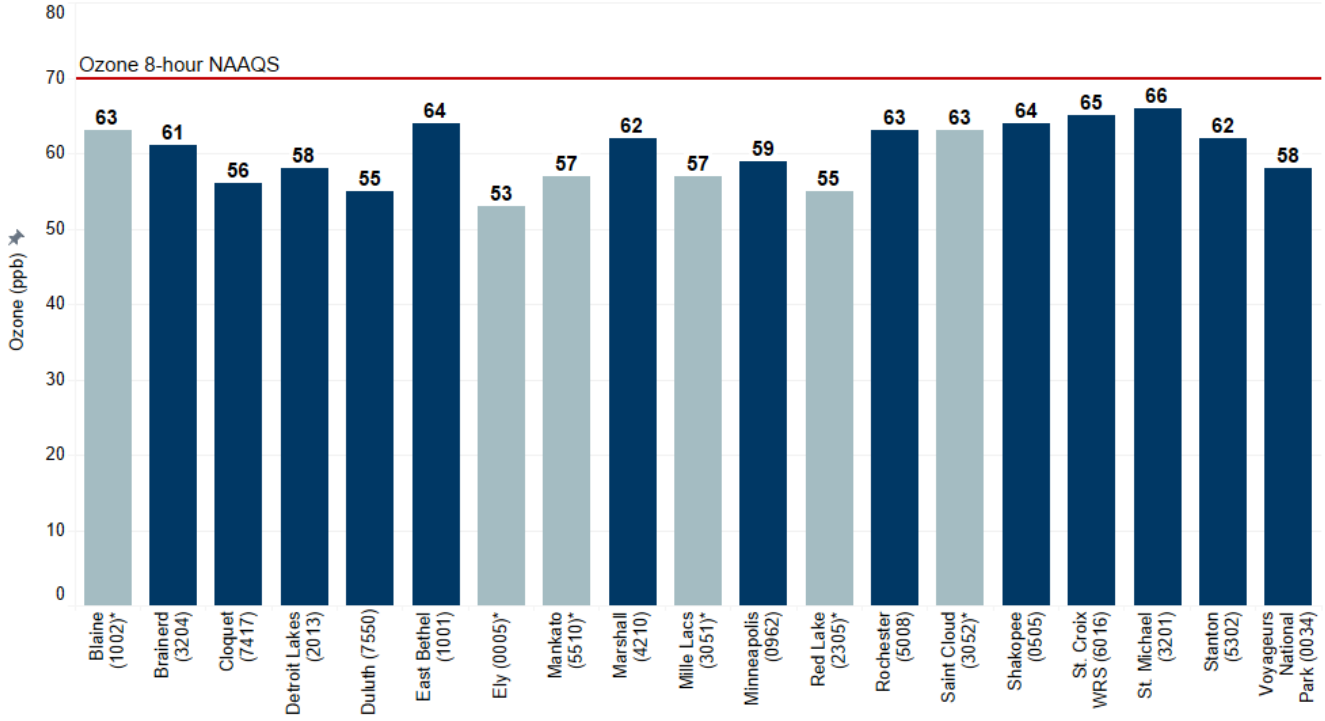
MPCA monitors ozone at 18 monitoring sites. An additional monitor, located at Voyageurs National Park (0034), is operated by the National Park Service (Figure 13). Since the MPCA does not have any role in the maintenance or use of this monitor, it is not included in our SLAMS or AQI monitoring networks.

Figure 13. 2024 ozone monitoring sites in Minnesota.



A monitoring site meets the primary ozone NAAQS if the three-year average of the fourth highest daily maximum 8-hour concentration is less than or equal to 70 ppb. From 2022-2024, Minnesota eight-hour averages ranged from 53 ppb in Ely (0005) to 66 ppb in St. Michael (3021). All sites were below the eight-hour standard (Figure 14).

Figure 14. 2024 ozone design values compared to the 8-hour average NAAQS.

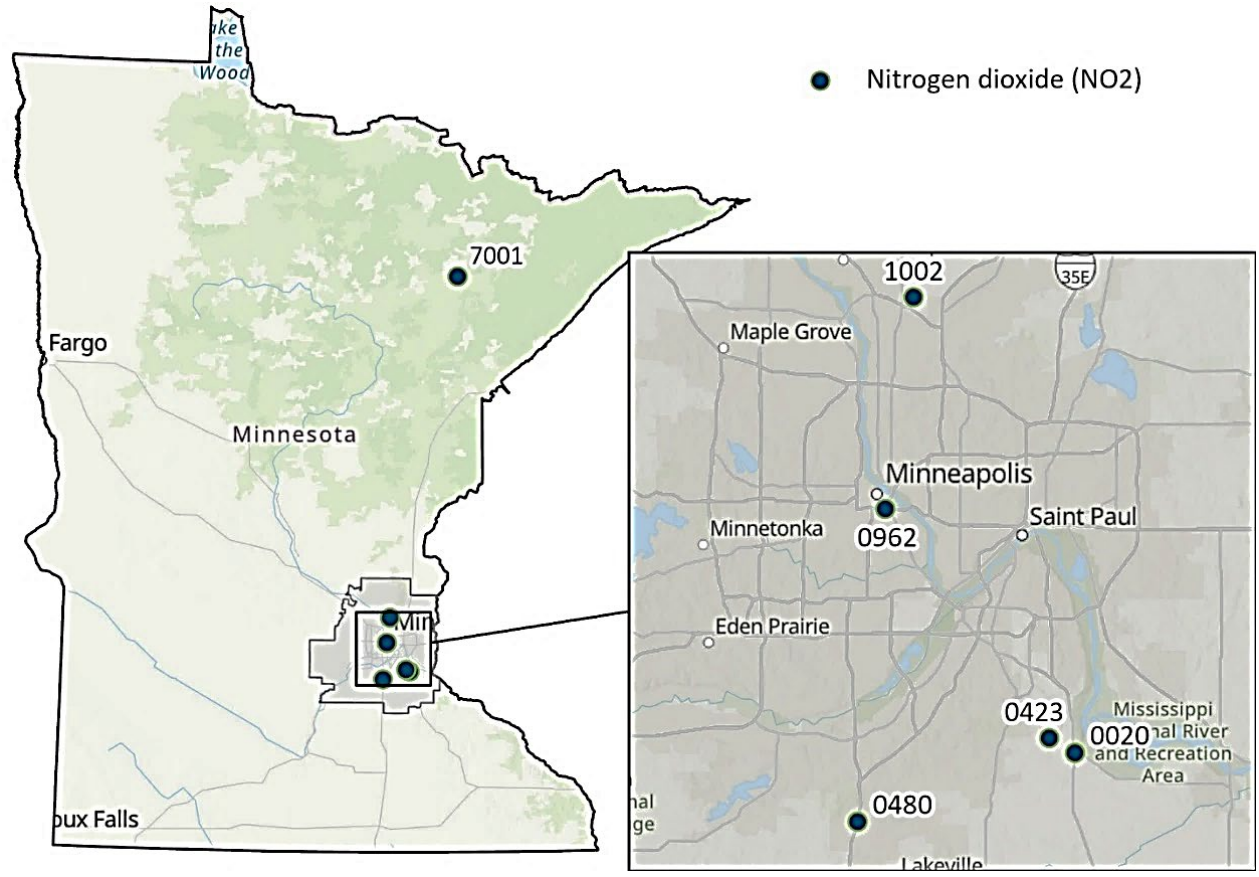


***Site did not meet data completeness criteria**

1.6. Nitrogen Dioxide (NO_2)

Currently, the MPCA monitors NO_2 at six sites in the Minnesota (Figure 15).

Figure 15. 2024 NO_x monitoring sites in Minnesota.



A monitoring site meets the annual NAAQS for NO_2 if the annual average is less than or equal to 53 ppb. Minnesota averages ranged from 4 ppb at Blaine (1002-1), Virginia (7001), and Rosemount (0423) to 9 ppb at the Minneapolis near-road site (0962); therefore, Minnesota met the annual NAAQS for NO_2 (Figure 16).

In addition to the annual standard, there is also a one-hour standard for NO_2. The one-hour NAAQS is intended to protect against adverse health effects associated with short-term exposures to elevated NO_2. To meet this standard, the three-year average of the annual 98th percentile daily maximum one-hour NO_2 concentration must not exceed 100 ppb. Minnesota averages ranged from 24 ppb at Rosemount (0423) to 43 ppb at Minneapolis (0962); therefore, all sites met the one-hour NAAQS for NO_2 (Figure 17).

Figure 16. 2024 NO_2 design values compared to the annual NAAQS.

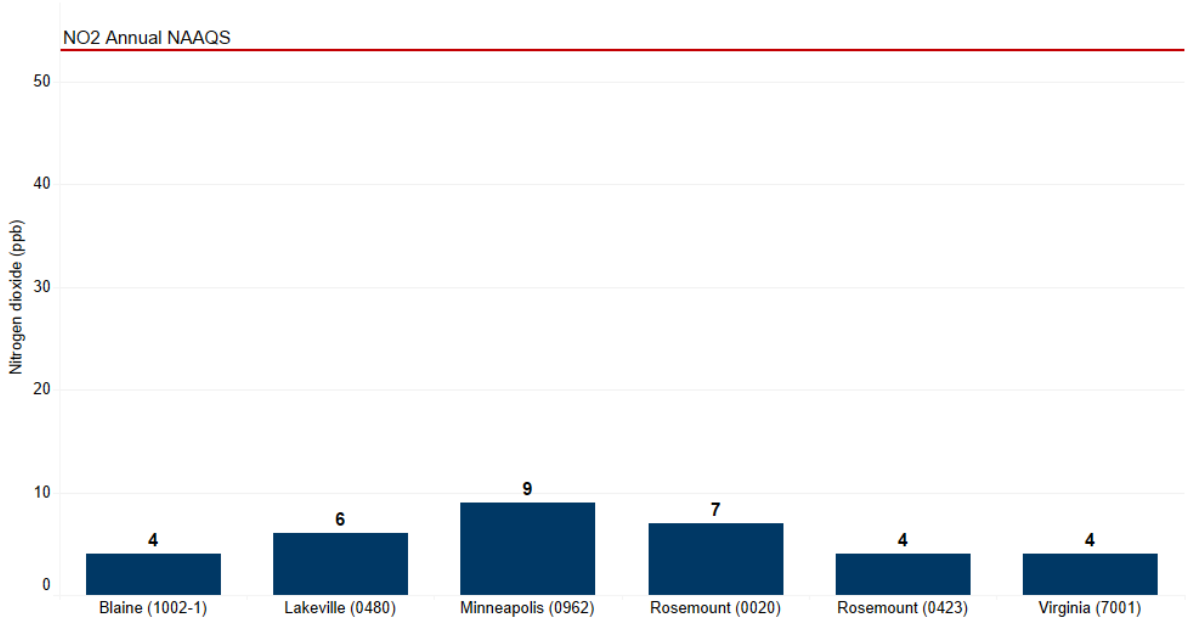
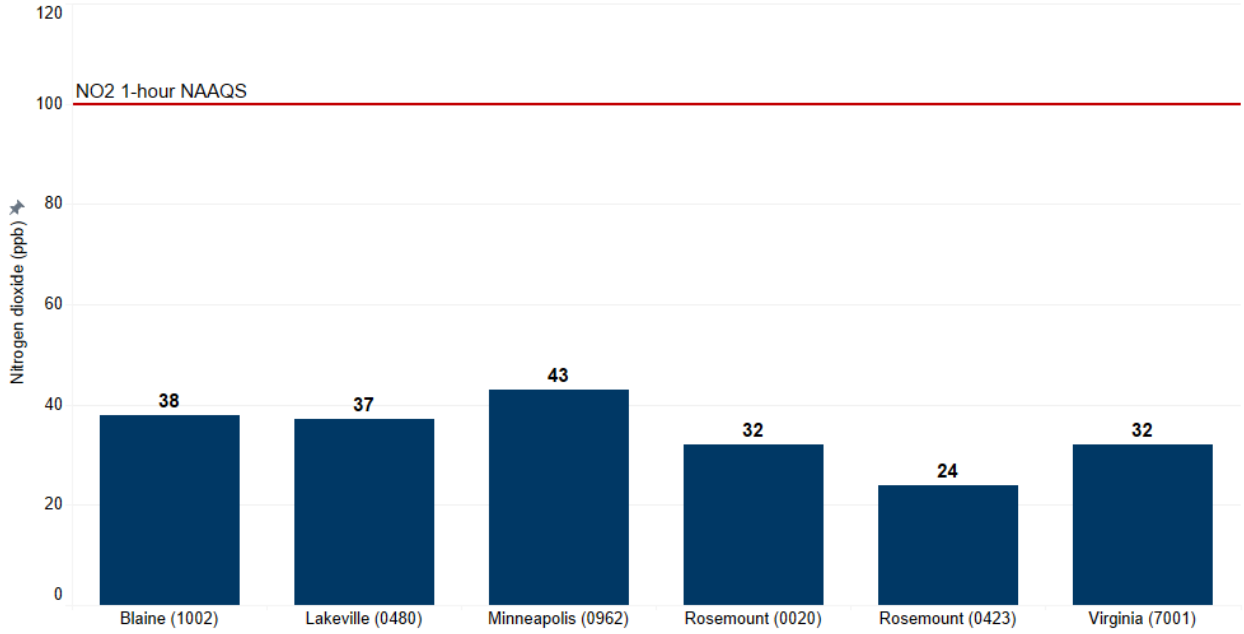


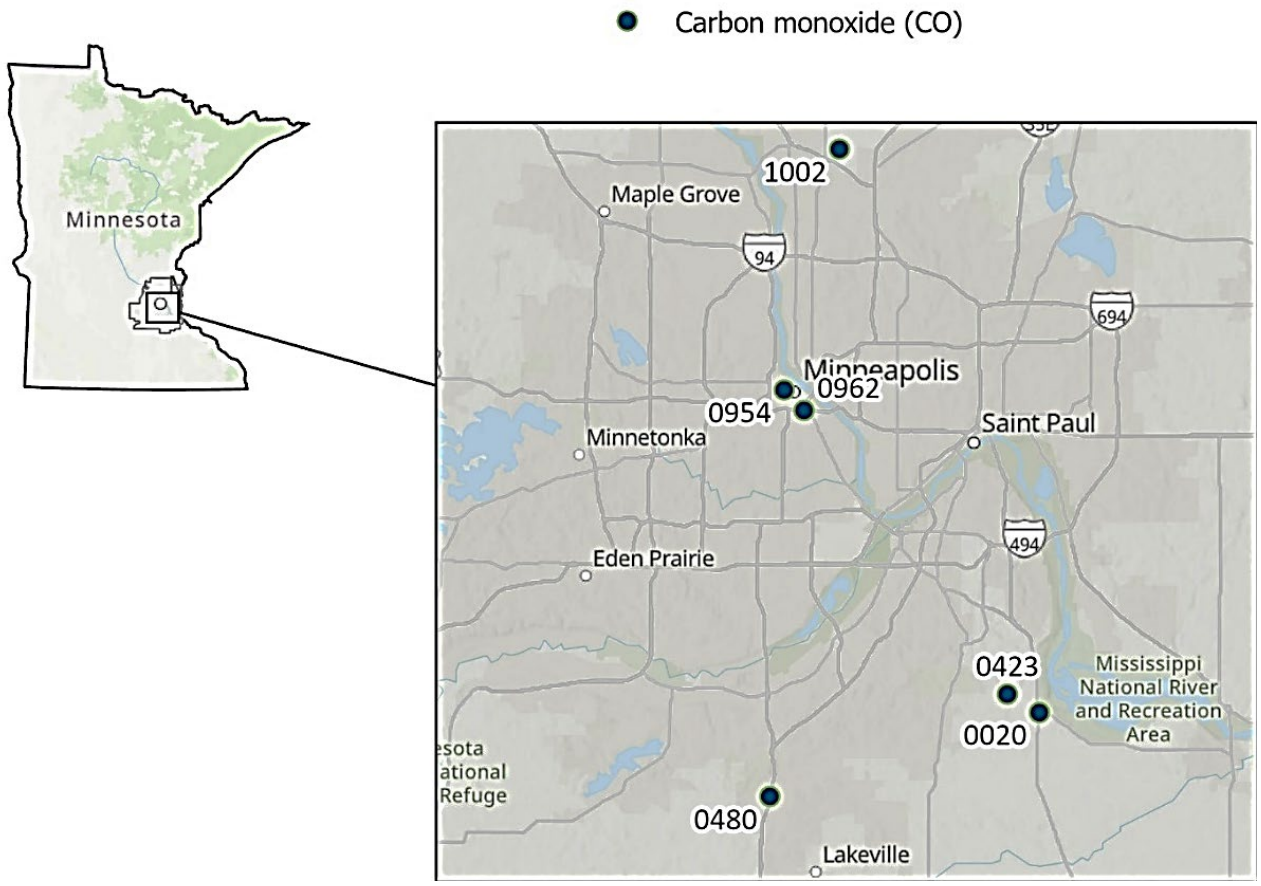
Figure 17. 2024 NO_2 design values compared to the 1-hour NAAQS.



1.7. Carbon monoxide (CO)

The MPCA monitors CO at six sites in Minnesota, all in the Twin Cities metropolitan area (Figure 18).

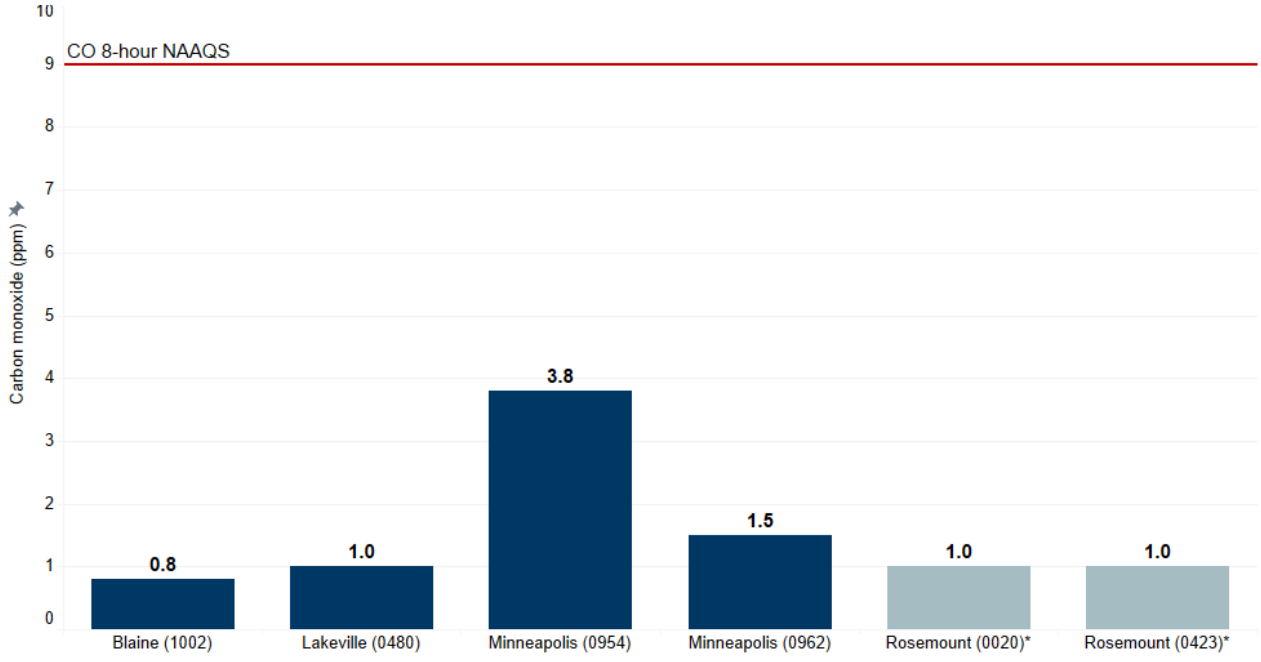
Figure 18. 2024 CO monitoring sites in Minnesota.



Minnesota currently meets applicable eight-hour NAAQS for CO. A monitoring site meets the 8-hour CO NAAQS when the level of 9 ppm is not exceeded more than once per year. A design value is a statistic that describes the air quality status of a given location relative to the level of the National Ambient Air Quality Standards (NAAQS). The design value for CO is evaluated over a two-year period. Specifically, the design value is the higher of each year's annual second maximum, non-overlapping 8-hour average. Minnesota CO design values for 2024 for ranged from 0.8 ppm at Blaine (1002) to 3.8 ppm at Minneapolis (0954) (Figure 19).

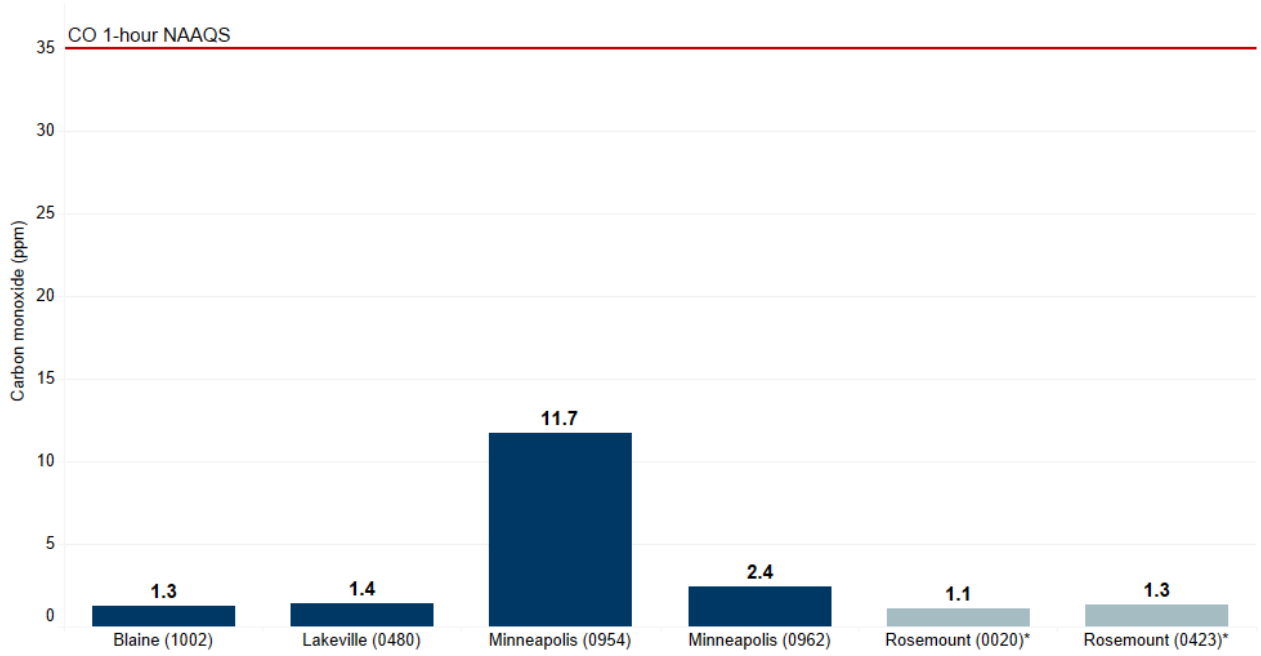
The one-hour CO NAAQS is met when the level of 35 ppm is not exceeded more than once per year. A design value is a statistic that describes the air quality status of a given location relative to the level of the National Ambient Air Quality Standards (NAAQS). The design value for CO is evaluated over a two-year period. Specifically, the design value is the higher of each year's annual second maximum, non-overlapping 1-hour average. Minnesota values for 2024 ranged from 1.1 ppm at Rosemount (0020) to 11.7 ppm at Minneapolis (0954) (Figure 20).

Figure 19. 2024 design values for CO compared to the 8-hour NAAQS.



*Site did not meet data completeness criteria

Figure 20. 2024 CO design values compared to the 1-hour average NAAQS.

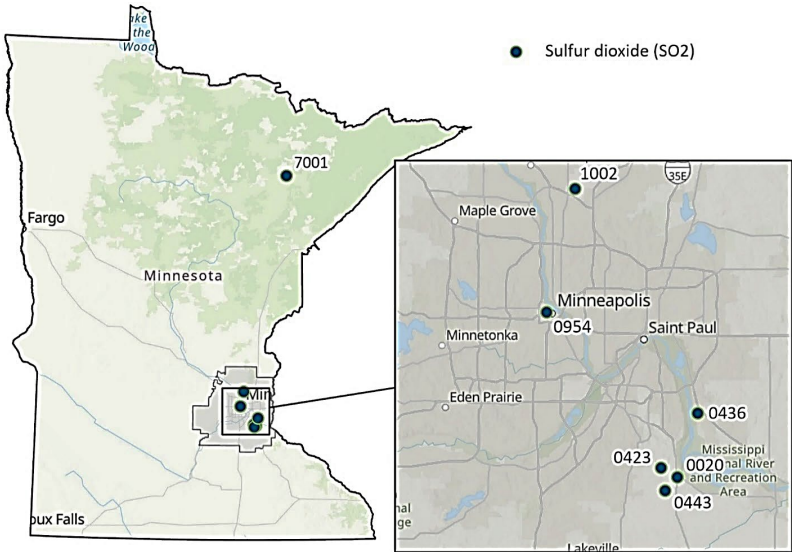


***Site did not meet data completeness criteria**

1.8. Sulfur dioxide (SO_2)

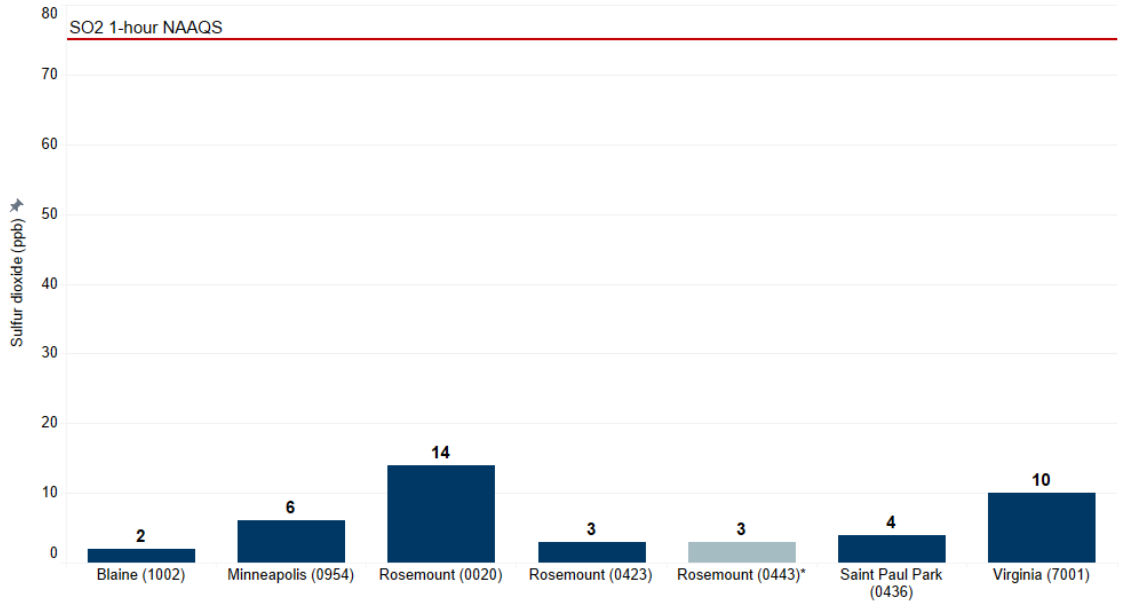
The MPCA monitors SO_2 at six sites in the Twin Cities metropolitan area (Figure 21) and one site in Virginia (7001). Trace level SO_2 at the NCore site in Blaine (1002) will help us understand the role of SO_2 at levels far below the NAAQS.

Figure 21. 2024 SO_2 monitoring sites in Minnesota.



The primary SO_2 NAAQS is a one-hour standard; it is met if the three-year average of the annual 99th percentile daily maximum one-hour SO_2 concentration is less than 75 ppb. Minnesota averages from 2022-2024 ranged from 2 ppb at Blaine (1002) to 14 ppb at Rosemount (0020); therefore, all Minnesota sites met the one-hour NAAQS for SO_2 (Figure 22).

Figure 22. 2024 SO_2 design values compared to the 1-hour NAAQS.



***Site did not meet data completeness criteria**

2. AQI

The AQI categories developed by the EPA are green (good), yellow (moderate), orange (unhealthy for sensitive groups or USG), red (unhealthy), purple (very unhealthy), and maroon (hazardous). Each category is assigned a color and corresponds to a different level of health concern (Figure 23). In the past, MPCA offered AQI forecasts for only the Twin Cities and Rochester. The MPCA issues daily forecasts for the majority of its AQI monitor locations through MPCA's AQI website, the Minnesota Air mobile app, Twitter, and to individuals who have signed up to receive e-mailed forecasts. 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, GovDelivery, the AirNow mobile app, Twitter, the media, and to individuals who have signed up to receive email 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. At no cost, the public can download the Minnesota Air mobile app and sign up for emailed forecasts and alerts from MPCA's AQI website (https://www.pca.state.mn.us/air/current-air-quality).

Figure 23. The Air Quality Index categories and respective levels of health concern.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is accepable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitve Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert; everyone may experience more serious health effects.
Hazardous	301 to 500	Health warnings of emvergency conditions. The entire population is more likely to be affected.

Compared to 2023, Minnesota experienced a quieter year with respect to Orange or worse AQI days for $PM_{2.5}$ during 2024 (Figure 24). Above normal precipitation during the spring helped suppress local fire activity, and relatively wetter conditions north of the border led to milder fire season in western and eastern Canada. There were 7 days with an AQI of orange or worse in 2024, which was near average. Northern portions of the state experienced more periods of smoke (Figure 25). The vast majority of days in 2024 were Green at any single monitor.

Figure 26 shows the maximum daily PM2.5 AQI throughout Minnesota in 2024. Yellow AQI winter stagnation episodes occurred in January and February, and again in November and December. Prescribed fire led to a few marginal yellow days during the spring. The worst air quality of the year was associated with several intrusions of wildfire smoke from Canada. AQIs reached Red during smoke intrusions in mid-May and mid-September and reached Orange on a few days between mid-August and early September.

Figure 24. Annual statewide $PM_{2.5}$ AQI category counts, 2001-2024.

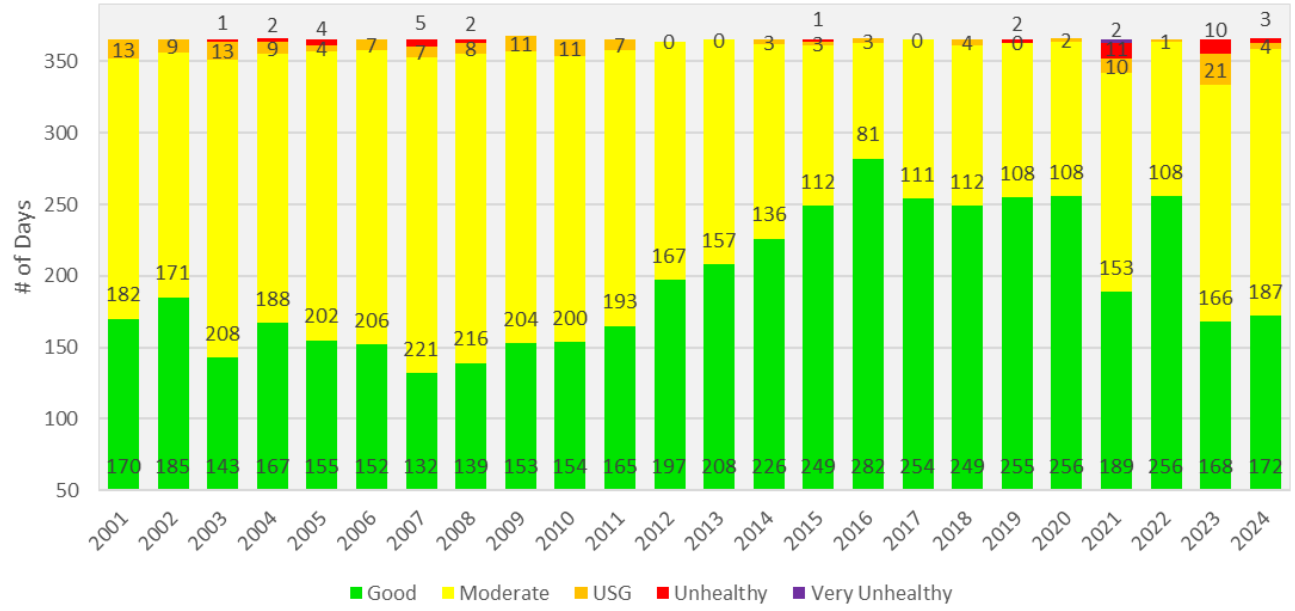
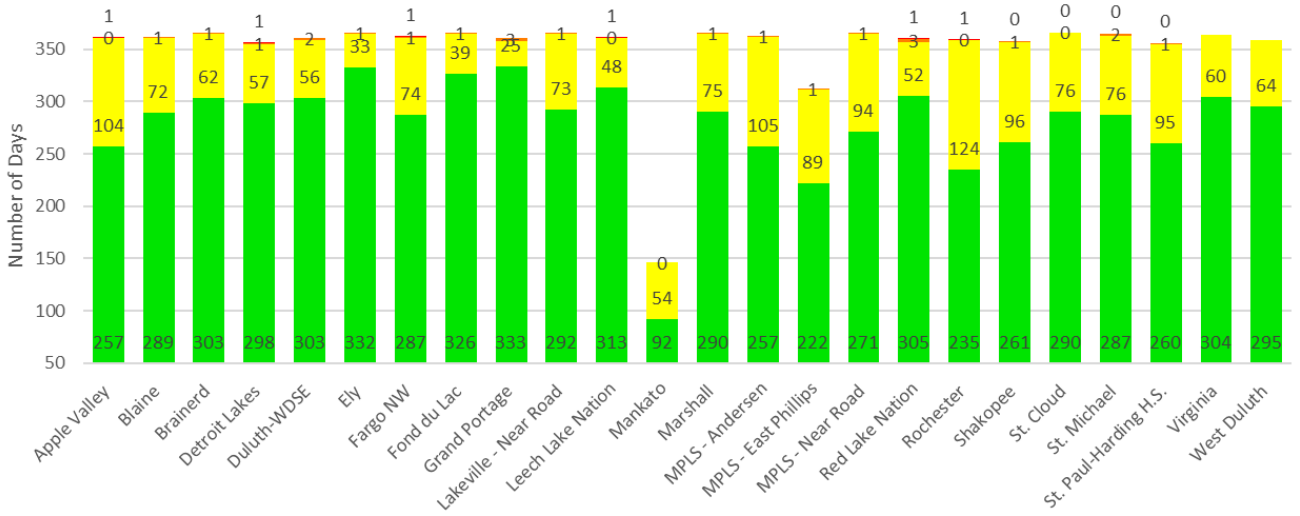
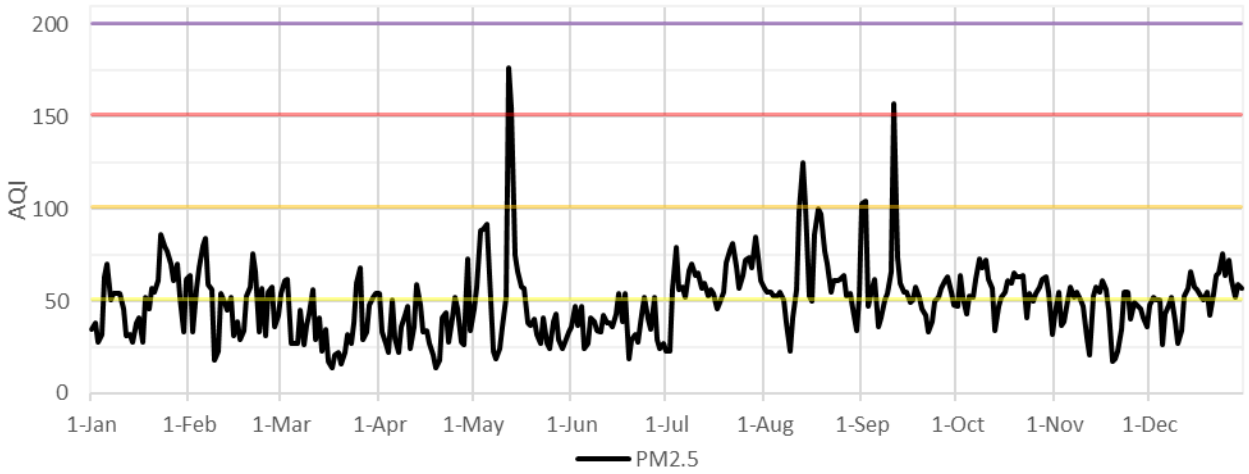


Figure 25. 2024 daily observed AQI category counts for $PM_{2.5}$ in Minnesota.



*Voyageurs N.P. a non-forecast location

Figure 26. Peak daily $PM_{2.5}$ AQI for Minnesota in 2024.



AQIs with respect to ozone were fairly benign in 2024 (Figure 10). The spatial extent of ozone followed the typical pattern, with higher ozone tending to be found near and downwind of the Twin Cities (Figure 26). The weather in Minnesota over the spring and early summer of 2024 was cloudy and wet, conditions which typically suppress ozone. The only Orange AQI occurred in late July due to pollution pooling along a weak frontal boundary (Figure 27). The majority of Yellow-Orange days occurred from mid-April to the end of July, which is typical for Minnesota (Figure 28).

Figure 27. Annual statewide ozone AQI category counts, 2001-2024.

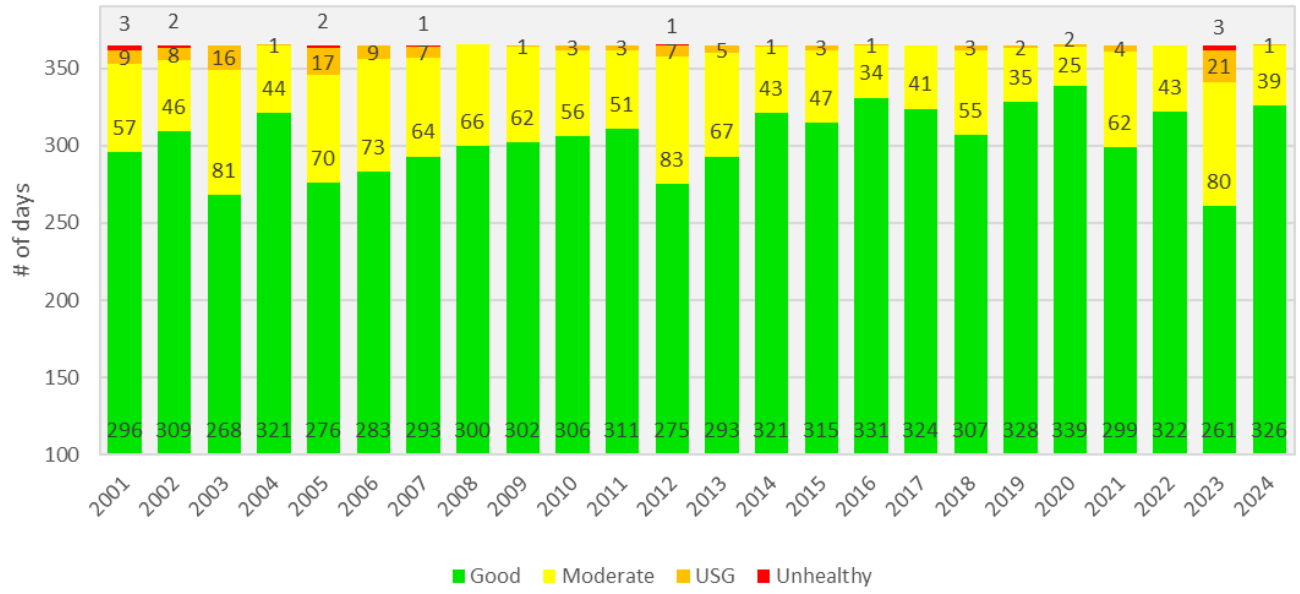
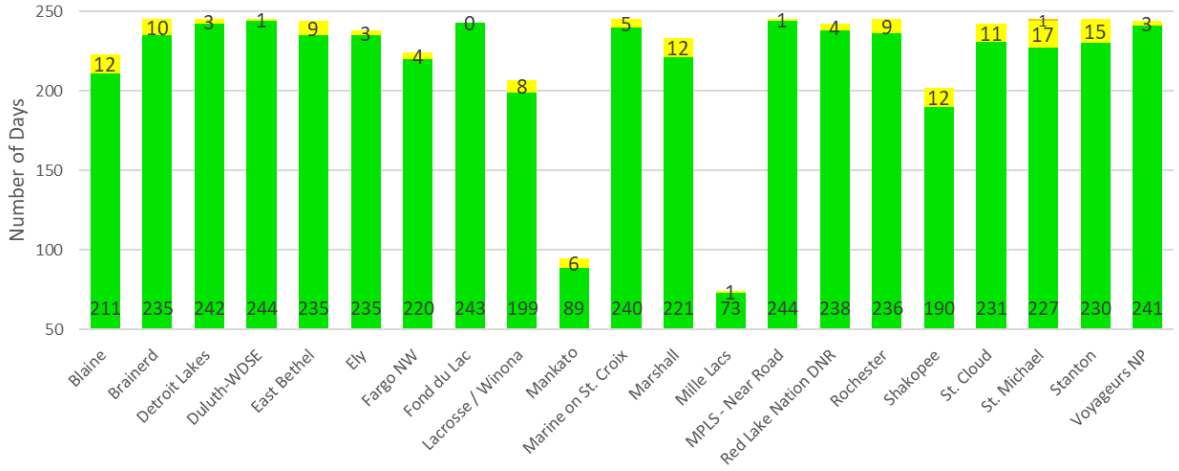
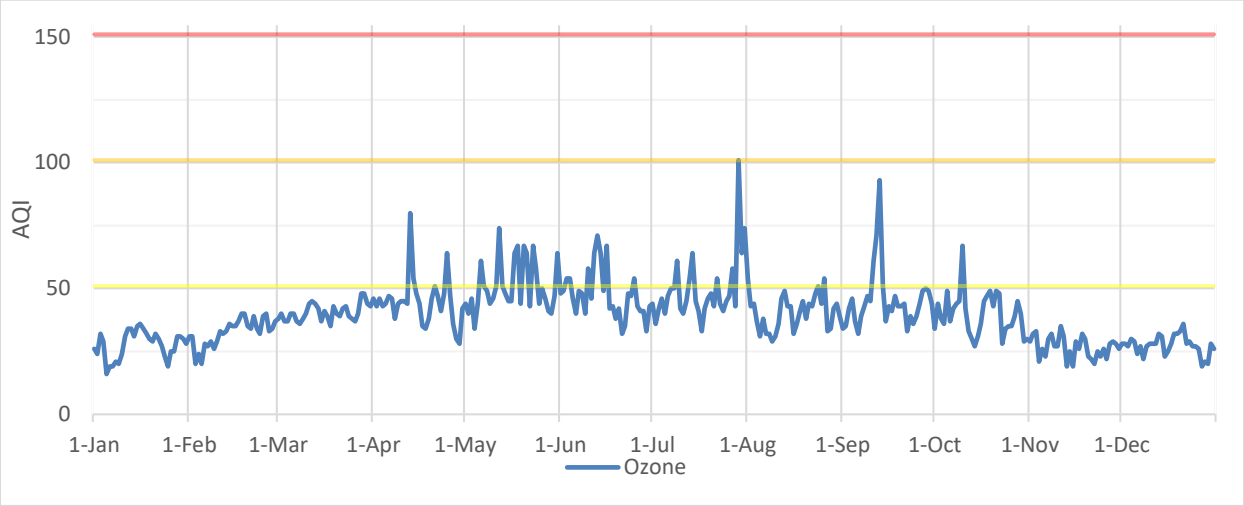


Figure 28. 2024 daily observed AQI category counts for ozone in Minnesota (during the official ozone season from March 1 to October 31).



*Voyageurs N.P. a non-forecast location

Figure 29. Peak daily ozone AQI for Minnesota in 2024.



The MPCA issued a six air quality alerts covering 14 days during 2024 (Figures 30 and 31). All of the alerts in 2024 were due to wildfire smoke.

Figure 30. Total count and causes of air quality alert forecasts issued in Minnesota counties, 2010-2024.

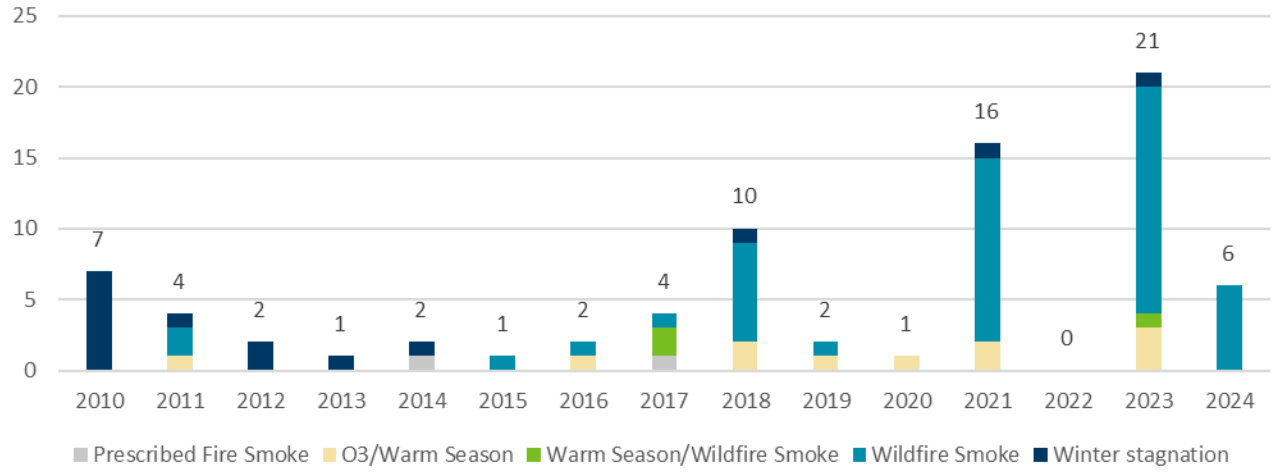
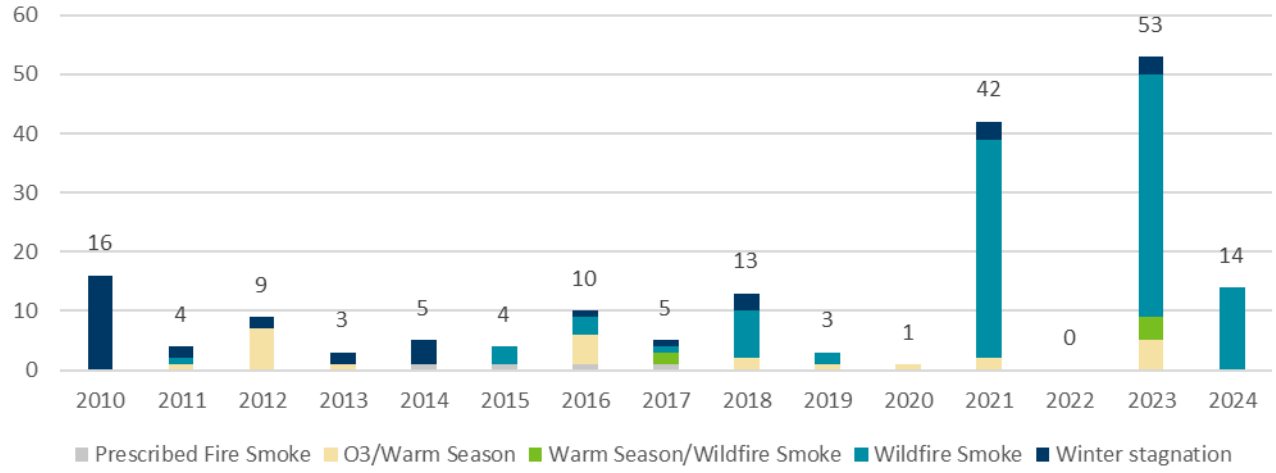


Figure 31. Total count and causes of air quality forecast alert days issued in Minnesota counties, 2010-2024.



3. Air Toxics

Air toxics are routinely monitored in Minnesota as part of the MPCA's ambient air toxics monitoring program. The MPCA monitors three types of air toxics: VOCs, carbonyls, and metals. To determine the health risk of the measured air toxics concentrations, the MPCA uses guidelines, called inhalation health benchmarks.

A compiled list of the health benchmarks can be found in the Ambient air toxicity values workbook (https://data.pca.state.mn.us/views/Airtoxicityvalues/Airtoxicityvalues?%3Aembed=y&%3AisGuestRedirectFromVizportal=y).

These health benchmarks come from a variety of sources, including the following:

- Minnesota Department of Health air risk guidance (https://www.health.state.mn.us/communities/environment/risk/guidance/air/table.html)
- EPA's Integrated Risk Information System (IRIS) (https:/www.epa.gov/iris)
- California's Office of Health Hazard Assessment (OEHHA) (https:/www.oehha.ca.gov/air.html)
- EPA's Superfund Program (https://www.epa.gov/superfund)

MPCA is currently in the process of updating the state-wide air toxics monitoring results.

There are select monitoring sites where measured concentrations are shared publicly. Data explorers for the following sites are available on MPCA's Data visualizations webpage (https://www.pca.state.mn.us/about-mpca/mpca-data-visualizations).

- Metals at Saint Paul west side community
- Lead at Federal Ammunition
- Air toxics at Otter Lake Technologies

4. Visibility

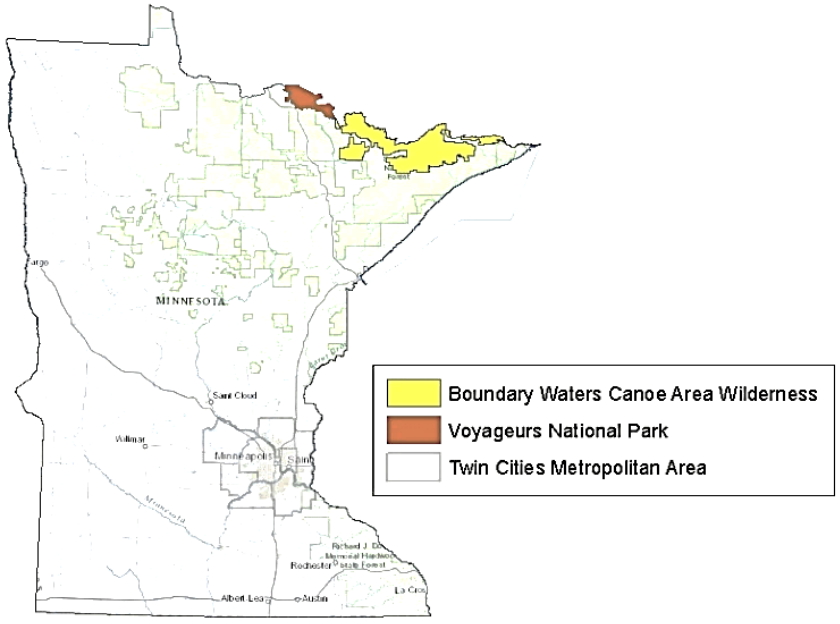
Air pollution can reduce visibility over wide areas, a phenomenon called regional haze. Haze occurs when sunlight encounters fine particles in the air, which absorb and scatter light. Haze-causing pollutants come from a variety of sources, both natural and human-made, including motor vehicles, electric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

In 1999, the EPA established a regulatory program to reduce haze caused by human-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 was set for 2018.

Minnesota has two Class I areas, both located in Northern Minnesota—the Boundary Waters Canoe Area Wilderness and Voyageurs National Park (Figure 32).

Visibility is calculated from $PM_{2.5}$ species measurements through the IMPROVE Aerosol Network website (http://vista.cira.colostate.edu/IMPROVE/). Figure 14 shows the location of Minnesota sites in the network. 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.

Figure 32. Class I areas in Minnesota impacted by regional haze.



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 calculated deciview values on the most impaired visibility days reach natural conditions by 2064. Interim goals are set for every ten years. Both the Boundary Waters and Voyageurs sites achieved the 2018 interim goal by 2012 and reached the 2028 interim goal in 2023. Visibility on the clearest days at both sites has not degraded over time and have actually improved (Figure 33).

Figure 33. Visibility progress measured at Boundary Waters and Voyageurs (2004-2023) and the estimated interim progress goals for 2018 and 2028.